Joshua Brown. Pelham
1808

Thos. Brown
The gift of his Father
18 January 1846
on my return to America

A

DICTIONARY

OF

ARTS AND SCIENCES.

BY G. GREGORY, D.D.

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&c. &c.

IN TWO VOLUMES.

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TO THE RIGHT HONOURABLE

THOMAS, LORD ERSKINE,

BARON ERSKINE OF RESTORMEL CASTLE, IN THE COUNTY OF CORNWALL,

LORD HIGH CHANCELLOR OF GREAT BRITAIN,

&c. &c. &c.

MY LORD,

THOUGH a Dedication is in general an expression of gratitude from an Author to his Patron, or of friendship from one literary character to another, yet I cannot but be of opinion, that there should be some accord between the character of the Work and that of the Patron to whom it is presented.

In this point of view the world will see the propriety of a Work which professes to treat of the Sciences and the Arts in general, being inscribed to a Nobleman who unites in himself more various, as well as more splendid talents, more general knowledge, and more diversified taste, than any other public character of the present age; who, deservedly filling the chair of Bacon, possesses the same excursive and expanded genius; but whose public duties, being more onerous than they were in the time of that great man, alone preclude him from gratifying and enlightening the Public by researches out of the line of his profession.

If a private sentiment might be indulged on such an occasion, the Editor would add, that your Lordship's unremitted zeal for true Religion, and your tried and disinterested Patriotism, must for ever endear the name of ERSKINE toevery friend of liberty, piety, and active virtue.

That your Lordship may long continue to serve your country, and promote the best interests of humanity, in the arduous situation to which the Divine Providence has been pleased to call you, is the fervent prayer of,

My Lord,

Your Lordship's

Ever faithful humble servant,

G. GREGORY.

West Ham, Jan. 20, 1807.

PREFACE.

FROM the time of Chambers, Dictionaries of Arts and Sciences have been increasing in magnitude, without (it is to be feared) a proportionable increase of utility. The authors appear to have regarded it as a kind of sacrilege to retrench, while they have equally thought it their duty to add every thing that came within their reach. Hence not only obsolete terms, but obsolete sciences, as magic, alchemy, and astrology, have been retained even in works of high character, and otherwise of distinguished merit. Hence, that which was new even in the living sciences, has been combined with what had been long since exploded: a practice calculated not only to confuse but to mislead.

It was upon this view of the subject it occurred to the editor of this work, that in framing a new Dictionary, selection was a more urgent duty than accumulation; that perspicuity, not less than convenience, would be consulted by reducing the size; and that whatever is practically useful in science and in art might be compressed within a smaller compass than had been commonly imagined. However deficient he may have been in the execution of his plan, he has the satisfaction to say, that in this idea he was not deceived or disappointed.

A dictionary of this kind is intended for two purposes: first, as a book of reference, to lie on the table of a man of letters, for occasional consultation where recollection has failed, or where a subject occurs in reading or conversation which had not previously come within the course of his studies. The second is, to serve as an introductory or elementary work for students, or for those who may not have leisure to bestow on the great works of science, or to travel through the many volumes which at this time almost every branch of knowledge includes.

The first of these ends it is humbly presumed will be sufficiently answered by the present publication. Most of the technical terms in science and the arts, are inserted with a proper definition or explanation, in the alphabetical order; or should there be a casual omission, the word will still be found under the head of the science to which it belongs, and probably in the index to the treatises at the end of each volume. To some sciences it was found necessary to attach a glossary. The technical phrases, however, in anatomy, surgery, &c. are generally referred to those branches of science expressly treating of them, that nothing may appear, on casually opening the book, to offend the most modest or delicate reader. Terms also which now constitute a part of common colloquial language, and which, therefore, every person must understand, have been omitted.

With respect to the second object, no pains have been spared in preparing those articles which treat of the respective sciences. In a work of this nature it cannot be expected that the whole should be original, nor could it in that case answer so well the ends for which it is designed. An Encyclopedia is in its nature a compilation; and its best commendation is, that it amasses together the best information from the best sources. Yet in this work there is much original composition; and such is the progress of science, that it contains scarcely any articles of importance which are to be found in any similar publication.

In order also to facilitate as much as possible the study of the sciences, every attention, consistent with the nature of the work, has been paid to method; and the student will not be much at a loss to distinguish the order in which the several parts of each science are to be read. Thus, under Natural History, he will find a synopsis of the several branches, the classes and orders, and under these the names of the genera; under Zoology, again, he will not only meet the classes and orders, but also an immediate reference to the genera. Under Chemistry, he will find the outlines of the science, and references to the different branches, which are treated more at large in other parts of the work. Thus under Furnace and Laboratory, is included the whole of the apparatus; and he will then turn to Air, and the simple substances as they stand enumerated there, or under the word Elements. Astronomy and Mineralogy, he will see, have similar references. Electricity, Hydrostatics, Hydraulics, Magnetism, Mechanics, Meteorology, Optics, Pneumatics, and the Medical Branches, are complete in themselves. Those articles which relate to the Arts are also complete. Those which treat of the different subjects of Trade and Commerce are also complete, and contain all the new information which could be obtained on those important topics.

The Editor cannot conclude this address without frankly stating, that whatever may be thought of the merits of the new Dictionary of Arts and Sciences, they are more to be attributed to the very able assistance with which he has been favoured from different quarters, than to his own exertions. He wishes he could make his acknowledgments in terms equal to his sense of the obligation. To his industrious and truly able coadjutor, the Rev. Mr. Joyce, he is indebted for much general assistance, and for the exclusive superintendance of all the mathematical and astronomical articles. A similar acknowledgment is due to his friend and neighbour, Luke Howard, Esq. particularly for his attention to all those articles connected with the almost new, and important science, Meteorology.

The public will estimate better than he can point out the extent of his and their obligations to Mr. Grellier, of the Royal Exchange Assurance-Office, when he mentions, that all the articles relative to Trade, Commerce, Political Economy, Finance, and Revenue, were drawn up by that gentleman.

The Medical and Physiological articles were written by Dr. Uwins, of Somers Town; Husbandry and Surveying by Mr. Crocker, of Froome; Rhetoric by Dr. Thomson, well known as the Continuator of Watson's History; Architecture by Mr. Henderson, the plates by Mr. Moore; Exchanges by Mr. P. Hamsbrow; Farriery by Mr. Lawrence; and Anatomy by Mr. A. Walker.

Those articles which are connected with History and Antiquities, have been furnished by a distinguished scholar, as will be easily perceived; those relative to the Fine Arts, by a gentleman well known in the literary world; Poetry by a lady, who, like Vida, has asserted her title to the character of a critic, by having excelled in the art itself; the Military articles are the production of a literary gentleman who was educated in that profession; and some of the principal Law articles are by a member of one of the inns of court. Besides these, the editor has been favoured with single communications from Dr. Mavor, Mr. M. Smart, and several correspondents who desire their names to be concealed.

A

DICTIONARY

OF

ARTS AND SCIENCES.

I, the ninth letter of the alphabet, used as a numeral, signifies no more than one, and stands for so many units as it is repeated times: thus, I, one; II, two; III, three, &c. and when put before a higher numeral, it subtracts itself, as IV, four; IX, nine, &c. but when set after it, so many are added to the higher numeral, as there are I's added; thus VI is 5 + 1, or six; VII, 5 + 2, or seven; VIII, 5 + 3, or eight. The antient Romans likewise used IↃ for 500, CIↃ for 1000, IↃↃ for 5000, CCIↃↃ for 10,000, IↃↃↃ for 50,000, and CCCIↃↃↃ for 100,000. Farther than this, as Pliny observes, they did not go in their notation; but when necessary, repeated the last number, as CCCIↃↃↃ, CCCIↃↃↃ for 200,000; CCCIↃↃↃ, CCCIↃↃↃ, CCCIↃↃↃ for 300,000; and so on.

JACK, in mechanics, an instrument in common use for raising heavy timber, or very great weights of any kind, being a powerful combination of teeth and pinions, and the whole inclosed in a strong wooden stock or frame BC, and moved by a winch or handle HP; the outside appearing as in Plate Miscel. fig. 131. In fig. 132, the wheel or rack work is shewn, being the view of the inside when the stock is removed. Though it is not drawn in the just proportions and dimensions, for the rack AB must be supposed at least four times as long in proportion to the wheel Q, as the figure represents it; and the teeth, which will be then four times more in number, to have about three in the inch. Now if the handle HP is seven inches long, the circumference of this radius will be 44 inches, which is the distance or space the power moves through in one revolution of the handle; but as the pinion of the handle has but four leaves, and the wheel Q suppose 20 teeth, or five times the number, therefore to make one revolution of the wheel Q, it requires five turns of the handle, in which case it passes through 5 times 44 or 220 inches; but the wheel having a pinion R of three leaves, these will raise the rack three teeth, or one inch, in the same space. Hence, then, the handle or power moving 220 times as fast as the weight, will raise or balance a weight of 220 times its own energy. And if this is the hand of a man who can sustain 50 pounds weight, he will, by the help of this jack, be able to raise or sustain a weight or force of 11000 pounds, or about five tons weight.

This machine is sometimes open behind from the bottom almost up to the wheel Q, to let the lower claw, which in that case is turned up as at B, draw up any weight. When the weight is drawn or pushed sufficiently high, it is kept from going back by hanging the end of the hook S, fixed to a staple, over the curved part of the handle at h.

The Society of Arts rewarded Mr. Mocock of Southwark, with a premium of 20 guineas, for his contrivance to prevent a jack from taking a retrograde course whenever the weight by any accidental circumstance overbalances the power. The improved jack only differs from those in common use in this respect, that it has a pall or clock, and ratchet, applied in such manner as to stop the motion of the machine as soon as it begins to run back again. As the difference in the mechanism is very trifling, the improvement may be easily applied to any common jacks already made.

Jack is also the name of a well-known engine in the kitchen, used for turning a spit. Here the weight is the power applied, acting by a set of pulleys; the friction of the parts, and the weight with which the spit is charged, are the forces to be overcome; and a steady uniform motion is maintained by means of a fly.

The common worm-jack is represented at Plate Miscel. fig. 130. ABC is the barrel round which the cord QR is wound; KL the main wheel, commonly containing 60 teeth; N the worm-wheel of about thirty teeth, cut obliquely; LM the pinion, of about 15; O the worm or endless screw, consisting of two spiral threads, making an angle of sixty or seventy degrees with its axis; X the stud, and Z the loop of the worm-spindle; P a heavy wheel or fly, connected with the spindle of the endless screw to make the motion uniform; DG the struck wheel fixed to the axis FD; S,S,S, are holes in the frame, by which it may be nailed to a board, and thence to any wall, the end D being permitted to pass through it; HI the handle going upon the axis ET, to wind up the weight when it has run down. R is a box of fixed pulleys, and V a corresponding one of moveable pulleys carrying the weight. The axis ET is fixed in the barrel AC, which axis being hollow, both it and the barrel turn round upon the axis FD, which is fixed to the wheel KL, when it turns in the order BTA; but cannot turn the contrary way, by reason of a catch nailed to the end AB, which lays hold of the cross-bars in the wheel LK.

The weight by means of the cord QR, in consequence of its descent, carries about the barrel AB, which by the action of the catch carries the wheel KL, and this moves the pinion LM and wheel N, the latter moving the worm O and the fly P. Also the wheel LM carries the axis FD with the wheel DG, which carries the cord or chain that goes about the wheel or pulley at the head of the spit. But when the handle H gives motion to the axis in a contrary order to that given by the weight, the catch is depressed; so that although the barrel BC moves and winds the cord upon it, the wheel DG continues at rest. The time which the jack will continue in motion depends upon the number of pulleys at R and V: and as these increase or decrease, so must the weight which communicates the motion, in order to perform the same work in the same time.

Jack, *smoke*, is an engine used for the same purpose as the common jack; and is so called from its being moved by means of the smoke, or rarefied air, ascending the chimney, and striking against the sails of the horizontal wheel AB (Plate Miscel. fig. 129), which being inclined to the horizon, is moved about the axis of the wheel, together with the pinion C, which carries the wheels D and E; and E carries the chain F, which turns the spit. The wheel AB should be placed in the narrow part of the chimney, where the motion of the smoke is swiftest, and where also the greatest part of it must strike upon the sails. The force of this machine depends upon the draught of the chimney, and the strength of the fire.

Smoke-jacks are sometimes moved by means of spiral flyers coiling about a vertical axle; and at other times by a vertical wheel with sails like the float-boards of a mill; but the above is the more customary construction.

JACK-FLAG, in a ship, that hoisted up at the sprit-sail top-mast head.

JACKALL. See CANIS.

JACOB'S STAFF, a mathematical instrument otherwise called cross-staff. See CROSS.

JACOBITES, in church history, a sect of christians in Syria and Mesopotamia; so called either from Jacob, a Syrian, who lived in the reign of the emperor Mauricius; or from one Jacob, a monk, who flourished in the year 550.

JACOBUS, an antient gold coin worth twenty-five shillings.

JACQUINIA, a genus of the monogynia order, in the hexandria class of plants; and in the natural method ranking with those of which the order is doubtful. The corolla is decemfid; the stamina inserted into the receptacle; the berry monospermous. There are four species, shrubs of South America.

JADE-STONE, lapis nephriticus, or Jaspachates, a genus of siliceous earths. It gives fire with steel, and is semitransparent like flint. It does not harden in the fire, but melts in the focus of a burning-glass into a transparent green glass with some bubbles. A kind brought from the river of the Amazons in America, and called circoncision stone, melts more easily in the focus into a brown opaque glass, far less hard than the stone itself. The jade-stone is unctuous to the touch; whence Mr. Kirwan seems to suspect, that it contains a portion of argillaceous earth, or rather magnesia. The specific gravity is from 2.970 to 3.389; the texture granular, with a greasy look, but exceedingly hard, being superior in this respect even to quartz itself. It is infusible in the fire, nor can it be dissolved in acids without a particular management; though M. Saussure seems to have extracted iron from it. Sometimes it is met with of a whitish milky colour from China; but mostly of a deep or pale green from America. The common lapis nephriticus is of a grey, yellowish, or olive colour. It has its name from a supposition of its being capable of giving ease in nephritic pains, by being applied externally to the loins. It may be distinguished from all other stones by its hardness, semipellucidity, and specific gravity.

According to Hoepfner it is composed of,

47	silica
38	carbonat of magnesia
9	iron
4	alumina
2	carbonat of lime
100.	

JALAP, *jalapa*, in botany, a plant of the pentandria monogynia class. See CONVOLVULUS, and MATERIA MEDICA.

IAMBIC, in ancient poetry, a sort of verse, so called from its consisting, either wholly or in great part, of iambuses.

IAMBUS, in antient poetry, a simple foot consisting of a short and a long syllable.

JAMES, or *knights of St James*, a military order in Spain, first instituted about the year 1170, by Ferdinand II. king of Leon and Galicia.

JANIZARIES, an order of the Turkish infantry, reputed the grand signior's guards, and the main strength of the Ottoman army.

JANSENISTS, in church-history, a sect of the Roman catholics in France, who follow the opinions of Jansenius, bishop of Ypres, and doctor of divinity of the universities of Louvain and Douay, nearly those of Calvin, in relation to grace and predestination.

JAPANNING is properly the art of varnishing and painting ornaments on wood, in the same manner as is done by the natives of Japan in the East Indies.

The substances which admit of being japanned are almost every kind that are dry and rigid, or not too flexible; as wood, metals, leather, and paper, prepared for the purpose.

Wood and metals do not require any other preparation, but to have their surfaces perfectly even and clean; but leather should be securely strained, either on frames or on boards; as its bending, or forming folds, would otherwise crack and force off the coats of varnish. Paper should be treated in the same manner, and have a previous strong coat of some kind of size; but it is rarely made the subject of japanning till it is converted into papier maché, or wrought by other means into such form, that its original state, particularly with respect to flexibility, is changed.

One principal variation from the method formerly used in japanning is, the omitting any priming, or undercoat, on the work to be japanned. In the older practice, such a priming was always used; the use of which was to save in the quantity of varnish, by filling up the inequalities in the surface of the substance to be varnished. But there is a great inconvenience arising from the use of it, that the Japan coats are constantly liable to be cracked, and peeled off, by any violence, and will not endure near so long as the articles which are japanned without any such priming.

Of the nature of Japan grounds.—When a priming is used, the work should first be prepared by being well smoothed with fish-skin or glass-paper, and being made thoroughly clean, should be brushed over once or twice with hot size, diluted with two-thirds water, if it is of the common strength. The priming should then be laid on as even as possible, and should be formed of a size, of a consistency between the common kind and glue, mixed with as much whiting as will give it a sufficient body of colour to hide the surface of whatever it is laid upon, but not more. This must be repeated till the inequalities are completely filled up, and then the work must be cleaned off with Dutch rushes, and polished with a wet rag.

When wood or leather is to be japanned, and no priming is used, the best preparation is to lay two or three coats of coarse varnish, composed in the following manner.

Take of rectified spirit of wine one pint, and of coarse seed-lac and resin each two ounces; dissolve the seed-lac and resin in the spirit, and then strain off the varnish.

This varnish, as well as all others formed of spirit of wine, must be laid on in a warm place; and if it can be conveniently managed, the piece of work to be varnished should be made warm likewise; and for the same reason, all dampness should be avoided; for either cold or moisture chills this kind of varnish, and prevents its taking proper hold of the substance on which it is laid.

When the work is so prepared, or by the priming with the composition of size and whiting above described, the proper japan ground must be laid on, which is much the best formed of shell-lac varnish, and the colour desired, except white, which requires a peculiar treatment; and if brightness is wanted, then also other means must be pursued.

The colours used with the shell-lac varnish may be any pigments whatever, which give the tint of the ground desired.

As metals never require to be under-coated with whiting, they may be treated in the same manner as wood or leather.

Method of painting Japan work.—Japan work ought properly to be painted with colours in varnish; though, for the greater dispatch, and in some very nice work in small, for the freer use of the pencil, the colours are sometimes tempered in oil; which should previously have a fourth part of its weight of gum animi dissolved in it; or in default of that, gum sandarach, or gum mastich. When the oil is thus used, it should be well diluted with oil of turpentine, that the colours may lie more evenly and thin; by which means fewer of the polishing or upper coats of varnish become necessary.

In some instances, water-colours are laid on grounds of gold, in the manner of other paintings; and are best, when so used in their proper appearance, without any varnish over them; and they are also sometimes so managed as to have the effect of embossed work. The colours employed in this way, for painting, are best prepared by means of isinglass size, corrected by honey or sugar-candy. The body, of which the embossed work is raised, need not, however, be tinged with the exterior colour, but may be best formed of very strong gum-water, thickened to a proper consistence by bole armenian and whiting in equal parts; which being laid on the proper figure, and repaired when dry, may be then painted with the proper colours, tempered with the isinglass size, or, in the usual manner, with shell-lac varnish.

Manner of varnishing japan work.—The finishing of japan-work depends on the laying on, and polishing, the outer coats of varnish which are necessary, as well in the pieces that have only one simple ground of colour, as with those that are painted. This is in general done best with common seed-lac varnish, except in the instances, and on those occasions, where particular methods are deemed to be more expedient; and the same reasons which decide as to the fitness or impropriety of the varnishes, with respect to the colours of the ground, hold equally with regard to those of the painting. For where brightness is the most material point, and a tinge of yellow will injure it, seed-lac must give way to the whiter gums; but where hardness and a greater tenacity are most essential, it must be adhered to; and where both are so necessary, that it is proper one should give way to the other in a certain degree reciprocally, a mixed varnish must be adopted.

This mixed varnish, as we have already observed, should be made of the picked seed-lac. The common seed-lac varnish, which is the most useful preparation of the kind hitherto invented, may be thus made.

Take of seed-lac three ounces, and put it into water, to free it from the sticks and filth that are frequently intermixed with it; and which must be done by stirring it about, and then pouring off the water, and adding fresh quantities, in order to repeat the operation, till it is freed from all impurities, as is very effectually done by this means. Dry it then, and powder it grossly, and put it, with a pint of rectified spirit of wine, into a bottle, of which it will not fill above two-thirds. Shake the mixture well together, and place the bottle in a gentle heat, till the seed-lac appears to be dissolved; the shaking being in the mean time repeated as often as may be convenient; and then pour off all that can be obtained clear by this method, and strain the remainder through a coarse cloth. The varnish thus prepared, must be kept for use in a bottle well stopped.

When the spirit of wine is very strong, it will dissolve a greater proportion of the seed-lac; but this quantity will saturate the common, which is seldom of a strength sufficient to make varnishes in perfection. As the chilling, which is the most inconvenient accident attending varnishes of this kind, is prevented or produced more frequently, according to the strength of the spirit; we shall therefore take this opportunity of shewing a method by which weaker rectified spirits may with great ease at any time be freed from the phlegm, and rendered of the first degree of strength.

Take a pint of the common rectified spirit of wine, and put it into a bottle, of which it will not fill above three parts; add to it half an ounce of pearl-ashes, salt of tartar, or any other alkaline salt, heated red-hot, and powdered as well as it can be without much loss of its heat. Shake the mixture frequently for the space of half an hour; before which time, a great part of the phlegm will be separated from the spirit, and will appear, together with the undissolved part of the salts, in the bottom of the bottle. Let the spirit be poured off, or freed from the phlegm and the salts, by means of a tritorium, or separating funnel; and let half an ounce of the pearl-ashes, heated and powdered as before, be added to it, and the same treatment repeated. This may be done a third time, if the quantity of phlegm separated by the addition of the pearl-ashes appears considerable. An ounce of alum reduced to powder, and made hot, but not burnt, must then be put into the spirit, and suffered to remain some hours, the bottle being frequently shaken; after which the spirit, being poured off from it, will be fit for use.

The addition of the alum is necessary to neutralize the remains of the alkaline salt, which would otherwise greatly deprave the spirit, with respect to varnishes and lacquer where vegetable colours are concerned, and must consequently render another distillation necessary.

The manner of using the seed-lac, or white varnish, is the same, except with regard to the substance used in polishing: which, where a pure white of a great clearness of other colours is in question, should be itself white; whereas the browner sorts of polishing-dust, as being cheaper, and doing their business with greater dispatch, may be used in other cases. The pieces of work to be varnished, should be placed near a fire, or in a room where there is a stove, and made perfectly dry; and then the varnish may be rubbed over them by the proper brushes made for that purpose, beginning in the middle, and passing the brush to one end, and then with another stroke from the middle, passing it to the other. But no part should be crossed, or twice passed over, in forming one coat, where it can be possibly avoided. When one coat is dry, another must be laid over it; and this must be continued at least five or six times, or more, if on trial, there is not sufficient thickness of varnish to bear the polish, without laying bare the painting or ground-colour underneath.

When a sufficient number of coats is thus laid on, the work is fit to be polished; which must be done, in common cases, by rubbing it with a rag dipped in tripoli, or rottenstone, finely powdered; but, towards the end of the rubbing, a little oil of any kind should be used along with the powder; and when the work appears sufficiently bright and glossy, it should be well rubbed with the oil alone, to clean it from the powder, and give it a still brighter lustre.

JARGON. See ZIRCON.

JASIONE, a genus of the monogamia order, in the syngenesia class of plants, and in the natural method ranking under the 49th order, campanaceæ. The common calyx is ten-leaved; and the corolla has five regular petals; the capsule beneath, two-celled. There are four species, shrubs of the West Indies.

JASMINUM, JASMINE, or JESSAMINE-TREE, a genus of the monogynia order, in the diandria class of plants, and in the natural method ranking under the 44th order, sepiariæ. The corolla is salver-shaped, the berry dicoccous; the seeds arillated, the antheræ within the tube. There are 17 species. The most remarkable are: 1. The officinalis, or common white jasmine, with shrubby long slender stalks and branches, rising upon supports 15 or 20 feet high, with numerous white flowers from the joints and ends, of a very fragrant odour. There is a variety with white-striped, and another with yellow-striped leaves. 2. The fruticans, or shrubby yellow jasmine, has shrubby, angular, trailing stalks and branches, rising upon support eight or ten feet high; trifoliate and simple alternate leaves; with yellow flowers from the sides and ends of the branches, appearing in June; frequently producing berries of a black colour. This species is remarkable for sending up many suckers from its roots, often so plentifully as to overspread the ground, if not taken up annually. 3. The humilis, or dwarf yellow jasmine, has shrubby firm stalks, and angular branches, of low, somewhat robust and bushy growth; broad, trifoliate, and pinnated leaves; and large yellow flowers in July, sometimes succeeded by berries. 4. The grandiflorum, or great-flowered Catalonian jasmine, has a shrubby, firm, upright stem, branching out into a spreading head from about three to six or eight feet high, with large flowers of a blueish-red colour without, and white within, appearing from July to November. Of this there is a variety with semidouble flowers, having two series of petals. 5. The azoricum, or azorian white jasmine, has shrubby, long, slender stalks and branches, rising upon supports 15 or 20 feet high, with pretty large flowers of a pure white colour, coming out in loose bunches from the ends of the branches, and appearing most part of the summer and autumn. 6. The odoratissimum, or most sweet-scented yellow Indian jasmine, has a shrubby upright stalk branching erect, without support, six or eight feet high, with bright yellow flowers in bunches, from the ends of the branches; flowering from July till October, and emitting a most fragrant odour.

The first three species are sufficiently hardy to thrive in this climate without any shelter. The other three species, which are tender, may be increased by layers or seeds, or by grafting and budding them upon the common white and shrubby yellow jasmine. They require shelter in a greenhouse in winter, and therefore must always be kept in pots to move them out and in occasionally.

JASPER. This stone is an ingredient in the composition of many mountains. It occurs usually in large amorphous masses, sometimes in rounded or angular pieces. Its fracture is conchoidal. Specific gravity from 2.3 to 2.7. Its colours are various. When heated, it does not decrepitate. It is usually divided into 4 subspecies.

1. *Egyptian pebble.* This variety is found chiefly in Egypt. It usually has a spheroidal or flat-rounded figure, and is enveloped in a coarse rough crust. Specific gravity 2.564 to 2.6. It is chiefly distinguished by the variety of colours which always exist in the same specimen, in concentric stripes or layers. These colours are different browns and yellows, greens, &c.

2. *Striped jasper.* This variety is also distinguished by concentric stripes or layers of different colours: these colours are yellow, brownish-red, and green. It is distinguished from the last variety by its occurring in large amorphous masses, and by the disposition of its stripes.

3. *Porcelain jasper.* So called because its fracture presents the appearance of porcelain. Its colours are various shades of grey, yellow, red, brown, green, mixed together. Found in mass, and in rounded pieces. Greasy. Fracture imperfectly conchoidal: opaque: brittle. According to Rose it is composed of

60.75	silica
27.25	alumina
3.00	magnesia
2.50	oxide of iron
3.60	potass
97.10	

Found in the neighbourhood of pseudo volcanoes, supposed to have been altered by the action of fire.

4. *Common jasper.* Specific gravity from 2.53 to 2.7. Its colours are different shades of white, yellow, red, brown, and green; often variegated, spotted, or veined, with several colours.

JATROPHA, the *cassada plant*, a genus of the monadelphia order, in the monœcia class of plants, and in the natural method ranking under the 38th order, tricocca. There is no male calyx; the corolla is monopetalous, and funnel-shaped; there are ten stamina, one alternately longer than the other. There is no female calyx; the corolla is pentapetalous and patent; there are three bifid styles; the capsule is trilocular, with one seed in each cell. There are nine species, of which the most remarkable are: 1. The curcas, or English physic-nut, with leaves cordate and angular, is a knotty shrub growing about 10 or 12 feet high. The extremities of the branches are covered with leaves; and the flowers, which are of a green herbaceous kind, are set on in an umbel fashion round the extremities of the branches, but especially the main stalks. These are succeeded by as many nuts, whose outward tegument is green and husky, which being peeled off discovers the nut, whose shell is black, and easily cracked; this contains an almond-like kernel, divided into two parts, betweed which separation lie two milk-white thin membranaceous leaves, easily separable from each other. These have not only a bare resemblance of perfect leaves, but have in particular every part, the stalk, the middle rib, and transverse ones, as visible as any leaf whatsoever. 2. The gossypifolia, cotton-leaved jatropha, or belly-ache bush, the leaves of which are quinquepartite, with lobes ovate and entire, and glandular branchy bristles. The stem, which is covered with a light-greyish bark, grows to about three or four feet high, soon dividing into several wide-extended branches. From among these rise several small deep-red pentapetalous flowers, the pistil of each being thick-set at the top with yellow farinaceous dust, which blows off when ripe. These flowers are succeeded by hexagonal husky blackish berries, which, when ripe, open by the heat of the sun, emitting a great many small dark-coloured seeds, which serve as food for ground doves. 3. The multifida, or French physic-nut, with leaves many-parted and polished. The flowers of this grow in bunches, umbel fashion, upon the extremities of each large stalk, very much resembling, at their first appearance, a bunch of red coral: these afterwards open into small five-leaved purple flowers, and are succeeded by nuts, which resemble those of the first species. 4. The manihot, or bitter cassada, has palmated leaves; the lobes lanceolate, very entire, and polished. 5. The janipha, or sweet cassada, has palmated leaves, with lobes very entire; the intermediate leaves lobed with a sinus on both sides. 6. The elastica, with ternate leaves, elliptic, very entire, hoary underneath, and longly petioled. See figures of the two last in plate 22, which renders a more particular description unnecessary.

The root of bitter cassada has no fibrous or woody filaments in the heart, and neither boils nor roasts soft. The sweet cassada has all the opposite qualities. The bitter, however, may be deprived of its noxious qualities (which reside in the juice) by heat. Cassada bread, therefore, is made of both the bitter and sweet, thus: the roots are washed and scraped clean, then grated into a tub or trough; after this they are put into a hair bag, and strongly pressed with a view to squeeze out the juice, and the meal or farina is dried in a hot stone bason over the fire; it is then made into cakes. It also makes excellent puddings, equal to millet. The scrapings of fresh bitter cassada are successfully applied to ill-disposed ulcers. Cassada roots yield a great quantity of starch, which the Brasilians export in little lumps under the name of tapioca. According to father Labat, the smallest bits of manioc which have escaped the grater, and the clods which have not passed the sieve, are not useless. They are dried in the stove after the flour is roasted, and then pounded in a mortar to a fine white powder, with which they make soup. It is likewise used for making a kind of thick coarse cassada, which is roasted till almost burnt; of this, fermented with melasses and West India potatoes, they prepare a much esteemed drink or beverage called ouycou. This liquor, the favourite drink of the natives, is sometimes made extremely strong, especially on any great occasion, as a feast: with this they get intoxicated, and remembering their old quarrels, massacre and murder each other. Such of the inhabitants and workmen as have not wine, drink ouycou. It is of a red colour, strong, nourishing, refreshing, and easily inebriates the inhabitants, who soon accustom themselves to it as easily as beer.

The 6th species is the hevea guianensis of Aublet, or tree which yields the elastic resin called caoutchouc, or India rubber: for a particular account of which see CAOUTCHOUC. The figure we have given is copied from Aublet's tab. 335, and not from the erroneous plate given in the Acta Parisiana.

JAU-RAIA. See RAJANIA.

JAUNDICE. See MEDICINE.

JAW. See ANATOMY.

IBERIS, *sciatica cresses*, or *candy-tuft*, a genus of the siliquosa order, in the tetradynamia class of plants, and in the natural method ranking under the 39th order, siliquosæ. The corolla is regular; the two exterior petals larger than the interior ones; the silicula polyspermous, emarginated. There are 14 species. The most remarkable are: 1. The umbellata, or common candy-tuft, a well-known annual. 2. The amara, or bitter candy-tuft. 3. The sempervirens, commonly called tree candy-tuft. 4. The semperflorens, with white flowers in umbels at the ends of the branches, appearing at all times of the year.

IBEX, in zoology. See CAPRA.

IBIS. See TANTALUS.

ICE. See WATER, and COLD.

ICE-HOUSE, a building contrived to preserve ice for the use of a family in the summer season. It is generally sunk some feet in the ground in a very shady situation, and covered with thatch.

ICELAND-AGATE, a precious stone met with in the islands of Iceland and Ascension, employed by the jewellers as an agate, though too soft for the purpose. It is supposed to be a volcanic product; being solid, black, and of a glassy texture. When held between the eye and the light, it is semitransparent, and greenish, like the glass bottles which contain much iron. In the islands which produce it, such large pieces are met with that they cannot be equalled in any glass-house.

ICHNEUMON *fly*, the name of a genus of flies of the hymenoptera order. The generic character is, mouth with jaws, without tongue; antennæ with more than thirty joints; abdomen in most species footstalked; piercer exserted, with a cylindric bivalve sheath. The animals of this genus provide for the support of their offspring in a manner highly extraordinary, depositing their eggs in the bodies of other living insects, and generally in those of caterpillars. These eggs in a few days hatch, and the young larvæ, which resemble minute white maggots, nourish themselves with the juices of the unfortunate animal, which however continues to move about and feed till near the time of its change to a chrysalis, when the young brood of ichneumon-larvæ creep out by perforating the skin in various places, and each spinning itself up in a small oval silken case, changes into a chrysalis, the whole number forming a groupe on the shrivelled body of the caterpillar which had afforded them nourishment; and after a certain period emerge in the state of complete ichneumons.

It was the want of an exact knowledge of the genus ichneumon that proved so considerable an embarrassment to the older entomologists, who having seen a brood of ichneumons proceed from the chrysalis of a butterfly, could not but conclude that the production of insects was rather a variable and uncertain operation of nature than a regular continuation of the same species. The observations however of Swammerdam, Malphigi, Roesel, and others, have long since removed the difficulties which formerly obscured the history of the insect tribe. See Plate Nat. Hist. figs. 232, 233. It is said there are no less than 415 species of this insect.

ICHNOGRAPHY, in perspective, the view of any thing cut off by a plane parallel to the horizon, just at the base of it. Among painters it signifies a description of images, or of antient statues of marble and copper, of busts and semi-busts, of paintings in fresco, mosaic works, and antient pieces of miniature.

ICHNOGRAPHY. See ARCHITECTURE.

ICHTHYOCOLLA. See ACCIPENSER, and GELATINA.

ICHTHYOLITHUS, in natural history, the body or parts of a fish changed into a fossil substance. Four species are enumerated. The niger is found in a black slate in the island of Sheppey, and various parts of Wales, in the mountains of Switzerland, Silesia, Germany, &c. impregnated with bitumen, pyritaceous matter, or oxide of copper. The fishes resemble the eel, swordfish, cod, flat fish, perch, roach, dace, mackrel, mullet, carp, &c. The albidus is found in various parts of England, on mount Libanus in Palestine, in the ecclesiastical territories of Italy, in Switzerland, Bavaria, &c. The fishes are rarely of the sea kind, but usually those that inhabit the fresh water. They are seldom found whole, but in different parts, as the head, gill-covers, and other bones, fins, tails, tendrils, or scales, in a grey slaty swinestone, or impressed on shistose marble, and sometimes penetrated with bitumen.

ICHTHYOLOGY, ιχθυολογια, the science of fishes, or that branch of zoology which treats of fishes. See FISH, and COMPARATIVE ANATOMY.

ICONOCLASTS, in church history, an appellation given to those persons who in the eighth century opposed image-worship, and still given by the church of Rome to all christians who reject the use of images in religious matters.

ICOSAHEDRON, in geometry, a regular solid, consisting of 20 triangular pyramids, whose vertices meet in the centre of a sphere, supposed to circumscribe it, and therefore have their height and bases equal; wherefore the solidity of one of those pyramids multiplied by 20, the number of bases, gives the solid content of the icosahedron.

If fig. 127, Plate Miscel. be nicely drawn on pasteboard, cut half through, and then folded up neatly together, it will represent an icosahedron. See fig. 128.

To form an icosahedron, describe upon card paper 20 equilateral triangles; cut it out by the extreme edges, and cut all the other lines half-through; then fold up by these edges, and the solid will be formed. The linear edge of the icosahedron being A, then the surface will be $5A^2\sqrt{3} = 8.660\ A^2$, and the solidity $\frac{5}{6}\ A^3\ \sqrt{\frac{7+3\sqrt{5}}{2}} = 2.1817\ A^3$.

ICOSANDRIA, from εικοσι "twenty," and ανηρ, "a man or husband;" the name of the 12th class in Linnæus's sexual method, consisting of plants with hermaphrodite flowers, which are furnished with 20 or more stamina, that are inserted into the inner side of the calyx or petals. See Botany.

IDES, *idus*, in the antient Roman calendar, were eight days in each month, the first of which fell on the 15th of March, May, July, and October, and on the 13th day of other months. They were reckoned backwards: thus they called the 14th day of March, May, July, and October, and the 12th of the other months, the pridie idus, or the day before the ides; the next preceding day, they called the tertio idus; and so on, reckoning always backwards, till they came to the nones. This method of reckoning time is still retained in the chancery of Rome, and in the calendar of the breviary.

IDIOT, is a fool or madman from his nativity. By the old common law there is a writ de idiota inquirendo, directed to the sheriff, to inquire by a jury whether the party is an idiot or not; and if they find him a perfect idiot, the profits of his lands and the custody of his person belong to the king, according to the stat. 17 Ed. II. c. 9. by which it is enacted, that the king shall have the custody of the lands of natural fools, taking the profits of them without waste or destruction, and shall find them necessaries, of whose fee soever the land shall be holden. And after the death of such idiots, he shall render it to the right heir, so that such idiots shall not alien, nor their heirs be disinherited. But it seldom happens that a jury finds a man an idiot from his nativity, but only non compos mentis from some particular time, which has an operation very different in point of law; for in this case he comes under the denomination of a lunatic, in which respect the king shall not have the profits of his lands, but is accountable for the same to the lunatic when he comes to his right mind, or otherwise to his executors or administrators. 1 Black. 303.

JEER, or Jeer-rope, in a ship, is a large rope reeved through double or treble blocks, lashed at the mast-head, and on the yard, in order to hoist or lower the yards.

JEJUNUM. See Anatomy.

JELLY, in chemistry. If we press out the juice of ripe blackberries, currants, and many other fruits, and allow it to remain for some time in a state of rest, it partly coagulates into a tremulous soft substance, well known by the name of jelly. If we pour off the uncoagulated parts, and wash the coagulum with a small quantity of water, we obtain jelly approaching to a state of purity.

In this state it is nearly colourless, unless tinged by the peculiar colouring matter of the fruit; it has a pleasant taste, and a tremulous consistency. It is scarcely soluble in cold water, but very soluble in hot water; and when the solution cools, it again coagulates into the form of a jelly. When long boiled, it loses the property of gelatinizing by cooling, and becomes analogous to mucilage. This is the reason that in making currant-jelly, or any other jelly, when the quantity of sugar added is not sufficient to absorb all the watery parts of the fruit, and consequently it is necessary to concentrate the liquid by long boiling, the mixture often loses the property of coagulating, and the jelly, of course, is spoiled.

Jelly combines readily with alkalies. Nitric acid converts it into oxalic acid, without separating any azotic gas. When dried it becomes transparent. When distilled it affords a great deal of pyromucous acid, a small quantity of oil, and scarcely any ammonia.

Jelly exists in all acid fruits, as oranges, lemons, gooseberries, &c. If the juice of these fruits is allowed to gelatinize, and then poured upon a searce, the acid gradually filtres through, and leaves the other; which may be washed with a little cold water, and allowed to dry. Its bulk gradually diminishes, and it concretes into a hard transparent brittle mass, which possesses most of the properties of gum. Perhaps, then, jelly is merely gum combined with vegetable acid.

Jelly, *animal*. See Gelatine.

JESUITS, or the society of Jesus, a most famous religious order in the Romish church, founded by Ignatius Loyola, a native of Guipuscoa in Spain, who in the year 1738 assembled ten of his companions at Rome, principally chosen out of the university of Paris, and made a proposal to them to form a new order; when, after many deliberations, it was agreed to add to the three ordinary vows of chastity, poverty, and obedience, a fourth, which was, to go into all countries whither the pope should please to send them, in order to make converts to the Romish church. Two years after, pope Paul III. gave them a bull, by which he approved this new order, giving them a power to make such statutes as they should judge convenient; on which, Ignatius was created general of the order, which in a short time spread over all the countries of the world, to which Ignatius sent his companions, while he staid at Rome, whence he governed the whole society. The order was abolished by pope Clement XIV. (Ganganelli) in 1773. See Gregory's Church History, vol. ii.

Jesuit's-*bark*. See Cinchona, and Pharmacy.

JET. See Coal.

Jet d'eau. See Hydraulics.

JETSON, Jetsen, or Jetsam, in law, is used for any thing thrown out of a ship or vessel that is in danger of being a wreck, and which is driven by the waves on shore.

JEWS. In England in former times, the Jews and all their goods belonged to the chief lord where they lived. By stat. Ed. I. the Jews, to the number of 15,000, were banished out of England, and never returned till Oliver Cromwell readmitted them.

Whenever any Jew shall present himself to take the oath of abjuration, in pursuance of the 10 Geo. III. c. 10. the words, upon the true faith of a christian, shall be omitted out of the said oath in administering it to such persons; and the taking the said oath by persons professing the Jewish religion, without the said words, in like manner as Jews are admitted to give evidence in courts of justice, shall be deemed a sufficient taking of it.

IGNATIA, a genus of the monogynia order, in the pentandria class of plants. The calyx is five-toothed; the corolla is long; the fruit an unilocular plum, with many seeds. There are two species, the principal of which is the amara, a native of India. The fruit of this tree contains the seeds called St. Ignatius's beans. According to some, it is from this plant that the columbo root is obtained.

IGNIS Fatuus, a common meteor, chiefly seen in dark nights about meadows, marshes, and other moist places, as also in burying-grounds, and near dung-hills. It is known among the people by the appellations, Will with a wisp, and Jack with a lantern. See Meteors.

IGNITION. See Caloric, and Chemistry.

IGNORAMUS, was formerly indorsed by the grand jury on the back of a bill, for which they did not find sufficient evidence; but now, since the proceedings were in English, they indorse "no bill," or "not a true bill," or which is the better way, "not found." 4 305.

IGUANA. See Lacerta.

JIB, the foremost sail of a ship, being a large stay-sail extended from the outer end of the bowsprit prolonged by the jib-boom, towards the fore-top-mast-head. See Sail.

Jib-*boom*, a boom run out from the extremity of the bowsprit, parallel to its length, and serving to extend the bottom of the jib, and the stay of the fore-top-gallant-mast.

ILEX, *the holm or holly tree*, a genus of the tetragynia order, in the tetrandria class of plants, and in the natural method ranking under the 43d order, dumosæ. The calyx is quadridentated; the corolla rotaceous; there is no style; the berry is monospermous. There are 16 species of this genus; but the most remarkable is the aquifolium, or common holly. Of this there are a great number of varieties with variegated leaves, which are propagated by the nursery gardeners for sale. The best of these varieties are the painted-lady holly, British holly, Bradley's best holly, phyllis or cream holly, milkmaid holly, Pritchet's best holly, gold-edged hedgehog holly, Chyney's holly, glory-of-the-west holly, Broaderick's holly, Partridge's holly, Herefordshire white holly, Blind's cream holly, Longstaff's holly, Eales's holly, silver-edged hedgehog holly. All these varieties are propagated by budding or grafting them upon stocks of the common green holly.

Sheep in the winter are fed with croppings of holly. Birds eat the berries. The bark fermented, and afterwards washed from the woody fibres, makes the common birdlime. The plant makes an impenetrable fence, and bears cropping; however, it is not found in all respects to answer for this purpose equally well with the hawthorn. The wood is used in fineering, and is sometimes stained black to imitate ebony. Handles for knives, and cogs for mill-wheels, are made of it. Mr. Miller says, he has seen the floor of a room laid with compartments of holly and mahogany, which had a very pretty effect.

ILIAC PASSION. See MEDICINE.

ILLECEBRUM, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 12th order, holoraceæ. The calyx is pentaphyllous, and cartilaginous; there is no corolla; the stigma is simple; the capsule quinquevalved, and monospermous. There are 21 species, of which the most remarkable are the paronychia and the capitatum. Both these have trailing stalks near two feet long, which spread on the ground, furnished with small leaves like those of knot-grass. The heads of the flowers come out from the joints of the stalks, having neat silvery bracteæ surrounding them, which make a pretty appearance. Their flowers appear in June, and there is generally a succession of them for at least two months; and when the autumn proves warm, they will ripen their seeds in October.

ILLICIUM, a genus of the pentagynia order, in the dodecandria class of plants, and in the natural method ranking with those of which the order is doubtful. The calyx is tetraphyllous, and deciduous; there are eight petals, and eight petaloid subulated nectaria. There are 16 stamina with bifid antheræ; the capsules are ovate, compressed, and monospermous. There are two species, viz. 1. The floridanum, with red flowers, and very odorous fruit. It is a native of China. 2. The anisatum, a native of the woods of China and Japan. The first is a very ornamental plant, and now common in our greenhouses.

ILLUMINATING, a kind of miniature-painting, antiently much practised for illustrating and adorning books. Besides the writers of books, there were artists whose profession was to ornament and paint manuscripts, who were called illuminators: the writers of books first finished their part, and the illuminators embellished them with ornamented letters and paintings. We frequently find blanks left in manuscripts for the illuminators, which were never filled up. Some of the antient manuscripts are gilt and burnished in a style superior to later times. Their colours were excellent, and their skill in preparing them must have been very great.

IMAM, a name applied by the Mahometans to him who is head of the congregation in their mosques; and by way of eminence to him who has the supreme authority both in respect to spirituals and temporals.

IMBEZLE, signifies to steal, pilfer, or purloin, and also to waste or diminish goods, &c. entrusted to a person's charge and care. Imbezlers of wool forfeit double damages, and may be committed to the house of correction till paid; and servants imbezling their masters' goods to the value of 40*s*. are deemed guilty of felony without benefit of clergy.

IMBRICATED, among botanists, an appellation given to such leaves of plants, as are placed over one another like the tiles of a house. The term is likewise applied to some of the heart-shells, from their being ridged transversely in the same manner.

IMMEMORIAL, in a legal sense, a thing is said to be of time immemorial, or time out of mind, that was before the reign of king Edward II.

IMMERSION, in astronomy, is when a star or planet is so near the sun with regard to our observations, that we cannot see it; being enveloped and hid in the rays of that luminary. It also denotes the beginning of an eclipse of the moon, or that moment when the moon begins to be darkened, and to enter into the shadow of the earth; and the same term is also used with regard to an eclipse of the sun, when the disk of the moon begins to cover it. In this sense emersion stands opposed to immersion, and signifies the moment wherein the moon begins to come out of the shadow of the earth, or the sun begins to shew the parts of his disk which were hid before. Immersion is frequently applied to the satellites of Jupiter, and especially to the first satellite; the observation of which is of so much use for discovering the longitude. The immersion of that satellite is the moment in which it appears to enter within the disk of Jupiter, and its emersion the moment when it appears to come out. The immersions are observed from the time of the conjunction of Jupiter with the sun, to the time of his opposition; and the emersions from the time of his opposition to his conjunction.

IMPALED, in heraldry: when the coats of a man and his wife who is not an heiress are borne in the same escutcheon, they must be marshalled in pale; the husband's on the right side, and the wife's on the left: and this the heralds call baron and feme, two coats impaled. See HERALDRY.

IMPARLANCE, in law, a petition in court for a day to consider or advise what answer the defendant shall make to the plaintiff's action, and is the continuance of the cause till another day, or a longer time given by the court.

An imparlance is general or special; general is when it is entered in general terms, without any special clause therein; special is where the defendant desires a further day to answer. And this last imparlance is of use to plead some matters, which cannot be pleaded after a general imparlance.

It is said that imparlance was formerly from day to day, but now it is from one term to another. In case the plaintiff amends his declaration after the same is delivered or filed, the defendant may in course impارl to the next term afterwards, unless the plaintiff pays costs; but if he does, and they are accepted, the defendant may not have an imparlance. Likewise the not delivering a declaration in time is sometimes the cause of imparlance; and when the plaintiff declares, yet does not proceed in three terms after, in such case the defendant may imparl to the next succeeding term. But there are divers cases wherein imparlances are not to be given: as where a person is sued by an attorney or any other privileged person of the court, in an assize, one may not imparl, except good cause be given; nor shall there be imparlance in action of special clausum fregit, &c.

IMPATIENS, the common balsam, or noli me tangere, a genus of the class and order syngenesia monogamia. The calyx is two-leaved; corolla five-petalled, irregular, with a cowled nectarium; capsule superior, five-valved. There are 12 species, all annuals. The noli me tangere is indigenous to Britain, and has its specific name from the capsule shooting forth its seeds to a great distance when touched.

IMPEACHMENT, is the accusation and prosecution of a person in parliament, for treason or other crime and misdemeanor. An impeachment before the lords by the commons of Great Britain, is a presentment to the most high and supreme court of criminal jurisdiction, by the most solemn, grand inquest of the whole kingdom. A commoner cannot be impeached before the lords for any capital offence, but only for high misdemeanors; but a peer may be impeached for any crime. The articles of impeachment are a kind of bill of indictment, found by the house of commons, and afterwards tried by the lords, who are in cases of misdemeanors considered not only as their own peers, but as the peers of the whole nation. By stat. 12 and 13 W. c. 2. no pardon under the great seal shall be pleadable to an impeachment by the commons in parliament. 4 Black. 259.

In the case of Warren Hastings, in the year 1791, it was solemnly determined that impeachments do not abate by a dissolution of parliament.

IMPEACHMENT *of waste*, signifies a restraint from committing of waste upon lands and tenements; and therefore he that has a lease without impeachment of waste, has by that a property or interest given him in the houses and trees, and may make waste in them without being impeached for it, that is, without being questioned or demanded any recompence for the waste done. 11 Rep. 82.

IMPEDIMENTS IN LAW. Persons under impediments are those within age, under coverture, non compos mentis, in prison, or beyond seas, who, by a saving in our laws, have time to claim and prosecute the right, after the impediments removed, in case of fines levied, &c.

IMPERATIVE, one of the moods of a verb, used when we would command, entreat, or advise.

IMPERATORIA, *masterwort*, a genus of the digynia order, in the pentandria class of plants, and in the natural method ranking under the 45th order, umbellatæ. The fruit is roundish, compressed in the middle, gibbous, and surrounded with a border; the petals are inflexo-emarginated. There is but one species, viz. the ostruthium, a native of the Austrian and Stythian Alps, and other mountainous places of Italy. The plant is cultivated in gardens for the sake of its roots, which are used in medicine. The root has a flavour similar to that of angelica, and is esteemed a good sudorific. There are instances of its having cured the ague when the bark had failed. It should be dug up in winter, and a strong infusion made in wine.

IMPERFECT, something that is defective, or that wants some of the properties found in other beings of the same kind: thus mosses are called imperfect plants, because almost all the parts of fructification are wanting in them; and for the like reason is the appellation imperfect given to the fungi and submarine plants. See MOSS, FUNGI, and SUBMARINE.

Imperfect flowers, those otherwise called stamineous.

Imperfect numbers, such whose aliquot parts, taken together, do either exceed or fall short of that whole number of which they are parts: they are either abundant or deficient.

IMPERSONAL verb, in grammar, a verb to which the nominative of any certain person cannot be prefixed; or, as others define it, a verb destitute of the two first and primary persons.

IMPETUS, in mechanics, the force with which one body impels or strikes another.

IMPLICATION, is where the law implies something that is not declared by parties in their deeds and agreements; and when our law gives any thing to a man, it gives implicitly whatsoever is necessary for enjoying the same. 4 Black. 200.

An implied contract is such, where the terms of agreement are not expressly set forth in words, but are such as reason and justice dictate, and which therefore the law presumes that every man undertakes to perform. Id.

An implication cannot be intended by deed, unless there are apt words, but otherwise in a will. Brownl. 153.

IMPORTATION, the act of bringing goods into a country from foreign parts. It has generally been considered, that for any country to carry on a profitable trade, it is necessary that the value of the goods sent out of it should be greater than that of the articles imported: this, however, is a very erroneous axiom, unless it is understood with great limitations. All articles of merchandize, imported merely for re-exportation, and also such as are used or worked up in our own manufactures, are far from being hurtful to our commerce; and may even, in many respects, be deemed of equal profit with our own native commodities. It is therefore an excess of such importations alone as are either for mere luxury or mere necessity, or for both together, which is disadvantageous to the country, and not such importations as, like many of ours, consist of raw silk, Spanish wool, cotton wool and yarn, mohair, flax and hemp, oils, potasses, dyeing stuffs, naval stores, &c. either used in our ship-building, or worked up in our manufactures, a principal part of which are for exportation: neither can our importations of East India goods and colonial produce, which are chiefly designed to be afterwards exported, be deemed unprofitable, but are, on the contrary, some of the most lucrative branches of our foreign trade.

The following statement of the total value of the imports of England, in the year 1354, furnishes a curious comparison with their present magnitude.

	£.	s.	d.
1831 fine cloths, at 6*l*. per cloth, which, with the customs, come to - -	11,083	12	0
397¾ hundred weight of wax, at 40*s*. per hundred weight, which, with the customs, come to - -	815	7	5
1829½ tons of wine, at 40*s*. per ton, which, with the customs, come to - -	3,841	19	0
Linen-cloth, mercery, grocery, and all other wares -	22,943	6	10
On which the customs were	285	18	3
Total -	38,970	3	6

At this period, and for a long time after, foreigners were the principal importers of goods in this country; and as it was thought that many of them, after disposing of their merchandise here, returned with the value in money to their own country, which was deemed a serious injury, many laws were made against carrying out of the realm any gold or silver, either in coin, plate, or bullion; and merchant strangers were compelled to give security that they would lay out all the money they received for the wares they imported, in English merchandize to be exported. These injudicious restrictions have been long since done away; and excepting the prohibition of some foreign manufactures, the import trade of this country is probably as free as the regulations necessary to secure the payment of heavy duties on almost every article of trade will admit.

Total official value of the imports of Great Britain in the year 1800.

Port of London -	£18,843,172	2	10
The outports -	9,514,642	11	10
England - -	28,357,814	14	8
Scotland - -	2,212,790	11	8
	30,570,605	6	4

	East Indies and China.	All other parts.
In 1801	£5,424,441	£27,371,115
1802	5,794,906	25,647,412
1803	6,348,887	21,643,577
1804	5,214,621	23,986,869
1805		24,273,451

The official value of the imports of Ireland in the year 1805, was 5,982,194*l*. 19*s*. 9*d*.

IMPOSSIBLE roots, in algebra. To discover how many impossible roots are contained in any proposed equation, sir I. Newton gave this rule, in his Algebra, viz.: Constitute a series of fractions, whose denominators are the series of natural numbers 1, 2, 3, 4, 5, &c. continued to the number shewing the index or exponent of the highest term of the equations, and their numerators the same series of numbers in the contrary order; and divide each of these fractions by that next before it, and place the resulting quotients over the intermediate terms of the equation; then under each of the intermediate terms, if its square multiplied by the fraction over it, be greater than the product of the terms on each side of it, place the sign +; but if not, the sign —; and under the first and last term place the sign +. Then will the equation have as many imaginary roots as there are changes of the underwritten signs from + to —, and from — to +. So for the equation $x^3 - 4x^2 + 4x - 6 = 0$, the series of fractions is $\frac{3}{1}, \frac{2}{2}, \frac{1}{3}$; then the second divided by the first gives $\frac{2}{6}$ or $\frac{1}{3}$, and the third divided by the second gives $\frac{1}{3}$ also; hence these quotients placed over the intermediate terms, the whole will stand thus,

$$\begin{array}{cccc} & \frac{1}{3} & \frac{1}{3} & \\ x^3 & - 4x^2 & + 4x & - 6. \\ + & + & - & + \end{array}$$

Now because the square of the second term multiplied by its superscribed fraction, is $\frac{16}{3}x^4$, which is greater than $4x^4$, the product of the two adjacent terms, therefore the sign + is set below the second term; and because the square of the third term multiplied by its overwritten fraction, is $\frac{16}{3}x^2$, which is less than $24x^2$, the product of the terms on each side of it, therefore the sign — is placed under that term; also the sign + is set under the first and last terms. Hence the two changes of the underwritten signs + + — +, the one from + to —, and the other from — to +, shew that the given equation has two impossible roots.

When two or more terms are wanting together, under the place of the first of the deficient terms write the sign —, under the second the sign +, under the third —, and so on, always varying the signs, except that under the last of the deficient terms must always be set the sign +, when the adjacent terms on both sides of the deficient terms have contrary signs. As in the equation,

$$\begin{array}{ccccccc} x^5 & + ax^4 & * & * & * & + a^5 = 0, \\ + & + & - & + & - & + \end{array}$$

which has four imaginary roots.

The author remarks, that this rule will sometimes fail of discovering all the impossible roots of an equation, for some equations may have more of such roots than can be found by this rule, though this seldom happens.

Mr. Maclaurin has given a demonstration of this rule of Newton's, together with one of his own, that will never fail. And the same has also been done by Mr. Campbell. See Phil. Trans. vols. 34 and 35.

The real and imaginary roots of equations may be found from the method of fluxions, applied to the doctrine of maxima and minima; that is, to find such a value of x in an equation, expressing the nature of a curve, made equal to y, an abscissa which corresponds to the greatest and least ordinate. But when the equation is above three dimensions, the computation is very laborious. See Stirling's Treatise on the Lines of the Third Order.

IMPOSTHUME, the same with abscess. See Surgery.

IMPRESSING men. The power of impressing seamen for the sea service, by the king's commission, has been a matter of some dispute, and submitted to with great reluctance, though it has very learnedly been argued by sir Michael Forster, that the practice of impressing, and granting power to the admiralty for that purpose, is of very antient date, and has been continued by a regular series of precedents to the present time, whence he concludes it to be part of the common law. The difficulty arises hence, that no statute has expressly declared this power to be in the crown, though many of them very strongly imply it. The stat. 2 R. II. c. 4. speaks of mariners being arrested and retained for the king's service, as of a thing well known and practised without dispute, and provides a remedy against the running away.

By stat 2 and 3 P. and M. c. 16, if any waterman who uses the river Thames, shall hide himself during the execution of any commission for pressing for his majesty's service, he is liable to heavy penalties. By stat. 5 Eliz. c. 6. no fisherman shall be taken by the queen's commission to serve as a mariner; but the commission shall be first brought to two justices of the peace, inhabiting near the sea-coast where the mariners are to be taken, to the intent that the justices may choose out and return such a number of able-bodied men as in the commission are contained to serve her majesty. And by stat. 7 and 8 W. c. 21.; 2 Anne, c. 6.; 4 and 5 Anne, c. 19.; 13 Geo. II. c. 17.; especial protections are allowed to seamen in particular circumstances, to prevent them from being impressed. All which certainly imply a power of impressing to reside somewhere; and if any where, it must, from the spirit of our constitution, as well as from the frequent mention of the king's commission, reside in the crown alone. 1 Black. 419.

IMPRISONMENT, is the restraint of a man's liberty under the custody of another, and extends not only to a gaol, but a house, stocks, or where a man is held in the street, or any other place; for, in all these cases, the party so restrained is said to be a prisoner so long as he has not his liberty freely to go about his business as at other times.

None shall be imprisoned but by the lawful judgment of his peers, or by the law of the land. Magna Charta.

IMPRISONMENT, *false*. To constitute the injury of false imprisonment, two points are necessary: the detention of the person, and the unlawfulness of such detention. Every confinement of the person is imprisonment, whether it is in a common prison, or in a private house, or in the stocks, or even by forcibly detaining one in the streets. 2 Inst. 589.

By Magna Charta, no freeman shall be taken and imprisoned, but by the lawful judgment of his equals, or by the law of the land: and by the petition of right, 3 C. I. no freeman shall be imprisoned or detained without cause shewn, to which he may make answer according to law. And by the 16 C. I. c. 10. if any person is restrained of his liberty, he may, upon application by his counsel, have a writ of habeas corpus, to bring him before the court of king's bench or common pleas, who shall determine whether the cause of his commitment is just, and thereupon do as to justice appertains.

For false imprisonment the law has not only decreed a punishment by fine and imprisonment, as a heinous public crime, but has also given a private reparation to the party by action at law, wherein he shall recover damages for the loss of his time and liberty. 3 Black. 127.

IMPROPER FRACTIONS. See ARITHMETIC, and ALGEBRA.

IMPROPRIATION, is properly so called when a benefice ecclesiastical is in the hands of a layman; and appropriation when in the hands of a bishop, college, or religious house; though sometimes these terms are confounded. It is said there are 3845 impropriations in England.

IMPULSE, or IMPULSIVE FORCE, the same with impetus. See MECHANICS.

INARCHING, in gardening. See GRAFTING.

INCA, or YNCA, a name given by the natives of Peru to their kings, and the princes of the blood.

INCAPACITY, in the canon law, is of two kinds: 1. The want of a dispensation for age in a minor, for legitimation in a bastard, and the like: this renders the provision of a benefice void in its original. 2. Crimes and heinous offences, which annul provisions at first valid.

INCH, a well-known measure of length, being the twelfth part of a foot, and equal to three barleycorns in length.

INCIDENCE, in mechanics, denotes the direction in which one body strikes on another. See MECHANICS, and OPTICS.

INCLINATION, is a word frequently used by mathematicians, and signifies the mutual approach, tendency, or leaning, of two lines or two planes towards each other, so as to make an angle.

Inclination of a right line to a plane, is the acute angle which that line makes with another right line drawn in the plane through the point where the inclined line intersects it, and through the point where it is also cut by a perpendicular drawn from any point of the inclined plane.

Inclination of the axis of the earth, is the angle which it makes with the plane of the ecliptic; or the angle contained between the planes of the equator and ecliptic.

Inclination of a planet, is an arch of the circle of inclination comprehended between the ecliptic and the plane of a planet in its orbit. See ASTRONOMY.

The greatest inclination of Saturn, according to Kepler, is $2° 32'$; of Jupiter, $1° 20'$; of Mars, $1° 50' 30''$; of Venus, $3° 22'$; of Mercury, $6° 54'$. According to de la Hire, the greatest inclination of Saturn is $2° 33' 30''$; of Jupiter, $1° 19' 20''$; of Mars, $1° 51'$; of Venus, $3° 25' 5''$; of Mercury, $6° 52'$.

Inclination of a plane, in dialling, is the arch of a vertical circle, perpendicular both to the plane and the horizon, and intercepted between them. To find this, let AB (see Plate Misc. fig. 135) be a plane inclined to the horizon HR; apply to the plane AB a quadrant DCF, so that the plummet CE may cut off any number of degrees on the limb, as EF: then the arch DE is the measure of the angle of inclination ABH; for draw BG perpendicular to HR, then because CE is parallel to BG, the angle ECF is equal to CBG; but DCF is equal to GBH, being both right angles, therefore the angle DCF — ECF, is equal to the angle GBH — CBG; that is, DCE is equal ABH.

INCLINED PLANE, in mechanics, one that makes an oblique angle with the horizon. See MECHANICS.

INCOMMENSURABLE, a term in geometry, used where two lines, when compared to each other, have no common measure, how small soever, that will exactly measure them both. And in general, two quantities are said to be incommensurable, when no third quantity can be found that is an aliquot part of both.

Such are the diagonal and side of a square; for though each of those lines has infinite aliquot parts, as the half, the third, &c. yet not any part of the one, be it ever so little, can possibly measure the other, as is demonstrated by Euclid.

INCOMMENSURABLE NUMBERS, are such as have no common divisor that will divide them both equally.

INCORRUPTIBILES, or INCORRUPTICOLÆ, in church history, heretics which had their original at Alexandria, in the time of the emperor Justinian. Their distinguishing tenet was, that the body of Jesus Christ was incorruptible from his conception, by which they meant that after and from the time he was formed in the womb of his holy mother, he was not susceptible of any change or alteration, not even of any natural and innocent passions, as hunger, thirst, &c. so that he ate without any occasion before his death, as well as after his resurrection.

INCUBUS, or NIGHT-MARE. See MEDICINE.

INCUMBENT, a clerk or minister who is resident on his benefice: he is called incumbent, because he does, or at least ought, to bend his whole study to discharge the cure of his church.

INCURVATION *of the rays of light*, their bending out of a rectilinear or straight course, occasioned by refraction.

INDEMNITY, in law, the saving harmless; or, a writing to secure one from all damage and danger that may ensue from any act. An indemnity in regard to estates is called a warranty.

INDENTED, in heraldry, is when the outline of an ordinary is notched like the teeth of a saw.

INDENTED LINE, in fortification, the same with what the French engineers call redent; being a trench and parapet running out and in, like the teeth of a saw, and much used in irregular fortification.

INDENTURE, is a writing containing a conveyance between two or more, indented or cut unevenly, or in and out, on the top or side, answerable to another writing that likewise comprehends the same words. Formerly when deeds were more concise than at present, it was usual to write both parts on the same piece of parchment, with some words or letters written between them, through which the parchment was cut, either in a straight or indented line, in such a manner as to leave half the word on one part, and half on the other: and this custom is still preserved in making out the indentures of a fine. But at last, indenting only has come into use without cutting through any letters at all; and it seems at present to serve for little other purpose than to give name to the species of the deed. 2 Black. 294.

INDEPENDENTS, a sect of protestants in England and Holland, so called from their independency on other churches, and their maintaining that each church or congregation has sufficient power to act and perform every thing relating to religious government within itself, and is no way subject or accountable to other churches or their deputies.

The present independents differ from the presbyterians only in their church government, in being generally more attached to the doctrines distinguished by the term orthodoxy, such as original sin, election, reprobation, &c. and in administering the Lord's supper at the close of the afternoon's service. The several sects of baptists are all independents with respect to church-government; and, like them, administer the Lord's supper in the evening, whereas the presbyterians administer it after the forenoon's service.

INDETERMINATE PROBLEM, in algebra, one which is capable of an indefinite number of solutions.

INDEX, in arithmetic and algebra, shews to what power any quantity is involved, and is otherwise called exponent.

INDEX *of a logarithm*, that which shews of how many places the absolute number belonging to a logarithm consists, and of what nature it is, whether an integer or fraction. Thus, in this logarithm 2.523421, the number 2 standing on the left hand of the point is called the index; because it shews that the absolute number, answering to the above logarithm, consists of three places: for the number is always one more than the index. If the absolute number is a fraction, then the index of the logarithm has a negative sign marked thus $\bar{2}$.523421.

Index *of a globe*, the little style or gnomon, which being fixed on the pole of the globe, and turning round with it, points out the hours upon the hour-circle. See Globe.

INDIAN berry, in commerce, &c. See Coculus.

INDICATIVE, in grammar, the first mood or manner of conjugating a verb, by which we simply affirm, deny, or ask something; as, *amant*, they love; *non amant*, they do not love; *amantne*, do they love?

INDICTION, in chronology, a cycle of 15 years. The Roman or papal indiction, which is that used in the pope's bulls, begins on the 1st of January; and by it the popes have dated their acts ever since Charlemagne made them sovereigns. But besides this, there are other two kinds of indiction mentioned by authors, viz. that of Constantinople, beginning on the 1st of September; and the imperial or Cæsarian indiction, which commenced on the 14th of September. See Cycle.

Indiction is also used for the convoking an ecclesiastical council or assembly.

INDICTMENT, is a written accusation of one or more persons of a crime or misdemeanor, preferred to, and presented on oath by, a grand jury. 4 Black. 302.

An indictment may be found on the oath of one witness only, unless it is for high treason, which requires two witnesses; and unless in any instance it is otherwise specially directed by acts of parliament. 2 Haw.

The sheriff of every county is bound to return to every session of the peace, and every commission of oyer and terminer, and of general gaol-delivery, 24 good and lawful men, of the county, some out of every hundred, to enquire, present, do, and execute, all those things which on the part of our lord the king, shall then and there be commanded therein. As many as appear upon this pannel are sworn of the grand jury, to the amount of twelve at the least, and not more than twenty-three, that twelve may be a majority. This grand jury is previously instructed in the articles of their enquiry, by a charge from the judge on the bench. They then withdraw from court to sit and receive indictments, which are preferred to them in the name of the king, but at the suit of any private prosecutor; and they are only to hear evidence on behalf of the prosecution: for the finding an indictment is only in the nature of an enquiry or accusation, which is afterwards to be tried and determined; and the grand jury are only to enquire upon their oaths whether there is sufficient cause to call upon the party to answer it.

It seems generally agreed, that the grand jury may not find part of an indictment true and part false; but must either find a true bill or ignoramus for the whole; and if they take upon them to find it specially or conditionally, or to be true for part only and not for the rest, the whole is void, and the party cannot be tried upon it, but ought to be indicted anew. 2 Haw. 210.

All capital crimes whatever, and all kinds of inferior crimes which are of a public nature, as misprisions, contempts, disturbances of the peace, oppressions, and all other misdemeanors whatever of a public evil example against the common law, may be indicted, but no injuries of a private nature, unless they in some degree concern the king. And generally where a statute prohibits a matter of public grievance to the liberties and security of a subject, or commands a matter of public convenience, as the repairing of the common streets of the town, &c. every disobedience of such statute is punishable, not only at the suit of the party grieved, but also by way of indictment, for contempt of the statute, unless such method of proceeding shall manifestly appear to be excluded by it. Yet if the party offending has been fined in an action brought by the party (as it is said he may in every action for doing a thing prohibited by statute), such fine is a good bar to the indictment, because by the fine the end of the statute is satisfied; otherwise he would be liable to a second fine for the same offence. 2 Inst. 55.

If several offenders commit the same offence, though in law they are several offences in relation to the several offenders, yet they may be joined in one indictment; as if several commit a robbery, or burglary, or murder. 2 H. H. 173.

No indictment for high treason, or misprision thereof (except indictments for counterfeiting the king's coin, seal, sign, or signet), nor any process or return thereupon, shall be quashed for mis-reciting, mis-spelling, false or improper Latin, unless exception concerning the same is taken and made in the respective court where the trial shall be, by the prisoner or his counsel assigned, before any evidence given in open court on such indictment; nor shall any such mis-reciting, mis-spelling, false or improper Latin, after conviction on such indictment, be any cause or stay, or arrest of judgment; but nevertheless, any judgment on such indictment shall be liable to be reversed on writ of error as formerly.

An indictment accusing a man in general terms, without ascertaining the particular fact laid to his charge, is insufficient; for no one can know what defence to make to a charge which is uncertain, nor can plead it in bar or abatement of a subsequent prosecution; neither can it appear that the facts given in evidence against a defendant on such a general accusation, are the same of which the indictors have accused him; nor can it judicially appear to the court what punishment is proper for an offence so loosely expressed. 2 Haw. 266.

It is therefore best to lay all the facts in the indictment as near to the truth as possible; and not to say, in an indictment for a small assault (for instance) wherein the person assaulted received little or no bodily hurt, that such a one, with swords, staves, and pistols, beat, bruised, and wounded him, so that his life was greatly despaired of; not to say in an indictment for a highway being obstructed, that the king's subjects cannot go thereon without manifest danger of their lives, and the like: which kind of words not being necessary, may stagger an honest man upon his oath to find the fact as so laid.

No indictment can be good without expressly shewing some place wherein the offence was committed, which must appear to have been within jurisdiction of the court. 2 Haw. 236.

There are several emphatical words which the law has appropriated for the description of an offence, which no circumlocution will supply; as *feloniously*, in the indictment of any felony; *burglariously*, in an indictment of burglary, and the like. 2 H. H. 184.

An indictment on the black act for shooting at any person must charge that the offence was done wilfully and maliciously.

By 10 and W. c. 23, it is enacted, that no clerk of assize, clerk of the peace, or other person, shall take any money of any person bound over to give evidence against a traitor or felon for the discharge of his recognizance, nor take more than 2*s.* for drawing any bill of indictment against any such felon, on pain of 5*l.* to the party grieved, with full costs. And if he shall draw a defective bill, he shall draw a new one gratis on the like penalty.

With respect to drawing indictments for other misdemeanors, not being treason or felony, no fee is limited by the statute; the same, therefore, depends on the custom and antient usage.

Every person charged with any felony or other crime, who shall on his trial be acquitted, or against whom no indictment shall be found by the grand jury, or who shall be discharged by proclamation for want of prosecution, shall be immediately set at large in open court, without payment of any fee to the sheriff or gaoler; but in lieu thereof, the treasurer, on a certificate signed by one of the judges or justices before whom such prisoner shall have been discharged, shall pay out of the general rate of the county or district, such sum as has been usually paid, not exceeding 13*s.* 4*d.*

But an action cannot be brought by the person acquitted against the prosecutor of the indictment, without obtaining a copy of the record of his indictment and acquittal; which in prosecutions for felony it is not usual to grant, if there is the least probable cause to found such prosecution upon. For it would be a very great discouragement to the public justice of the kingdom, if prosecutors who had a tolerable ground of suspicion were liable to be sued at law whenever their indictments miscarried. But an action on the case for a malicious prosecution may be founded on such an indictment whereon no acquittal can be, as if it is rejected by the grand jury, or is coram non judice, or is insufficiently drawn; for it is not the danger of the plaintiff, but the scandal, vexation, and expence, upon which this action is founded. However, any probable cause for preferring it is sufficient to justify the defendant, provided it does not appear that the prosecution was malicious. 3 Black. 126.

INDIGOFERA, *the indigo plant*, a genus of the decandria order, in the diadelphia class of plants, and in the natural method ranking under the 32d order, papilionaceæ. The calyx is patent; the carina of the corolla furnished with a subulated patulous spur on each side; the legumen is linear.

There are 35 species, the most remarkable of which is the tinctoria, a native of the warm parts of Asia, Africa, and America. This plant requires a rich soil, well tilled, and not too dry. The seed of it, which, as to figure and colour, resembles gunpowder, is sown in little furrows that are about the breadth of the hoe, two or three inches deep, at a foot distance from each other, and in as straight a line as possible. Continual attention is required to pluck up the weeds, which would soon choke the plant. Though it may be sown in all seasons, the spring is commonly preferred. Moisture causes this plant to shoot above the surface in three or four days. It is ripe at the end of two months. When it begins to flower, it is cut with pruning-knives; and cut again at the end of every six weeks, if the weather is a little rainy. It lasts about two years, after which term it degenerates: it is then plucked up, and planted afresh. As this plant soon exhausts the soil, because it does not absorb a sufficient quantity of air and dew to moisten the earth, it is of advantage to the planter to have a vast space which may remain covered with trees, till it becomes necessary to fell them in order to make room for the indigo.

The valuable dye-stuff called indigo bears some faint resemblance to starch; but its properties are sufficiently peculiar to distinguish it from all other substances, and its importance entitles it to a distinguished place among vegetable principles. It is commonly procured by the following process:

When the plant has been cut down, it is placed in strata in a large wooden vessel, and covered with water. In this situation it cannot remain long in these warm climates without undergoing some change. Putrefaction, accordingly, very soon commences, or rather a kind of fermentation, which goes on best at the temperature of 80°. The water soon becomes opaque, and assumes a green colour; a smell resembling that of volatile alkali is exhaled, and bubbles of carbonic acid are emitted. When the fermentation has continued long enough, which is judged of by the paleness of the leaves, and which requires from six to twenty-four hours according to the temperature of the air and the state of the plant, the liquid is decanted off the plants into large flat vessels, where it is constantly agitated till blue floculi begin to make their appearance; water is now poured in, which causes the blue flakes to precipitate. The yellow liquid is decanted off, and the blue sediment poured into linen bags. When the water has drained from it sufficiently, it is formed into small lumps, and dried in the shade. In that state it is imported into Europe, and sold under the name of indigo.

The leaves of the indigofera yield a green infusion to hot water, and a green powder may be precipitated from it; but unless a fermentation has taken place, neither the colour nor properties of it have any resemblance to indigo.

Indigo may be obtained from the merium tinctorium, and the isatis tinctoria or woad; a plant commonly enough cultivated in Britain, and even found wild in England When arrived at maturity, this plant is cut down, washed, dried hastily in the sun, ground in a mill, placed in heaps, and allowed to ferment for a fortnight. It is then well mixed, and made up into balls, which are piled upon each other, and exposed to the wind and sun. In this state they become hot, and exhale a putrid ammoniacal smell. The fermentation is promoted, if necessary, by sprinkling the balls with water. When it has continued for a sufficient time, the woad is allowed to fall to a coarse powder; in which state it is sold as a dye-stuff. By treating woad nearly in the same manner with the indigofera, indigo has been obtained from it by different chemists.

Indigo is a fine light friable substance, of a deep-blue colour. Its texture is very compact, and the shade of its surface varies according to the manner in which it has been prepared. The principal tints are copper, violet, and blue; the lightest indigo is the best: but it is always more or less mixed with foreign substances, partly owing, doubtless, to the carelessness of the preparation, and partly to the bodies which the plant containing indigo yields to water. From the analysis of Bergman, to whom we are indebted for one of the most complete treatises on the properties of indigo which has yet appeared, the purest indigo which he could procure, was composed of the following constituents:

47	pure indigo
12	gum
6	resin
22	earth
13	oxide of iron
100.	

The earth consisted of,

10.2	barytes
10.0	lime
1.8	silica
22.0	

But in all probability the earth differs in different specimens; for Proust found magnesia in considerable quantity in the specimens which he examined. The forty-seven parts of blue pigment are alone entitled to the name of indigo; and to them therefore we shall confine our attention.

Indigo is a soft powder, of a deep blue, without either taste or smell. It undergoes no change, though kept exposed to the air. Water does not dissolve any part of it, nor produce any change upon it. Bergman, however, found that indigo, when kept long under water, underwent a kind of putrefaction, or at least exhaled a fetid odour. When heat is applied to indigo, it emits a bluish red smoke, and at last burns away with a very faint white flame, leaving behind it the earthy parts in the state of ashes.

Neither oxygen nor the simple combustibles have any effect upon indigo, except it is in a state of solution; and the same remark applies to the metallic bodies.

The fixed alkaline solutions have no action on indigo, except it is newly precipitated from a state of solution. In that case they dissolve it with facility. The solution has at first a green colour, which gradually disappears, and the natural colour of the indigo cannot be again restored. Hence we see that the alkalies when concentrated decompose indigo. Pure liquid ammonia acts in the same way. Even carbonat of ammonia dissolves precipitated indigo, and destroys its colour; but the fixed alkaline carbonats have no such effect.

Lime-water has scarcely any effect upon indigo in its usual state; but it readily dissolves precipitated indigo. The solution is at first green, but becomes gradually yellow. When the solution is exposed to the air, a slight green colour returns, as happens to the solution of indigo in ammonia; but it soon disappears. The effect of the other alkaline earths upon indigo has not hitherto been tried; but it cannot be doubted that they would act nearly as lime-water, but with more energy. The other earths seem to have but little action on indigo in any state.

The action of the acids upon indigo has been examined with most attention, and it certainly exhibits the most important phenomena.

When diluted sulphuric acid is digested over indigo, it produces no effect, except that of dissolving the impurities; but concentrated sulphuric acid dissolves it readily. One part of indigo, when mixed with eight parts of sulphuric acid, evolves heat, and is dissolved in about 24 hours. According to Haussman, some sulphurous acid and hydrogen gas are evolved during the solution. If so, we are to ascribe them to the mucilage and resin, which are doubtless destroyed by the action of the concentrated acid. The solution of indigo is well known in this country by the name of liquid blue. Bancroft calls it sulphat of indigo. While concentrated it is opaque and black; but when diluted it assumes a fine deep-blue colour; and its intensity is such, that a single drop of the concentrated sulphat is sufficient to give a blue colour to many pounds of water. Bergman ascertained the effect of different reagents on this solution with great precision. His experiments threw light, not only on the properties of indigo, but upon the phenomena that take place when it is used as a dye-stuff. The following is the sum of these experiments:

Dropt into sulphurous acid. Colour at first blue, then green, and very speedily destroyed.—In weak tartaric acid. Becomes gradually green, and in 144 hours had assumed a very pale yellow colour. Colour not restored by alkalies.—In vinegar. Becomes green, and in four weeks the colour disappeared.——In weak potass. Becomes green, and then colourless.——In weak carbonat of potass. The same changes, but more slowly. If the solution is very weak, the colour of the indigo is not destroyed.—In ammonia and its carbonat. Colour becomes green, and then disappears.——In a weak solution of sulphat of soda. Colour after some weeks becomes green.——In tartrat of potass. Became green, and then colourless.——In a solution of sugar. Became green, and at last yellowish.——In sulphat of iron. Colour became green, and in three weeks disappeared.—In the sulphurets. Colour destroyed in a few hours.—Realgar, white oxide of arsenic, and orpiment, produced no change.—Black oxide of manganese destroyed the colour completely.——In the infusion of madder. Colour became green, and at last yellow.—In the infusion of woad, the same changes, but more speedily.

From these experiments it is obvious that all those substances which have a very strong affinity for oxygen give a green colour to indigo, and at last destroy it. Hence it is extremely probable that indigo becomes green by giving out oxygen. Of course it owes its blue colour to that principle. This theory was first suggested by Mr. Haussman, and still farther confirmed by Berthollet. Now it is only when green that it is in a state capable of being held in solution by lime, alkalies, &c. in which state it is applied as a dye to cloth. The cloth when dipt into the vat containing it thus dissolved, combines with it, and the blue colour is restored by exposure to the atmosphere. It may be restored equally by plunging the cloth into oxy-muriatic acid. Hence the restoration cannot but be ascribed to oxygen. Hence, then, the reason that sulphurous acid, the vegetable acids, sulphat of iron, give sulphat of indigo a green colour.

From these experiments we see also that the colour of indigo is destroyed by the addition of those substances which part with oxygen very readily, as the black oxide of manganese. In that case the indigo is destroyed, for its colour cannot be again restored.

Nitric acid attacks indigo with great violence, the evolution of abundance of heat, and nitrous gas. When of the specific gravity 1.52, it even sets fire to indigo. When the acid is diluted the indigo becomes brown, and crystals make their appearance, doubtless consisting of oxalic acid. What remains behind is a brown viscid substance of a very bitter taste, probably analogous to the yellow bitter principle of Welter.

Muriatic acid does not act upon indigo in its common state, but it readily dissolves indigo precipitated from the sulphat, and forms a blue coloured solution. The same phenomena are exhibited by the phosphoric, acetic, tartaric acids, and probably by all, except the acid supporters.

Oxymuriatic acid destroys the colour of indigo as readily as nitric acid, and obviously for the same reason.

Indigo is not acted upon by alcohol, ether, nor oils. The two first solvents, indeed, acquire a yellow colour when digested on common indigo by dissolving its resin.

When indigo is mixed up with bran, woad, and other similar substances, which readily undergo fermentation, it assumes a green colour during the fermentation, and is then easily dissolved by lime or potass. It is by this process that it is usually rendered proper for dyeing.

When indigo is distilled, it yields products different from any other vegetable substance, if the accuracy of Bergman, who alone has made the experiment, is to be trusted. He distilled 576 grains in a small retort connected with a pneumatic apparatus. He obtained the following products:

19 grains	carbonic acid gas
173 ——	of a yellow acid liquid, containing ammonia
53 ——	oil
331 ——	charcoal
576.	

INDIVISIBLES, in geometry, the elements or principles into which any body or figure may be ultimately resolved; which elements are supposed infinitely small: thus a line may be said to consist of points, a surface of parallel lines, and a solid of parallel and similar surfaces; and then, because each of these elements is supposed indivisible, if in any figure a line be drawn through the elements perpendicularly, the number of points in that line will be the same as the number of the elements; whence we may see that a parallelogram, prism, or cylinder, is resolvable into elements or indivisibles, all equal to each other, parallel and like to the base; a triangle into lines parallel to the base, but decreasing in arithmetical proportion; and so are the circles which constitute the parabolic conoid, and those which constitute the plane of a circle, or surface of an isosceles cone.

A cylinder may be resolved into cylindrical curve surfaces, having all the same height, and continually decreasing inwards, as the circles of the base do on which they insist.

The method of indivisibles is only the antient method of exhaustions, a little disguised and contracted. It is found of great use in shortening mathematical demonstrations, of which take the following instance in the famous proposition of Archimedes, viz. that a sphere is two-thirds of a cylinder circumscribing it.

Suppose a cylinder, a hemisphere, and an inverted cone (Plate Miscel. fig. 133) to have the same base and altitude, and to be cut by infinite planes all parallel to the base, of which dg is one. It is plain the square of dh will be every where equal to the square of kc (the radius of the sphere); and consequently, since circles are to one another as the squares of the radii, all the circles of the hemisphere will be equal to all those of the cylinder, deducting thence all those of the cone: wherefore the cylinder, deducting the cone, is equal to the hemisphere; but it is known that the cone is one-third of the cylinder, and consequently the sphere must be two-thirds of it.

INDORSEMENT, in law, any thing written on the back of a deed, as a receipt for money received. See BILLS OF EXCHANGE.

INDUCEMENT, in law, what is alledged as a motive or incitement to a thing, and is used specially in many cases; as, there is an inducement in actions, to a traverse in pleadings, a fact or offence committed, &c.

Inducements to actions need not have so much certainty as in other cases: a general indebitatus is not sufficient where it is the ground of the action; but where it is the inducement to the action, as in consideration of forbearing a debt till such a day (for that the parties are agreed upon the debt), this being but a collateral promise, is good without shewing how due. 2 Mod. 70. An inducement to a traverse must be such matter as is good and justifiable in law. There is an inducement to a justification when what is alledged against it is not the substance of the plea. Moor. 847.

INDUCTION, in law, is the giving a clerk instituted to a benefice the actual possession of the temporalities thereof, in the nature of livery of seisin. It is performed by a mandate from the bishop to the archdeacon, who commonly issues out a precept to some other clergyman to perform it for them; which being done, the clergyman who inducts him indorses a certificate of his induction on the archdeacon's mandate, and they who were present testify the same under their hands, and by this the person inducted is in full and complete possession of all the temporalities of his church.

INDULT, in the church of Rome, the power of presenting to benefices granted to certain persons by the pope. Of this kind is the indult of kings and sovereign princes, in the Romish communion, and that of the parliament of Paris granted by several popes. By the concordat for the abolition of the pragmatic sanction, made between Francis I. and Leo X. in 1516, the French king had the power of nominating to bishoprics, and other consistorial benefices, within his realm. At the same time, by a particular bull, the pope granted him the privilege of nominating to the churches of Brittany and Provence.

INERTIA OF MATTER, in philosophy, is defined by sir Isaac Newton to be a passive principle by which bodies persist in their motion or rest, receive motion in proportion to the force impressing it, and resist as much as they are resisted. It is also defined by the same author to be a power implanted in all matter, whereby it resists any change endeavoured to be made in its state. See MECHANICS.

INFAMY, which extends to forgery, perjury, gross cheats, &c. disables a man to be a witness or a juror; but a pardon of crimes restores a person's credit to make him a good evidence. 2 Haw. 432.

INFANCY, *management and diseases of.* We have been induced to treat of those disorders which are peculiar to infancy separately from other affections, partly by the difference of character which such ailments assume from those of the adult periods of life, and partly by the opportunity the subject will afford of introducing some preliminary observations on the management of infants; observations which we shall endeavour to make familiar and intelligible to the heads of families, or those engaged in conducting the human frame through its more tender and dependant states of existence.

It would be altogether superfluous to urge the importance of this subject. It has been calculated that more than a fourth part of the human race die in the first year after birth; and we have nearly the same evidence that this remarkable mortality originates not in the unchangeable dispositions of nature, but principally from erroneous and perverted management!

In the first division of this article we propose, therefore, to suggest a few hints respecting infantile diet; the regulation of temperature, or external heat; clothing; air, and exercise.

PART I.

SECT. I.—*Diet of infants.*

In the proper nourishment of children we are faithfully instructed by the almost unerring counsels of nature. Where mothers are capable of suckling their offspring, this ought, in no instance, to be omitted: it is, indeed, equally a cause of astonishment and regret that such an obvious and important principle could at any time be neglected or questioned. "See the infant (says a modern writer, while addressing himself to mothers) nourished by your fluids, and brought to a certain degree of perfection while yet in the womb. See him separated from it, and then see his nourishment flowing in another channel. See the secretion and preparation of the milk, the increasing size of the breast, and the formation of the nipples. Behold the economy of the infant himself; see him instinctively taught to search for the breast, and to suck the breast; to draw his nourishment from a new source, yet still from your body, and from your fluids. Did you see this connection sufficiently, you would neither give him over to the suckling of another woman, nor would you feed him with any other substance than your own milk." Dr. Herdman on Infancy.

Dr. Buchan gives it as his opinion, that not one in a hundred of those children survives who are abandoned by their mothers, and committed to the charge of foster-parents in the earliest stages of life; and although we may deem this statement in some measure exaggerated, the reflection of its approach to truth ought to be a sufficient incitement for the appointed and professed guardians of the health and well-being of society to enter a severe and unbiassed protest against the custom to which we now refer.

For the first two or three months the nutriment of the infant ought to be received entirely from the breast of its mother. During the whole of this time its wants are almost confined to nourishment and sleep. It is, however, to be confessed that there are some, although but comparatively few, instances of inability on the part of the parent to furnish milk in due quantity or suitable quality to the requisitions of her offspring. "To the puny progeny of a puny consumptively-disposed mother I would forbid (says Dr. Beddoes) the mother's breast." Now, although we are inclined to suppose that the author just quoted has admitted too much in favour of what is termed rearing by hand (for capacity of bearing is commonly connected with a capacity of nursing children), yet, where circumstances necessarily deprive the child of its regular and more salutary nutriment, it becomes a question of moment, What is to be substituted in its place? Not by any means what the generality of hired attendants direct. As soon as an infant by its cries denotes hunger, the nurse has, for the most part, instant recourse to a mixture of bread and water (pap), which is perhaps spiced, or qualified with a little brandy. To attempt the union of oil and water would be scarcely less incongruous: it is not hazarding any thing to assert, that the major part of infantile ailments are to be attributed to the heterogeneous compounds that are early given to children; and the spicy or spirituous ingredients which are added, in order to force an artificial digestion. The necessity of the latter bears decided evidence against the propriety of the former. In no period of life, during health, ought food to be of such a quality as to require the assistance of condiments or spirits; which last are especially injurious to the assimilating organs of a new-born infant.

About half a tea-cupful of cow's milk, gently warmed, is the only food that ought to be given to a child at its birth, after which it will frequently sleep for ten hours; a symptom which, although often alarming to the obtrusive ignorance of nurses, is to be regarded as a demonstration of the proper nature of the food that has been given, and an indication of future health.

To this plan it is sometimes necessary to have recourse, even when it is the intention of the mother to suckle her child, as women who have had many children frequently have no proper secretion of milk until after the second or third day from delivery.

Before quitting this part of the subject it is proper to observe, that the custom of immediately pouring down purgatives, as if to prove to the little stranger that it has arrived in a world of physic and of evils, is, although very generally adopted, highly injudicious. The bowels do not, in general, require to be thus artificially cleansed.

With respect to the quantity and times of administering food, mothers and nurses are accustomed to err. Nothing can be more improper than to suckle or feed an infant two or three times in the course of an hour. A child judiciously regulated does not demand nourishment, even during the first months, more than once in three or four hours; as it advances it requires feeding even less frequently, and less sleep during the day.

It has already been stated that, with the exceptions pointed out, the mother's breast ought, at least during the first two or three months, to be the sole repository and entire source of infantile nutriment. If the child is brought up by hand, cow's milk gently warmed is all the food that will be necessary for the first four or five months. After these times milk may be alternated, not by moist bread, biscuit, cakes, sugar, panadas, and gruel, but by ground rice or flour well baked; the gravy of boiled meat, which last will generally be taken with avidity; small quantities of beef-tea, or veal-jelly, and other substances of the like nature; still avoiding, unless during the actual existence of disease, and under professional direction, every article in the long list of fermented, fermenting, spicy, and spirituous materials; the withholding of which, however it may offend and alarm the nurse, will be of incalculable benefit to the child.

The time of weaning must be regulated entirely by circumstances. The process should not be abrupt, but gradual. It is very seldom advisable to refuse the breast entirely before the ninth or tenth month.

We have particularly insisted on the necessity of excluding those substances from the diet of infants which are disposed to ferment, or turn sour. A general acquaintance with the laws which regulate the existence and decomposition of such substances may be acquired with less labour than would be requisite to retain in the memory, without the aid of some connecting principle, all the individual articles which are prescribed or admitted as part of the diet in childhood and youth; and in consequence of such pleasing and easy acquisition, we should find knowledge and humanity joining issue in the joyous task of averting the artificial evils which ignorance and error have made to attach to the extremely susceptible, though not naturally unhealthy, state of the primary periods of existence. Whence does the perversity of nurses respecting the treatment of children arise? Solely from ignorance. Were they convinced that the plans which are adopted prove ultimately subversive of their intended object, they would readily consent to abandon them. "Obedience will always be more cheerful and steady after a reasonable explanation." "I have heard a variety of mothers (says Dr. Beddoes) complain that sugar, biscuit, and cakes, disagreed in the most evident manner; and yet that it was impossible, by any injunctions, to prevent the one from being made a part of the food, and the other (sugar) from being given to stop the hiccups, or produce a sensation that should suspend crying for a moment. Now it is well known that perpetually recurring complaints in the stomach and bowels arise from mere sourness; and the parties, by whose mistaken kindness, or by whose delicacy of ear they are occasioned, are perfectly informed so far. It remains only to carry their knowledge a step further. Respecting the juice of the sugar-cane, it is a very striking particular, that the poorest sort will scarcely keep a quarter of an hour in the receiver without turning sour. This can only be *told*. The acescent nature of bread, of sugar, and of the various compositions into which bread and sugar enter, may be *shewn*. For this purpose it is only necessary that a solution of sugar and water should be made into vinegar. In like manner bread and sweet cake should be placed in a heat nearly equal to that of the human body, and the servant be put to taste the infusion when it becomes acid. By an address suited to the object in view, there will surely be small difficulty in giving these simple experiments all the effect that can be desired.

"I shall very contentedly allow the childless wit to laugh at me for the whimsical idea of tutoring nurse-maids in chemistry. I have a balm at hand for any wound the shafts of ridicule may inflict. Considerate parents will avail themselves of so practicable an expedient, and many little sufferers will escape the consequences of an improper regimen. And these are probably (the author might have said *certainly*) far more serious, even in respect to the future than the present. For it clearly results from a contemplation of the manner in which human feelings and ideas gain their connection, that frequent discomposure of the stomach in the morning of life may be instrumental in overcasting its meridian and its close with a cloud of misery, such as neither skill nor fortune can disperse." Beddoes' Hygeia. For further information on the subject of diet, consult the article MATERIA MEDICA, section Dietetics.

SECT. II.—*Of temperature, including remarks on the clothing, and likewise on the washing or bathing, of infants.*

The remarkable success with which the subject of animal temperature has been recently investigated, and the application of facts, deduced from a developement of its laws, to the living system, both in its healthy and disordered state, constitute perhaps the most material improvements in modern physiology and medical practice.

Respecting the generation and adjustment of animal heat, it is not the business of this article to enquire (see PHYSIOLOGY, and MEDICINE); our present plan extends no further than the statement of a few practical rules on the subject of heat and cold, absolutely necessary to be attended to by all who undertake the guardianship of infancy and childhood: "for the management of temperature is of high importance in the treatment of the infant. It runs through, and is connected with, every part of his general treatment. It is to be considered in his dress, in his covering while asleep, in his bathing or washing, in his treatment in the house as well as out of it, in his air and exercise. In short, with a competent knowledge of the management of temperature, a nurse can scarcely go wrong in any part of the general treatment of an infant." Herdman. It must be obvious to every one that the infant at birth necessarily undergoes a sudden and material alteration in the temperature of the medium by which, without clothing, it is surrounded. The effects which would result otherwise from this remarkable change, with respect to external warmth, are in some measure obviated by the immediate commencement of respiration. This, however, is not sufficient of itself to supply the defect of external heat. The change then must be artificially rendered as gradual and imperceptible as possible; and the infant, during the first month, ought scarcely to be exposed to any sensible degree of cold, even for the shortest period. It has been with many midwives a common practice to direct that the new-born child be immediately washed with cold water, and other irritating substances, in order to cleanse the surface of the body previously to its being covered with clothing. All that is necessary, or even proper, is the use of warm water and sponge, without any further friction, after washing, than what is necessary completely to dry the skin; indeed the propriety of washing, or in any way cleansing, the skin of an infant at birth, has lately been denied by an author whom we have already quoted; but we think that the use of tepid water, applied with gentleness, and without any subsequent violence of friction, can in no case be objectionable, but ought always to be had recourse to.

As soon as this process is completed, the infant is to be immediately clothed; and now let the habits of the common routine of nurses and of friends be as sedulously watched, and as earnestly opposed, as in relation to its diet If the customary mode of feeding infants has induced a long train of present and permanent evils, the manner of dressing, (and which, till of very late years, has been persisted in with all the cruel pertinacity of contumacious ignorance), has also been productive of incalculable mischief. The evil is now diminished, but is not by any means destroyed. It has happened in this, as on every other occasion where the clamour of senseless conceits has been made to silence the simple and artless dictates of nature, that the most preposterous customs have obtained. "Physicians speculated about the infant's imperfect structure at birth, about the imperfect structure of his bones, the shapeless forms of his head, and the injuries he might sustain in birth; about injuries and distortions from hurtful motions and unnatural positions. They thought the infant's body unable to support itself, and that even its own motions might destroy it. Then in came the midwives for their share of the concern. The task was theirs to model the head, and to straighten the limbs; to improve upon nature; and to support their improvements by the application of fillets, rollers, and swaddling-bands. They vied with each other who should work the work most cunningly; for, strange to tell, dexterity in working this work of cruelty was reckoned one of their most necessary and important qualifications." Dr. Herdman.

In clothing, then, nothing further is requisite than to guard against the variations of external temperature, and to preserve a genial warmth for the maintenance of functions: the fillets, rollers, and bandages, of the nursery are not useless merely, but beyond measure dangerous. They are to be entirely laid aside, as implements of torture and destruction. No pressure on any part is to be employed. A broad strip of flannel or cotton loosely folded round the body is all that is requisite, even as a bandage for the navel. A thin single cap is the whole of the covering that the head requires or should receive. The body should be enveloped with a shirt of fine cotton, made loose and easy, over which should be a covering of flannel: and in a word, the dress is to be so constructed, that the rapid motion of the circulating fluids may be preserved without the smallest impediment. It may be necessary, before quitting this subject, to state, that the writer's experience has convinced him of the propriety and importance of the above regulations in regard to dress and diet, even where relationship has ensured an attentive and unprejudiced scrutiny into particulars.

But it is not as it regards clothing merely that the medium to which a young infant is exposed demands assiduous attention; much care ought to be taken in providing likewise "a fit habitation for the expected little visitor." The apartment devoted to the rearing of infants, during the first months especially, ought to be so constructed and situated as to ensure a steady, equable, and mild temperature. Small confined nurseries, where it is possible, ought to be avoided. In such apartments it is difficult to guard against the extremes of either heat or cold. An exposure to a stream or current of air, occasioned by an unsuspected breach in the window, directed on the body of a sleeping infant, has often been productive of serious injury. Dr. Beddoes directs that the air of the nursery be never suffered to fall below fifty degrees; and it is always to be carefully retained in the memory, that the deficiencies occasioned by ill-constructed buildings can never be compensated by heaping coals on the fire; by this custom indeed not only is the air rendered impure, but the temperature of the room is made still more irregular, and the danger of colds consequently increased.

There is one caution which is especially necessary with respect to the management and economy of nurseries. All occasions and sources of *damp* should most assiduously be guarded against. This caution is the more needful, because the danger from this source appears to be the least understood or suspected. It is not uncommon to observe that parents and nurses who would dread the opening of a sash-window, at the same time unwittingly expose themselves and their charge to a much greater degree of cold by permitting the suspension of wet clothes, in order to dry, about different parts of the apartment, and even by carelessness respecting the washing of the floor. The process of drying is the process of producing cold, and that too of the most noxious kind; for cold, when combined with moisture, has been proved, in an excessive degree, inimical to the animal economy. Damp is equally insidious and detrimental. We are fully persuaded that from this cause originate many scrophulous and other infantile ailments so peculiarly prevalent in the British isles; and that where the diseases have been fancifully attributed to deleterious impregnations in the waters we drink, and various other sources. By every individual, but more especially by the parents and guardians of infancy and youth, freedom from damp should be the first and great requisite in the choice of apartments and houses.

But to return to the infant's dress. The covering which we have recommended ought to be continued for the first six or seven weeks of infancy; during this period, as we have already observed, nourishment, warmth, and repose, are almost its only requisites. After this time, however, or towards the close of the second month, the infant economy begins to change; vascular action comes now to be connected with voluntary muscular motion; the percipient faculty is gradually developed; and the whole organization appears to undergo a change. The body is now warmed in a greater degree and more regular manner, by actions of its own production, and heat of its own formation. Exterior warmth is daily less necessary; and that quantity and kind of clothing, which before were proper and genial, now become irksome and debilitating. If with this progress of growth the summer months are at the same time about to appear, the covering of the child may, in a short time, be reduced even to a shirt and single external garment: the utility of this light clothing will be rendered evident by the feelings and expressions of the infant. It is almost unnecessary to observe, that general precepts are incapable of undeviating and indiscriminate application. The changes of the weather, the season of the year, and the delicacy or robustness of the constitution, will interfere with every rule, and give exercise to the independant judgment of every parent. Providence, however, has so ordained it, that in this, as in every other respect, the dictates of nature, which are communicated by the desire and aversion of the infant, furnish the most faithful directories with respect to its management; and these are conveyed with such distinctness and precision as to be generally intelligible. It is only by disobeying nature s laws that, in the treatment of infancy, we have wandered wide of the path of rectitude, and are under the necessity of retracing our steps.

We now close the present section by a few additional remarks on the much-contested question of bathing. It has already been observed, that an infant, upon its first entrance into the world, should be immediately washed with tepid or warm water. Others recommend immersion rather than ablution. "For a new-born infant (says Dr. Beddoes) I should prefer instant immersion in water at eighty degrees to washing." It is perhaps immaterial to which mode of cleansing we have recourse, unless the latter may be deemed objectionable on account of the unnecessary shock it may occasion to the tender frame. It is likewise to be observed, that conveniences for the former are procured with more facility than the latter; and that it is not every nursery that can, without difficulty, be furnished with a "proper vessel for a warm bath." The question, however, now to be resolved is, in what mode, and at what temperature, bathing or washing should be continued through the period of childhood. This question, like others, is incapable of decision by an appeal to separate principles. By one writer, daily immersion in, or ablution with, cold water, for the first two or three years of life, is earnestly recommended; by another, it is condemned as an unnecessary piece of cruelty, while tepid washing is directed to supply its place. Like the different decisions past on the cameleon's hue, these precepts, although opposite, may each be equally just. The weakly infant shall be washed "with cold water into irrecoverable debility," into convulsions and death; while to the robust and hardy child the same element at the same temperature shall be congenial, and by its use he will be prepared for the variations of cold and heat, to which he will in the course of life be exposed. In a popular treatise on consumption, recently published by Dr. Reid, we meet with the following judicious regulations on the subject of bathing: "It may be proper to premise (says our author), that by the cold bath is understood water at an inferior standard to eighty degrees of Fahrenheit's thermometer. Between this point and that of 90 degrees the bath may be termed temperate; and it is only beyond this last degree of heat that the epithet warm can with propriety be applied. From neglecting accurately to observe these distinctions, which are of very material importance, a want of precision has often connected itself with directions for the employment of both warm and cold bathing.

"Immersion in cold water, during the period of infancy, has been very generally recommended, and too often had recourse to, in an indiscriminate manner, to preserve health, and ensure hardiness. The author has remarked several instances where sensible, and sometimes considerable, injury has arisen from neglecting to observe the precautions necessary to regulate the employment of this important agent in very early years. In infancy danger to the lungs from cold bathing has been stated to exist in a very inferior degree; and by the practice of dipping children in cold water, susceptibility to the injurious impression of cold, in succeeding years, has been thought to be materially diminished. This principle, in the abstract, is undoubtedly correct; and, with the exceptions and precautions now to be mentioned, may be pursued with propriety and advantage. Two infants may be supposed of one family, of reverse constitutions. In the one a general torpor, debility, and great susceptibility to the impression of cold, shall prevail: in the other comparative vigour, activity, and warmth. That degree of cold which would refresh and invigorate the one, would confirm debility and augment torpor in the other. A bath which is not cold to the sensations must, in the first instance at least, be resorted to for the weaker infant; and in neither case should immersion in cold water be practised when the external warmth of the body is inferior in degree to its general standard; when after immersion the body appears to be chilled, or when returning heat is attended with febrile languor, instead of the grateful and genial warmth characteristic of the appropriate action of exciting powers. If the practice of immersion is guided by a cautious observance of these particulars, it may be adopted with safety, and will be attended with success; but a total neglect of bathing would be greatly preferable to the severe and incautious manner in which infants are frequently exposed to these violent and rapid changes in temperature." It ought to be added, that whether washing or immersion is employed, much care should be taken in drying the skin, particularly in those parts in which it is loosely situated, as about the groin, and in the arm-pits.

It may be necessary likewise to observe, that the breast ought on no account to be given to the child while being washed and dressed. A perseverance in this respect will ultimately prove of essential advantage. The habits of the child are greatly under the command of the parent or nurse. At the expence of a few temporary tears permanent comfort may be attained.

Sect. III.—*Air and exercise.*

It has recently been conjectured that the air we breathe contributes equally, and nearly in the same manner, to the nourishment of the body, with the aliment that is taken into the stomach: respecting the grounds of this opinion it would not be in place, in the present article, to institute any enquiry. (See Physiology; and Materia Medica, section Dietetics). We have here only to impress the necessity of a constant and unremitting regard to ventilation, in order to ensure a healthful condition in the infantile economy.

Both the truth and importance of this principle would seem too obvious even to require notice by a writer on regimen, had he not daily opportunities of witnessing the mischief arising from neglecting its application. The public mind, however, appears to be at length awakening from a long lethargy of prejudice and error. We at length begin to breathe and to live. Even among the poorer and least informed classes of society, cleanliness and ventilation come to be acknowledged as the surest barriers against the invasion of disease. Although, however, on this subject modern science has much to boast, much likewise remains to be accomplished; and even in the present day examples cannot be too frequently pressed upon public observation of the injurious tendency, especially in the susceptible and delicate period of infancy, of neglected ventilation. "There is reason to suppose that, from the inattention of our ancestors to fresh air, multitudes must have perished in the very dawn of existence. In our times grown persons have been dangerously affected by such a deficiency of this necessary of life, as did not even produce immediate uneasiness. *Infants have perished in great numbers by a slow suffocation, terminating in convulsions.* As soon as the want of ventilation was observed the mortality has ceased." Beddoes. A fact, of which the following relation furnishes irrefragable evidence. In the lying-in hospital at Dublin 2,944 infants, out of 7,650, died in the year 1782, within the first fortnight from their birth: they almost all expired in convulsions; many foamed at the mouth, their thumbs were drawn into the palms of their hands, their jaws were locked, their faces swelled, and they presented, in a greater or inferior degree, every appearance of suffocation. This last circumstance at length induced an enquiry whether the rooms were not too close, and insufficiently ventilated. The apartments of the hospital were rendered more airy; and the consequence has been, that the proportion of deaths, according to the register of the succeeding years, is diminished from three to one.

Such facts as these cannot be too often made to pass under review. By the parent anxious for the well-being of her offspring they ought constantly to be enforced upon the minds of servants and nurses, whose supineness in respect to proper ventilation is often only to be equalled by their mismanagement in other particulars. This indolence is often by servants carried to such an extent as very materially to injure their own health. "In a large family (says Dr. Darwin) many female servants slept in one room, which they had contrived to render inaccessible to every blast of air. I saw four who were thus seized with convulsions. They were removed into more airy apartments, but were some weeks before they all regained their health." Had infants unfortunately been confined in the same tainted atmosphere, convulsions in these would have been more readily induced, and might perhaps have proved fatal! A child then ought never, if it can be avoided, to be permitted to sleep with many individuals in the same apartment. It should not be lulled to rest in its nurse's arms. When put to sleep in the couch or cradle the face must not be covered; at night the clothes should be entirely changed; after the first or second month it should be daily taken out in the open air, when the weather is not cold or damp: this is best done in the forenoon, immediately upon being washed and dressed; care being taken that the infant is not carried too much in one position, and that it does not suffer from cold. Every impediment to the purity of the air within doors is to be as speedily as possible removed; and when the skin is preternaturally hot, or the little patient becomes restless and febrile, the fires of the nursery are to be extinguished, the windows thrown open, or the apartments changed.

To the full enjoyment of the atmosphere the free use of the limbs must likewise be added. On exercise scarcely any thing remains to be said. Freedom from all constraint is implied in the mode of dress above recommended. To those, however, who imagine that nature can be assisted by the contrivances of art, or that symmetry of form is to be ensured by unnatural restriction, it may not be improper to observe, that deformities are only known in those countries where mechanical dexterity has been called upon to prevent them. "The infants of the Caffres (says the author of Travels into the interior of Southern Africa), soon after birth, are suffered to crawl about perfectly naked; and at six or seven months they are able to run. A cripple or deformed person is never seen. In Egypt, again, the haram is the cradle or school of infancy. The new-born feeble being is not there swaddled and filleted up in a swathe, the source of a thousand diseases. Laid naked on a mat, exposed in a vast chamber to the pure air, he breathes freely, and with his delicate limbs sprawls at pleasure. The new element in which he is to live is not entered with pain and tears. Daily bathed beneath his mother's eye he grows apace. Free to act he tries his coming powers; rolls, crawls, rises, and, should he fall, cannot much hurt himself on the carpet or mat that covers the floor."

PART II.

DISEASES OF INFANCY.

SEC. I.—*Mesenteric atrophy* (Tabes mesenterica, Atrophia infantilis).

This is, in a great measure, the origin and root of the major part of infantile diseases. An affection of the mesenteric glands in children is often connected with, is not unusually the occasion of, and is still more frequently mistaken for, worms; it is the medium through which rickets are produced; it is, in general, the more immediate cause of diarrhœas, and other bowel complaints; and in several instances has been the "forerunner, if not the cause, of hydrocephalus, or dropsy in the brain."

Than this no complaint bears more evident characters. The physician who has been accustomed to the general aspect of infantile disorders, will most commonly commence his enquiries by an inspection of the abdomen. If he perceives a fulness and tenseness about the navel, and a general protuberance and hardness about the belly, attended sometimes with a knotty irregularity, indicating glandular tumefaction; and if, combined with this symptom, a tendency to atrophy, or, as it is called, falling away in flesh and strength, is observed; a greater or inferior degree of mesenteric consumption is present. Such then are the never-failing attendants of the disorder now under notice; they are its distinct and prominent features. A variety, however, of other adjunctive symptoms, for the most part, display themselves, and constitute part of the malady. Sometimes an universal languor and listlessness will be connected with aversion to food; at others an inordinate appetite is present. The bowels are at times costive, but at others the contrary; the evacuations are discoloured, and unhealthy in their appearance; they are, for the most part, slimy, or viscid in their consistence, but are discharged, both with respect to quantity and quality, with the utmost irregularity: the countenance is pale, "except when the hectic flush prints its deceitful and ill-omened animation on the cheek:" the features are, for the most part, full and tumid: the eye is dull: the breathing is oppressed, and spasmodic: the pulse is invariably feeble, but is sometimes slow, and at others inordinately accelerated. In the advanced stages swellings of the feet and ancles are sometimes observed. The little sufferer generally moans piteously; and this, if the disorder has arrived to any considerable extent, is almost the only sign which is given of consciousness or feeling.

Causes.—Mesenteric atrophy is most prevalent among the children of the poor, especially in large cities, and in dirty confined situations. "The noxious powers producing it," in the language of Dr. Brown, (see BRUNONIAN SYSTEM, vol. I. p. 274) "are the same with those of every other asthenia. They are want of food, or diet of watery matter and bread; cold and moisture, the latter increasing the effects of the former; too little nursing (gestationis justò minus); habitual vomiting and purging; irregularities in the times of sleep, meals, and every other part of infantile management; filth; impure air; an inattention to the instincts of nature in the treatment of children." Elementa Medicinæ. To these causes Dr. Brown ought to have added the practice of giving children fermented or spirituous liquors, and those other artificial stimuli, to which we have referred in the former part of the present essay. This custom is extremely prevalent in the inferior classes of society; and hence, in part, the frequency of mesenteric atrophy among the offspring of the poor.

Immediate cause of, and constitutions most obnoxious to, mesenteric consumptions.—The unusual bulk of the abdomen, which is so characteristic of this disease, obviously depends upon a deranged state of the mesenteric glands. The tumefaction, however, does not arise from the source to which it is vulgarly referred, "the presence of tough, ropy humours, causing an obstruction in the tumefied parts." The theory of mechanical obstruction is indeed totally founded in error. It is inconsistent with the laws of the animal economy. It is incompatible with living action; and, as we shall immediately have occasion to observe, has been the cause of much and serious mischief, both in the domestic, and even the professional treatment, of this and other ailments. "The idea of attenuating humours, purifying blood, and clearing passages, rests upon a wrong principle." So far indeed from the glands of the mesentery being less permeable under disease than when in a state of health, the exact contrary is the fact; and not only is their area enlarged, but new vessels are often at the same time formed; and hence the morbid increase of bulk.

The attendant atrophy is easy of explanation. The deranged action of the glands in question interferes with the due preparation of the chyle, the whole of which has to undergo a preparation in these organs. The chyle is the fluid from which the blood is formed: on the quantity and quality of the blood depend health, growth, and life; by its deficiency, or want of due proportion in its component principles, debility, disease, and atrophy, are produced.

The attendant symptoms are not difficult to account for; the torpid and irregular state of the bowels is partly owing to the general inactivity in the lymphatics of the liver; hence the thinner portions of the bile remain unabsorbed, and this fluid is in consequence too diluted to afford a due excitation to the intestinal fibre. The sliminess and viscidity of the fæces arise from the disordered state of the glands of the intestines; and the œdematous swellings of the feet are evidences of a general inactivity, or deficient excitement, pervading the whole lymphatic system.

The constitutions in which tabes mesenterica most readily makes its appearance, are those which are denominated scrophulous. The marks of scrophula we shall not here enumerate; it may be sufficient to observe, that in habits of this description the lymphatic and glandular systems are especially prone to suffer from the exciting causes of disease. This indeed is more or less the case in every individual during growth, as, at this period of existence, the office which these vessels perform in the animal economy, is more important and complicated than in the succeeding stages of life.

Treatment.—The most effectual remedies are necessarily the converse of those which occasioned the disease. These we shall likewise enumerate from the Elements of Dr. Brown: "nourishing exciting milk; three or four meals in the course of the day, composed chiefly of warm milk; pure animal, and by no means weak, soups, mixed with wheaten flour or bread; a due temperature, so that a genial warmth may be preserved, without producing irritation, or occasioning too copious sweat; avoiding every species of evacuation; good nursing; a proper regulation of the times of sleep, food, and every other circumstance connected with the management of the susceptible and tender condition of infancy; cleanliness; tepid bathing in moderately cold weather, and cold bathing in warm; pure air; being sent out of doors as much as possible, excepting when the weather is damp; and, finally, a judicious attention to desires and propensities; this ought to be carried to such an extent as to obviate, if possible, the most trifling local irritation, as by the scratching of a part that itches."

The above are necessarily adapted to the milder forms of the complaint. When the disorder has arrived to a certain extent, medicinal is now required in aid of domestic treatment: for although the mesenteric atrophy, unless it is a consequence of defective structure, may at all times be prevented, and in its earlier stages with facility combated, without the aid of drugs; these, at length, come to be absolutely indispensable. It ought, however, to be impressed on the public mind, that pharmacy, although it may correct the errors, can in no wise become a substitute for, or supply the deficiencies of, regimen.

The objects of the medical practitioner, in the treatment of the disease in question, will be twofold. 1st. That of immediately and forcibly stimulating the lacteals and mesenteric glands; and, 2dly, the preservation of a due and equable excitement in order to obviate the recurrence of the disorder.

[N. B. For the explanation of any terms that may not be familiar, the reader is referred to the articles ANATOMY, PHYSIOLOGY, and MEDICINE.]

The first of the above intentions is most speedily and effectually accomplished by mercurial purgatives; and of these calomel (submurias hydrargyri) is generally to be preferred. The benefit which has often resulted from preparations of mercury, particularly in the form of calomel, has frequently been accounted for upon very erroneous principles. It is customary to attribute every complaint of childhood, where the stomach and intestines shew marks of derangement, to worms. With the signs of the actual existence of these animalculæ, we have already remarked those of tabes mesenterica are, from their affinity, often confounded. Advertisements of infallible cures for worms, as indeed for every other malady, are constantly before the public: these, for the most part, contain mercury, as the only agent of consequence in their composition; and from the operation of this medicine upon the diseased glands, provided, by accident, the quantity taken is apportioned to the age and constitution of the recipient, immediate, and temporary relief is perceptible. Worms are supposed to be expelled the system, and the infallible medicine is indiscriminately, and often fatally, circulated among the public.

A further error with respect to the agency of calomel in mesenteric affections, is that of attributing its effects solely to its purgative quality. This last error is not confined to the unprofessional. Ill-founded notions, as we have above hinted, are still too general in regard to obstructing humours; and the cure of this disorder, with all others which are conjectured to arise from obstruction, is consequently imagined to be performed by evacuating medicines. We are disposed to believe that a recent publication, although in the main extremely useful, has, by the unqualified recommendation of purgatives, given too much encouragement to this mistaken principle.

Dr. Hamilton, the author of the work to which we allude, has classed, under the title of marasmus, the asthenic affections which are common to young persons, and of which the disorder now under consideration is one of the most general; and these affections he "is convinced have often been removed by the diligent exhibition of purgative medicines." Now we are fully persuaded, although actual, and even repeated, purgations are in many cases indispensable; that for the most part, especially in "incipient marasmus," such a qualification in the dose of cathartics is to be preferred as may ensure an excitation of the glandular, lacteal, and lymphatic organs (the organs principally concerned in the production of the complaints in question), without copiously evacuating the contents of the bowels. For this persuasion we have the authority of experience. Further, it is to be remarked, even where large and repeated evacuations, in these diseases of debility especially, have been followed by beneficial effects, that, even then, the evacuation itself has constituted but a share in the process of recovery. This principle may be evidenced in the example of either vomiting or purging. Let a case be supposed of mesenteric affection carried to such an extent, that the torpid condition of the lacteal glands has extended itself to the hepatic and biliary organs; where even dropsical effusions have taken place, and contributed to the enlargement of the belly; and where this abdominal protuberance is contrasted, in a most distressing degree, with the emaciation of the limbs. Under these circumstances (and the writer of the present article has witnessed them in the full extent described), if either a quantity of ipecacuana, emetic tartar, or any other emetic drug, is given sufficient to occasion vomiting, or such a dose of calomel as alone, or in combination, may produce a copious alvine discharge: the immediate result will prove, that the principal part of the medicinal agency has been constituted by a sudden and powerful impulse communicated to the glandular and absorbent vessels. The liver shall commence a regular secretion of bile, the fæces in consequence assume a proper colour and consistence, the skin shall lose suddenly its sallow sickly hue, the size of the abdomen be lessened, and even the swellings of the ancles be diminished; all evincing, in the most unequivocal manner, an increased action in the absorbent system.

By those who are aware of the importance of acquiring correct notions in respect to medicinal agency, the above remarks, although perhaps in some measure irregularly introduced, will not be deemed misplaced. They will, it is hoped, facilitate the conception, and serve to curtail the discussion, of the remaining disorders that are to be treated of in this article.

We now recur to the more immediate subject of the present section.

We have observed, that the first object of the physician, in cases of deeply rooted mesenteric disorder, is to produce an immediate and forcible excitement in the lacteal glands; the manner in which this object is to be attained may be gathered from the preceding remarks. Either calomel purgatives, or emetic substances, are to be employed, according to the circumstances of the case, or the inclination of the practitioner; and now the judicious regulations of diet and regimen prescribed by Brown, are to be assisted by medicines, in order to accomplish the second purpose, that of preserving a due excitement to secure against the recurrence of the disease.

The physician will be careful to keep in view, that the absorbent system is principally concerned in this, as well as in the other asthenia of infants. It is to this part of the frame that remedies are especially to be directed. Among the various stimuli, those therefore are to be preferred, the influence of which appears in an especial manner to be directed to this part of the organization. Chalybeates have this property in a remarkable degree; and accordingly one or other of the various preparations of steel has been judiciously and successfully had recourse to in tabes mesenterica: these are to be conjoined with pure air, and due exercise, without which the most appropriate medicines will be in vain administered. The continued use of small doses of calomel, or other mercurial preparations, either in conjunction with, and sometimes to the exclusion of, steel, will prove highly useful in restoring a due energy and action to the absorbents. These, like all other active medicinals, require much address and discrimination in their employment. It is from the presence of mercury, as above hinted, that both the utility and dangerous tendency of quack medicines are for the most part derived.

In the practice of the writer of this article, extremely small, and very gradually augmented, doses of digitalis have appeared to restore, in a remarkable degree, the wonted vigour of the lacteal vessels. The free use of this very important and active medicine has long been admitted in dropsy, an affection of the highest debility. In tabes mesenterica we believe its employment is novel; but we are, at the same time, persuaded, from the result of several cases of this and other modifications of infantile asthenia, that foxglove might be made, under due regulation, a very successful agent in the treatment of these complaints. Under these circumstances, on account of the comparative minuteness of the dose, the digitalis is best given in the form of tincture: a preparation which has not hitherto been received into the London Pharmacopeia. See MATERIA MEDICA, and PHARMACY.

SECT. II.—*Water in the head.* (Hydrocephalus.)

The discriminating characters of this disease demand assiduous attention from the medical practitioner. It cannot be doubted that a great number of children are constantly destroyed by water in the brain, where the nature of the malady has been entirely misunderstood, and the symptoms referred to other sources, most commonly worms; while, on the other hand, hydrocephalus has been very frequently suspected, and the event has proved that the suspicion was destitute of any proper foundation.

Hydrocephalus is generally divided by authors into the internal, or that in which the fluid is contained in the ventricles of the brain; and external, where the disease is exterior to the substance of this organ, and the water is found in its investing membranes. The first species has likewise been denominated acute, the second chronic. This division, however, is calculated to mislead; not merely on account of the frequent connection between the two species (internal and external) of hydrocephalus, but because the former, as well as the latter, is oftentimes chronic, and by no means necessarily preceded by an inflammatory affection of the parts concerned in its production.

The chronic internal, chronic external, and the acute, species of hydrocephalus, would constitute a classification of the disease, approaching nearer to accuracy than that which has been hitherto adopted; and we shall proceed to give a brief description of each, requesting the reader to recollect that the different kinds are often mixed, and consequently exhibit characters in an almost endless variety.

Chronic internal.—This, although overlooked in the ordinary division, is perhaps the most usual form in which the affection presents itself; it arises from the same disposition in the habit, and is oftentimes combined with the disease treated of in the preceding section. More commonly, however, it is in a manner vicarious of this last; and the same causes may, perhaps from accidental circumstances, at one time occasion tabes mesenterica, which would at another have produced hydrocephalus. Its symptoms are less decided than those of the other species. When, however, in children of a sluggish habit, or scrophulous constitution, an unusual drowsiness or stupor is present, the child gradually loses his vivacity and spirits, is indisposed to make any exertion of his limbs, is unusually fretful and peevish, complains or exhibits signs of an uneasiness in the head, is affected with convulsive fits without any apparent cause, has an unusually tardy pulse, and more especially if the pupil of the eye is not found to contract upon the application of light, there is reason to suspect the presence of water in the brain, although there may be no symptoms of external disease, and no preternatural enlargement of the head, except what is usually met with in young persons of a torpid scrophulous habit; and the suspicion has been too often confirmed by dissection, even where a fatal termination has happened, without being preceded, during any period of the malady, by the symptoms immediately to be mentioned, characteristic of the acute species. This first kind of hydrocephalus is succinctly described by Dr. Heberden, in the following words: "Capitis dolores, manus ad caput crebro admotæ, clamores subiti, distensio nervorum, stupor, mentis perturbatio, motus venarum lentus, postremo cæcitas." He adds, "Justam hujus morbi suspicionem injicjunt hæc symptomata etiamsi capitis moles non fuerit aucta."

Chronic external.—The head of an infant at, or soon after, the period of birth exhibits a preternatural size and form; the regular process of ossification does not take place; but the principal part of the external surface of the cranium continues soft and yielding, while not unfrequently, in the progress of the complaint, an undulation of a fluid may be perceived by applying the hand to the sutures of the skull. As the disease continues to advance, the signs of its existence become shortly obvious to the most superficial observation; not only does the head increase to an enormous size, but the growth of other parts is in a proportionate ratio defective; the limbs do not often acquire a much greater bulk than at birth; at the ordinary period of teething no teeth present themselves; the percipient faculty is not gradually unfolded, as in other infants; and, indeed, although vitality is preserved, it appears to be a vitality almost entirely unconnected with feeling. In this state of torpid existence life however is, in some instances, prolonged for four, six, or even a greater number of years. In the Commentaries of Van Swieten, we have the relation of life being maintained under this malady for thirty years: this, however, is an anomaly; and indeed the hydrocephalic patient seldom survives the second year.

Acute hydrocephalus.—The acute, phrenitic, inflammatory, or, as it has been termed by some writers, apoplectic hydrocephalus, is not, like the other species, entirely confined to any constitution. Although most frequent in children under twelve years, it is sometimes observed in adults. It has been divided by Dr. Whytt, and others who have followed him, into three distinct stages: the first of which is invariably characterised by a pulse of much celerity and comparative strength; in the second the pulsations become slower, and more feeble; in the third and last period their rapidity is increased even beyond that of the primary stage; but this increased action is now connected with extreme debility. These different changes in the circulation are not, however, always to be traced even in the acute species of hydrocephalus, in that order which the observations of Dr. Whytt would lead us to suppose.

Obscure affections of the stomach, a general feeling of lassitude, with sometimes a kind of palsy of the limbs, or an affection of them, in some measure similar to that observed in St. Vitus's dance, if the child has previously been able to walk, sometimes present themselves as precursors of the first, or the inflammatory stage; at other times the feverish state, intolerance of light, violent pains in the head, and vomiting, are the first signs of disorder that are noticed. These symptoms are in some cases connected, according to the observations of Dr. Rush, with an impatience of sound; the pain of the head is often confined to one side, and in proportion to its intensity the nausea and vomiting become less urgent, while with the remission of the pain these affections of the stomach are disposed to recur. Respiration at this time is spasmodic and irregular; the bowels are generally so costive as to require very drastic purgatives, in order to produce evacuations. This stage of the complaint continues sometimes for several days, but is more usually in a shorter period succeeded by the second, which commences by a sudden reduction of the pulse, and other symptoms of irritation. The pain of the head now becomes less urgent, torpor succeeds to watchfulness, the infant lifts his hands to his head, and frequently utters piercing screams (clamores subiti); a degree of strabismus takes place of the previously morbid susceptibility of light; the little patient lies in an horizontal posture, with the head low, and shows an indisposition to be taken up; the bowels still continue torpid; the urine not unfrequently deposits a thick sediment; and after these symptoms have lasted from seven to fourteen days, the complaint sometimes appears suddenly to decline. This semblance of returning health is, however, deceitful, and is but a prelude to the final period of the complaint: it is now that the pulse increases in frequency, and oftentimes so quick as not to be counted. Dr. Whytt informs us that in some children he has been able to number 210 pulsations in the space of a minute; this extraordinary rapidity, however, does not last through the whole of the day; it comes on and declines with the accessions and remissions of the hectic flush in the cheek. The eyes at length become insensible to the strongest light, convulsions come on, and life is terminated. The duration of this last period, like that of the others, is irregular. Sometimes the patient is carried off in less than a week from its commencement; at other times the child lingers in a hectic state for three, four, or six weeks; and Dr. Monro has informed us, that the last stage has been known to be protracted even to the fourth month.

Causes.—The two first species of the complaint are decidedly of a scrophulous nature. They generally come on without any evident exciting cause, and, like other asthenic affections, in the early periods of life, originate from lymphatic debility, without previous excitement in the vessels of the brain to produce the effusion: the last species is perhaps always preceded by an inflammation in the internal vessels of the brain. The immediate cause of this irritation is not, however, in every instance to be detected; it may arise in subjects predisposed, in common with all other inflammations, from the sudden alternations of cold and heat. It has been observed to supervene upon the contagious eruptive affections, especially when these have been unusually violent; and Dr. Beddoes, in a letter to Dr. Darwin, enquires "whether it may not happen more frequently than has been suspected from external injury?" Zoonomia.

Treatment.—Evacuations of every kind, viz. cathartics, sudorifics, emetics, general and local blood-letting, as well as the external application of cold, and of blisters to the scalp, with due attention to the erect position of the head, had all, in conjunction or separately, been tried in the acute species of hydrocephalus, but, according to the general report of physicians, without effect.

In consequence, therefore, of the ill success that had attended the common routine of treatment in hydrocephalus, Dr. Dobson, of Liverpool, was induced to make trial of mercurials, with an intention of exciting the absorbents of the brain, and in this manner removing the extravasated fluid. The event appeared to justify his theory; and we have several cases recorded by this physician and by others, in which mercury, carried to the extent of salivation, accomplished a speedy and effectual cure. The following case is from Dr. Percival: "One of my own children, a girl, aged three years and three months, has lately been a severe sufferer under this alarming malady. As soon as the characteristic symptoms of the disease clearly manifested themselves, I laid aside all other remedies, convinced by repeated observation of their insufficiency, and trusted solely, though with much solicitude, to the internal and external use of mercury. In forty-eight hours, signs of amendment appeared, and her recovery was perfected in six days. During this space of time, thirteen grains of calomel were administered, and seven scruples of unguentum mercuriale fortius carefully rubbed into the legs."

With the same design of exciting the absorbents, digitalis has recently been employed. "In one child," says Dr. Darwin, "I tried the foxglove in tincture, but it was given with too timid a hand and too late in the disease to determine its effects." In the work of Dr. Reid, to which we referred in a former part of this article, we meet with the following observations: "The universality of lymphatic absorbents is rather conceived than actually demonstrated. Dissection has hitherto not been able to detect these vessels in the brain; analogy, however, favours the supposition of their existence. If that frequent and too fatal disease of young persons, water in the brain, admits of cure, the remedies which effect it, must necessarily operate by producing an absorption of the effused fluid. The author imagines he has witnessed the cure of hydrocephalus by means of foxglove. The symptoms, however, of worms and other infantile affections, so often resemble those indicative of water in the ventricles of the brain, that it is scarcely possible to decide with absolute certainty on the interesting question of the inevitable fatality or remediable nature of hydrocephalus."

If foxglove should be proved by future experience to succeed as a remedy for this alarming malady, its modus operandi must be referred to the extraordinary faculty which it possesses of repressing the arterial, while it stimulates the absorbent system. Both in the acute and chronic hydrocephalus, it appears to be deserving of a more extensive trial. To the earlier stages of the former we should, *a priori*, be disposed to conceive it more applicable than even mercury.

SECT. III.—*Worms.* (Vermes.)

The marks by which the presence of worms is indicated are confessedly at times, both in the infant and adult, obscure and equivocal. In the majority of cases, however, the phenomena which they present require only for their detection a careful and discerning scrutiny.

In persons affected with worms, the countenance in general has a peculiarly livid and dirty kind of appearance, very different from that which characterizes mere lymphatic debility, as in tabes mesenterica, and hydrocephalus. The eyes become dull, the pupil dilated, but not averse to light, as in hydrocephalus, the upper lip swelled, the sides of the nostrils enlarged, and there is almost constantly a violent itching of their internal membrane. The breath is remarkably offensive, saliva is secreted in unusual abundance; during sleep there is most generally some grinding of the teeth, and epileptic affections are by no means uncommon; the pulse is intermittent, the febrile irritation is not always of the hectic kind, the appetite is often voracious, lancinating pains are complained of in the stomach and bowels, and tenesmus, attended with a distressing irritation about the anus, is, especially from some species of worms, exceedingly frequent. Cough is not uncommon. These last, however, are more frequent symptoms in the adult than in the child. See MEDICINE.

Causes.—"The tumid belly, bloated countenance, and swelled upper lip," says Dr. Darwin, "are concomitant circumstances attending the general inactivity of the absorbent system, which is therefore to be esteemed the remote cause of the generation of worms." Worms, however, are often produced through the medium of intestinal viscidities, independantly of the absorbent vessels. The immediately exciting causes are some of those already mentioned as productive of mesenteric atrophy, more especially the reception into the stomach of indigestible substances. Dr. Darwin, indeed, supposes, that not merely the nidus of worms is thus formed from aliment incapable of assimilation, but that these animalculæ are actually received from without: for this opinion, however, there does not appear any foundation. Worms are actually engendered in the alimentary passage.

Treatment.—Emetics; mercurial purgatives; chalybeates; vegetable bitters; avoiding indigestible aliment. For an account of the different kinds of worms, and specific anthelmintics, consult the articles MEDICINE, and MATERIA MEDICA.

SECT. IV.—*Rickets.* (Rachites. Atrophia infantilis.)

This is likewise an affection of the lymphatic system. Every one knows the characters by which it is marked. An infant with a large head, protuberant forehead, swellings in the smaller joints, depressed flattened ribs, emaciated limbs, and tumid abdomen, is decidedly rickety. These symptoms, in common with the other asthenia of infants, usually make their appearance before the second year. The first indication of a rickety tendency is a remarkable flaccidity of the muscular fibre; disinclination to exertion follows; and the irregularities above enumerated shortly supervene, followed by hectic, cough, confirmed atrophy, death, or permanently distorted limbs.

Causes.—Debility, most commonly of an hereditary nature, constitutes the predisposition to rickets. Bad air, bad nursing, improper diet, uncleanliness, and damp, are its exciting causes. Hoffman describes the proximate cause to be a deficient supply of nervous influence to the spinal marrow, preventing the due nutrition of parts. Dr. Cullen supposes, a deficiency of bony matter in the fluids constitutes the disease. A more correct account, however, of the essentials of rickets, would make it to consist in deficient excitement or power in those vessels, by the action of which osseous matter is thrown out, and bone constituted.

Treatment.—Indication 1st. To cleanse the first passages from obstructions. Methodus medendi: emetics, cathartics, calomel.

Indication 2d. To restore due energy to the secretory vessels of the bones. M. M. chalybeates, exercise, bathing.

SECT. V.—*Disorder in the bowels.* (Diarrhœa infantilis.)

Among the morbi infantiles in the yearly catalogue of every medical practitioner, diarrhœa occupies a conspicuous situation. The griping, green and otherwise discoloured fæces, pains in the abdomen, with drawing up of the knees towards the stomach, severe crying, febrile irritation, and a greater or less degree of actual convulsion, are perhaps the most common among the diseases of infancy.

Causes.—These affections, as we have already observed, are almost invariably occasioned by improper diet. Dr. Darwin gives us the following relation: "A child of a week old, which had been taken from the breast of its dying mother, and had by some uncommon error been suffered to take no food but water-gruel, became sick and griped in 24 hours, was convulsed on the second day, and died on the third!" He adds, "That among the poor children of Derby who are thus fed hundreds are starved into scrophula, and either perish or live in a state of wretched debility." Zoonomia.

Treatment.—Calomel, with rhubarb, is to be immediately given, which is to be followed by antacids, such as prepared chalk and magnesia. With these are to be connected, according to the violence of the disorder, aromatics and stimulants, such as cinnamon, nutmeg, and opium. Sometimes it is necessary to give an emetic. In all cases indigestible food is to be avoided.

SECT. VI.—*Affections occasioned by teething.* (Dentitio.)

Pains in the head, convulsions, frequent and sudden startings, more especially in sleep, eruptions on the skin, disorders of the stomach and bowels, cough, and hectic fever, are not unfrequently occasioned by the process of toothing. Dr. Darwin conjectures, that "the pain of toothing often begins much earlier than is suspected;" and that the apparent cause of the disease is in reality its cure, as the convulsions, which are oftentimes the most violent and then by far the most alarming of the above symptoms, are commonly relieved when "the gum swells and becomes inflamed; at other times a diarrhœa supervenes, which is generally esteemed a favourable circumstance."

In difficult dentition, the pains in the head, convulsions, vomiting, and hectic, sometimes give rise to the suspicion of hydrocephalus: from this, however, the disease in question may generally be distinguished with facility by the ease with which, in the last case, the bowels are evacuated; by the inflammatory redness of the gum, and by the pupil of the eye being dilated in an obscure, and contracted in a vivid light, the contrary of which takes place in hydrocephalus.

Treatment.—Frequent doses of rhubarb, with magnesia, will often allay the intestinal irritation, and mitigate the teething cough. The gums are to be lanced in all cases where the redness and swelling are considerable. This practice can indeed never be objectionable. Antispasmodics for the convulsions are inefficacious while the cause remains.

SECT. VII.—*Croup.* (Cynanche trachealis.)

The characteristics, or pathognomic symptoms of this disease are, difficult respiration, loud and stridulous cough, with the emission of a sound of a peculiar nature, which has been compared to the crow of a young cock.

These symptoms sometimes supervene upon the common precursors of violent inflammation; at other times the disease is formed without previous warning, and has been known to prove fatal in a very few hours from its apparent commencement. If life is not speedily terminated in this manner, the disorder frequently runs on for the space of six days, and terminates for the most part by crisis, with the evacuation of much pale urine.

Causes.—The croup is an inflammation of the upper part, as the peripneumony is of the lower part of the same organ, viz. the trachea or windpipe. It originates from the same sources as other inflammation. The circumstance of its frequent occurrence and fatal tendency in infants, appears to be owing to the extremely disproportionate smallness of the glottis at this period of life. The cause of death, when it happens suddenly, is a deposition of concreted mucus (consequent upon the inflammation), which lines the trachea, and fills up the bronchial cavities. Independantly, however, of this circumstance, sudden death may be occasioned by the great loss of power in the muscular fibres of the glottis, induced by the previously high excitement, "infantes enim miram incitationis vicissitudinem, brevissimis temporum spatiis, experiuntur."

Treatment.—This, to be effectual, must be speedy and decisive. Emetics; copious bleeding by leeches, applied near to the part affected; blisters; warm bath; antimonials. Recently, calomel in large doses has been tried, and with success. Might not digitalis prove useful in consequence of its extraordinary power in rapidly reducing arterial excitement?

N. B. Croup, in some instances, assumes more of the asthenic than of the inflammatory nature; and in this case the disorder of the glottis is often protracted to a longer period. The treatment in this latter species requires to be stimulating. Calomel; opiates; blisters; volatile embrocations to the throat; nourishing diet.

For those diseases of young persons which often require local, in connection with general treatment, such as distortions of the spine, affections of the eyes, scrophulous swellings of lymphatic glands, &c. consult the article SURGERY.

For eruptive and contagious diseases, see MEDICINE.

INFANT. From the observations daily made on the actions of infants, as to their arriving at discretion, the laws and customs of every country have fixed upon particular periods, on which they are presumed capable of acting with reason and discretion; in our law the full age of man or woman is 21 years. 3 Bac. Abr. 118.

The ages of male and female are different for different purposes: a male at 12 years of age may take the oath of allegiance; at 14 is at discretion, and therefore may consent or disagree to marriage, may choose his guardian, and if his discretion is actually proved, may make his testament of his personal estate; at 17 he may be a procurator or an executor; and at 21 is at his own disposal, and may alien his lands, goods, and chattels. A female at seven years of age may be betrothed or given in marriage; at nine is entitled to dower; and at 12 is of years of maturity, and therefore may consent or disagree to marriage, and if proved to have sufficient discretion may bequeath her personal estate; at 14 is at years of legal discretion, and may choose a guardian; at 17 may be executrix; and at 21 may dispose of herself and her lands. 1 Black. 463.

An infant is capable of inheriting, for the law presumes him capable of property; also an infant may purchase, because it is intended for his benefit, and the freehold is in him till he disagrees thereto, because an agreement is presumed, it being for his benefit, and because the freehold cannot be in the grantor contrary to his own act, nor can be in abeyance, for then a stranger would not know against whom to demand his right; and if at his full age the infant agrees to the purchase, he cannot afterwards avoid it; but if he dies during his minority his heirs may avoid it, for they shall not be bound by the contracts of a person who wanted capacity to contract. Co. Litt. 2.

As to infants being witnesses, there seems to be no fixed time at which children are excluded from giving evidence; but it will depend in a great measure on the sense and understanding of the children, as it shall appear on examination in court. Bull. N. P. 293.

And where they are admitted, concurrent testimony seems peculiarly desirable. 4 Bla. 214.

An infant is not bound by his contract to deliver a thing; so if one deliver goods to an infant upon a contract, &c. knowing him to be an infant, he shall not be chargeable in trover and conversion, or any other action for them; for the infant is not capable of any contract but for necessaries, therefore such delivery is a gift to the infant; but if an infant, without any contract, wilfully takes away the goods of another, trover lies against him; also it is said, that if he takes the goods under pretence that he is of full age, trover lies, because it is a wilful and fraudulent trespass. 1 Sid. 129.

Infants are disabled to contract for any thing but necessaries for their person, suitable to their degree and quality; and what is necessary must be left to the jury. Co. Litt. 172.

An infant, knowing of a fraud, shall be as much bound as if of age. 13 Vin. Abr. 536. But it is held that this rule is confined to such acts only as are voidable; and that a warrant of attorney given by an infant being absolutely void, the court will not confirm it, though the infant appeared to have given it, knowing it was not good, and for the purpose of collusion.

As to acts of infants being void, or only voidable, there is a diversity between an actual delivery of the thing contracted for, and a bare agreement to deliver it; the first is voidable, but the last absolutely void.

As necessaries for an infant's wife are necessaries for him, he is chargeable for them, unless provided before marriage; in which case he is not answerable, though she wore them afterward. 1 Str. 168.

An infant is also liable for the nursing of his lawful child.

Where goods are furnished to the son, he is himself liable if they are necessaries. If tradesmen deal with him, and he undertakes to pay them, they must resort to him for payment; but if they furnished the infant on the credit of his father, the father only is liable. 2 Esp. 471.

With respect to education, &c. infants may be charged, where the credit was given bona fide to them. But where the infant is under the parent's power, and living in the house with them, he shall not be liable even for necessaries. 2 Black. Rep. 1325.

If a taylor trusts a young man, under age, for clothes to an extravagant degree, he cannot recover; and he is bound to know whether he deals at the same time with any other taylor. 1 Esp. Rep. 212.

If one lends money to an infant to pay a debt for necessaries, and he pays it, although he is not bound in law, it is said he is in equity; but if the infant misapplies the money it is at the peril of the lender.

A promissory note given by an infant for board and lodging, and for teaching him a trade, is valid, and will support an action for the money. 1 T. R. 41.

And debts contracted during infancy are good considerations to support a promise made to them when a person is of full age; but the promise must be express.

A bond without a penalty for necessaries will bind an infant, but not a bond with a penalty. Esp. Rep. 164.

Legacies to infants cannot be paid either to them or their parents.

An infant cannot be a juror, neither can he be an attorney, bailiff, factor, or receiver. Co. Lit. 172.

By the custom of London an infant unmarried, and above the age of 14, if under 21, may bind himself apprentice to a freeman of London, by indenture with proper covenants, which covenants, by the custom of London, will be as binding as if of age.

If an infant draws a bill of exchange, yet he shall not be liable on the custom of merchants; but he may plead infancy in the same manner as he may to any other contract.

An infant cannot be sued but under the protection and joining the name of his guardian; but he may sue either by his guardian, or his next friend, who is not his guardian. Co. Lit. 135.

An action on an account stated will not lie against an infant, though it should be for necessaries. Co. Lit. 172.

INFINITE, or INFINITELY GREAT LINE, in geometry, denotes only an indefinite or indeterminate line, to which no certain bounds, or limits, are prescribed.

INFINITESIMALS, among mathematicians, are defined to be infinitely small quantities.

In the method of infinitesimals, the element, by which any quantity increases or decreases, is supposed to be infinitely small, and is generally expressed by two or more terms, some of which are infinitely less than the rest, which being neglected as of no importance, the remaining terms form what is called the difference of the proposed quantity. The terms that are neglected in this manner, as infinitely less than the other terms of the element, are the very same which arise in consequence of the acceleration, or retardation, of the generating motion, during the infinitely small time in which the element is generated; so that the remaining terms express the elements that would have been produced in that time, if the generating motion had continued uniform: therefore those differences are accurately in the same ratio to each other as the generating motions or fluxions. And hence, though in this method infinitesimal parts of the elements are neglected, the conclusions are accurately true without even an infinitely small error, and agree precisely with those that are deduced by the method by fluxions.

For example (see Plate Miscel. fig. 136), when DG, the increment of the base AD, of the triangle ADE, is supposed to become infinitely little, the trapezium DGHE (the simultaneous increment of the triangle) consists of two parts, the parallelogram EG, and the triangle EIH; the latter of which is infinitely less than the former, their ratio being that of one-half DG to AD: therefore, according to this method in fluxions, the part EIH is neglected, and the remaining part, viz. the parallelogram EG, is the difference of the triangle ADE. Now it might be shewn, that EG is precisely that part of the increment of the triangle ADE which is generated by the motion with which this triangle flows, and that EIH is the part of the same increment which is generated in consequence of the acceleration of this motion, while the base, by flowing uniformly, acquires the augment DG, whether DG be supposed finite or infinitely less.

Example 2. The increment DELMHG (fig. 137) of the rectangle AE, consists of the parallelograms EG, EM, and I*h*; the last of which, I*h*, becomes infinitely less than EG, or EM, when DG and LM, the increments of the sides, are supposed infinitely small; because I*h* is supposed to be to EG as LM to AL, and to EM as DG to AD; therefore, I*h* being neglected, the sum of the parallelograms EG and EM is the difference of the rectangle AE: and the sum of EG and EM is the space that would have been generated by the motion with which the rectangle AE flows continued uniformly, but that I*h* is the part of the increment of the rectangle which is generated in consequence of the acceleration of this motion, in the time that AD and AL, by flowing uniformly, acquire the augments DG and LM. The same may be observed in propositions wherein the fluxions of quantities are determined; and thus the manner of investigating the differences, or fluxions of quantities, in the method of infinitesimals, may be deduced from the principles of the method of fluxions. For instead of neglecting EIH because it is infinitely less than EG, (according to the usual manner of reasoning in that method), we may reject it; because we may thence conclude, that it is not produced in consequence of the generating motion DG, but of the subsequent variations of this motion. And it appears why the conclusions in the method of infinitesimals are not to be represented as if they were only near the truth, but are to be held as accurately true.

In order to render the application of this method easy, some analogous principles are admitted, as that the infinitely small elements of a curve are right lines, or that a curve is a polygon of an infinite number of sides, which being produced, give the tangents of the curve; and by their inclination to each other measure the curvature. This is as if we should suppose, when the base flows uniformly, the ordinate flows with a motion which is uniform for every infinitely small part of time, and increases or decreases by infinitely small differences at the end of every such time.

But however convenient this principle may be, it must be applied with caution and art on various occasions. It is usual therefore, in many cases, to resolve the element of the curve into two or more infinitely small right lines; and sometimes it is necessary, if we would avoid error, to resolve it into an infinite number of such right lines, which are infinitesimals of the second order. In general, it is a postulatum in this method, that we may descend to the infinitesimals of any order whatever, as we find it necessary; by which means any error that might arise in the application of it may be discovered and corrected by a proper use of this method itself. For an example of this, see Maclaurin's Fluxions.

INFLAMMABILITY, that property of bodies which disposes them to kindle or catch fire. See Caloric, Chemistry, &c.

INFLAMMATION. See Surgery, and Medicine.

INFLECTION, or *point of inflection*, in the higher geometry, is the point where a curve begins to bend a contrary way. See Flexure.

To determine the point of inflection in curves, whose semi-ordinates CM, Cm (Pl. Miscel. fig. 184) are drawn from the fixed point C; suppose CM to be infinitely near Cm, and make mH = Mm; let Tm touch the curve in M. Now the angles CmT, CMm, are equal; and so the angle CmH, while the semi-ordinates increase, does decrease, if the curve is concave towards the centre C, and increases if the convexity turns towards it. Whence this angle, or, which is the same, its measure, will be a minimum or maximum, if the curve has a point of inflection or retrogression; and so may be found, if the arch TH, or fluxion of it, be made equal to 0, or infinity. And in order to find the arch TH, draw mL, so that the angle TmL be equal to mCL; then if C$m = y$, $mr = x$, mT $= t$, we shall have $y : \dot{x} :: \dot{t} : \frac{t\ddot{x}}{y}$. Again, draw the arch HO to the radius CH; then the small right lines mr, OH, are parallel; and so the triangles OLH, mLr, are similar; but because HI is also perpendicular to mL, the triangles LHI, mLr, are also similar; whence $\dot{t} : \dot{x} :: y : \frac{\dot{x}\ddot{y}}{\dot{t}}$; that is, the quantities mT, mL, are equal. But HL is the fluxion of Hr, which is the distance of Cm $= y$; and HD is a negative quantity, because while the ordinate CM increases, their difference rH decreases; whence $\dot{x}x + \dot{y}y - \dot{y}\dot{y} = 0$, which is a general equation for finding the point of inflection, or retrogradation. See Fluxions.

INFORMATION, in law. An information may be defined an accusation or complaint exhibited against a person for some criminal offence, either immediately against the king, or against a private person, which, from its enormity or dangerous tendency, the public good requires should be restrained and punished. It differs principally from an indictment in this, that an indictment is an accusation found by the oath of 12 men, but an information is only the allegation of the officer who exhibits it. 3 Bac. Abr. 164.

Informations are of two kinds: first, those which are partly at the suit of the king, and partly at the suit of a subject; and, secondly, such as are only in the name of the king: the former are usually brought upon penal statutes, which inflict a penalty on conviction of the offender, one part to the use of the king, and another to the use of the informer; and are called qui tam, or popular actions, only carried on by a criminal instead of a civil process.

Informations that are exhibited in the name of the king alone are also of two kinds: first, those which are truly and properly his own suits, and filed ex officio by his own immediate officer, the attorney-general; secondly, those in which, though the king is the nominal prosecutor, yet it is at the relation of some private person, or common informer; and they are filed by the master of the crown office, under the express direction of the court. The objects of the king's own prosecutions, filed ex officio by the attorney-general, are properly such enormous misdemeanours as peculiarly tend to disturb or endanger the government. The objects of the other species of informations, filed by the master of the crown office, upon the complaint or relation of a private subject, are any gross and notorious misdemeanors, riots, batteries, libels, or other immoralities, of an atrocious kind, not peculiarly tending to disturb the government, but which, on account of their magnitude or pernicious example, deserve the most public animadversion. And when an information is filed either thus, or by the attorney-general ex officio, it must be tried by a petty jury of the county where the offence arises; after which, if the defendant is found guilty, he must resort to the court of king's bench for his punishment. 4 Black. 308.

If a common informer should willingly delay his suit, or discontinue, or be nonsuit, or shall have a verdict or judgment against him, he shall pay costs to the defendant. 18 Eliz. c. 5.

And in the court of king's bench, particularly if the defendant shall appear and plead to issue, and the prosecutor shall not at his own costs, within a year after issue joined, procure the same to be tried; or if a verdict pass for the defendant, or the informer procure a noli prosequi to be entered; the said court of king's bench may award the defendant his costs, unless the judge shall certify that there was a reasonable cause for exhibiting such information; and if the informer shall not, in three months after such costs taxed, and demand made, pay the same, the defendant shall have the benefit of the recognizance, to compel him thereunto. 4 and 5 W. c. 18.

INFRALAPSARIANS, in church history, an appellation given to such predestinarians as think the decrees of God, in regard to the salvation and damnation of mankind, were formed in consequence of Adam's fall.

INFUSION, a method of obtaining the virtues of plants, roots, &c. by steeping them in a hot or cold liquid.

INFUSORIA, in natural history, minute simple animalcules, seldom visible to the naked eye. When water is examined with the microscope, particularly that which has long been stagnant, and has vegetable matter growing in it, or water in which vegetables have been infused, thousands of minute animals have been discovered, which have been arranged together in this order. When wheat that is richety is infused in water, small eel-shaped worms are discovered, which were the cause of the disease. Wheat thus injured is very different from smutty wheat. The grains are brown, shrivelled, and of irregular forms; each contains one or more of these worms, which lie dormant as long as the grain is dry; but as soon as it is moistened by being sown, or otherwise, the worms are revivified, feed on the flour, and lay their eggs. If such grain vegetates, the young, as soon as they are hatched, eat their way up the stem, and bury themselves in the young succulent ear.

INGRESS, in astronomy, signifies the sun's entering the first scruple of one of the four cardinal signs, especially Aries.

INGROSSER. See Forestalling.

INHALER, in medicine, a machine for steaming the lungs with warm water, recommended by Mr. Mudge in the cure of the catarrhous cough. The body of the instrument resembles a porter-pot, holds about a pint, and the handle, which is fixed to the side of it, is hollow. In the lower part of the vessel, where it is soldered to the handle, is a hole, by means of which and three others on the upper part of the handle, the water, when it is poured into the inhaler, will rise to the same level in both. To the middle of the cover a flexible leathern tube, about six or seven inches long, is fixed, with a mouth-piece of wood or ivory. In the cover there is a valve fixed, which opens and shuts the communication between the upper and internal part of the inhaler and the external air. This valve is extremely simple: being formed only of a short tube descending inwards from the cover, and having beneath a small hole upon which a ball of cork plays. When the mouth is applied to the end of the tube in the act of inspiration, the air rushes into the handle, and up through the body of warm water, and the lungs become, consequently, filled with hot vapour. In exspiration, the mouth being still fixed to the tube, the breath, together with the steam on the surface of the water in the inhaler, is forced up through the valve in the cover.

INHERITANCE, is a perpetuity in lands or tenements to a man and his heirs; and the word inheritance is not only intended where a man has lands or tenements by descent, but also every fee-simple, or fee-tail, which a person has by purchase, may be said to be an inheritance, because his heirs may inherit it. Lit. s. 9.

Inheritances are corporeal or incorporeal. Corporeal inheritances relate to houses and lands which may be touched or handled; and incorporeal hereditaments are rights issuing out of, annexed to, or exercised with, corporeal inheritances; as advowsons, tithes, annuities, offices, commons, franchises, privileges, and services. 1 Inst. 49.

There are several rules of inheritances of lands, according to which estates are transmitted from ancestor to heir, viz. 1. That inheritances shall lineally descend to the issue of the person last actually seized, in infinitum, but shall never lineally ascend. 2. The male issue shall be admitted before the female. 3. Where there are two or more males in equal degree the eldest only shall inherit; but the females all together. 4. The lineal descendants, in infinitum, of any person deceased shall represent their ancestor; that is, shall stand in the same place as the person himself would have done had he been living: thus the child, grandchild, or great-grandchild (either male or female), of the eldest son, succeeds before the younger son, and so in infinitum. 5. On failure of issue of the person last seized, the inheritance shall descend to the blood of the first purchaser. 6. The collateral heir of the person last seized must be his next collateral kinsman of the whole blood. 7. In collateral inheritances the male stocks shall be preferred to the female, unless where lands are descended from a female: thus the relations on the father's side are admitted in infinitum before those on the mother's side are admitted at all; and the relations of the father's father before those of the father's mother, and so on. 2 Black. c. 14.

INHIBITION, a writ to inhibit or forbid a judge from farther proceedings in the cause depending before him. F. N. B. 39.

INJUNCTION. An injunction is a prohibitory writ, restraining a person from committing or doing a thing which appears to be against equity and conscience. 3 Bac. Abr. 172.

An injunction is usually granted for the purpose of preserving property in dispute pending a suit; as to restrain the defendant from proceedings at the common law against the plaintiff, or from committing waste, or doing any injurious act. Milf. Treat. Chan. Plead.

Injunctions issue out of the courts of equity in several instances. The most usual injunction is to stay proceedings at law; as, if one man brings an action at law against another, and a bill is brought to be relieved either against a penalty, or to stay proceedings at law, or some equitable circumstances, of which the party cannot have the benefit at law. In such case the plaintiff in equity may move for an injunction either upon an attachment, or praying a dedimus, or praying a farther time to answer; for it being suggested in the bill that the suit is against conscience, if the defendant is in contempt for not answering, or prays time to answer, it is contrary to conscience to proceed at law in the mean time; and therefore an injunction is granted of course: but this injunction only stays execution touching the matter in question; and there is always a clause giving liberty to call for a plea to proceed to trial, and for want of it to obtain judgment; but execution is stayed till answer, or farther order. 3 Bac. Abr. 173.

When a bill in chancery is filed in the office of the six clerks, if an injunction is prayed therein, it may be had, at various stages of the cause, according to the circumstances of the case. If the bill is to stay execution upon an oppressive judgment, and the defendant does not put in his answer within the time allowed by the rules of the court, an injunction will issue of course; and when the answer comes in, the injunction can only be continued upon a sufficient ground appearing from the answer itself. But if an injunction is wanted to stay waste, or other injuries of an equally unjust nature, then upon the filing of the bill, and a proper case supported by affidavits, the court will grant an injunction immediately; to continue till the defendant has put in his answer, and till the court shall make some further order concerning it; and when the answer comes in whether it shall then be dissolved, or continued till the hearing of the cause, is determined by the court upon argument, drawn from considering the answer and affidavits together. 3 Bla. 443.

The methods of dissolving injunctions are various; when the answer comes in, and the party has cleared his contempt by paying the costs of the attachment, if there is one, he obtains an order to dissolve nisi, and serves it on the plaintiff's clerk in court: this order takes notice of the defendant's having fully answered the bill, and thereby denied the whole equity thereof, and being regularly served, the plaintiff must shew cause at the day; or the defendant's counsel, where there is no probability of shewing cause, may move to make the order absolute, unless cause, sitting the court. 3 Bac. Abr. 177.

If the plaintiff who has an injunction die pending the suit, in strictness the whole proceedings are abated, and the injunction with them; but even in this case the party shall not take out execution without special leave of the court; he must move the court for the plaintiff to revive his suit within a limited time, or the injunction to stand dissolved; and as this is never denied, so if the suit is not revived, the party takes out execution. There are some instances where a plaintiff may move to revive his injunction; but as that rarely happens, so it is rarely granted, especially where the injunction has been before dissolved; but where a bill is dismissed, the injunction and every thing else are gone, and execution may be taken out the next day. 3 Bac. Abr. 178.

INJURY, a wrong or damage to a man's person or goods. The law will suffer a private injury rather than a public evil; and the act of God or the law does injury to none. 4 Rep. 124.

INK. There are two principal kinds of ink, writing and printing ink.

Writing-ink. When to an infusion of gall-nuts some solution of sulphate of iron (green copperas) is added, a very dark-blue precipitate takes place. This precipitate is the gallic acid of the galls united to the iron of the green vitriol, forming gallat of iron, which is the basis of writing-ink. If galls and sulphate of iron only were used, the precipitate would fall down, leaving the water colourless; and in order to keep it suspended in the water, forming a permanently black, or rather very dark blue fluid, gum arabic is added, which, by its viscid nature, prevents the precipitate from falling down.

Various receipts have been given for the composition of writing-ink, but very few have been founded upon a knowledge of its real nature. The receipt given by M. Ribancourt is as follows: Take eight ounces of Aleppo galls, in coarse powder; four ounces of logwood, in thin chips; four ounces of sulphate of iron (green copperas); three ounces of gum arabic, in powder; one ounce of sulphate of copper (blue vitriol); and one ounce of sugar-candy. Boil the galls and logwood together in twelve pounds of water for one hour, or till half the liquid has been evaporated. Strain the decoction through a hair sieve, or linen cloth, and then add the other ingredients. Stir the mixture till the whole is dissolved, more especially the gum; after which leave it to subside for 24 hours. Then decant the ink, and preserve it in bottles of glass or stone ware, well corked.

The following will also make a good ink: To one quart of soft water add four ounces of galls, one ounce of copperas roughly bruised, and two ounces of gum arabic. Let the whole be kept near the fire a few days, and occasionally well shaken.

Red writing-ink is made in the following manner: Take of the raspings of Brazil wood a quarter of a pound, and infuse them two or three days in vinegar. Boil the infusion for an hour over a gentle fire, and afterwards filtre it while hot. Put it again over the fire, and dissolve in it, first, half an ounce of gum arabic; and afterwards of alum and white sugar, each half an ounce.

Printing-ink is a black paint, composed of lamp-black and linseed or suet oil boiled, so as to acquire considerable consistence and tenacity. The art of preparing it is kept a secret; but the obtaining good lamp-black appears to be the chief difficulty in making it.

The ink used by copper-plate printers differs from the last only in the oil not being so much boiled, and the black which is used being Frankfort black.

Sympathetic inks are such as do not appear after they are written with, but which may be made to appear at pleasure, by certain means to be used for that purpose. A variety of substances have been used for this purpose. We shall describe the best of them.

1. Dissolve some sugar of lead in water, and write with the solution. When dry, no writing will be visible. When you want to make it appear, wet the paper with a solution of alkaline sulphuret (liver of sulphur), and the letters will immediately appear of a brown colour. Even exposing the writing to the vapours of these solutions will render it apparent.

2. Write with a solution of gold in aqua regia, and let the paper dry gently in the shade. Nothing will appear; but draw a sponge over it wetted with a solution of tin in aqua regia, the writing will immediately appear of a purple colour.

3. Write with an infusion of galls, and when you wish the writing to appear, dip it into a solution of green vitriol; the letters will appear black.

4. Write with diluted sulphuric acid, and

nothing will be visible. To render it so, hold it to the fire, and the letters will instantly appear black.

5. Juice of lemons, or onions, a solution of sal ammoniac, green vitriol, &c. will answer the same purpose, though not so easily, nor with so little heat.

6. Green sympathetic ink. Dissolve cobalt in nitromuriatic acid, and write with the solution. The letters will be invisible till held to the fire, when they will appear green, and will disappear completely again when removed into the cold. In this manner they may be made to appear and disappear at pleasure.

A very pleasant experiment of this kind is to make a drawing representing a winter scene, in which the trees appear void of leaves, and to put the leaves on with this sympathetic ink; then, upon holding the drawing near to the fire, the leaves will begin to appear in all the verdure of spring, and will very much surprise those who are not in the secret.

7. Blue sympathetic ink. Dissolve cobalt in nitric acid; precipitate the cobalt by potass; dissolve this precipitated oxide of cobalt in acetic acid, and add to the solution one-eighth of common salt. This will form a sympathetic ink, that, when cold, will be invisible, but will appear blue by heat.

INK, *removing stains of.* The stains of ink on cloth, paper, or wood, may be removed by almost all acids; but those acids are to be preferred which are least likely to injure the texture of the stained substance. The muriatic acid, diluted with five or six times its weight of water, may be applied to the spot, and, after a minute or two, may be washed off, repeating the application as often as may be found necessary. But the vegetable acids are attended with less risk, and are equally effectual. A solution of the oxalic, citric (acid of lemons), or tartareous acids, in water, may be applied to the most delicate fabrics without any danger of injuring them; and the same solutions will discharge writing, but not printing-ink. Hence they may be employed in cleaning books which have been defaced by writing on the margin, without impairing the text. Lemon-juice, and the juice of sorrel, will also remove ink-stains, but not so easily as the concrete acid of lemons, or citric acid.

INNS AND INNKEEPERS. Common inns were instituted for passengers; and the duty of innkeepers extends chiefly to the entertaining and harbouring of travellers, finding them victuals and lodging, and securing the goods and effects of their guests; and therefore if one who keeps a common inn refuses either to receive a traveller as a guest into his house, or to find him victuals or lodging, upon his tendering a reasonable price for the same, he is not only liable to render damages for the injury in an action on the case, at the suit of the party grieved, but also may be indicted and fined at the suit of the king. Dyer, 158.

In return for such responsibility the law allows him to retain the horse of his guest until paid for his keep; but he cannot retain such horse for the bill of the owner, although he may retain his goods for such bill; neither can he detain one horse for the food of another. 1 Bulst. 207, 217.

An innkeeper, however, is not bound to receive the horse, unless the master lodge there also. 2 Brown, 254.

Neither is a landlord bound to furnish provisions unless paid beforehand. 9 Co. 87.

If an innkeeper makes out unreasonable bills, he may be indicted for extortion; and if either he or any of his servants knowingly sell bad wine or bad provisions, they will be responsible in an action of deceit.

Any person may set up a new inn, unless it is inconvenient to the public, in respect of its situation, or to its increasing the number of inns, not only to the prejudice of the public, but also to the hindrance and prejudice of other antient and well-governed inns: for the keeping of an inn is no franchise, but a lawful trade, open to every subject, and therefore there is no need of any licence from the king for that purpose. 2 Roll. Abr. 84.

An innkeeper is distinguished from other trades in that he cannot be a bankrupt; for though he buys provisions to be spent in his house, yet he does not properly sell them, but utter them at such rates as he thinks reasonable; and the attendance of his servants, furniture of his house, &c. are to be considered; and the statutes of bankruptcy only mention merchants that use to buy and sell in gross, or buy retail, and such as get their living by buying and selling; but the contracts with innkeepers are not for any commodities in specie, but they are contracts for house-room, trouble, attendance, lodging, and necessaries, and therefore cannot come within the design of such words, since there is no trade carried on by buying and bartering commodities. 1 Jones, 437.

But where an innkeeper is a chapman also, and buys and sells, he may, on that account, be a bankrupt, though not barely as an innkeeper, and this has been frequently seen. 7 Vin. Abr. 57.

Innkeepers are clearly chargeable for the goods of guests stolen or lost out of their inns, and this without any contract or agreement for that purpose; for the law makes them liable in respect of the reward, as also in respect of their being places appointed and allowed by law, for the benefit and security of traders and travellers. Dyer, 266.

But if a person comes to an innkeeper, and desires to be entertained by him, which the innkeeper refuses, because his house is already full; whereupon the party says he will shift among the rest of his guests, and there he is robbed, the host shall not be charged. Dyer, 158.

If a man comes to a common inn to harbour, and desires that his horse may be put to grass, and the host put him to grass accordingly, and the horse is stolen, the host shall not be charged; because by law the host is not bound to answer for any thing out of his inn, but only for those that are infra hospitium. 8 Co. 32 b.

Innkeepers may detain the person of the guest who eats, or the horse which eats, till payment, and this he may do without any agreement for that purpose; for men that get their livelihood by entertainment of others, cannot annex such disobliging conditions, that they should retain the party's property in case of non-payment, nor make such disadvantageous and impudent a supposition, that they shall not be paid; and therefore the law annexed such a condition without the agreement of the parties. Roll. Abr. 85.

By the custom of London and Exeter, if a man commits a horse to a hostler, and he eats out the price of his head, the hostler may take him as his own, upon the reasonable appraisement of four of his neighbours; but the innkeeper has no power to sell the horse, by the general custom of the whole kingdom. Moor. 876. 3 Bulst. 271.

But it has been held, that though an innkeeper in London may, after long keeping, have the horse appraised, and sell him; yet when he has, in such case, had him appraised, he cannot justify the taking him to himself, at the price it was appraised at. 1 Vin. Abr. 233.

INNS OF COURT, are so called, because the students therein study the law, to enable them to practise in the courts at Westminster, or elsewhere; and also because they use all other gentle exercises, as may render them better qualified to serve the king in his court. Fortesq. c. 49.

INNOMINATA OSSA. See ANATOMY.

INNUENDO, is a word used in declarations and law proceedings, to ascertain a person or thing which was named before; as to say he (innuendo the plaintiff) did so and so, when there was mention before of another person.

Innuendo may serve for an explanation where there is precedent matter, but never for a new charge; it may apply what is already expressed, but cannot add or enlarge the importance of it. 2 Salk. 513.

INOCULATION. See MEDICINE.

INOCULATION, or *Budding*. See GRAFTING.

INOLITHUS, in mineralogy, a stone consisting of carbonate of lime, carbonic acid gas, and a little iron; entirely soluble in nitric acid with effervescence; fibrous, parasitic, soft, lightish, breaking into indeterminate fragments. There are several species: of the filamentosius there are three varieties; the satin spar, so called from its rich satiny lustre, is found in Russia, Poland, Germany, Saxony, and Bohemia, with the fibres straight and a little curved. It is found also about a mile from Alston in Cumberland, washed by the river Tyne, near the level of its bed; colour white, with sometimes a rosy tinge from a diluted oxide of iron, and transmits light from the edges, or in thinner pieces: fracture in the direction of the striæ fibrous, straight or curved; specific gravity about 2.71, contains carbonic acid 47, carbonate of lime 50, water of crystallization 2, and a small portion of iron.

INORDINATE PROPORTION, is where there are three magnitudes in one rank, and three others proportional to them in another, and you compare them in a different order. Thus suppose the numbers in one rank to be 2, 3, 9; and those of the other rank 8, 24, 36; which are compared in a different order, viz. 2 : 3 : : 24 : 36; and 3 : 9 : : 8 : 24. Then rejecting the mean terms of each rank, you conclude 2 : 9 : : 8 : 36.

INQUEST, in law, signifies an enquiry made by a jury, in a civil or criminal cause, by examining witnesses. There is also an inquest of office, used for the satisfaction of the judges, and sometimes to make an enquiry whether a criminal is a lunatic or not; upon which inquest, if it is found that the criminal only feigns himself to be a lunatic, and at the same time refuses to plead, he may be dealt with as one standing mute. Where a person is attainted of felony, and escapes, and afterwards, on being retaken, denies that he is the same man, inquest must be made into the identity of the person by a jury, before he can be executed.

INQUISITION, in law, a manner of proceeding by way of search or examination used on the king's behalf, in cases of outlawry, treason, felony, self-murder, &c. to discover lands, goods, and the like, forfeited to the crown. Inquisition is also had upon extents of lands, tenements, &c. writs of elegit, and where judgment being had by default, damages and costs are recovered.

INQUISITION, in the church of Rome, a tribunal in several Roman-catholic countries, erected by the popes for the examination and punishment of heretics.

This court was founded in the 12th century by father Dominic and his followers, who were sent by pope Innocent III. with orders to excite the catholic princes and people to extirpate heretics, to search into their number and quality, and to transmit a faithful account thereof to Rome. Hence they were called inquisitors; and this gave birth to the formidable tribunal of the inquisition, which was received in all Italy, and the dominions of Spain, except the kingdom of Naples, and the Low-countries. See ACT OF FAITH.

INROLLMENT, in law, is the registering, recording, or entering in the rolls of the chancery, king's-bench, common-pleas, or exchequer, or by the clerk of the peace in the records of the quarter-sessions, of any lawful act; a statute or recognizance acknowledges a deed of bargain and sale of lands, and the like; but the inrolling a deed does not make it a record, though it thereby becomes a deed recorded; for there is a difference between a matter of record, and a thing recorded to be kept in memory; a record being the entry in parchment of judicial matters controverted in a court of record, and whereof the court takes notice, whereas an inrollment of a deed is a private act of the parties concerned, of which the court takes no cognizance at the time of doing it, although the court permits it. 2 Lill. Abr. c. 9.

By stat. 27 H. VIII. c. 16. no lands shall pass, whereby any estate of inheritance or freehold shall take effect, or any use thereof be made, by reason only of any bargain and sale thereof, except the bargain and sale is made by writing indented, sealed, and within six months inrolled in one of the king's courts of record at Westminster; or else within the county where the lands lie, before the clerk of the peace, and one or more justices.

But by 5 Eliz. c. 26, in the counties palatine, they may be inrolled at the respective courts there, or at the assizes.

Every deed before it is inrolled is to be acknowledged to be the deed of the party, before a master of chancery, or a judge of the court wherein it is inrolled, which is the officer's warrant for inrolling the same; and the inrollment of a deed, if it is acknowledged by the grantor, will be a good proof of the deed itself upon trial. 2 Lill. Abr. 69.

But a deed may be inrolled without the examination of the party himself; for it is sufficient if oath is made of the execution. If two are parties, and the deed is acknowledged by one, the other is bound by it. And if a man lives abroad, and would pass lands here in England, a nominal person may be joined with him in the deed, who may acknowledge it here, and it will be binding. 1 Salk. 389.

INSCRIBED, in geometry. A figure is said to be inscribed in another when all its angles touch the sides or planes of the other figure.

INSECTS. See ENTOMOLOGY.

INSOLATION, in chemistry, a term made use of to denote an exposure to the sun, to promote the chemical action of one substance upon another.

INSTALLMENT, the instating or establishing a person in some dignity. This word is chiefly used for the induction of a dean, prebendary, or other ecclesiastical dignitary, into the possession of his stall, or other proper seat in the cathedral to which he belongs. It is also used for the ceremony whereby the knights of the garter are placed in their rank in the chapel of St. George at Windsor, and on many other like occasions. It is sometimes termed installation.

INSTITUTES, in literary history, a book containing the elements of the Roman law, and constituting the last part of the civil law. The institutes are divided into four books, and contain an abridgment of the whole body of the civil law, being designed for the use of students.

INSTITUTION, in general, signifies the establishing or founding something.

In the canon and common law it signifies the investing a clerk with the spiritualities of a rectory, &c. which is done by the bishop, who uses the formula, "I institute you rector of such a church, with cure of souls, and receive your care and mine." This makes him a complete parson as to spirituality, but not as to temporality, which depends on induction. The term institutions is also used, in a literary sense, for a book containing the elements of any art or science: such are institutions of medicine, institutions of rhetoric, &c.

INSTRUMENT, in law, some public act or authentic deed, by which any truth is made apparent, or any right or title established in a court of justice. See DEED.

INSTRUMENTS, in music, are either played on by means of wind, as the organ, &c.; or by strings, as the violin, &c.

INSTRUMENTS, ASTRONOMICAL. We shall, under the word OBSERVATORY, give an account of the several instruments made use of in practical astronomy.

INSTRUMENTS, *mathematical*. A pocket case of mathematical instruments contains the following particulars, viz. 1. A pair of plain compasses. 2. A pair of drawing compasses, with its several parts. 3. A drawing-pen and pointer. 4. A protractor, in form of a semicircle, or sometimes of a parallelogram. 5. A parallel ruler. 6. A plain scale. 7. A sector, besides the black-lead pencil for drawing lines. The general uses of the above instruments are as follow: see Plate Mathematical Instruments.

I. *Of the plain compasses*, Fig. 1. The use of the common or plain compasses is, (1.) to draw a blank line A B, by the edge of a ruler, through any given point or points C D, &c. (2.) Take any extent or length between the points of the compasses, and to set it off, or apply it successively upon any line, as from C to D, fig. 2. (3.) To take any proposed line C D between the points, and, by applying it to the proper scale, to find its length. (4.) To set off equal distances upon a given line, by making a dot with the point at each, through which to draw parallel lines. (5.) To draw any blank circle, intersecting arches, &c. (6.) To lay off an angle of a given quantity upon an arch of a circle from the line of chords, &c. (7.) To measure any arch or angle, upon the chords, &c. (8.) To construct any proposed figure, in plotting or making plans, &c. by setting off the quantity of the sides and angles from proper scales. In short, the use of the compasses occurs in every branch of practical mathematics.

II. *Of the drawing-compasses*. These compasses are chiefly designed for drawing circles, and circular arches; and it is often necessary they should be drawn with different materials; and therefore this pair of compasses has, in one of its legs, a triangular socket, and screw, to receive and fasten the following parts or points for that purpose, viz. (1.) A steel point, which being fixed in the socket, makes the compasses then but a plain pair, and has all the same uses as just now described in drawing blank circles, setting off lines, &c. (2.) A port-crayon with a black-lead pencil, cut to a fine point, for drawing lines that may be easily rubbed out again, if not right. A piece of slate-pencil may also be used in this part for drawing on slate. (3.) The dotting-point, or dotting-pen, with a small rowel, or indented wheel at the end, moving very freely; and receiving ink from the brass pen over it, communicates the same in equal and regular dots upon the paper, where dotted lines are chosen. (4.) The steel pen or point, for drawing and describing black lines with ink; for this purpose the two parts or sides of the pen are opened or closed with an adjusting screw, that the line drawn may be as fine or as coarse as you please.

In the port-crayon, dotter, and steel pen, there is a joint, by which you can set the lower part always perpendicular to the paper, which is necessary for drawing a line well, in every extent or opening of the compasses.

In some of the better sort of instruments, these points slide into the socket, and are kept tight by a spring on the inside, that is not seen.

The steel point is sometimes made with a joint, and furnished with a fine spring and screw; by which, when you have opened the compasses nearly to the extent required, you can, by turning the screw, move the point to the true extent as it were, to a hair's breadth; which is the reason these are called hair-compasses.

The common compasses, at large, are not altogether so well adapted for small drawings; and therefore a small sort called bows, are contrived to answer all such purposes; they consist only of a steel point and drawing-pen, with a joint, and of a small length, so that very small circles may be nicely drawn with them, as they are to be conveniently moved and turned about in the hand, by a short stem or shaft.

III. *Of the drawing pen and pencil.* The drawing-pen is only the common steel pen at the end of a brass rod, or shaft, of a convenient length, to be held in the hand for drawing all kinds of straight black lines by the edge of a rule. The shaft or handle has a screw in the middle part; and, when unscrewed, there is a fine steel round pin or point, by which you make as nice a mark or dot upon the paper as you please, for terminating your lines in curious draughts.

The black-lead pencil, if good, is of frequent use for drawing straight lines, and for supplying the place of the drawing-pen, where lines of ink are not necessary; it is also often substituted for the common pen in writing, figuring, &c. Because in all cases, if what be drawn with it be not right, or does not please, it may be very easily rubbed out with a piece of crumb-bread, and the whole new-drawn.

IV. *Of the protractor.* The protractor is a semicircle of brass, A D B, divided into 180 degrees, and numbered each way from end to end of the semicircle by 10°, 20°, 30°, &c. The central line is the external edge of the protractor's diameter, or straight side, sloped down to the under side, and is generally called a fiducial edge; in the middle of which is a small line or fine notch in the very edge, for the centre of the protractor. The uses of the protractor are two: (1.) To measure any angle proposed. (2.) To lay down any angle required.

For example: suppose it required to find what number of degrees are contained in the angle ACB (fig. 4); you place the centre of the protractor upon the angular point C, and the fiducial edge exactly upon the line C A; then observe what number of degrees the line C B cuts upon the graduated limb of the protractor, and that will be the measure of the angle A C B as required.

Secondly, suppose it required to protract or lay off from the line A C, an angle A C B, equal to 35 degrees. To do this, you place the centre of the protractor upon the given point C, and the straight edge upon A C very exactly; then make a fine point or dot at 35 degrees on the limb at B, and the protractor being removed, you draw through B the straight line C B, and it will make the angle A C B required.

Protractors in form of a parallelogram, or long square, as *a* E F *b* fig. 3, are usually made in ivory or brass; are more exact than the common semicircular ones, for angles to 40 or 50 degrees, because at and about each end, the divisions (being farther from the centre) are larger.

V. *Of the parallel ruler.* The parallel ruler is so called, because as it consists of two straight rules, connected together by two brass bars, yet so as to admit a very free motion to each: the one ruler must always move parallel-wise to the other, that is, one rule will be every where equidistant from the other, and by this means it becomes naturally fitted for drawing one or more lines parallel to, or equally distant from, any line proposed. The manner of doing which is thus:

Let it be required to draw a straight line parallel to a given line A B, and at the distance AC, from it. (fig. 5.) First open the rulers to a greater distance than A C, and place the edge of the rulers exactly on the line A B; then holding the other rule (or side) firmly on the paper, you move the upper rule down from A to the point C, by which (holding it fast) you draw the line C D, which will be parallel to the given line A B as required.

Many very useful problems in the mathematics are performed by this instrument, of which the following are examples.

Let it be required to find a fourth proportional to three right lines given, A B, B C, and A D (fig. 6). To do this, draw the lines A C, A E, making any angle at pleasure. Upon A C with the compasses set off the lines A B and B C; and upon A E set of the line A D; join D B, and parallel to it draw E C, then will D E be the fourth proportional required. For A B : B C :: A D : D E.

Again, suppose it required to divide any line, A B, as another line A C is divided (fig. 7). To do this, join the extremities of each line C B, and parallel to C B draw E I, E H D G, through the given points D E F in the line A C; and by these lines the line A B will be divided exactly similar to the line A C.

The parallel ruler is seldom put into a case of instruments, but those of the larger and better sort; being generally sold by itself of various sizes, from 6 inches to 2 feet in length.

Of the plain scale. The lines generally drawn on the plain scale, are these following:

	Marked
I. Lines of equal parts.	E. P.
II. ——— Chords.	Cho.
III. ——— Rhumbs.	Ru.
IV. ——— Sines.	Sin.
V. ——— Tangents.	Tan.
VI. ——— Secants.	Sec.
VII. ——— Half-Tangents.	S. T.
VIII. ——— Longitude.	Long.
IX. ——— Latitude.	Lat.
X. ——— Hours.	Ho.
XI. ——— Inclinations.	In. Mer.

Of the lines of equal parts. Lines of equal parts are of two sorts, viz. simply divided, and diagonally divided, Plate 5.

1. Simply divided. Draw three lines parallel to one another, at unequal distances (fig. 8), and of any convenient length; divide this length into what number of equal parts is thought necessary, allowing some certain number of these parts to an inch, such as 2, $2\frac{1}{2}$, 3, $3\frac{1}{2}$, 4, $4\frac{1}{2}$, &c. which divisions distinguish by lines drawn across the three parallels. Divide the left-hand division into 10 equal parts, which distinguish by lines drawn across the lower parallels only; but for distinction's sake, let the fifth division be somewhat longer than the others: and it may not be inconvenient to divide the same left hand division into 12 equal parts, which are laid down on the upper parallel line, having the third, sixth, and ninth divisions distinguished by longer strokes than the rest, whereof that at the sixth division make the longest.

There are, for the most part, several of these simply divided scales put on rulers, one above the other, with numbers on the left hand, shewing in each scale, how many equal parts an inch is divided into; such as 20, 25, 30, 35, 40, 45, &c. and are severally used, as the plan to be expressed should be larger or smaller.

The use of these lines of equal parts, is to lay down any line expressed by a number of two places or denominations, whether decimally or duodecimally divided; as leagues, miles, chains, poles, yards, feet, inches, &c. and their tenth parts, or twelfth parts; thus, if each of the divisions be reckoned 1, as 1 league, mile, chain, &c. then each of the subdivisions will express $\frac{1}{10}$ part thereof; and if each of the large divisions be called 10, then each small one will be 1; and if the large divisions be 100, then each small one will be 10, &c.

Therefore to lay off a line $8\frac{7}{10}$, 87, or 870 parts, let them be leagues, miles, chains, &c. set one point of the compasses on the 8th of the large divisions, counting from the left hand towards the right, and open the compasses, till the other point falls on the 7th of the small divisions, counting from the right hand towards the left, then are the compasses opened to express a line of $8\frac{7}{10}$ 87, or 870 leagues, miles, chains, &c. and bears such proportion in the plan, as the line measured does to the thing represented.

But if a length of feet and inches was to be expressed, the same large divisions may represent the feet, but the inches must be taken from the upper part of the first division, which (as before noted) is divided into twelve equal parts.

Thus if a line of 7 feet 5 inches was to be laid down, set one point of the compasses on the fifth division among the twelve, counting from the right hand towards the left, and extend the other to 7, among the large divisions: and that distance laid down in the plan, shall express a line of 7 feet 5 inches; and the like is to be understood of any other dimensions.

2. Diagonally divided. Draw eleven lines parallel to each other, and at equal distances; divide the upper of these lines into such a number of equal parts, as the scale to be expressed is intended to contain; and from each of these divisions draw perpendiculars through the eleven parallels (fig. 9): subdivide the first of these divisions into 10 equal parts, both in the upper and lower lines; then each of these subdivisions may be also subdivided into ten equal parts, by drawing diagonal lines; viz. from the 10th below, to the ninth above; from the ninth below to the eighth above; from the eighth below to the seventh above, &c. till from the first below to the 0th above, so that by these means one of the primary divisions on the scale will be divided into 100 equal parts.

There are generally two diagonal scales laid on the same plane or face of the ruler, one being commonly half the other (fig. 9).

The use of the diagonal scale is much the same with the simple scale; all the difference is, that a plan may be laid down more accurately by it; because in this, a line may be taken of three denominations, whereas from the former, only two could be taken.

Now from this construction it is plain, if each of the primary divisions represent 1, each of the first subdivisions will express $\frac{1}{10}$ of 1; and each of the second subdivisions (which are taken on the diagonal lines, counting from the top downwards) will express $\frac{1}{10}$ of the former subdivisions or a 100th of the primary divisions; and if each of the primary divisions express 10, then each of the first subdivisions will express 1, and each of the 2d, $\frac{1}{10}$; and if each of the primary divisions represent 100, then each of the first subdivisions will be 10, and each of the 2d will be 1, &c.

Therefore to lay down a line, whose length is expressed by 347, 34 $\frac{7}{10}$ or 3 $\frac{47}{100}$, whether leagues, miles, chains, &c.

On the diagonal line, joined to the 4th of the first subdivisions, count 7 downwards, reckoning the distance of each parallel 1; there set one point of the compasses, and extend the other, till it falls on the intersection of the third primary division with the same parallel in which the other foot rests, and the compasses will then be opened to express a line of 347, 34 $\frac{7}{10}$, or 3$\frac{47}{100}$, &c.

Those who have frequent occasion to use scales, perhaps will find, that a ruler with the 20 following scales on it, viz. 10 on each face, will suit more purposes than any set of simply divided scales hitherto made public, on one ruler.

One Side.—The divisions to an inch.
10, 11, 12, 13½, 15, 16½, 18, 20, 22, 25.

Other Side—The divisions to an inch.
28, 32, 36, 40, 45, 50, 60, 70, 85, 100.

The left-hand primary division, to be divided into 10 and 12 and 8 parts; for these subdivisions are of great use in drawing the parts of a fortress, and of a piece of cannon.

It will here be convenient to shew, how any plan expressed by right lines and angles, may be delineated by the scales of equal parts, and the protractor. Suppose three adjacent things in any right-lined triangle being given, to form the plan thereof.

Example. Let ABC (fig. 10,) be a triangular field, the side AB = 327 yards; AC = 208 yards; and the angle at A = 44½ degrees.

Construction. Draw a line A B at pleasure; then from the diagonal scale take 327 between the points of the compasses, and lay it from A to B; set the centre of the protractor to the point A, lay off 44½ degrees, and by that mark draw A C; take with the compasses from the same scale 208, lay it from A to C, and join C B; so shall the parts of the triangle A B C, in the plan, bear the same proportion to each other, as the real parts in the field do.

The side C B may be measured on the same scale from which the sides A B, A C, were taken; and the angles at B and C may be measured by applying the protractor to them.

If two angles and the side contained between them were given.

Draw a line to express the side (as before); at the ends of that line, point off the angles, as observed in the field; lines drawn from the ends of the given line through those marks, shall form a triangle similar to that of the field.

Five adjacent things, sides and angles, in a right-lined quadrilateral, being given, to lay down the plan thereof, fig. 11.

Example. Given ∠ A = 70°; AB = 215 links; ∠ B = 115°; BC = 596 links; ∠ C = 114°.

Construction. Draw A D at pleasure; from A draw A B, so as to make with A D an angle of 70°: make AB=215 (taken from the scales); from B, draw B C, to make with A B an angle of 115°; make B C = 596; from C, draw C D, to make with C B an angle of 114°; and by the intersection of C D with A D, a quadrilateral will be formed similar to the figure in which such measures could be taken as are expressed in the example.

If three of the things were sides, the plan might be formed with equal ease.

Following the same method, a figure of many more sides may be delineated; and in this manner, or some other like to it, surveyors make their plans or surveys.

The remaining lines of the plain scale are thus constructed.

Describe a circumference with any convenient radius, and draw the diameters fig. 12 A B, D E, at right angles to each other; continue B A at pleasure towards F; through D, draw D G parallel to B F; and draw the chords B D, B E, A D, A E. Circumscribe the circle with the square H M N, whose sides H M, M N, shall be parallel to A B, E D.

1. *To construct the line of chords.* Divide the arc A D into 90 equal parts: mark the 10th divisions with the figures 10, 20, 30, 40, 50, 60, 70, 80, 90; on D, as a centre, with the compasses, transfer the several divisions of the quadrantal arc, to the chord A D, which marked with the figures corresponding, will become a line of chords.

Note. In the construction of this, and the following scales, only the primary divisions are drawn; the intermediate ones are omitted, that the figure may not appear too much crowded.

2. *The line of rhumbs.* Divide the arc B E into 8 equal parts, which mark with the figures 1, 2, 3, 4, 5, 6, 7, 8, and divide each of those parts into quarters; on B, as a centre, transfer the divisions of the arc to the chord B E, which marked with the corresponding figures, will be a line of rhumbs.

3. *The line of sines.* Through each of the divisions of the arc A D, draw right lines parallel to the radius A C; and C D will be divided into a line of sines which are to be numbered from C to D for the right sines, and from D to C for the versed sines. The versed sines may be continued to 180 degrees by laying the divisions of the radius C D, from C to E.

4. *The line of tangents.* A ruler on C, and the several divisions of the arc A D, will intersect the line D G, which will become a line of tangents, and is to be figured from D to G, with 10, 20, 30, 40, &c.

5. *The line of secants.* The distances from the centre C to the divisions on the line of tangents being transferred to the line C F from the centre C, will give the divisions of the line of secants; which must be numbered from A towards F, with 10, 20, 30, &c.

6. *The line of half-tangents (or the tangents of half the arcs).* A ruler on E, and the several divisions of the arc A D, will intersect the radius C A, in the divisions of the semi or half tangents; mark these with the corresponding figures of the arc A D.

The semitangents on the plane scales are generally continued as far as the length of the ruler they are laid on will admit; the divisions beyond 90° are found by dividing the arc A E like the arc A D, then laying a ruler by E and these divisions of the arc A E, the divisions of the semitangents above 90 degrees will be obtained on the line C A continued.

7. *The line of longitude.* Divide A H into 60 equal parts; through each of these divisions, parallels to the radius A C, will intersect the arc A E, in as many points; from E as a centre, the divisions of the arc E A, being transferred to the chord E A, will give the divisions of the line of longitude.

The points thus found on the quadrantal arc, taken from A to E, belong to the sines of the equally increasing sexagenary parts of the radius; and those arcs reckoned from E, belong to the cosines of those sexagenary parts.

8. *The line of latitude.* A ruler on A, and the several divisions of the sines on C D, will intersect the arc B D, in as many points; on B as a centre, transfer the intersections of the arc B D, to the right line B D; number the divisions from B to D, with 10, 20, 30, &c. to 90; and B D will be a line of latitude.

9. *The line of hours* Bisect the quadrantal arcs B D, B E, in *a*, *b*; divide the quadrantal arc *ab* into 6 equal parts (which gives 15 degrees for each hour); and each of these into 4 others (which will give the quarters). A ruler on C, and the several divisions of the arc *ab*, will intersect the line M N in the hour, &c. points, which are to be marked as in the figure.

10. *The line of inclinations of meridians.* Bisect the arc E A in *c*; divide the quadrantal arc *bc* into 90 equal parts; lay a ruler on C and the several divisions of the arc *bc*, and the intersections of the line H M will be the divisions of a line of inclinations of meridians.

Of the sector. A sector is a figure formed by two radii of a circle, and that part of the circumference comprehended between the two radii.

The instrument called a sector, consists of two flat rulers moveable round an axis or joint; and from the centre of this joint several scales are drawn on the faces of the rulers.

The two rulers are called legs, and represent the radii of a circle; and the middle of the joint expresses the centre.

The scales generally put on sectors, may be distinguished into single, and double.

The single scales are such as are commonly put on plain scales, and from whence dimensions or distances are taken, as have been already directed.

The double scales are those which proceed from the centre; each scale is laid twice on the same face of the instrument, viz. once on each leg: from these scales, dimensions or distances are to be taken, when the legs of the instrument are in an angular position, as will be shewn hereafter.

The SCALES *commonly put on the best* SECTORS, *are*

	No.		Scale		Mark
Single	1	a line of	Inches, each Inch divided into 8 and 10 parts.		
	2		Decimals, containing 100 parts.		
	3		Chords,	marked	Cho.
	4		Sines,		Sin.
	5		Tangents,		Tang.
	6		Rhumbs,		Rum.
	7		Latitude,		Lat.
	8		Hours,		Hou.
	9		Longitude,		Lon.
	10		Inclin. Merid.		In. Me.
	11		the Logarithms of Numbers,		Num.
	12		the Logarithms of Sines,		Sin.
	13		the Logarithms of Versed Sines,		V. Sin.
	14		the Logarithms of Tangents,		Tan.
Double	1	a line of	Lines, or of equal parts,	marked	Lin.
	2		Chords,		Cho.
	3		Sines,		Sin.
	4		Tangents to 45°		Tan.
	5		Secants,		Sec.
	6		Tangents above 45°		Tan.
	7		Polygons,		Pol.

The scales of lines, chords, sines, tangents, rhumbs, latitudes, hours, longitude, incl. merid. may be used, whether the instrument is shut or open, each of these scales being contained on one of the legs only. The scales of inches, decimals, log. numbers, log. sines, log. versed sines, and log. tangents, are to be used with the sector quite opened, part of each scale lying on both legs.

The double scales of lines, chords, sines, and lower tangents, or tangents under 45 degrees, are all of the same radius or length; they begin at the centre of the instrument, and are terminated near the other extremity of each leg; viz. the lines at the division 10, the chords at 60, the sines at 90, and the tangents at 45; the remainder of the tangents, or those above 45 degrees, are on other scales beginning at $\frac{1}{4}$ of the length of the former, counted from the centre, where they are marked with 45, and run to about 76°. The secants also begin at the same distance from the centre, where they are marked with 0, and are from thence continued to as many degrees as the length of the sector will allow, which is about 75 degrees.

Each double scale, one being on each leg and proceeding from the centre, make an angle; and in an equal angular position are all the double scales, whether of lines, or of chords, or of sines, or of tangents to 45 degrees.

And the angles made by the scales of upper tangents, and of secants, are also equal; and sometimes these angles are made equal to those made by the other double scales.

The scales of polygons are put near the inner edge of the legs: their beginning is not so far removed from the centre, as the 60 on the chords is: where these scales begin, they are marked with 4, and from thence are figured backwards, or towards the centre, to 12.

From this disposition of the double scales, it is plain, that those angles which were equal to each other, while the legs of the sector were close, will still continue to be equal, although the sector be opened to any distance it will admit of.

We shall now illustrate the nature of this instrument by examples.

Let CL, CL, (fig. 13) be the two lines of lines upon the sector, opened to an angle LCL; join the divisions 4 and 4, 7 and 7, 10 and 10, by the dotted lines *a*, *b*, *c*, *d*, L L. Then by the nature of similar triangles, it is C L to C *b*, as L L to *a b*; and CL to C *d*, as L L to *c d*; and therefore *a b* is the same part of L L as C *b* is of C L. Consequently, if L L be 10, then *a b* will be 4, and *c d* will be 7 of the same parts.

And hence, though the lateral scale C L be fixed, yet a parallel scale LL, is obtainable at pleasure; and therefore though the lateral radius is of a determined length in the lines of chords, sines, tangents and secants, yet the parallel radius may be had of any size you want, by means of the sector, as far as its length will admit; and all the parallel sines &c. peculiar to it; as will be evident by the following examples in each pair of lines.

Ex. 1. *In the lines of equal parts.* Having 3 numbers given, 4, 7, 16, to find out a 4th proportional. To do this, take the lateral extent of 16 in the line C L, and apply it parallel-wise, from 4 to 4, by a proper opening of the sector; then take the parallel distance from 7 to 7 in your compasses, and applying one foot in C, the other will fall on 28 in the line of lines C L, and is the number required; for 4 : 7 :: 16 : 28.

Ex. 2. *In the lines of chords.* Suppose it required to lay off an angle A C B, (fig. 4) equal to 35 degrees; then with any convenient opening of the sector, take the extent from 60 to 60, and with it (as radius) on the point C describe the arch A D indefinitely; then in the same opening of the sector take the parallel distance from 35 degrees to 35 degrees, and set it from A to B in the arch A D and draw A B, and it makes the angle at C required.

Ex. 3. *In the lines of sines.* The lines of sines, tangents, and secants, are used in conjunction with the lines of lines in the solution of all the cases of plain trigonometry; thus let there be given in the triangle A B C, (fig. 14) the side A B = 230; and the angle A B C = 36° 30′; to find the side A C. Here the angle at C is 53° 30′. Then take the lateral distance 230, from the line of lines, and make it a parallel from 53° 30′ to 53° 30′ in the line of sines; then the parallel distance between 36° 30′ in the same lines, will reach laterally from the centre to 170, 19 in the line of lines for the side A C required.

Ex. 4. *In the lines of tangents.* If instead of making the side B C radius (as before) you make A B radius; then A C which before was a sine, is now the tangent of the angle B; and therefore to find it, you use the lines of tangents, thus:

Take the lateral distance 230 from the line of lines, and make it a parallel distance on the tangent radius, viz. from 45° to 45°, then the parallel tangent from 36° 30′, to 36° 30′, will measure laterally on the line of lines 170, 19, as before, for the side A C.

Ex. 5. *In the lines of secants.* In the same triangle, in the base A B, and the angles at B and C given, as before, to find the side or hypothenuse B C. Here B C is the secant of the angle B.

Take the lateral distance 230 from the line of lines, and make it a parallel distance on the tangent radius or beginnings of the lines of secants; then the parallel secant of 60° 30′ will measure laterally on the line of lines 287, 12, for the length of B C as required.

Ex. 6. *In the lines of sines and tangents conjointly.* In the solution of spherical triangles, you use the line of sines and tangents only, as in the following example. In the spherical triangle A B C (fig. 15) right-angled at A, there are given the side A B = 36° 15′, and the adjacent angle B = 42° 34′, to find the side A C. The analogy is radius: sine of A B :: tangent of B : tangent of A C; therefore make the lateral sine of 36° 15′ a parallel at radius, or between 90 and 90; then the parallel tangent of 42° 34′ will give the lateral tangent of 28° 30′ for the side A C.

Ex. 7. *In the lines of polygons.* It has been observed that the chord of 60 degrees is equal to radius; and 60° is the sixth part of 360°; therefore such a chord is the side of a hexagon, inscribed in a circle: so that in the line of polygons, if you make the parallel distance between 6 and 6, the radius of a circle, as A C (fig. 16), then if you take the parallel distance between 5 and 5, and place it from A to B, the line A B will be the side of a pentagon A B D E F, inscribed in the circle; in the same manner may any other polygon, from 4 to 12 sides, be inscribed in a circle, or upon any given line A B.

Ex. 8. *Of Gunter's lines.* We have now shewn the use of all that are properly called sectoral lines, or that are to be used sectorwise; but there is another set of lines usually put upon the sector, that will in a more ready and simple manner give the answers to the questions in the above examples, and these are called artificial lines of numbers, sines, and tangents: because they are only the logarithms of the natural numbers, sines, and tangents, laid upon lines of scales, which method was first invented by Mr. Edmund Gunter, and is the reason why they have ever since been called Gunter's lines, or the Gunter.

Logarithms are only the ratios of numbers, and the ratios of all proportional numbers are equal. Now all questions in multiplication, division, the rule of three, and the analogies of plain and spherical trigonometry, are all stated in proportional numbers or terms; therefore, if in the compasses you take the extent (or ratio) between the first and second terms, that will always be equal to the extent (or ratio) between the third and fourth terms; and consequently, if with the extent between the first and second terms, you place one foot of the compasses on the third term, then turning the compasses about, the other foot will fall on the fourth term sought.

Thus in example I, of the three given numbers 4, 7, and 16, if you take the extent from 4 to 7 in the compasses, and place one foot in 16, the other will fall on 28 the answer, in the line of numbers marked *n*.

Again, the artificial lines of numbers and sines, are used together in plain trigonometry, as in example 3, where the two angles B and C, and the side AB are given; for here if you take the extent of the two angles 53° 30′ and 36° 30′ in the line of sines marked *s*, then placing one foot upon 230 in the line of numbers *n*, the other will reach to 170, 19 the answer.

Also the lines of numbers and tangents are used conjointly, as in the example 4, for take in the line of tangents *t*, the extent from 45° (radius) to 36° 30′; that will reach from 230 to 170, 19 the answer as before.

Lastly, the artificial lines of sines and tangents are used together in the analogies of spherical triangles.

Thus example 6 is solved by taking in the line of sines *s*, the extent from 90° (radius) to 36° 15′, then that in the line of tangents *t*, will reach from 42° 34′ to 28° 30′, the answer required.

We shall only further observe that each pair of sectoral lines contain the same angle, viz. 6 degrees in the common 6-inch sector; therefore to open these lines to any given angle, as 35° for instance, you have only to take 35° laterally from the line of chords, and apply it parallelwise from 60° to 60° in the same lines, and they will all be opened to the given angle of 35°.

If to the angle 35° you add the angle 6°, which they contain, the sum is 41°: then take 41° laterally from the line of chords, and apply it parallelwise, from 60 to 60, then will the sides or edges of the sector contain the same angle of 35 degrees.

Of proportional compasses. Though this sort of compasses does not pertain to a common case of instruments, yet a short account of their nature and use may not be unacceptable to those who are not acquainted with them. They consist of two parts or sides of brass, which lie upon each other, so nicely as to appear but one when they are shut. These sides easily open, and move about a centre, which is itself moveable in a hollow canal cut through the greatest part of their length. To this centre on each side is affixed a sliding piece of a small length, with a fine line drawn on it serving as an index, to be set against other lines or divisions placed upon the compasses on both sides. These lines are: 1. A line of lines. 2. A line of superficies, areas, or plans. 3. A line of solids. 4. A line of circles, or rather of polygons to be inscribed in circles.

These lines are all unequally divided, the three first from 1 to 10, the last from 6 to 20; their uses are as follow:

By the line of lines you divide a given line into any number of equal parts; for by placing the index against 1, and screwing it fast, if you open the compasses, then the distance between the points at each end will be equal. If you place the index against 2, and open the compasses, the distance between the points of the longer legs will be twice the distance between the shorter ones; and thus a line is bisected, or divided into two equal parts. If the index be placed against 3, and the compasses opened, the distances between the points will be as 3 to 1, and so a line is divided into three equal parts; and so you proceed for any other number of parts under 10.

The numbers of the line of plans answer to the squares of those in the line of lines; for because superficies or plans are to each other, as the squares of their like sides, therefore if the index be placed against 2 in the line of plans; then the distance between the small points will be the side of a plan whose area is 1; but the distance of the larger points will be the like side of a plan whose area is 2, or twice as big. If the index be placed at 3, and the compasses opened, the distances between the points at each end will be the like sides of plans, whose areas are 1 to 3, and so of others.

The numbers of the line of solids answer to the cubes of those in the line of lines; because all solids are to each other as the cubes of their like sides or diameters; therefore, if the index be placed to No. 2, 3, 4, &c. in the line of solids, the distances between the lesser and larger points will be the like sides of solids, which are to each other as 1 to 2, 1 to 3, 1 to 4, &c. For example, if the index be placed at 10, and the compasses be opened, so that the small points may take the diameter of a bullet weighing 1 ounce, then the distance between the larger points will be the diameter of a bullet or globe of 10 ounces, or which is 10 times as big.

Lastly the numbers in the line of circles are the sides of polygons to be inscribed in a given circle, or by which a circle may be divided into those equal parts from 6 to 20. Thus if the index be placed at 6, the points of the compasses at either end, when opened to the radius of a given circle, will contain the side of a hexagon, or divide the circle into 6 equal parts. If the index be placed against 7, and the compasses opened, so that the larger points may take in the radius of the circle; then the shorter points will divide the circle into 7 equal parts for inscribing a heptagon. Again, placing the index to 8, and opening the compasses, the larger points will contain the radius, and the lesser points divide the circle into 8 equal parts, for inscribing an octagon or square. And thus you proceed for others.

INSTRUMENTS, *surgical.* A case of pocket instruments for surgeons, which they ought always to carry about with them, contains lancets of different sizes; scissars fit for several uses; forceps, plain and furnished with teeth; incision-knives, straight and crooked; a spatula, probes, needles, &c. See SURGERY.

INSURANCE, LAWS OF. Insurance is regarded by the law as a contract between two or more parties; that on one paying a certain premium he shall be indemnified or insured against certain risks set forth in the policy. This is extremely convenient in commerce, but was made use of as a kind of gambling till the statute 14 Geo. III. c. 48, that no insurance shall be made on lives, or on any other event, wherein the party insured hath no interest; that in all policies the name of such interested party shall be inserted, and nothing more shall be recovered thereon than the amount of the interest of the insured. This, however, does not extend to marine insurances. But as it was a common practice of insuring large sums without having property on board, and which were called wager policies or insurances, interest or no interest, and of insuring the same goods several times over, it was enacted, that all insurances, interest or no interest, or without further proof of the interest than the policy, or by way of gaming, or without benefit of salvage to the insurer, should be void, except on privateers, or on ships or goods from the Spanish or Portuguese dominions; and that no re-assurance shall be legal, unless the former insurer be insolvent or dead; and that in the East India trade the lender of money on bottomry, or at respondentia, shall alone have a right to be insured for the money lent; and the borrower shall recover no more upon any insurance than the surplus of his bottomry or respondentia bond. No insurance can be made on any illegal voyage.

It is generally stipulated in policies that the insurer shall not be answerable for any partial loss on certain articles, but on others less difficult to be preserved at sea, but liable to partial injuries, shall be liable for any partial loss above five per cent.; and as to all other goods, and the ship and freight, he shall only be liable for such losses above three per cent. But he is liable on all losses, however small, called general average or losses occasioned by the ship stranding; but this loss must be an immediate, not a remote, consequence of the stranding.

The commencement of the risk on the ship varies in most cases, and usually continues till the ship has been 24 hours at safe anchor. Upon goods it commences when they are on board, and continues till they are removed or landed. The ship insured must be sound, and in every respect fit to bear the sea, and perform the voyage; and if she deviates from the usual course, and stops at places not usually stopped at, without a proper cause, the contract is void.

Insurance upon life is a contract by which the insurer, for a certain sum proportioned to the age, health, and profession of the person whose life is to be insured, engages that the person shall not die within a certain period, or if he do, the underwriter will pay a sum of money to the person to whom the policy is granted.

Insurance against fire. The insurer undertakes, in consideration of a premium, to indemnify the insured against all losses by fire which he may sustain in his house or goods during the time mentioned in the policy.

INTAGLIOS, precious stones on which are engraven the heads of great men, inscriptions, and the like; such as we frequently see set in rings, seals, &c.

INTEGER, in arithmetic, a whole number, in contradistinction to a fraction.

INTERCALARY, in chronology. See BISSEXTILE, &c.

INTERCOMMONING, in law, is when the commons of two manors lie together, and the inhabitants of both have, time out of mind, caused their cattle to feed promiscuously on them.

INTERCOSTAL. See ANATOMY.

INTERDICT, an ecclesiastical censure,

by which the church of Rome forbids the performance of divine service in a kingdom, province, town, &c. This censure has been frequently executed in France, Italy, and Germany; and in the year 1170 pope Alexander III. put all England under an interdict, forbidding the clergy to perform any part of divine service, except baptising of infants taking confessions, and giving absolution to dying penitents.

INTEREST, a sum of money, paid or allowed for the loan or use of some other sum, lent for a certain time, according to some fixed rate or proportion. The sum lent, and on which the interest is reckoned, is called the principal; and in any case where there is hazard of the loss or diminution of the principal, a proportionately greater interest is usually paid. The current rate of interest is generally considered as the barometer of public credit; and its lowness is a sign almost infallible of the flourishing condition of a state; it proves the increase of industry, and the free circulation of wealth, little inferior to a demonstration. In order to prevent individuals from taking unjust advantages of the necessities of others, it has been found necessary in most countries to establish by law a fixed rate of interest for the use of money: this however must, in a great measure, depend on the current rate of interest in the country; for if it is attempted to reduce by law the common rate of interest below the lowest ordinary market rate, the restriction will be sure to be evaded. This was the case in France in 1766, when, although the legal rate of interest was reduced from five to four per cent., money continued to be lent at five per cent.

The first act of parliament for regulating the interest for money lent in England was 37 Hen. VIII. c. 9, by which interest was fixed at 10 per cent.; before that time interest had usually been taken at higher rates. In 1552 an act was passed against usury, or taking any interest whatever for money lent: the impolicy and oppression of this measure soon became evident; and in 1571 the statute of Henry VIII. which fixed interest at 10 per cent., was revived. As the increase of commerce brought wealth into the country, the rate of interest lowered; and in 1625 it was, by 21 James I. c. 17, reduced to eight per cent. The first positive law made in Scotland for fixing the rate of interest was in 1587, when an act was passed, by which the rate of interest was not for the future to exceed 10 per cent. In France, in 1601, Henry IV. issued an edict for reducing the public or national interest of money in that kingdom to six and a quarter per cent. In 1651 the interest of money in several parts beyond sea being lower than the legal interest in England, the Rump-parliament reduced the legal rate from eight to six per cent.; and upon the Restoration it was confirmed by 12 Cha. II. c. 13. The last act of parliament for regulating the interest of money was 12 Ann. st. 2. c. 16, by which it was fixed at five per cent. per annum, the present legal rate. But although this is the utmost interest which can be taken for money lent in Great Britain, yet if a contract which carries interest was made in a foreign country, our courts will direct the payment of interest according to the laws of the country in which the contract was made: thus American, Turkish, and Indian interest have been allowed, to the amount of even 12 per cent.

The various rates which have been paid in Great Britain at different periods, as the current interest for money, are as follows:

	Per cent. per ann.		
In 1255 - - -	£. 50	0	0
1263, 2*d.* a-week for 1*l.* or	43	6	8
1270 to 1307 - -	45	0	0
1422 to 1470 - -	15	0	0
1545 restricted to -	10	0	0
1553 to 1558 -	12	0	0
1571 restricted to -	10	0	0
1524 to 1604, about -	9	16	0
1625 reduced to -	8	0	0
1645 to 1660 - -	6	0	0
1660 reduced to -	6	0	0
1660 to 1690 - -	7	6	6
1690 to 1697 - -	7	10	0
1697 to 1706 - -	6	0	0
1714 reduced to -	5	0	0

In the United States of America, the lawful interest of money is 6 per cent. in most of the States; in a few it is 7 per cent.; in one it is 5 per cent. In Greece, the mean rate of interest is 20 per cent., and in the other parts of Turkey nearly the same; in Persia 25 per cent.; and in the Mogul Empire 30 per cent. In these countries there is no fixed rate of interest, and the usual high rate arises chiefly from the insecurity of lending. In Sydney and the other English settlements in New South Wales, the rate of interest is fixed by an ordinance, dated 14th June, 1804, at 8 per cent. per annum.

Interest is distinguished into *Simple Interest* and *Compound Interest.*

INTEREST, *Simple*, is that which is reckoned on the principal only, at a certain rate for a year, and at a proportionately greater or less sum for a greater or less time; thus, if 5*l.* is the rate of interest of 100*l.* for a year, 10*l.* is the interest for two years, 15*l.* for three years, &c. In most computations of interest the work is much shortened if the interest of 1*l.* for a given term is known, as the interest of any other sum for the same term will then be found by only multiplying by the given sum. The interest of 1*l.* for a year must be in the same proportion as the interest of 100*l.* to its principal; therefore, at 5 per cent., as $100 : 5 :: 1 : \frac{5}{100} = ,05$; and thus:—

The interest of One Pound for One Year,

£.		£.
at 3 per cent. is	- -	,03
$3\frac{1}{2}$	- - - -	,035
4	- - - -	,04
$4\frac{1}{2}$	- - - -	,045
5	- - - -	,05
$5\frac{1}{2}$	- - - -	,055
6	- - - -	,06

The interest of One Pound for any number of years.

Years.	3 per Cent.	$3\frac{1}{2}$ per Cent.	4 per Cent.	$4\frac{1}{2}$ per Cent.	5 per Cent.
10	,3	,35	,4	,45	,5
20	,6	,7	,8	,9	1,0
30	,9	1,05	1,2	1,35	1,5
40	1,2	1,4	1,4	1,8	2,0
50	1,5	1,75	2,0	2,25	2,5
60	1,8	2,1	2,4	2,7	3,0
70	2,1	2,45	2,8	3,15	3,5
80	2,4	2.8	3,2	3,6	4,0
90	2,7	3,15	3,6	4,05	4,5
100	3,0	3,5	4,0	4,5	5,0

Although the law forbids any person lending money to take more than 5*l.* for the interest of 100*l.* for a year; yet by allowing the proportionate part of 5*l.* to be taken for part of a year, it permits any one who lends money for a less term than a year, to receive more than he ought if he were to make only 5 per cent. per annum of his money; for, if he lends 100*l.* for six months, he receives 102*l.* 10*s.*, and this being lent again for the remaining six months, amounts to 105*l.* 1*s.* 3*d.*; if the time is less than six months the difference must be still greater. The letter of the law is however the rule in practice, and therefore the 365th part of the yearly interest is always considered as the proper interest for a day, and its multiples as the interest for any number of days.

The Interest of One Pound for One Day,

£.		£.
At 3 per cent. is	-	,00008219
$3\frac{1}{2}$	- - -	,00009589
4	- - - -	,00010959
$4\frac{1}{2}$	- - -	,00012329
5	- - - -	,00013699
$5\frac{1}{2}$	- - -	,00015068
6	- - - -	,00016438

As tables of Simple Interest are chiefly referred to, in order to find the interest or discount on bills of exchange, and as by far the greater number of bills which are discounted have less than 100 days to run, the following table will answer most useful purposes; but those who have constant occasion to make such computations, will derive much assistance from the extensive tables which have been computed by Smart, Thomson, King, Reid, and others. See also DISCOUNT.

TABLE

Shewing the Simple Interest of One Pound, for any number of days. not exceeding 100, at 5 per Cent.

days	Amount.	days	Amount.	days	Amount.
1	,0001369	35	,0047945	69	,0094520
2	,0002739	36	,0049315	70	,0095890
3	,0004109	37	,0050684	71	,0097260
4	,0005479	38	,0052054	72	,0098630
5	,0006849	39	,0053424	73	,0100000
6	,0008219	40	,0054794	74	,0101369
7	,0009589	41	,0056164	75	,0102739
8	,0010958	42	,0057534	76	,0104109
9	,0012328	43	,0058904	77	,0105479
10	,0013698	44	,0060274	78	,0106849
11	,0015068	45	,0061643	79	,0108219
12	,0016438	46	,0063013	80	,0109589
13	,0017808	47	,0064383	81	,0110958
14	,0019178	48	,0065753	82	,0112328
15	,0020547	49	,0067123	83	,0113698
16	,0021917	50	,0068493	84	,0115068
17	,0023287	51	,0069868	85	,0116438
18	,0024657	52	,0071232	86	,0117808
19	,0026027	53	,0072602	87	,0119178
20	,0027397	54	,0073972	88	,0120547
21	,0028767	55	,0075342	89	,0121917
22	,0030137	56	,0076712	90	,0123287
23	,0031506	57	,0078082	91	,0124657
24	,0032876	58	,0079452	92	,0126027
25	,0034246	59	,0080821	93	,0127397
26	,0035616	60	,0082191	94	,0128767
27	,0036986	61	,0083561	95	,0130137
28	,0038356	62	,0084931	96	,0131506
29	,0039726	63	,0086301	97	,0132876
30	,0041095	64	,0087671	98	,0134246
31	,0042465	65	,0089041	99	,0135616
32	,0043835	66	,0090411	100	,0136986
33	,0045205	67	,0091780		
34	,0046575	68	,0093150		

The interest of any sum for any number of days contained in the table, is found by only multiplying the figures corresponding with the number of days by the sum: thus, if the interest of 150*l.* for 61 days is required, the interest of one pound for 61 days is, by the table, ,0083561, which multiplied by 150, gives 1*l.* 5*s.* $0\frac{3}{4}$*d.* If the given sum contains shillings and pence, they must be reduced to the decimal of a pound.

The interest for any greater number of days than are contained in the table, is easily found by means of it; thus, if it is required to find the interest of 100*l.* for 165 days, the interest for 100 days by the table is 1,36986, and for 65 days ,89041, which two sums added together, make 2,26027, or 2*l.* 5*s.* 2*d.* But, although it is most convenient in common practice to make use of tables for finding the interest for days, the interest of any sum for any number of days may be correctly and expeditiously obtained without the use of any table, by the following rule:

"Multiply the given sum by the number of days, and divide by 7300."

Example 1. What is the interest of 356*l.* for 112 days?

356 multiplied by 112, and divided by 7300, gives 5,4619, or 5*l.* 9*s.* 2¼*d.*

Example 2. What is the interest of 137*l.* 18*s.* for 97 days?

137,9 multiplied by 97, and divided by 7300, gives 1,8323, or 1*l.* 16*s.* 7¾*d.*

The amount of a given sum in any time may be found by multiplying the Principal, Time, and Rate together; and adding the product to the principal.

Example 1. What sum will 37*l.* 10*s.* amount to in 3 years and 146 days, at 4 per cent. per annum?

37,5 multiplied by 3,4, and the product multiplied by ,04, gives 5,1; which added to 37,5, makes 42,6, or 42*l.* 12*s.*

Example 2. What sum will One Penny amount to in 1806 years, at 5 per cent. per annum?

,004166 multiplied by 1806, and the product multiplied by ,05, gives ,37625, which, added to the principal, makes ,380416, or 7*s.* 7¼*d.*

This example sets the difference between simple and compound interest in a most striking point of view; it appears that one penny put out to interest at the birth of Christ, would (at 5 per cent. simple interest) have amounted at the present time to 7*s.* 7¼*d.*, but at compound interest, it would have increased in the same period to a greater sum than would be contained in six hundred millions of globes, each equal to the earth in magnitude, and all solid gold.

Interest, *compound*, is that which is reckoned on the principal and its interest put together, as the interest becomes due, so as to form a new capital from each period at which the interest is payable: it is sometimes called interest upon interest. It is not lawful to lend money at compound interest; but in the granting or purchasing of annuities, leases, or reversions, it is usual to allow the purchaser compound interest for his money; and the difference from simple interest is so great, in all cases in which the period of time is considerable, that almost all computations relating to annual payments of money for a number of years, are made at compound interest, unless it is otherwise agreed.

Let $r =$ the amount of 1*l.* in one year, viz. principal and interest,
$n =$ the number of years, in which
$p =$ the principal, increases to
$a =$ the amount:

then $1 : r :: r : r^2$ the amount of 1*l.* in 2 years
$1 : r :: r^2 : r^3$ the amount of 1*l.* in 3 years
$1 : r :: r^3 : r^4$ the amount of 1*l.* in 4 years, &c.;

therefore r^n, or r raised to the power whose exponent is the number of years, will be the amount of 1*l.* in those years; and as

$1l. : r^n :: p : a$, the amount of a given principal in the same time. Thus,

If Principal, Time, and Rate, are given, to find the Amount?

Theo. 1. $p \times r^n = a$.

If Amount, Time, and Rate, are given, to find the Principal?

Theo. 2. $\frac{a}{r^n} = p$.

If Principal, Amount, and Time, are given, to find the Rate?

Theo. 3. $\sqrt[n]{\frac{a}{p}} = r$.

If Principal, Amount, and Rate, are given, to find the Time?

Theo. 4. $\frac{a}{p} = r^n$, therefore $\frac{a}{p}$ being divided by r till nothing remains, the number of divisions will $= n$.

But for greater convenience in practice, these theorems may be expressed in logarithms, as follows:

1. $\log. p + \overline{n \times \log. r} = \log. a$.
2. $\log. a - \overline{n \times \log. r} = \log. p$.
3. $\frac{\log. a - \log. p}{n} = \log. r$.
4. $\frac{\log. a - \log. p}{\log. r} = n$.

On these principles all tables of Compound Interest are formed, of which the following are the most useful.

TABLE I.

Shewing the Sum to which 1*l.* Principal will increase at 5 per Cent. Compound Interest, in any number of years not exceeding a hundred.

Yrs.	Amount.	Yrs.	Amount.	Yrs.	Amount.
1	1.05	35	5.516015	69	28.977548
2	1.1025	36	5.791816	70	30.426425
3	1.157625	37	6.081406	71	31.947746
4	1.215506	38	6.385477	72	33.545134
5	1.276281	39	6.704751	73	35.222390
6	1.340095	40	7.039988	74	36.983510
7	1.407100	41	7.391988	75	38.832685
8	1.477455	42	7.761587	76	40.774320
9	1.551328	43	8.149666	77	42.813036
10	1.628894	44	8.557150	78	44.953688
11	1.710339	45	8.985007	79	47.201372
12	1.795856	46	9.434258	80	49.561441
13	1.885649	47	9.905971	81	52.039513
14	1.979931	48	10.401269	82	54.641488
15	2.078928	49	10.921333	83	57.373563
16	2.182874	50	11.467399	84	60.242241
17	2.292018	51	12.040769	85	63.254353
18	2.406619	52	12.642808	86	66.417071
19	2.526950	53	13.274948	87	69.737924
20	2.623297	54	13.938696	88	73.224820
21	2.785962	55	14.635630	89	76.886061
22	2.925260	56	15.367412	90	80.730365
23	3.071523	57	16.135783	91	84.766883
24	3.225099	58	16.942572	92	89.005227
25	3.386354	59	17.789700	93	93.455488
26	3.555672	60	18.679185	94	98.128263
27	3.733456	61	19.613145	95	103.034676
28	3.920129	62	20.593802	96	108.186410
29	4.116135	63	21.623492	97	113.595730
30	4.321942	64	22.704667	98	119.275517
31	4.538039	65	23.839900	99	125.239293
32	4.764941	66	25.031895	100	131.501257
33	5.003188	67	26.283490		
34	5.253347	68	27.597664		

In order to find what any sum will amount to in a given number of years, it is only necessary to multiply the number in the Table opposite to the term of years by the sum, and the product will be the answer.

Example. To what sum will 50*l.* increase in 69 years, at 5 per cent. compound interest?

The number in the table corresponding with 69 years is 28.977548, which multiplied by 50, gives 1448.8774, or 1448*l.* 17*s.* 6*d.*

The number of years in which a given sum will increase to another given sum in consequence of being improved at interest, is found by dividing the latter sum by the former, and the sum in the table which is nearest to the quotient will shew the term required.

Example. In what time will 100*l.* increase to 500*l.*, if improved at 5 per cent.?

Divide 500 by 100, and the number in the table nearest to 5 the quotient, is 5.003188, which shews that 33 years is the answer.

TABLE II.

Shewing the present Value of 1*l.* to be received at the end of any number of years, not exceeding 100; discounting at 5 per Cent. Compound Interest.

Yrs.	Value.	Yrs.	Value.	Yrs.	Value.
1	.952381	35	.181290	69	.034509
2	.907029	36	.172657	70	.032866
3	.863838	37	.164436	71	.031301
4	.822702	38	.156605	72	.029811
5	.783526	39	.149148	73	.028391
6	.746215	40	.142046	74	.027039
7	.710681	41	.135282	75	.025752
8	.676839	42	.128840	76	.024525
9	.644609	43	.122704	77	.023357
10	.613913	44	.116861	78	.022245
11	.584679	45	.111297	79	.021186
12	.556837	46	.105997	80	.020177
13	.530321	47	.100949	81	.019216
14	.505068	48	.096142	82	.018301
15	.481017	49	.091564	83	.017430
16	.458112	50	.087204	84	.016600
17	.436297	51	.083051	85	.015809
18	.415521	52	.079096	86	.015056
19	.395734	53	.075330	87	.014339
20	.376889	54	.075743	88	.013657
21	.358942	55	.068326	89	.013006
22	.341850	56	.065073	90	.012387
23	.325571	57	.061974	91	.011797
24	.310068	58	.059023	92	.011235
25	.295303	59	.056212	93	.010700
26	.281241	60	.053536	94	.010191
27	.267848	61	.050986	95	.009705
28	.255094	62	.048558	96	.009243
29	.242946	63	.046246	97	.008803
30	.231377	64	.044044	98	.008384
31	.220359	65	.041946	99	.007985
32	.209866	66	.039949	100	.007604
33	.199873	67	.038047		
34	.190355	68	.036235		

In order to find the present worth of any sum which is to be received at the end of a certain number of years, multiply the number in the table opposite to the term of years, by the sum, and the product will be the answer.

Example. What is the present value of 500*l.* to be received at the expiration of 14 years?

The number in the table corresponding with 14 years, is .505068, which multiplied by 500, gives 252,534, or 252*l.* 10*s.* 8*d.*

For the present value or amount of annual payments, as Annuities, Pensions, Leases, &c. at Compound Interest, see Annuities.

Interest, in law, is generally taken for a chattel real, or a lease for years, &c. but more for a future term.

An estate in lands, &c. is better than a bare interest therein; yet, according to the legal sense of the word, an interest extends to estates and titles which a person has in or out of lands, &c.; for by grant of a person's whole interest in land, a reversion, as well as possession, in fee-simple, passes.

INTERJECTION, in grammar, an indeclinable part of speech, signifying some passion or emotion of the mind.

INTERLOCUTORY ORDER, in law, an order that does not decide the cause, but only some matter incident to it, which happens between the beginning and end of a cause; as when, in chancery or exchequer, the plaintiff obtains an order for an injunction until the hearing of the cause; which order, not being final, is called interlocutory.

INTERMITTENT, or INTERMITTING FEVERS. See MEDICINE.

INTERNAL, in general, signifies whatever is within a thing.

Euclid proves that the sum of the three internal angles of every triangle is equal to two right angles; whence he deduces several useful corollaries. He likewise adduces, from the same proposition, this theorem, viz. that the sum of the angles of every rectilinear figure, is equal to twice as many right angles, as the figure hath sides, excepting or subtracting four.

INTERROGATORIES, are questions exhibited in writing to be asked witnesses or contemnors to be examined. Those interrogatories are in the nature of a charge or accusation; and if any of them is improper, the defendant may refuse to answer it, and move the court to have it struck out. Str. 444.

INTERSECTION, in the mathematics, signifies the cutting of one line or plane by another: thus we say, that the mutual intersection of two planes is a right line.

INTERVAL, in music, the difference in point of gravity or acuteness between any two sounds. Taking the word in its more general sense, we must allow that the possible intervals of sound are infinite, but we only speak of those intervals which exist between the different tones of any established system. The antients divided the intervals into simple, or uncomposite, which they call diastems, and composite intervals, which they call systems. The least of all the intervals in the Greek music was, according to Bacchius, the enharmonic diesis, or fourth of a tone; but our scale does not notice so small a division, since all our tones concur in consonances, to which order only one of the three antient genera, viz. the diatonic, was accommodated. Modern musicians consider the semitone as a simple interval, and only call those composite which consist of two or more semitones:, thus from B to C is a semitone, or simple interval, but from C to D is two half-tones, or a compound interval.

INTESTATES. There are two kinds of intestates; one that makes no will at all; and another that makes a will, and nominates executors, but they refuse; in which case he dies an intestate, and the ordinary commits administration. 2 Par. Inst. 397.

The ordinary by special acts of parliament is required to grant administration of the effects of the deceased to the widow or next of kin, who shall first pay the debts of the deceased, and then distribute the surplus among the kindred, in the manner and according to the proportions directed by 22 and 23 Car. II. c. 10.

INTESTINA, in natural history, an order of vermes. The individuals of this order are of a formation the most simple, and live some of them within other animals, some in waters, and a few in the earth. The gordius perforates clay to give a passage to springs and water; the lumbricus pierces the earth, that it may be exposed to the action of the air and moisture: in like manner the teredo penetrates wood; and the phloas and mytillus rocks, to effect their dissolution.

INTESTINES. See ANATOMY, and PHYSIOLOGY.

INTRUSION, in law, is when the ancestor dies seised of any estate of inheritance, expectant upon an estate for life; and then the tenant for life dies, between whose death, and the entry of the heir, a stranger intrudes.

INVECTED, in heraldry, denotes a thing fluted or furrowed. See HERALDRY.

INVENTION. See PAINTING.

INVESTITURE, in law, is the giving possession of lands by actual seisin. The ancient feudal investiture was, where the vassal on descent of land was admitted into the lord's court, and there received his seisin, in the nature of a renewal of his ancestor's grant, in the presence of the rest of the tenants: but in aftertimes, entering on any part of the lands, or other notorious possession, was admitted to be equivalent to the formal grant of seisin and investiture. 2 Black. 209.

The manner of grant was by words of pure donation, "have given and granted:" which are still the operative words in our modern infeodations or deeds of feoffment. This was perfected by the ceremony of corporal investiture, or open and notorious delivery of possession in the presence of the other vassals.

But a corporal investiture being sometimes inconvenient, a symbolical delivery of possession was in many cases anciently allowed of; by transferring something near at hand, in the presence of credible witnesses, which by agreement should serve to represent the very thing designed to be conveyed; and an occupancy of this sign or symbol was permitted as equivalent to the occupancy of the land itself. And to this day, the conveyance of many of our copyhold estates is made from the seller to the lord, or his steward, by delivering a rod or verge, and then from the lord to the purchaser, by a re-delivery of the same, in the presence of a jury of tenants. 2 Black. 313.

INULA, fleabane, a genus of the syngenesia polygamia-superflua class of plants, with radiated flowers: the receptacle is naked; the down is simple; and the antheræ terminate in setæ at their bases. There are thirty-four species, of no note.

INVOICE, an account in writing of the particulars of merchandise, with their value, custom, charges, &c. transmitted by one merchant to another in a distant country.

One copy of every invoice is to be inserted verbatim in the invoice-book, for the merchant's private use; and another copy must, immediately upon shipping off the goods, be dispatched by post, or otherwise, to the correspondent. This copy is commonly drawn out upon a sheet of large post-paper, to the end of which is subjoined a letter of advice.

INVOLUCRUM. See BOTANY.

INVOLUTION. See ALGEBRA.

JOINT ACTIONS: in personal actions, several wrongs may be joined in one writ; but actions founded upon a tort and a contract cannot be joined, for they require different pleas and different process. 1 Vent. 336.

JOINT AND SEVERAL: an interest cannot be granted jointly and severally; as if a man grants the next advowson, or makes a lease for years, to two jointly and severally; these words (severally) are void, and they are joint tenants. 5 Rep. 19.

JOINT LIVES: lease for years to husband and wife, if they or any issue of their bodies should so long live, has been adjudged so long as either the husband, wife, or any of their issue, should live; and not only so long as the husband and wife, &c. should jointly live. Moor, 539.

JOINT TENANTS, are those that come to, and hold lands or tenements by one title pro indiviso, or without partition.

These are distinguished from sole or several tenants, from parceners, and from tenants in common: and they must jointly implead, and jointly be impleaded by others, which properly is common between them and coparceners; but joint tenants have a sole quality of survivorship, which coparceners have not; for if there are two or three joint tenants, and one has issue and dies, then he or those joint tenants that survive, shall have the whole by survivorship. Cowel.

The creation of an estate in joint tenantcy depends on the wording of the deed or devise, by which the tenant claims title; for this estate can only arise by purchase or grant, that is, by the act of the parties; and never by the mere act of law. Now if any estate is given to a plurality of persons, without adding any restrictive, exclusive, or explanatory words, as if an estate is granted to A and B and their heirs, this makes them immediately joint tenants in fee of the lands; for the law interprets the grant, so as to make all parts of it take effect, which can only be done by creating an equal estate in them both. As therefore the grantor has thus united their names, the law gives them a thorough union in all other respects. 2 Black. 180.

If there are two joint tenants, and one releases the other, this passes a fee without the word heirs, because it refers to the whole fee, which they jointly took, and are possessed of by force of the first conveyance; but the tenants in common, cannot release to each other, for a release supposes the party to have the thing in demand, but tenants in common have several distinct freeholds, which they cannot transfer otherwise than as persons who are sole seized. Co. Lit. 9.

Although joint tenants are seized per mie et per tout, yet to divers purposes each of them has but a right to a moiety; as to enfeoff, give, or demise, or to forfeit or lose by default in a præcipe; and therefore where there are two or more joint tenants, and they all join in a feoffment, or each of them in judgment gives but his part. Co. Lit. 186.

The right of survivorship shall take place immediately upon the death of the joint tenant, whether it is a natural or civil death; as if there are two joint tenants, and one of them enters into religion, the survivor shall have the whole. Co. Lit. 181.

At common law, joint tenants in common were not compellable to make partition, except by the custom of some cities and boroughs. Co. Lit. 187.

But now joint tenants may make partition; the one party may compel the other to make partition, which must be by deed: that is to to say, all the parties must by deed actually convey and assure to each other the several estates, which they are to take and enjoy severally and separately. 2 Black. 324.

Joint tenants being seized per mie et per tout, and deriving by one and the same title, must jointly implead, and be jointly impleaded with others. Co. Lit. 180.

If one joint tenant refuses to join in action, he may be summoned and severed; but herein it is to be observed, that if the person severed dies, the writ abates, because the survivor then goes for the whole, which he cannot do on that writ, where on the summons and severance he went only for a moiety before; for the writ cannot have a double effect, to wit, for a moiety in case of summons and severance, and for the whole in case of survivorship. Co. Lit. 188.

But in personal and mixed actions where there is summons and severance, and yet after such summons and severance the plaintiff goes on for the whole, there if one of them dies, yet the writ shall not abate, because they go on for the whole after summons and severance; and if they were to have a new writ, it would only give the court authority to go on for the whole. Co. Lit. 197.

JOINTURE. A jointure strictly speaking, signifies a joint estate, limited to both husband and wife; but in common acceptation, it extends also to a sole estate, limited to the wife only, and may be thus defined, viz. a competent livelihood of freehold for the wife of lands and tenements, to take effect, in profit or possession, presently after the death of the husband; for the life of the wife at least. 2 Black. 137.

By the statute of the 27th H. VIII. c. 10. if a jointure is made to the wife, it is a bar of her dower, so that she shall not have both jointure and dower. And to the making of a perfect jointure within that statute six things are observed: 1. Her jointure is to take effect presently after her husband's decease. 2. It must be for the term of her own life, or greater estate. 3. It should be made to herself. 4. It must be made in satisfaction of her whole dower, and not of part of her dower. 5. It must either be expressed or averred to be in satisfaction of her dower. 6. It should be made during the coverture. 1 Inst. 32.

The estate must take effect presently after her husband's decease; therefore if an estate is made to the husband for life, remainder to another person for life, remainder to the wife for her jointure, this is no good jointure, for it is not within the words or intent of the statute; for the statute designed nothing as a satisfaction for dower, but that which came in the same place, and is of the same use to the wife; and though the other person dies during the life of the husband, yet this is not good; for every interest not equivalent to dower not being within the statute, is a void limitation to deprive the wife of her dower. 4 Co. 3.

The estate must be for term of the wife's life, or a greater estate; therefore if an estate is made for the life or lives of many others, this is no good jointure; for if she survives such lives, as she may, then it would be no competent provision during her life, as every jointure within the statute ought to be. Co. Lit. 36.

The estate should be made to herself; but as the intention of the statute was to secure the wife a competent provision, and also to exclude her from claiming dower, and likewise her settlement, it seems that a provision or settlement on the wife, though by way of trust, if in other respects it answers the intention of the statute, will be inforced in a court of equity.

The estate must be in satisfaction of the whole dower; the reason hereof is, that if it is made in satisfaction of part only, it is uncertain for what part it is in satisfaction of her dower, and therefore void in the whole. Co. Lit. 36.

The estate must be expressed or averred to be in satisfaction of her dower. Lord Coke says, that it must be expressed or averred to be in satisfaction of her dower; but quære, for this does not seem requisite either within the words or intention of the statute. Co. Lit. 36.

It should be made during the coverture; this the very words of the act of parliament require: and therefore if a jointure is made to a woman during her coverture in satisfaction of dower, she may wave it after her husband's death; but if she enters and agrees thereto, she is concluded; for though a woman is not bound by any act when she is not at her own disposal, yet if she agrees to it when she is at liberty, it is her own act, and she cannot avoid it. Co. Lit. 36. 4 Co. 3.

JOISTS, or Joysts. See Architecture.

JONCQUETIA, a genus of the decandria tetragynia class and order. The cal. is five-leaved; pet. five and spreading; filaments growing to a glandule; styles none; caps. sub-globular, one-celled, five-valved, five-seeded. There is one species, a large tree of Guiana.

IONIC ORDER. See Architecture.

JONK, or Jonque, in naval affairs, is a kind of small ship, very common in the East Indies: these vessels are about the bigness of our fly-boats, and differ in the form of their building, according to the different methods of naval architecture used by the nations to which they belong. Their sails are frequently made of mats, and their anchors are made of wood.

JOURNAL, at sea. See Navigation.

IPECACUANHA. See Materia Medica.

IPOMEA, *quamoclit*, or scarlet convolvulus, a genus of the monogynia order, in the pentandria class of plants; and in the natural method ranking under the 29th order, campanaceæ. The corolla is funnel-shaped; the stigma round-headed; the capsule trilocular. There are twenty-seven species; but not more than one (the coccinea) cultivated in our gardens. This has long, slender, twining stalks, rising upon support six or seven feet high, from the sides of which arise many slender footstalks, each supporting several large and beautiful funnel-shaped and scarlet flowers. There is a variety with orange-coloured flowers. Both of them are annual.

IRELAND. By statutes 39 and 40 Geo. III. c. 67. the kingdoms of Great Britain and Ireland shall, upon the first day of Jan. 1801, and for ever after, be united, by the name of the United Kingdom of Great Britain and Ireland; and the royal style and titles appertaining to the imperial crown of the said united kingdom and its dependancies, and also the ensigns armorial, flags and banners thereof, shall be such as his majesty, by his royal proclamation under the great seal of the united kingdom, shall be pleased to appoint.

Where a debt is contracted in England, and a bond is taken for it in Ireland, it shall carry Irish interest; for it must be considered as referable to the place where it is made: but if it was a simple-contract debt only, it ought to carry English interest, the variation of place in this case making no difference. 2 Atk. 382.

IRESINE, a genus of the pentandria order, in the diœcia class of plants; and in the natural method ranking under the 54th order, miscellaneæ. The male calyx is diphyllous, the corolla pentapetalous, and there are five nectaria. The female calyx is diphyllous, the corolla pentapetalous; there are two sessile stigmata, and a capsule with flocky seeds. There is one species, a herb of Jamaica.

IRIDIUM, a new metal lately discovered by Mr. Tennant in the ore of platina. It is of a white colour, and perfectly infusible. It does not combine with sulphur or arsenic. Lead unites with it, but may be separated by cupellation. Copper, silver, and gold, are found to combine with it.

IRIS, the flower-de-luce, or flag-flower, &c.; a genus of the monogynia order in the triandria class of plants; and in the natural method ranking under the sixth order, ensatæ. The corolla is divided into six parts; the petals alternately reflexed; the stigmata resembling petals.

There are fifty species, all herbaceous flowering perennials, both of the fibrous, tuberous, and bulbous-rooted kind, producing thick annual stalks from three or four inches to a yard high, terminated by large hexapetalous flowers, having three of the petals reflexed quite back, and three erect; most of which are very ornamental, appearing in May, June, and July. All the species are easily propagated by offsets from the roots, which should be planted in September, October, or November, though almost any time from September to March will do. They may also be raised from seed, which is the best method for procuring varieties. It is to be sown in autumn, soon after it ripens, in a bed or border of common earth, and raked in. The plants will rise in the spring, and are to be transplanted next autumn.

IRON, the most abundant, and the most useful of all metals, was neither known so early, nor wrought so easily as gold, silver, and copper.

Iron is of a bluish white colour; and when polished, has a great deal of brilliancy. It has a styptic taste, and emits a smell when rubbed. Its specific gravity varies from 7.6 to 7.8. It is attracted by the magnet or loadstone, and is itself the substance which constitutes the loadstone. But when iron is perfectly pure, it retains the magnetic virtue a very short time. It is malleable in every temperature, and its malleability increases in proportion as the temperature augments; but it cannot be hammered out nearly so thin as gold or silver, or even copper. Its ductility, however, is more perfect; for it may be drawn out into wire as fine at least as a human hair. Its tenacity is such, that an iron wire 0.078 of an inch in diameter is capable of supporting 549.25 lbs. avoirdupois without breaking. When heated to about 158° Wedgewood, it melts. This temperature being nearly the highest to which it can be raised, it has been impossible to ascertain the point at which this melted metal begins to boil and to evaporate. Neither has the form of its crystals been examined: but it is well known that the texture of iron is fibrous; that is, it appears when broken to be composed of a number of fibres or strings bundled together.

When exposed to the air, its surface is soon tarnished, and it is gradually changed into a brown or yellow powder, well known under the name of rust. This change takes place more rapidly if the atmosphere is moist. It is occasioned by the gradual combination of the iron with the oxygen of the atmosphere, for which it has a very strong affinity.

When iron filings are kept in water, provided the temperature is not under 70°, they are gradually converted into a black powder, while a quantity of hydrogen gas is emitted. This is occasioned by the slow decomposition of the water. The iron combines with its oxygen, while the hydrogen makes its escape under the form of gas.

If the steam of water is made to pass through a red-hot iron tube, it is decomposed instantly. The oxygen combines with the iron, and the hydrogen gas passes through the tube, and may be collected in proper vessels. This is one of the easiest methods of procuring pure hydrogen gas.

These facts are sufficient to show that iron has a strong affinity for oxygen, since it is capable of taking it from air and water. It is capable also of taking fire and burning with great rapidity. Twist a small iron wire into the form of a cork-screw, by rolling it round a cylinder; fix one end of it into a cork, and attach to the other a small bit of cotton thread dipt in melted tallow. Set fire to the cotton, and plunge it while burning into a jar filled with oxygen gas. The wire catches fire from the cotton, and burns with great brilliancy, emitting very vivid sparks in all directions. For this very splendid experiment we are indebted to Dr. Ingenhousz. During this combustion the iron combines with oxygen, and is converted into an oxide. Mr. Proust has proved that there are only two oxides of iron; the protoxide has usually a black colour, but the peroxide is red.

The protoxide of iron may be obtained by four different processes. 1. By keeping iron filings a sufficient time in water at the temperature of 70°. The oxide thus formed is a black powder, formerly much used in medicine under the name of martial ethiops, and seems to have been first examined by Lemeri; but a better process is that of De Roover. He exposes a paste formed of iron filings and water to the open air, in a stoneware vessel; the paste becomes hot, and the water disappears. It is then moistened again, and the process repeated till the whole is oxydized. The mass is then pounded, and the powder is heated in an iron vessel till it is perfectly dry, stirring it constantly. 2. By making steam pass through a red-hot iron tube, the iron is changed into a brilliant black brittle substance, which, when pounded, assumes the appearance of martial ethiops. This experiment was first made by Lavoisier. 3. By burning iron wire in oxygen gas. The wire as it burns is melted, and falls in drops to the bottom of the vessel, which ought to be covered with water, and to be of copper. These metallic drops are brittle, very hard, and blackish, but retain the metallic lustre. They were examined by Lavoisier, and found precisely the same with marthial ethiops. They owe their lustre to the fusion which they underwent. By dissolving iron in sulphuric acid, and pouring potass into the solution. 4. A green powder falls to the bottom, which assumes the appearance of martial ethiops when dried quickly in close vessels. This first oxide of iron, however formed, is always composed of 73 parts of iron and 27 of oxygen, as Lavoisier and Proust have demonstrated. It is attracted by the magnet, and is often itself magnetic. It is capable of crystallizing, and is often found native in that state.

The peroxide or red oxide of iron may be formed by keeping iron filings red-hot in an open vessel, and agitating them constantly till they are converted into a dark-red powder. This oxide was formerly called saffron of Mars. Common rust of iron is merely this oxide combined with carbonic acid gas. The red oxide may be obtained also by exposing for a long time a diluted solution of iron in sulphuric acid to the atmosphere, and then dropping into it an alkali, by which the oxide is precipitated. This oxide is also found native in great abundance. Proust proved it to be composed of 48 parts of oxygen and 52 of iron. Consequently the protoxide, when converted into red oxide, absorbs 0.40 of oxygen; or, which is the same thing, the red oxide is composed of 66.5 parts of black oxide and 33.5 parts of oxygen. One hundred parts of iron, when converted into a protoxide, absorb 37 parts of oxygen, and the oxide weighs 137; when converted into peroxide, it absorbs 52 additional parts of oxygen, and the oxide weighs 189.

The peroxide cannot be decomposed by heat; but when heated along with its own weight of iron filings, the whole, as Vauquelin first observed, is converted into black oxide. The reason of this conversion is evident: The 100 parts of peroxide are composed of 52 parts of iron, combined with two different doses of oxygen: 1. With 14 parts, which, with the iron, make 66 of protoxide: 2. With 34 parts, which, with the protoxide, make up the 100 parts of peroxide. Now, the first of these doses has a much greater affinity for the iron than the second has. Consequently the 34 parts of oxygen, which constitute the second dose, being retained by a weak affinity, are easily abstracted by the 100 parts of pure iron; and combining with the iron, the whole almost is converted into black oxide: for 100 parts of iron, to be converted into black oxide, require only 37 parts of oxygen.

The peroxide of iron is not magnetic. It is converted into black oxide by sulphureted hydrogen gas and many other substances; which deprive it of the second dose of oxygen, for which they have a stronger affinity, though they are incapable of decomposing the protoxide. Iron is capable of combining with all the simple combustible bodies.

A small mixture of it constitutes that particular kind of iron, known by the name of cold short iron, because it is brittle when cold, though it is malleable when hot.

Rinman has shewn that the brittleness and bad qualities of cold short iron may be removed by heating it strongly with limestone, and with this the experiments of Levavasseur correspond.

There are a great many varieties of iron, which artists distinguish by particular names; but all of them may be reduced under one or other of the three following classes: cast iron; wrought or soft iron; and steel.

Cast iron, or pig iron, is the name of the metal when first extracted from its ores. The ores from which iron is usually obtained are composed of oxide of iron and clay. The object of the manufacturer is to reduce the oxide to the metallic state, and to separate all the clay with which it is combined. These two objects are accomplished at once, by mixing the ore reduced to small pieces with a certain portion of limestone and of charcoal, and subjecting the whole to a very violent heat in furnaces constructed for the purpose. The charcoal absorbs the oxigen of the oxide, flies off in the state of carbonic acid gas, and leaves the iron in the metallic state; the lime combines with the clay, and both together run into fusion, and form a kind of fluid glass; the iron is also melted by the violence of the heat, and being heavier than the glass, falls down, and is collected at the bottom of the furnace. Thus the contents of the furnace are separated into two portions; the glass swims at the surface, and the iron rests at the bottom. A hole at the lower part of the furnace is now opened, and the iron allowed to flow out into moulds prepared for its reception.

The cast iron thus obtained is distinguished by the following properties: It is scarcely malleable at any temperature. It is generally so hard as to resist the file. It can neither be hardened nor softened by ignition and cooling. It is exceedingly brittle. It melts at 130° Wedgewood. It is more sonorous than steel. For the most part it is of a dark-grey or blackish colour; but sometimes it is whitish, and then it contains a quantity of phosphuret of iron, which considerably impairs its qualities. A great number of utensils are formed of iron in this state.

To convert it into wrought iron, it is put into a furnace, and kept melted, by means of the flame of the combustibles, which is made to play upon its surface. While melted, it is constantly stirred by a workman, that every part of it may be exposed to the air. In about an hour the hottest part of the mass begins to heave and swell, and to emit a lambent blue flame. This continues nearly an hour; and by that time the conversion is completed. The heaving is evidently produced by the emission of an elastic fluid. As the process advances, the iron gradually acquires more consistency; and at last, notwithstanding the continuance of the heat, it congeals all together. It is then taken while hot, and hammered violently, by means of a heavy hammer driven by machinery. This not only makes the particles of iron approach nearer each other, but drives away several impurities which would otherwise continue attached to the iron.

In this state it is the substance described under the name of iron. As it has never yet been decomposed, it is considered at present, when pure, as a simple body; but it has seldom or never been found without some small mixture of foreign substances. These substances are either some of the other metals, or oxygen, carbon, or phosphorus.

When small pieces of iron are stratified in a close crucible, with a sufficient quantity of charcoal-powder, and kept in a strong red heat for eight or ten hours, they are converted into steel, which is distinguished from iron by the following properties.

It is so hard as to be unmalleable while cold, or at least it acquires this property by being immersed while ignited into a cold liquid: for this immersion, though it has no effect upon iron, adds greatly to the hardness of steel.

It is brittle, resists the file, cuts glass, affords sparks with flint, and retains the magnetic virtue for any length of time. It loses this hardness by being ignited and cooled very slowly. It melts at above 130° Wedgewood. It is malleable when red-hot, but scarcely so when raised to a white heat. It may be hammered out into much thinner plates than iron. It is more sonorous; and its specific gravity, when hammered, is greater than that of iron.

By being repeatedly ignited in an open vessel, and hammered, it becomes wrought iron, which is a simple substance, and if perfectly pure would contain nothing but iron.

Steel is iron combined with a small portion of carbon, and has been for that reason called carbureted iron. The proportion of carbon has not been ascertained with much precision. From the analysis of Vauquelin, it amounts, at an average, to $\frac{1}{140}$ part. Mr. Clouet seems to affirm that it amounts to $\frac{1}{32}$ part; but he has not published the experiments which led him to a proportion, which so far exceeds what has been obtained by other chemists.

That steel is composed of iron combined with pure carbon, and not with charcoal, has been demonstrated by Morveau, who formed steel by combining together directly iron and diamond. At the suggestion of Clouet, he inclosed a diamond in a small crucible of pure iron, and exposed it completely covered up in a common crucible to a sufficient heat. The diamond disappeared, and the iron was converted into steel. The diamond weighed 907 parts, the iron 57800, and the steel obtained 56384; so that 2313 parts of the iron had been lost in the operation. From this experiment it follows, that steel contains about $\frac{1}{60}$ of its weight of carbon. This experiment was objected to by Mr. Mushet, but the objections were fully refuted by sir George M'Kenzie.

Rinman, long ago, pointed out a method by which steel may be distinguished from iron. When a little diluted nitric acid is dropt upon a plate of steel, allowed to remain a few minutes, and then washed off, it leaves behind it a black spot; whereas the spot formed by nitric acid on iron is whitish-green. We can easily see the reason of the black spot: it is owing to the carbon of the iron which is converted into charcoal by the acid. This experiment shows us, that carbon is much more readily oxidated when combined with iron than when crystallized in the diamond.

Cast iron, is iron combined with a still greater proportion of carbon than is necessary for forming steel. The quantity has not yet been ascertained with precision: Mr. Clouet makes it amount to $\frac{1}{8}$ of the iron. The blackness of the colour, and the fusibility of cast iron, are proportional to the quantity of carbon which it contains. Cast iron is almost always contaminated with foreign ingredients: these are chiefly oxide of iron, phosphuret of iron, and silica.

It is easy to see why iron is obtained from its ore in the state of cast iron. The quantity of charcoal, along with which the ore is fused, is so great, that the iron has an opportunity of saturating itself with it.

The conversion of cast iron into wrought iron is effected by burning away the charcoal, and depriving the iron wholly of oxygen: this is accomplished by heating it violently while exposed to the air. Mr. Clouet has found, that when cast iron is mixed with $\frac{1}{4}$ of its weight of black oxide of iron, and heated violently, it is equally converted into pure iron. The oxygen of the oxide, and the carbon of the cast iron, combine, and leave the iron in a state of purity.

The conversion of iron into steel is effected by combining it with carbon. This combination is performed in the large way by three different processes, and the products are distinguished by the names of natural steel, steel of cementation, and cast steel.

Natural steel is obtained from the ore by converting it first into cast iron, and then exposing the cast iron to a violent heat in a furnace while its surface is covered with a mass of melted scoriæ five or six inches deep. Part of the carbon combines with the oxygen which cast iron always contains, and flies off in the state of carbonic acid gas. The remainder combines with the pure iron, and constitutes it steel. This steel is inferior to the other species; its quality is not the same throughout; it is softer, and not so apt to break; and as the processes by which it is obtained are less expensive, it is sold at a lower price than the other species.

It is obvious that iron and carbon are capable of combining together in a variety of different proportions. When the carbon exceeds, the compound is carburet of iron, or plumbago. When the iron exceeds, the compound is steel or cast iron in various states, according to the proportion. All these compounds may be considered as subcarburets of iron. The hardness of iron increases with the proportion of charcoal with which it combines, till the carbon amounts to about $\frac{1}{60}$ of the whole mass. The hardness is then a maximum; the metal acquires the colour of silver, loses its granulated appearance, and assumes a crystallized form. If more carbon is added to the compound, the hardness diminishes in proportion to its quantity.

The affinities of iron, and its oxides, are arranged by Bergman as in the following table:

IRON.	OXIDE OF IRON.
Nickel,	Oxalic acid,
Cobalt,	Tartaric,
Manganese,	Camphoric,
Arsenic,	Sulphuric,
Copper,	Saclatic,
Gold,	Muriatic,
Silver,	Nitric,
Tin,	Phosphoric,
Antimony,	Arsenic,
Platinum,	Fluoric,
Bismuth,	Succinic,
Lead,	Citric,
Mercury.	Lactic,
	Acetic,
	Boracic,
	Prussic,
	Carbonic.

IRON-SICK, in the sea-language, is said of a ship or boat, when her bolts or nails are so eaten with rust, and so worn away, that they occasion hollows in the planks, whereby the vessel is rendered leaky.

IRRATIONAL, an appellation given to surd numbers and quantities. See ALGEBRA.

IRREGULAR, in grammar, such inflections of words as vary from the general rules; thus we say, irregular nouns, irregular verbs.

ISATIS, WOAD; a genus of the siliquosa order, in the tetradynamia class of plants; and in the natural method ranking under the 39th order, the siliquosa. The siliqua is lanceolated, unilocular, monospermous, bivalved, and deciduous; the valves navicular or canoe-shaped. There are four species; but the only one worthy of notice is the tinctoria, or common woad, which is cultivated in several parts of Britain for the purposes of dyeing, being used as a foundation for many of the dark colours. See DYEING.

ISCHÆMUM, a genus of the monœcia order, in the polygamia class of plants; and in the natural method ranking under the 4th order, gramina. The calyx of the hermaphrodite is a biflorous glume; the corolla bivalved; there are three stamina, two styles, and one seed. The calyx and corolla of the male, as in the former, with three stamina. There are eight species.

ISCHURY. See MEDICINE.

ISERTIA, a genus of the hexandria monogynia class and order; the cal. is coloured, four or six toothed; cor. six-cleft, funnel-form; pome subglobular, six-celled. There is one species, a tree of Cayenne.

ISINGLASS, in the materia medica, &c. See ACCIPENSER.

ISNARDIA, a genus of the monogynia order, in the tetrandria class of plants; and in the natural method ranking under the 17th order, calycanthemæ. There is no corolla; the calyx is quadrifid; the capsule quadrilocular, and girt with the calyx. There is one species, an aquatic and annual.

ISOCELES TRIANGLE, in geometry, one that has two equal sides.

ISOCHRONAL, ISOCHRONE, or ISO-

CHRONOUS, is applied to such vibrations of a pendulum, as are performed in the same space of time; as all the vibrations or swings of the same pendulum are, whether the arches it describes are longer or shorter: for when it describes a shorter arch, it moves so much the slower, and when a long one proportionably faster.

ISOCHRONAL LINE, that in which a heavy body is supposed to descend without any acceleration.

ISOETES, a genus of the natural order of filices, belonging to the cryptogamia class of plants. The antheræ of the male flower are within the base of the frons or leaf. The capsule of the female flower is bilocular, and within the base of the leaf. There are two species.

ISOPERIMETRICAL FIGURES, in geometry, are such as have equal perimeters, or circumferences.

1. Of isoperimetrical figures, that is the greatest that contains the greatest number of sides, or the most angles, and consequently a circle is the greatest of all figures that have the same ambit as it has.

2. Of two isoperimetrical triangles, having the same base, whereof two sides of one are equal, and of the other unequal, that is the greater whose two sides are equal.

3. Of isoperimetrical figures, whose sides are equal in number, that is the greatest which is equilateral and equiangular. From hence follows that common problem of making the hedging or walling that will wall in one acre, or even any determinate number of acres, a, fence or wall in any greater number of acres whatever b. In order to the solution of this problem, let the greater number b be supposed a square. Let x be one side of an oblong, whose area is a; then will $\frac{a}{x}$ be the other side; and $2\frac{a}{x} + 2x$ will be the ambit of the oblong, which must be equal to four times the square-root of b; that is, $2\frac{a}{x} + 2x = 4\sqrt{b}$. Whence the value of x may be easily had, and you may make infinite numbers of squares and oblongs that have the same ambit, and yet shall have different given areas, thus

Let $\sqrt{b} = d$,

Then, $\frac{2a + 4xx}{x} = 4d$

$$a + 2xx = 2dx$$

$$2xx - 2dx = -a$$

$$xx - dx = -\frac{a}{2}$$

$$xx - dx + \tfrac{1}{4}dd = -\frac{a}{2} + \tfrac{1}{4}dd$$

$$x = \sqrt{-\frac{a}{2} + \tfrac{1}{4}dd} + \tfrac{1}{2}d.$$

Thus, if one side of the square be 10; and one side of an oblong be 19, and the other 1: then will the ambits of that square and oblong be equal, viz. each 40, and yet the area of the square will be 100, and of the oblong but 19.

ISOPYRUM, in botany; a genus of the polygynia order, in the polyandria class of plants; and in the natural method ranking under the 26th order, multisiliquæ. There is no calyx, but five petals; the nectaria trifid and tubular; the capsules recurved and polyspermous. There are two species, of no note.

ISSUE, in law, has several significations, it being sometimes taken for the children begotten between a man and his wife; sometimes for profits arising from amercements and fines; and sometimes for the profits issuing out of lands or tenements: but this word generally signifies the conclusion, or point of matter, that issues from the allegations and pleas of the plaintiff and defendant in a cause to be tried by a jury or court.

There are two kinds of issues in relation to causes, that upon a matter of fact, and that upon a matter of law: that of fact is where the plaintiff and defendant have fixed upon a point to be tried by a jury: and that in law is where there are a demurrer to a declaration, &c. and a joinder in demurrer, which is determinable only by the judges. Issues of fact are either general or special: they are general, when it is left to the jury to find whether the defendant has done any such thing as the plaintiff has alleged against him; and special, where some special matter, or material point alleged by the defendant in his defence, is to be tried. General issue also signifies a plea in which the defendant is allowed to give the special matter in evidence, by way of excuse or justification; this is granted by several statutes, in order to prevent a prolixity in pleading, by allowing the defendant to give any thing in evidence, to prove that the plaintiff had no cause for his action.

ISSUES *on sheriffs*, are such amercements and fines to the crown, as are levied out of the issues and profits of the lands of sheriffs, for their faults and neglects: but these issues, on shewing a good and sufficient cause, may be taken off before they are estreated into the exchequer.

ISSUES. See SURGERY.

ITEA, a genus of the monogynia order, in the pentandria class of plants; and in the natural method ranking with those of which the order is doubtful. The petals are long, and inserted into the calyx; the capsule unilocular and bivalved. There are two species, natives of North America.

IVA, a genus of the pentandria order, in the monœcia class of plants; and in the natural method ranking under the 49th order, compositæ. The male calyx is common and triphyllous; the florets of the disc monopetalous and quinquefid; the receptacle divided by small hairs. There is no female calyx nor corolla; but five florets in the radius; two long styles; and one naked and obtuse seed. There are two species, natives of America.

JUDGE. The judges are the chief magistrates in the law, to try civil and criminal causes. Of these there are twelve in England, viz. the lords chief justices of the courts of king's-bench and common-pleas; the lord chief baron of the exchequer; the three puisne or inferior judges of the two former courts, and the three puisne barons of the latter.

By stat. 1 Geo. III. c. 23. the judges are to continue in their offices during their good behaviour, notwithstanding any demise of the crown (which was formerly held immediately to vacate their seats), and their full salaries are absolutely secured to them during the continuance of their commissions, by which means the judges are rendered completely independant of the king, his ministers, or his successors.

A judge at his creation takes an oath, that he will serve the king, and indifferently administer justice to all men, without respect of persons, take no bribe, give no counsel where he is a party, nor deny right to any, though the king or any other, by letters, or by expressed words, command the contrary, &c. and in default of duty, to be answerable to the king in body, land, and goods.

Where a judge has an interest, neither he nor his deputy can determine a cause, or sit in court; and if he does, a prohibition lies. Hardw. 503.

Judges are punishable for wilful offences, against the duty of their situations; instances of which happily live only in remembrance. There are ancient precedents of judges who were fined when they transgressed the laws, though commanded by warrants from the king.

Judge is not answerable to the king, or the party, for mistakes or errors of his judgment, in a matter of which he has jurisdiction. 1 Salk. 397.

JUDGMENT. The opinion of the judges is so called, and is the very voice and final doom of the law, and therefore is always taken for unquestionable truth; or it is the sentence of the law pronounced by the court, upon the matter contained in the record.

JUDGMENTS are of four sorts, viz. 1. Where the facts are confessed by the parties, and the law determined by the court, which is termed judgment by demurrer.

2. Where the law is admitted by the parties, and the facts only are disputed, as in judgment upon a demurrer.

3. Where both the fact and the law arising thereon are admitted by the defendant, as in case of judgment by confession or default.

4. Where the plaintiff is convinced that fact or law, or both, are insufficient to support his action, and therefore abandons or withdraws his prosecution, as in case of judgment upon a nonsuit or retraxit. See WARRANT OF ATTORNEY.

Judgments are either interlocutory or final.

Interlocutory judgments are such as are given in the middle of a cause, upon some plea, proceeding, or default, which is only intermediate, and does not finally determine or complete the suit; as upon dilatory pleas, when the judgment in many cases is, that the defendant shall answer over; that is, put in a more substantial plea.

Final judgments, are such as at once put an end to the action, by declaring that the plaintiff has either entitled himself, or has not, to recover the remedy he sues for. 3 Black. 398.

JUGERUM, in Roman antiquity, a square of 120 Roman feet; its proportion to the English acre being as 10,000 to 16,097.

JUGLANS, the walnut, a genus of the monœcia class, and polyandria order of plants; and in the natural method ranking under the 50th order, amentaceæ. The male calyx is monophyllous, and squamiform; the corolla divided into six parts; there are 18 filaments: the female calyx is quadrifid, superior; the corolla quadripartite; there are two styles, and the fruit is a plum with a furrowed kernel. There are 8 species, the most remarkable of which is the regia or common walnut. Other two species, called the nigra and alba, or black and white Virginian walnut, are also cultivated in this country, though they are less proper for fruit, having very small kernels.

JUGULAR. See ANATOMY.

JUGULARES, in the Linnæan system, is the name of an order or division of fish, the general character of which is that they have ventral fins. See FISH.

JUJUBES. See MATERIA MEDICA.

JULEP. See PHARMACY.

JULIAN PERIOD. See CHRONOLOGY.

JULUS, a genus of insects, of the order aptera. The generic character is, antennæ moniliform; feelers two, jointed; body subcylindric; legs numerous, twice as many on each side as the segments of the body. The juli are very nearly allied to the scolopendræ or centipedes, but their body, instead of being flattened, as in those insects, is nearly cylindrical; and every joint or segment is furnished with two pair of feet, the number on each side doubling that of the segments, whereas in the scolopendræ the number of joints and of feet is equal on each side. The eyes of the juli are composed of numerous hexagonal convexities, as in the major part of the insect tribe, and the mouth is furnished with a pair of denticulated jaws. These animals, when disturbed, roll themselves up in a flat spiral: their general motion is rather slow and undulatory. The most common species, the julus sabulosus, is often seen in similar situations with the onisci and scolopendræ, and usually measures about an inch and quarter in length: its colour is a polished brownish black, except the legs, which are pale or whitish: it is an oviparous animal, and the young, when first hatched, are very small, of a whitish colour, and are furnished only with three pair of legs, which are situated on each side the superior part, or near the head; the remaining pairs not making their appearance till some days after, when about seven on a side become visible: the rest are gradually acquired till the number is complete, which usually amounts, according to Linnæus, to a hundred and twenty on each side: so long as this species continues in its young or growing state, it is of a pale colour, with a dark-red spot on each side of every segment: in this state it may sometimes be found in the soft mould of hollow trees.

Julus Indus, or great Indian julus, bears an extreme resemblance to the former, but is of such a size as to measure six or seven inches in length: its colour is similar to that of the preceding. It is found in the warmer parts of Asia and America, inhabiting woods and other retired places: the number of legs, according to Linnæus, is a hundred and fifteen on each side, but this seems to be a variable character.

Julus lagurus, or hare-tailed julus, is a very minute and singular species, not exceeding, when at full growth, the eighth of an inch in length. Its colour is pale-brown, and its shape rather broad, and flattish. This insect is by no means uncommon, being seen during the summer months creeping about the barks of trees, walls, &c. It is considered by Linnæus as a species of scolopendra, but as the legs are double the number the segments on each side, it is more properly referred by Degeer, Scopoli, and others, to the present genus. In fact it may be allowed, like the julus complanatus, another slightly flattened species, to form a kind of connecting link between the two genera. The julus terrestris has 100 legs on each side: the body is a polished black. It inhabits most parts of Europe, under stones and in the earth. See Plate Nat. Hist. fig. 234.

JUNCUS, the rush, a genus of the monogynia order, in the hexandria class of plants; and in the natural method ranking under the 5th order, tripetaloideæ. The calyx is hexaphyllous; there is no corolla; the capsule is unilocular. There are 29 species, universally known, being very troublesome weeds, and difficult to be eradicated. The pith of two kinds, called the conglomeratus and effusus, or round-headed and soft rushes, is used for wicks to lamps and rushlights. The conglomeratus, and aculus or marine rush, are planted with great care on the banks of the sea in Holland, in order to prevent the water from washing away the earth; which would otherwise be removed every tide, if it was not for the roots of those rushes, which fasten very deep in the ground, and mat themselves near the surface in such a manner as to hold the earth closely together. In the summer-time when the rushes are fully grown, they are cut and tied up in bundles, which are dried, and afterwards carried into the larger towns and cities, where they are wrought into baskets, and several other useful things, which are frequently sent into England. These sorts do not grow so strong in this country as on the Maese, where they sometimes arrive at the height of four feet and upwards.

JUNGERMANNIA, a genus of the natural order of algæ, in the cryptogamia class of plants. The male flower is pedunculated, and naked; the anthera quadrivalved: the female flower is sessile, naked, with roundish seeds. There are 48 species, all natives of Britain, growing in woods, shady places, by the sides of ditches, &c. Many of them are beautiful objects for the microscope.

JUNGIA, a genus of the polygamia segregata order, in the syngenesia class of plants: the common receptacle is chaffy; the perianthium three-flowered; the florets tubular, two-lipped; the exterior lip ligulate; the interior one bipartite. There is one species, a native of S. America.

JUNIPERUS, the juniper tree; a genus of the monadelphia order, in the monœcia class of plants; and in the natural method ranking under the 51st order, coniferæ. The male amentum is a calyx of scales; there is no corolla; three stamina: the female calyx tripartite; there are three petals, and as many styles; the berry is trispermous, and equal, by means of three tubercles of the indurated calyx adhering to it. There are 12 species; the most remarkable are, 1. The communis, or common juniper, grows naturally in many parts of Britain upon dry barren commons, where it seldom rises above the height of a low shrub, which grows naturally only in dry, chalky, or sandy land. Of this species there is a variety called Swedish juniper, which grows ten or twelve feet high, very branchy the whole length, with the branches growing more erect, and leaves, flowers, and fruit, like the former. 2. The oxycedrus, or Spanish juniper, rises from ten to fifteen feet high, closely branched from bottom to top; having short, awl-shaped, spreading leaves by threes, and small diœcious flowers, succeeded by large reddish-brown berries. 3. The thurifera, or blue-berried Spanish juniper, grows twenty feet high or more. 4. The Virginiana, or Virginia cedar, grows thirty or forty feet high, branching from bottom to top in a conic manner. 5. The Lycia, Lycian cedar, or olibanum tree, grows twenty feet high. 6. The Phœnicia, or Phœnician cedar, grows about twenty feet high. It is a native of Portugal. 7. The Bermudiana, or Bermudian cedar, grows twenty or thirty feet high. 8. The sabina, or savin tree; of which there are three varieties, the spreading, upright, and variegated savin. The propagation of all the junipers is by seed, and of the savins by layers and cuttings.

Juniper-berries have a strong, not disagreeable smell; and a warm, pungent, sweet taste, which, if they are long chewed, or previously well bruised, is followed by a bitterish one. The pungency seems to reside in the bark; the sweet in the juice; the aromatic flavour in oily vesicles spread through the substance of the pulp, and distinguishable even by the eye; and the bitter in the seeds.

JURY. This strong tower of defence of the British constitution, which is one of the leading features of the Magna Charta, is composed of a certain number of persons sworn to enquire of, and try some fact, and declare the truth upon the evidence brought before them.

In criminal cases juries are divided into grand and petty. The grand jury must be all freeholders, but it does not appear that any specific estate has been determined to be necessary; before them the charge is laid, and unless twelve or more of them are of opinion that it is well founded, the accusation is dismissed; which they call not finding a true bill. If they find a true bill, it must afterwards be confirmed by the unanimous suffrage of a petty jury of 12 men upon whom no suspicion of partiality can possibly rest.

In civil cases juries are divided into common and special. The latter are generally employed in cases where any difficulties with respect to commercial transactions arise, and are best decided by a special jury of merchants.

To obtain a special jury, a motion is made in court, and rule granted, for the sheriff to attend the master, prothonotary, or other proper officer, with his freeholders' book, in the presence of the attorneys on both sides, and to take indifferently forty-eight freeholders, when each party strikes off twelve, and the remaining twenty-four are returned upon the pannel.

A common jury is one returned by the sheriff according to the directions of 3 Geo. II. c. 25. which appoints that the sheriff shall not return a separate pannel for every cause, but the same for every cause to be tried at the same assizes, containing not less than forty-eight, nor more than seventy-two; and that their names being written on tickets, shall be put into a box, and when the cause is called, twelve whose names shall be first drawn shall be sworn, unless absent, challenged, or excused. They are then sworn to give a true verdict according to the evidence, unless they are challenged.

Challenges are of two kinds: challenges to the array, and challenges to the poll. Challenges to the array are an exception to the whole pannel. Challenges to the poll are exceptions to particular jurors, and are reduced to four heads by sir Edward Coke.

1. Propter honoris respectum; as a lord of parliament may be challenged by both parties, or challenge himself.

2. Propter defectum. If a juryman is an alien-born, or if he is a slave or bondman, they are defects; but the principal deficiency is want of a sufficient estate, which is now ten pounds per annum in England, and six pounds in Wales, of freehold or copyhold lands; and any leaseholder for the term of five hundred years, or any term determinable upon life or lives of the clear yearly value of twenty pounds per annum above the rent, is qualified.

3. Propter affectum. When the juror may be suspected of partiality.

4. Propter delictum. For some crime or misdemeanor that affects the juror's credit, and renders him infamous.

The service of jurymen is also sometimes excused; as sick and decrepid persons, persons not commorant in the county, men above seventy years old, and infants; physicians, counsel, attorneys, officers of the courts, and the like. Clergymen are also usually excused, but are liable in respect of their lay fees, unless they are in the service of the king, or some bishop.

In criminal cases, when the prisoner has put himself upon the country, the sheriff returns a pannel of unexceptionable freeholders of the county where the fact is committed.

In these cases, at least in capital ones, challenges may be made not only on the accounts before mentioned, both to the array or to the polls on the parts of the king and prisoner, but the prisoner is allowed a kind of peremptory challenge (which is now limited to twenty persons), without shewing any cause at all. This privilege is denied to the king, who must assign a reason for the challenge.

If by reason of challenges, or in default of the jurors, a sufficient number cannot be had of the original pannel, a tales may be awarded both in civil and criminal cases, that is, a sufficient number of persons present in court to be joined to the other jurors, who are however liable to the same challenges as the principal jurors.

The jury, after the proofs are summed up, unless the case is very clear, retire to consider, and are kept without meat, drink, fire, or candle, till they are unanimously agreed. If the jury eat or drink, or have victuals about them, without the consent of the court, before the verdict, it is finable; and if they do it at the charge of him for whom they find, the verdict will be set aside. Also if they speak with either of the parties, or their agents, after they are gone from the bar, or if they receive any fresh evidence, or cast lots to prevent dispute, the verdict is bad.

When the jury have delivered their verdict, and it is recorded in court, they are dismissed.

A jury when either party is an alien-born, shall be half denizens, and the other aliens (if there are so many in the place); but when both parties are aliens, it is presumed there is no more partiality for the one than the other, and therefore it was resolved the jury shall all be denizens.

If a juror receives a bribe from either party, he shall forfeit ten times as much as he has taken, half to the king, and half to him who sues.

A man who threatens or assaults a juror for giving a verdict against him, is punishable by fine and imprisonment; and if he strikes him in court in the presence of the judge, he shall lose his hand and his goods, and the profits of his land during life, and suffer perpetual imprisonment.

IVORY, ebur, in natural history, &c. a hard, solid, and firm substance, of a white colour, and capable of a very good polish. It is the tusk of the elephant, and is hollow from the base to a certain height, the cavity being filled up with a compact medullary substance, seeming to have a great number of glands in it. It is observed that the Ceylon ivory, and that of the island of Achem, do not become yellow in the wearing, as all other ivory does; for this reason the teeth of these places bear a larger price than those of the coast of Guinea.

To soften ivory and other bones, lay them for twelve hours in aqua fortis, and then three days in the juice of beets, and they will become so soft that they may be worked into any form. To harden them again, lay them in strong vinegar. Dioscorides says, that by boiling ivory for the space of six hours with the root of mandragoras, it will become so soft that it may be managed as one pleases.

IVORY-*black* is the coal of ivory or bone formed by great heat, while deprived of all access of air.

JUPITER, in astronomy, one of the superior planets, remarkable for its great brightness. See ASTRONOMY.

JURY-MAST, whatever is set up in room of a mast that has been lost in a storm or in an engagement, and to which a lesser yard, ropes, and sails, are fixed.

JUSSIEA, a genus of the monogynia order, in the decandria class of plants; and in the natural method ranking under the 17th order, calycanthemæ. The calyx is quadripartite, or quinquepartite superior; there are four or five petals; the capsule quadrilocular or quinquelocular, oblong, opening at the angles: the seeds are numerous and small. There are 11 species, mostly herbaceous plants of the W. Indies.

JUSTICE, in a legal sense, a person deputed by the king to administer justice to his subjects, whose authority arises from his deputation, and not by right of magistracy.

In the courts of king's bench and common pleas there are two judges styled chief justices, each of whom retains the title of lord during the time of his continuing in office. The first of these, who is styled lord chief justice of England, has a very extensive power and jurisdiction in pleas of the crown. He hears all pleas in civil causes brought before him in the court of king's bench, and also the pleas of the crown; while, on the other hand, the lord chief justice of the common pleas has the hearing of all civil causes between common persons. Besides the lords chief justices, there are in each of the above courts three puisne justices; there are also several other justices appointed by the king for the execution of the laws; such as the lords justices in eyre of the forests, who are two justices appointed to determine all offences committed in the king's forests; justices of assize, of oyer and terminer, of gaol-delivery, &c. They are also called justices of nisi prius, and so denominated from the words used in a common form of adjournment of a cause in the court of common pleas. See NISI PRIUS, OYER and TERMINER, COMMON PLEAS, and KING'S BENCH.

JUSTICES *of the Peace*. See PEACE.

JUSTICIARY, or court of JUSTICIARY, in Scotland, a court of supreme jurisdiction in all criminal cases.

This court came in place of the justice-eyre or justice-general, which last was taken away by parliament in 1672, and was erected into a justice or criminal court, consisting of a justice-general alterable at the monarch's pleasure, justice clerk, and five other judges, who are lords of session.

This court commonly sits upon Mondays, and has an ordinary clerk, who has his commission from the justice-clerk. They have four macers, and a doomster appointed by the lords of the session.

The form of the process is this: the clerk raises a libel or indictment upon a bill passed by any of the lords of that court, at the instance of the pursuer, against the defendant or criminal, who is immediately committed to prison after citation. When the party, witnesses, great assize, or jury of forty-five men, are cited, the day of compearance being come, fifteen of the great assize are chosen to be the assize upon the pannel, or prisoner at the bar. The assize sits with the judges to hear the libel read, witnesses examined, and the debates on both sides, which are written verbatim in the adjournal books. The king's advocate pleads for the pursuer, being the king's cause, and other advocates for the pannel. The debates being closed, the judges find the libel or indictment either non-relevant, in which case they desert the diet, and assoil or absolve the party accused; or, if relevant, then the assize or jury of fifteen is removed into a closer room, none being present with them, where they choose their chancellor and clerk, and consider the libel, deposition, and debates; and bring in their verdict of the pannel sealed, guilty or not guilty: if not guilty, the lords absolve; if guilty, they condemn and declare their sentence of condemnation, and command the sentence to be pronounced against the pannel by a macer and the mouth of the doomster. The lords of the justiciary likewise go circuits twice a year into the country. See the article CIRCUIT.

JUSTICIES, a writ directed to a sheriff, by virtue of which he is empowered to hold a plea of debt in his county-court for a sum above 40*s*. though by his ordinary power he has only cognizance of sums under 40*s*.

JUSTIFICATION, in law, is an affirming or shewing good reason in court, why one does such a thing as he is called to answer; as to justify in a cause of a replevin.

IVY. See HEDERA.

IXIA, a genus of the monogynia order, in the triandria class of plants; and in the natural method ranking under the sixth order, ensatæ. The corolla is hexapetalous, patent, and equal; there are three stigmata, a little upright and petalous. There are fifty-four species, consisting of herbaceous, tuberous, and bulbous-rooted flowery perennials, from one to two feet high, terminated by hexapetalous flowers of different colours. They are propagated by offsets, which should be taken off in summer at the decay of the leaves: but as all the plants of this genus are natives of warm climates, few of them can bear the open air of this country in winter.

IXORA, a genus of the tetrandria monogynia class of plants. The corolla consists of a single petal; the tube is cylindric, very long and slender; the limb is plane, and divided into four oval segments; the fruit is a berry of a roundish figure, with only one cell; the seeds are four in number, convex on one side, and angular on the other. There are nine species, very ornamental shrubs for the stove.

JUSTICIA, Malabar nut; a genus of the monogynia order, in the diandria class of plants; and in the natural method ranking under the 40th order, personatæ. The corolla is ringent; the capsule bilocular, parting with an elastic spring at the heel; the stamina have only one anthera. There are eighty species, most of them natives of the East Indies, growing many feet high; some adorned with fine large leaves, others with small narrow ones, and all of them with monopetalous ringent flowers. Only two species are commonly cultivated in our gardens, viz. the adhatoda, or common Malabar nut, and the hyssopifolia or snap-tree. The first grows ten or twelve feet high, with a strong woody stem; and from the ends of the branches short spikes of white flowers, with dark spots, having the helmet of the corolla concave. The second has a shrubby stem, and white flowers, commonly by threes, from the sides of the branches; succeeded by capsules, which burst open with elastic force for the discharge of the seeds; whence the name of snap-tree.

JYNX, the wryneck, a genus of birds belonging to the order of picæ; the characters of which are, that the bill is slender, round, and pointed; the nostrils are concave and naked; the tongue is very long, very slender, cylindric, and terminated by a hard point; and the feet are formed for climbing. There is only one species, viz. the torquilla. The colours of this bird are elegantly pencilled, though its plumage is marked with the plainest colours. The wryneck, Mr. Pennant apprehends, is a bird of passage, appearing with us in the spring before the cuckoo. Its note is like that of the kestril, a quick-repeated squeak; its eggs are white, with a very thin shell; it builds in the hollows of trees, making its nest of dry grass. It has a very whimsical way of turning and twisting its neck about, and bringing its head over its shoulders, whence it had its Latin name torquilla, and its English one of wryneck.

K.

K, or k, the tenth letter of our alphabet; as a numeral, denotes 250; and with a line over it, K, 250000.

KÆMPFERIA, *zedoary*, a genus of the monogynia order, in the monandria class of plants, and in the natural method ranking under the eighth order, scitamineæ. The corolla is sexpartite, with three of the segments larger than the rest, patulous; and one only bipartite. The species are, 1. The galanga, common galangal, or long zedoary. 2. The rotunda, or round zedoary. Both are perennial in root; but the leaves rise annually in spring, and decay in winter. They flower in summer; each flower is of one petal, tubulous below, but plain above, and divided into six parts; they continue three or four weeks in beauty, but are never succeeded by seeds in this country. Both these plants must be potted in light rich mould, and always kept in the hot-house.

KALI, a genus of marine plants, which are burnt to procure mineral alkali.

KALMIA, a genus of the monogynia order, in the decandria class of plants, and in the natural method ranking under the 18th order, bicornes. The calyx is quinquepartite; the corolla salver-shaped, formed with five nectariferous horns on the under or outer side; the capsule quinquelocular. Of this genus there are four species. Those chiefly in cultivation with us are,

1. The latifolia, a most beautiful shrub, which rises usually to the height of five or six feet, and sometimes twice that height in its native places. The flowers grow in bunches on the tops of the branches to footstalks three inches long; they are white, stained with purplish red, consisting of one petal in form of a cup, divided at the verge into five sections; in the middle are a stylus and 12 stamina, which, when the flower first opens, appear lying close to the sides of the cup at equal distances, their apices being lodged in 10 little hollow cells, which being prominent on the outside, appear as so many little tubercles. This plant is a native of Carolina, Virginia, and other parts of the northern continent of America, yet is not common, but found only in particular places; it grows on rocks hanging over rivulets and running streams, and on the sides of barren hills.

2. The angustifolia, rises to the height of about 16 feet, with evergreen leaves. The flowers grow in clusters, and when blown, appear white; but on a near view, are of a faint blueish colour, which as the flower decays grows paler.

KAOLIN, the name of an earth which is used as one of the two ingredients in oriental porcelain. See PORCELAIN.

KECKLE, or KECKLING, in the sea language, is the winding of old ropes about cables, to prevent them from galling.

KEDGING, in the sea-language, is when a ship is brought up or down a narrow river by means of the tide, the wind being contrary.

KEEL, the lowest piece of timber in a ship, running her whole length from the lower part of her stem to the lower part of her stern-post. Into it are all the lower futtocks fastened; and under part of it, a false keel is often used.

KEELSON, a principal timber in a ship, fayed withinside cross all the floor-timbers; and being adjusted to the keel with suitable scarfs, it serves to strengthen the bottom of the ship.

KEEP, in antient military history, a kind of strong tower which was built in the centre of a castle or fort, to which the besieged retreated, and made their last efforts of defence. Of this description is the keep of Windsor castle.

KEEPER *of the great seal*, is a lord by his office, is styled lord-keeper of the great seal of Great Britain, and is always one of the privy council. All grants, charters, and commissions of the king under the great seal, pass through the hands of the lord-keeper, for without that seal many of those grants, &c. would be of no force, the king being, in the interpretation of the law, a corporation, and therefore passing nothing but by the great seal, which is also said to be the public faith of the kingdom, being in the highest esteem and reputation. Whenever there is a lord-keeper, he is invested with the same place, authority, pre-eminence, jurisdiction, or execution of laws, as the lord chancellor of Great Britain is vested with.

KEEPER *of the privy seal*. See PRIVY-SEAL.

KEISELSCHIEFER. This mineral occurs usually in blocks and amorphous masses of different sizes; very often in the beds of rivers: colour various shades of grey: structure slaty: usually opaque: brittle: specific gravity from 2.880 to 2.415: infusible per se. This species is divided into two subspecies.

Keiselschiefer, common: colour blackish grey or greenish: often traversed by veins of quartz: surface smooth: texture compact: fracture splintery, or imperfectly conchoidal: composed according to Wiegleb of

75.00	silica
10.00	lime
4.58	magnesia
3.54	iron
5.02	inflammable matter
98.14	

Lydian stone is another species of keiselschiefer: commonly intersected by veins of quartz: fracture even: sometimes inclining to conchoidal: specific gravity 2.596: powder black: colour greyish black.

This, or a stone similar to it, was used by the antients as a touchstone. They drew the metal to be examined along the stone, and judged of its purity by the colour of the metallic streak. On this account they called it βασανος, "the trier." They called it also Lydian stone, because, as Theophrastus informs us, it was found most abundantly in the river Tmolus in Lydia.

KELP, in the glass trade, a term used for a sort of potass made use of in many of the glass works, particularly for the green glass. It is the calcined ashes of a plant called by the same name; and in some places of sea-tangs or-laces, a sort of thick-leaved fucus or sea-wrack. This plant is thrown on the rocks and shores in great abundance, and in the summer months is raked together and dried as hay in the sun and wind, and afterwards burned to the ashes called kelp.

KEMO, a shell found on the coast of Sumatra; it is sometimes three or four feet in diameter, as white as ivory. See Marsden's Hist. of Sumatra.

KENKS, in the sea-language, doublings in a rope or cable, when handed in and out, so that it does not run easy; or when any rope makes turns or twists, and does not run free in the block.

KERATOPHYTUM, in natural history. See CORALLINES.

KERMES. See COCCUS.

KERMES MINERAL, a compound of sulphuret of antimony and potass.

KETCH, in naval architecture, a vessel with two masts, usually applied to one carrying bombs, or rather mortars.

KEVEL, in ship-building, a piece of plank fayed against the quickwork on the quarter-deck, in the shape of a semicircle; about which the running rigging is belaid.

KEY, in music, a fundamental note or tone to which the whole of a movement has a certain relation or bearing, to which all its modulations are referred and accommodated, and in which it both begins and ends. There are but two species of keys, one of the major, and one of the minor mode; all the keys in which we employ sharps or flats being deduced from the natural keys of C major, and A minor, of which indeed they are only transpositions.

KEY-STONE. See ARCHITECTURE.

KEYS. See ORGAN, HARPSICHORD, &c.

KIDNAPPING, is the forcible taking and carrying away a man, woman, or child, from their own country, and sending them to another. This is an offence at common law, and punishable by fine, imprisonment, and pillory.

By stat. 11 and 12 W. III. c. 7, if any captain of a merchant vessel shall during his being abroad force any person on shore, and wilfully leave them behind, or refuse to bring home all such men as he carried out, if able and desirous to return, he shall suffer three months imprisonment. Exclusive of the above punishment for this as a criminal offence, the party may recover upon an action for compensation in damages for the civil injury.

KIDNEYS. See ANATOMY.

KIFFEKIL. This mineral is dug up near Konie in Natolia, and is employed in forming the bowls of Turkish tobacco-pipes. The sale of it supports a monastery of dervises established near the place where it is dug. It is found in a large fissure six feet wide, in grey calcareous earth. The workmen assert that it grows again in the fissure, and puffs itself up like froth. This mineral, when fresh dug, is of the consistence of wax; it feels soft and greasy; its colour is yellow; its specific gravity 1.600: when thrown on the fire it sweats, emits a fetid vapour, becomes hard, and perfectly white.

According to the analysis of Klaproth, it is composed of 50.50 silica

50.50	silica
17.25	magnesia
25.00	water
5.00	carbonic acid
.50	lime.
98.25	

KIGGELARIA, a genus of the decandria order, in the dioecia class of plants, and in the natural method ranking under the 37th order, columniferæ. The male calyx is quinquepartite; the corolla pentapetalous; there are five trilobous glandules; the antheræ are perforated at top; the female calyx and corolla as in the male; there are five styles; the capsule unilocular, quinquevalved, and polyspermous. There is but one species, viz. the Africana. As this is a native of warm climates, it must be constantly kept in a stove in this country. It is propagated by seeds, layers, or cuttings, though most readily by seeds.

KILDERKIN, a liquid measure containing two firkins, or 18 gallons.

KINDRED. See DESCENT.

KING, signifies him who has the highest power and absolute rule over the whole land; and therefore the king is, in intendment of law, cleared of those defects which common persons are subject to; for he is always supposed to be of full age, though ever so young. He pardons life and limb to offenders against the crown and dignity, except such as he binds himself by oath not to forgive. The law ascribes to his majesty, in his political capacity, an absolute immortality. The king never dies. For immediately on the decease of the reigning prince in his natural capacity, his imperial dignity, by act of law, without any interregnum or interval, is vested at once in his heir, who is eo instanti king to all intents and purposes. And so tender is the law of supposing even a possibility of his death, that his natural dissolution is generally called his demise, an expression signifying merely a transfer of property. Plowd. 177.

By the articles of the union of the two kingdoms of England and Scotland, all papists, and persons marrying papists, are for ever excluded from the imperial crown of Great Britain; and in such case, the crown shall descend to such person being a protestant, as should have inherited the same, in case such papist, or person marrying a papist, was naturally dead. 5 Anne, c. 8.

KING'S BENCH. The king's bench is the supreme court of common law in the kingdom, and is so called because the king used to sit there in person; it consists of a chief justice, and three puisne justices, who are by their office the sovereign conservators of the peace, and supreme coroners of the land.

This court has a peculiar jurisdiction, not only over all capital offences, but also over all other misdemeanours of a public nature, tending either to a breach of the peace, or to oppression, or faction, or any manner of misgovernment. It has a discretionary power of inflicting exemplary punishment on offenders, either by fine, imprisonment, or other infamous punishment, as the nature of the crime, considered in all its circumstances, shall require.

The jurisdiction of this court is so transcendant, that it keeps all inferior jurisdictions within the bounds of their authority; and it may either remove their proceedings to be determined here, or prohibit their progress below: it superintends all civil corporations in the kingdom; commands magistrates and others to do what their duty requires, in every case where there is no specific remedy; protects the liberty of the subject, by speedy and summary interposition; takes cognizance both of criminal and civil causes; the former in what is called the crown side, or crown office; the latter in the plea side of the court.

This court has cognizance on the plea side of all actions of trespass, or other injury alleged to be committed vi et armis; of actions for forgery of deeds, maintenance, conspiracy, deceit, and actions on the case which allege any falsity or fraud.

In proceedings in this court, the defendant is arrested for a supposed trespass, which in reality he has never committed; and being thus in the custody of the marshal of this court, the plaintiff is at liberty to proceed against him for any other personal injury, which surmise of being in the custody of the marshal, the defendant is not at liberty to dispute.

This court is likewise a court of appeal, into which may be removed, by writ of error, all determinations of the court of common pleas, and of all inferior courts of record in England.

KING'S BENCH PRISON. King's bench new rules. East. 30 G. III. it is ordered by the court, that from and after the first day of Trinity term next, the rule made in the sixth year of the reign of king George I. and all other rules for establishing the rules of the king's bench prison, shall be, and the same are hereby, repealed. And it is further ordered, that from and after the said first day of Trinity term next, the rules of the king's bench prison shall be comprized within the bounds following, exclusive of the public houses hereinafter mentioned; that is to say, from Great Cumber-court in the parish of St. George the Martyr, in the county of Surry, along the north side of Dirty-lane, and Melancholy-walk, to Blackfriars'-road, along the western side of the said road to the obelisk, and thence along the south-west side of the London-road, round the direction post in the centre of the roads, near the public house known by the sign of the Elephant and Castle, and thence along the eastern side of Newington causeway to Great Cumber-court aforesaid: and it is also ordered, that the new gaol Southwark, and the highway, exclusive of the houses on each side of it, leading from the king's bench prison to the said new gaol, shall be within and part of the said rules. And it is lastly ordered, that all taverns, victualling-houses, ale-houses, and wine-vaults, and houses or places licensed to sell gin, or other spirituous liquors, shall be excluded out of, and deemed no part of the said rules. It is ordered, that from and after the first day of Trinity term next, no prisoner in the king's bench prison, or within the rules thereof, shall have, or be entitled to have, day rules above three days in each term. And it is further ordered, that every such prisoner having a day rule, shall return within the walls or rules of the said prison, at or before nine o'clock in the evening of the day on which such rule shall be granted.

KING'S PALACE. The limits of the king's

palace at Westminster extend from Charing-cross to Westminster-hall, and shall have such privileges as the antient palaces. 28 H. VIII. c. 12.

King'sfisher. See Alcedo.

KLINGSTEIN: this mineral composes whole mountains. They are usually insulated; and like basalt, shew a tendency to assume the form of four-sided prisms. Its colour is usually deep grey, of various shades; but most commonly greenish. Sometimes various shades appear together, which gives it the appearance of being spotted. Found not only constituting mountains, but also in globular masses, &c. Internal lustre arises chiefly from some crystals of hornblende and felspar which it contains. Structure slaty. Texture compact. Fracture usually splintery; sometimes conchoidal. Brittle. Gives a clear sound when struck with a hammer. Specific gravity 2.575. Powder light grey. Melts easily into a glass. A specimen analysed by Klaproth yielded 57.25 silica

57.25	silica
23.50	alumina
2.75	lime
3.25	oxide of iron
0.25	oxide of manganese
8.10	soda
3.00	water.
98.10	

KLEINHOVIA, a genus of the class and order gynandria decandria: the calyx is five-leaved; corolla five-petalled; nect. bell-shaped; caps. inflated, five-lobed. There is one species, a tree of Java.

KNAPSACK, a rough leather or canvas bag, which is strapped to an infantry soldier's back when he marches, and which contains his necessaries. Square knapsacks are supposed to be most convenient. They should be made with a division to hold the shoes, blacking-balls, and brushes, separate from the linen. White goat-skins are sometimes used; but we do not conceive them to be equal to the painted canvas ones. Soldiers are put under stoppages for the payment of their knapsacks, which after six years become their property.

KNAUTIA, a genus of the monogynia order, in the tetrandria class of plants, and in the natural method ranking under the 48th order, aggregatæ. The common calyx is oblong, simple, quinqueflorous; the proper one simple, superior; the florets irregular; the receptacle naked. There are four species, chiefly annuals of the Levant.

KNEE. See Anatomy.

Knee, in a ship, a crooked piece of timber, bent like a knee, used to bind the beams and futtocks together, by being bolted fast into them both. These are used about all the decks.

KNEES, *carling*, in a ship, those timbers which extend from the sides to the hatchway, and bear up the deck on both sides.

KNIGHT, properly signifies a person, who, for his virtue and martial prowess, is by the king raised above the rank of gentleman into a higher class of dignity and honour. The ceremonies at the creation of knights have been various; the principal was a box on the ear, and a stroke with a sword on the shoulder; they put on him a shoulder-belt, and a gilt sword, spurs, and other military accoutrements; after which, being armed as a knight, he was led to the church in great pomp. Camden describes the manner of making a knight-bachelor among us, which is the lowest, though the most antient order of knighthood, to be thus: the person kneeling was gently struck on the shoulder by the prince, and accosted in these words, "rise," or "be a knight in the name of God." For the several kinds of knights among us, see Banneret, Baronet, Bath, Garter, &c.

KNIGHTS *of the shire*, or Knights *of parliament*, in the British polity, are two knights or gentlemen of estate, who are elected, on the king's writ, by the freeholders of every county, to represent them in parliament. The qualification of a knight of the shire is to be possessed of 600*l*. per ann. in a freehold estate. Their expences during their sittings were by a statute of Henry VIII. to be defrayed by the county; but this is now never required.

Knight-marshal, an officer in the king's household, who has jurisdiction and cognizance of any transgression within the king's household and verge; as also of contracts made there, whereof one of the house is party.

Knights, in a ship, two thick short pieces of wood, commonly carved like a man's head, having four shivers in each, three for the halyards, and one for the top-ropes to run in; one of them stands fast bolted on the beams abaft the foremast, and is therefore called the fore-knight; and the other, standing abaft the mainmast, is called the main-knight.

KNOXIA, a genus of the class and order tetrandria monogynia. The corolla is one-petalled, funnel-form; seeds two-grooved. There is one species, a herb of Ceylon.

KOENIGIA, a genus of the trigynia order, belonging to the triandria class of plants. The calyx is triphyllous; there is no corolla, and but one ovate and naked seed.

KORAN. See Alcoran.

KUPFERNICKEL, is a sulphuret of nickel, and is generally compounded of nickel, arsenic, and sulphuret of iron.

KURTUS, a genus of fishes of the order jugulares; the generic character of which is, body broad, carinated both above and below, with greatly elevated back; gill-membrane two-rayed. The genus kurtus, instituted by Dr. Bloch, consists at present of a single species only. This is a native of the Indian seas; and is supposed to feed on shell-fish, small cancri, and other sea insects, the remains of which were observed in the stomach of the specimen examined by Dr. Bloch. The length of this fish was about ten inches, including the tail, and its greatest breadth something more than four inches; its shape is deep or broad, the sides being much compressed, and the back rising very high in the middle. The colour of the whole body is silvery, as if covered with foil, without any appearance of scales; the back is tinged with gold-colour and marked by three or four black spots on its ridge, and the fins have a reddish cast.

L.

L, or l, the eleventh letter of our alphabet, as a numeral, denotes 50; and with over it, thus, L̄, 50000.

LA, in music, the syllable by which Guido denoted the last sound of each hexachord: if it begins in C, it answers to our *A*; if in G to E; and if in F to D.

LABARUM, in Roman antiquity, the standard borne before the Roman emperors; being a rich purple streamer, supported by a spear.

LABDANUM, or Ladanum. This resin is obtained from the cystus creticus, a shrub which grows in Syria and the Grecian islands. The surface of the shrub is covered with a viscid juice, which when concreted forms ladanum. It is collected while moist by drawing over it a kind of rake with thongs fixed to it; from these it is afterwards scraped with a knife. The best is in masses almost black, and very soft, having a fragrant odour and a bitterish taste. When dissolved in alcohol, it leaves behind it a little gum. The specific gravity of this resin is about 1.18. See Resins.

LABEL, in heraldry, a fillet usually placed in the middle along the chief of the coat, without touching its extremities.

Label of a circumferentor, a long thin brass ruler, with a sight at one end, and a centre-hole at the other; chiefly used with a tangent line to take altitudes.

LABORATORY and *Apparatus*, chemical. A chemical laboratory, though extremely useful, and even essential to all who embark extensively in the practice of chemistry, either as an art, or as a branch of liberal knowledge, is by no means required for the performance of those simple experiments which furnish the evidence of the fundamental truths of the science. A room that is well lighted, easily ventilated, and destitute of any valuable furniture, is all that is absolutely necessary for the purpose. It is even advisable that the construction of a regular laboratory should be deferred till the student has made some progress in the science; for he will then be better qualified to accommodate its plan to his own peculiar views and convenience.

It is scarcely possible to offer the plan of a laboratory, which will be suitable to every person, and to all situations; or to suggest any thing more than a few rules that should be generally observed. Different apartments are required for the various classes of chemical operations. The principal one may be on the ground floor; twenty-five feet long, fourteen or sixteen feet wide, and open to the roof, in which there should be contrivances for allowing the occasional escape of suffocating vapours. This will be destined chiefly for containing furnaces, both fixed and portable. It should be amply furnished with shelves and drawers, and with a large table in the centre, the best form of which is that of a double cross. Another apartment may be appropriated to the minuter operations of chemistry; such as those of precipitation on a small scale, the processes that require merely the heat of a lamp, and experiments on the gases. In a third, of smaller size, may be deposited accurate balances, and other instruments of considerable nicety, which would be injured by the acid fumes that are constantly spread through a laboratory.

The following are the principal instruments that are required in chemical investigations; but it is impossible, without entering into very tedious details, to enumerate all that should be in the possession of a practical chemist.

1. Furnaces. These may either be formed of solid brick-work, or of such materials as admit of their removal from place to place. See FURNACE, and CHEMISTRY.

2. For containing the materials, which are to be submitted to the action of heat in a wind furnace, vessels called crucibles are employed. They are most commonly made of a mixture of fire-clay and sand, occasionally with the addition of plumbago, or black lead. The Hessian crucibles are best adapted for supporting an intense heat without melting; but they are liable to crack when suddenly heated or cooled. The porcelain ones made by Messrs. Wedgewood, are of much purer materials, but are still more apt to crack on sudden changes of temperature; and when used, they should therefore be placed in a common crucible of larger size, the interval being filled with sand. The black-lead crucibles resist very sudden changes of temperature, and may be repeatedly used; but they are destroyed when some saline substances (such as nitre) are melted in them, and are consumed by a current of air. For certain purposes crucibles are formed of pure silver or platina. Their form varies considerably; but it is necessary, in all cases, to raise them from the bars of the grate, by a stand. For the purpose of submitting substances to the continued action of a red heat, and with a considerable surface exposed to the air, a hollow arched vessel, with a flat bottom, termed a muffle, is commonly used. See CHEMISTRY.

3. Evaporating vessels should always be of a flat shape, so as to expose them extensively to the action of heat. They are formed of glass, of earthenware, and of various metals. Those of glass are with difficulty made sufficiently thin, and are often broken by changes of temperature; but they have a great advantage in the smoothness of their surface, and in resisting the action of most acid and corrosive substances. Evaporating vessels of porcelain, or Wedgwood's ware, are next in utility, are less costly, and less liable to be cracked. They are made both of glazed and unglazed ware. For ordinary purposes, the former are to be preferred: but the unglazed should be employed when great accuracy is required, since the glazing is acted on by several chemical substances. Evaporating vessels of glass, or porcelain, are generally bedded up to their edge in sand; but those of various metals are placed immediately over the naked fire. When the glass or porcelain vessel is very thin, and of small size, it may be safely placed on the ring of a brass stand, and the flame of an Argand's lamp, cautiously regulated, may be applied beneath it. A lamp thus supported, so as to be raised or lowered at pleasure, on an upright pillar, to which rings of various diameters are adapted, will be found extremely useful; and when a strong heat is required, it is advisable to employ a lamp provided with double concentric wicks.

4. In the process of evaporation, the vapour for the most part is allowed to escape; but in certain chemical processes, the collection of the volatile portion is the principal object. This process is termed distillation. See DISTILLATION.

The common still, however, can only be employed for volatilizing substances that do not act on copper, or other metals, and is, therefore, limited to very few operations, and on that account alembics and retorts are necessary. See CHEMISTRY.

In several instances, the substance raised by distillation, is partly a condensible liquid, and partly a gas, which is not condensed till it is brought into contact with water. To effect this double purpose, a series of receivers termed Woulfe's apparatus is employed. See CHEMISTRY.

When a volatile substance is submitted to distillation, it is necessary to prevent the escape of the vapour through the junctures of the vessels; and this is accomplished by the application of lutes. The most simple method of confining the vapour, it is obvious, would be to connect the places of juncture accurately together by grinding; and accordingly the neck of the retort is sometimes ground to the mouth of the receiver. This, however, adds too much to the expence of apparatus to be generally practised.

When the distilled liquid has no corrosive property, (such as water, alcohol, ether, &c.) slips of moistened bladder, or of paper or linen spread with flour paste, white of egg, or mucilage of gum Arabic, sufficiently answer the purpose. The substance which remains, after expressing the oil from bitter almonds, and which is sold under the name of almond meal or flour, forms a useful lute, when mixed to the consistency of glaziers' putty, with water or mucilage.

For confining the vapour of acid or highly corrosive substances, the fat lute is well adapted. It is formed by beating perfectly dry and finely-sifted tobacco-pipe clay with painters' drying-oil, to such a consistence that it may be moulded by the hand. The same clay, beaten up with as much sand as it will bear without losing its tenacity, with the addition of cut tow, or of horse-dung, and a proper quantity of water, furnishes a good lute, which has the advantage of resisting a considerable heat, and is applicable in cases where the fat lute would be melted or destroyed. Various other lutes are recommended by chemical writers; but the few that have been enumerated are found to be amply sufficient for every purpose. See LUTE.

On some occasions, it is necessary to protect the retort from too sudden changes of temperature by a proper coating. For glass retorts, a mixture of common clay or loam with sand, and cut shreds of flax, may be employed. If the distillation is performed by a sand heat, the coating needs not to be applied higher than that part of the retort which is bedded in sand; but if the process is performed in a wind furnace, the whole body of the retort, and that part of the neck also which is exposed to heat, must be carefully coated. To this kind of distillation, however, earthen retorts are better adapted; and they may be covered with a composition originally recommended by Mr. Willis. Two ounces of borax are to be dissolved in a pint of boiling water, and a sufficient quantity of slaked lime added to give it the thickness of cream. This is to be applied by a painter's brush, and allowed to dry. Over this a thin paste is afterwards to be applied, formed of slaked lime and common linseed-oil, well mixed and perfectly plastic. In a day or two, the coating will be sufficiently dry to allow the use of the retort.

For joining together the parts of iron vessels used in distillation, a mixture of the finest China clay, with solution of borax, is well adapted. In all cases, the different parts of any apparatus made of iron should be accurately fitted by boring and grinding, and the above lute is to be applied to the part which is received into an aperture. This will generally be sufficient without any exterior luting; otherwise the lute of clay, sand, and flax, already described, may be used.

In every instance, where a lute or coating is applied, it is advisable to allow it to dry before the distillation is begun; and even the fat lute, by exposure to the air during one or two days after its application, is much improved in its quality. The clay and sand lute is perfectly useless, except it is previously quite dry. In applying a lute, the part immediately over the juncture should swell outwards, and its diameter should be gradually diminished on each side.

Besides the apparatus already described, a variety of vessels and instruments are necessary, having little resemblance to each other in the purposes to which they are adapted. Glass vessels are required for effecting solution, which often requires the application of heat, and sometimes for a considerable duration. In the latter case it is termed digestion, and the vessel called a mattrass is the most proper for performing it. When solution is quickly effected, a bottle, with a rounded bottom, may be used, or a common Florence-oil flask serves the same purpose extremely well, and bears without cracking, sudden changes of temperature. Glass rods, of various length, and spoons of the same material, or of porcelain, are useful for stirring acid and corrosive liquids; and a stock of cylindrical tubes of various sizes, is required for occasional purposes. It is necessary also to be provided with a series of glass measures, graduated into drachms, ounces, and pints.

Accurate beams and scales, of various sizes, with corresponding weights, some of which are capable of weighing several pounds, while the smaller size ascertain a minute fraction of a grain, are essential instruments in the chemical laboratory. So also are mortars of different materials, such as of glass, porcelain, agate, and metal. Wooden stands of various kinds for supporting receivers, should be provided. For purposes of this sort, and for occasionally raising to a proper height any article of apparatus, a series of blocks, made of well-seasoned wood, eight inches (or any other number) square, and respectively eight, four, two, one, and half an inch in thickness, will be found extremely useful; since by combining them in different ways, no less than thirty-one different heights may be attained.

The blowpipe is an instrument of much utility in chemical researches. A small one, invented by Mr. Pepys, with a flat cylindrical box for condensing the vapour of the breath, and for containing caps, to be occasionally applied with apertures of various sizes, is perhaps, the most commodious form. A blowpipe, which is supplied with air from a pair of double bellows, worked by the foot, may be applied to purposes that require both hands to be left at liberty, and will be found useful in blowing glass, and in bending tubes. The latter purpose, however, may be accomplished by holding them over an Argand's lamp with double wicks.

Laboratory, signifies also in military affairs, that place where all sorts of fire-works are prepared both for actual service, and for pleasure, viz. quick matches, fusees, portfires, grape-shot, case-shot, carcases, hand-grenades, cartridges, shells filled and fusees fixed, wads, &c.

LABRUS, a genus of fishes of the order thoracici: the generic character is, teeth strong and subacute: the grinders sometimes, as in the spari, convex and crowded: lips thick and doubled: rays of the dorsal fin, in some species, elongated into soft processes. Gill-covers unarmed and scaly.

Labrus hepatus, snout rather pointed: teeth small: palate furnished with a rough bone. Native of the Mediterranean, sometimes wandering into rivers. There are 41 species belonging to this genus, all of which are but imperfectly understood.

LABOURER. See Master and Servant.

LABYRINTH, in gardening, a winding mazy walk between hedges, through a wood or wilderness. The chief aim is to make the walks so perplexed and intricate, that a person may lose himself in them, and meet with as great a number of disappointments as possible. They are rarely to be met with, except in great gardens; as Versailles, Hampton-court, &c.

LAC, an appellation given to several chemical preparations.

Lac. This resin exudes from the tree called the croton lacciferum, when punctured by an insect. For the history of its formation, and the uses to which it is applied by the insects, the reader is referred to the article Gum, &c. It is a substance of a deep-red colour verging on brown, and semitransparent, and distinguished by various names according to its purity. It possesses the properties of a resin, and is the basis of many varnishes, and of the finest kinds of sealing-wax.

Lac *sulphuris*, is obtained by precipitating sulphur, when in combination: it is composed of sulphur united to a little water.

LACHENALIA, a genus of the class and order hexandria monogynia. The cor. is six-parted, three outer petals difform; caps. three-winged; cells many-seeded; seeds globular, affixed to the recept. There are twelve species, chiefly bulbs of the Cape.

LACTATS, in chemistry, a genus of salts but little known. 1. Lactat of potass, a deliquescent salt soluble in alcohol. 2. Lactat of soda. This salt does not crystallize. It is soluble in alcohol. 3. Lactat of ammonia. Crystals which deliquesce. Heat separates a great part of the ammonia before destroying the acid. 4. Lactat of barytes; lime; alumina; all deliquesce.

LACCIC acid. About the year 1786, Dr. Anderson of Madras mentioned, in a letter to the governor and council of that place, that nests of insects, resembling small cowry shells, had been brought to him from the woods by the natives, who ate them with avidity. These supposed nests he soon afterwards discovered to be the coverings of the females of an undescribed species of coccus, which he shortly found means to propagate with great facility on several of the trees and shrubs growing in his neighbourhood.

On examining this substance, which he called white lac, he observed in it a very considerable resemblance to bees' wax; he noticed also, that the animal which secretes it provides itself by some means or other with a small quantity of honey, resembling that produced by our bees; and in one of his letters he complains, that the children whom he employed to gather it were tempted by its sweetness to eat so much of it, as materially to reduce the produce of his crop. Small quantities of this matter were sent into Europe in 1789, both in its natural state and melted into cakes; and in 1793 Dr. Pearson, at the request of sir Joseph Banks, undertook a chemical examination of its qualities, and his experiments were published in the Philosophical Transactions for 1794.

A piece of white lac, from 3 to 15 grains in weight, is probably produced by each insect. These pieces are of a grey colour, opaque, rough, and roundish. When white lac was purified by being strained through muslin, it was of a brown colour, brittle, hard, and had a bitterish taste. It melted in alcohol, and in water of the temperature of 145°. In many of its properties it resembles bees' wax, though it differs in others; and Dr. Pearson supposes that both substances are composed of the same ingredients, but in different proportions.

1. Two thousand grains of white lac were exposed in such a degree of heat as was just sufficient to melt them. As they grew soft and fluid, there oozed out 550 grains of a reddish watery liquid, which smelled like newly baken bread. To this liquid Dr. Pearson has given the name of laccic acid.

2. It possesses the following properties:

It turns paper stained with turnsole to a red colour.

After being filtred, it has a slightly saltish taste with bitterness, but it is not at all sour.

When heated, it smells precisely like newly baken hot bread.

On standing, it grows somewhat turbid, and deposits a small quantity of sediment.

Its specific gravity at the temperature of 60° is 1.025.

A little of it having been evaporated till it grew very turbid, afforded on standing small needle-shaped crystals in mucilaginous matter.

Two hundred and fifty grains of it were poured into a very small retort and distilled. As the liquor grew warm, mucilage-like clouds appeared; but as the heat increased they disappeared again. At the temperature of 200° the liquor distilled over very fast: a small quantity of extractive matter remained behind. The distilled liquor while hot smelled like newly baken bread, and was perfectly transparent and yellowish. A shred of paper stained with turnsole, which had been put into the receiver, was not reddened; nor did another which had been immersed in a solution of sulphat of iron, and also placed in the receiver, turn to a blue colour upon being moistened with the solution of potass.

About 100 grains of this distilled liquid being evaporated till it grew turbid, after being set by for a night, afforded acicular crystals, which under a lens appeared in a group not unlike the umbel of parsley. The whole of them did not amount to the quarter of a grain. They tasted only bitterish.

Another 100 grains being evaporated to dryness in a very low temperature, a blackish matter was left behind, which did not entirely disappear on heating the spoon containing it very hot in the naked fire; but on heating oxalic acid to a much less degree, it evaporated and left not a trace behind.

Carbonat of lime dissolved in this distilled liquid with effervescence. The solution tasted bitterish, did not turn paper stained with turnsole red, and on adding to it carbonat of potass a copious precipitation ensued. A little of this solution of lime and of alkali being evaporated to dryness, and the residuum made red-hot, nothing remained but carbonat of lime, and carbonat of potass.

This liquid did not render nitrat of lime turbid, but it produced turbidness in nitrat and muriat of barytes.

To 500 grains of the reddish-coloured liquor obtained by melting white lac, carbonat of soda was added till the effervescence ceased, and the mixture was neutralized; for which purpose three grains of the carbonat were necessary. During this combination a quantity of mucilaginous matter, with a little carbonat of lime, was precipitated. The saturated solution being filtrated and evaporated to the due degree, afforded on standing deliquescent crystals, which on exposure to fire, left only a residuum of carbonat of soda.

Lime-water being added to this reddish-coloured liquor produced a light purple turbid appearance; and on standing there were clouds just perceptible.

Sulphuret of lime occasioned a white precipitation, but no sulphureted hydrogen gas was perceptible by the smell.

Tincture of galls produced a green precipitation.

Sulphat of iron produced a purplish colour, but no precipitation; nor was any precipitate formed by the addition first of a little vinegar and then of a little potass to the mixture.

Acetat of lead occasioned a reddish precipitation, which redissolved on adding a little nitric acid.

Nitrat of mercury produced a whitish turbid liquor.

Oxalic acid produced immediately the precipitation of white acicular crystals owing probably to the presence of a little lime in the liquid.

Tartrat of potass produced a precipitation not unlike what takes place on adding tartaric acid to tartrat of potass; but it did not dissolve again on adding potass.

LACE, in commerce, a work composed of many threads of gold, silver, or silk, interwoven one with the other, and worked upon a pillow with spindles, according to the pattern designed; the open work being formed with pins, which are placed and displaced as the spindles are moved.

Method of cleaning gold-lace and embroidery when tarnished.—For this purpose alkaline liquors are by no means to be used; for while they clean the gold they corrode the silk, and change or discharge its colour. Soap also alters the shade, and even the species of certain colours. But spirit of wine may be used without any danger of its injuring either the colour or quality of the subject; and in many cases proves as effectual for restoring the lustre of the gold as the corrosive detergents.

But though spirit of wine is the most innocent material that can be employed for this purpose, it is not in all cases proper. The golden covering may be in some parts worn off; or the base metal, with which it has been iniquitously alloyed, may be corroded by the air, so as to leave the particles of the gold disunited; while the silver underneath, tarnished to a yellow hue, may continue a tolerable colour to the whole: in which cases it is apparent that the removal of the tarnish would be prejudicial to the colour, and make the lace or embroidery less like gold than it was before.

LACE, *bone*, a lace made of fine linen thread or silk, much in the same manner as that of gold and silver. The pattern of the lace is fixed upon a large round pillow, and pins being stuck into the holes or openings in the pattern, the threads are interwoven by means of a number of bobins, made of bone or ivory, each of which contains a small quantity of fine thread, in such a manner as to make the lace exactly resemble the pattern. There are several towns in England, and particularly in Buckinghamshire, that carry on this manufacture; but vast quantities of the finest laces have been imported from Flanders.

LACERTA, *lizard*, a genus of the amphibia class, and of the order of reptiles: the generic character is, body four-footed, elongated, tailed; without any secondary integument.

This numerous genus may be divided into the following sections, viz.

1. Crocodiles, furnished with very strong scales.

2. Guanas, and other lizards, either with serrated or carinated backs and tails.

3. Cordyles, with denticulated, and sometimes spiny scales, either on the body or tail, or both.

4. Lizards proper, smooth, and the greater number furnished with broad square scales or plates on the abdomen.

5. Chamæleons, with granulated skin, large head, long missile tongue, and cylindric tail.

6. Geckos, with granulated or tuberculated skin, and lobated feet, with the toes lamellated beneath.

7. Scinks, with smooth, fish-like, scales.

8. Salamanders, newts, or efts, with soft skins, and of which some are water-lizards.

9. Snake-lizards, with extremely long bodies, very short legs, and minute feet.

The above divisions neither are, nor can be, perfectly precise; since species may occur which may, with almost equal propriety, be referred to either of the neighbouring sections; but, in general, they will be found useful in the investigation of the species. The following are the most noted:

1. Lacerta crocodilus, or crocodile. The crocodile, so remarkable for its size and powers of destruction, has in all ages been regarded as one of the most formidable animals of the warmer regions. It is a native of Asia and Africa, but seems to be most common in the latter; inhabiting large rivers, as the Nile (see Plate Nat. Hist. fig. 237), the Niger, &c. and preying principally on fish, but occasionally seizing on almost every animal which happens to be exposed to its rapacity. The size to which the crocodile sometimes arrives is prodigious; specimens being frequently seen of 20 feet in length, and instances are commemorated of some which have exceeded the length of 30 feet. The armour with which the upper part of the body is covered may be numbered among the most elaborate pieces of nature's mechanism. In the full-grown animal it is so strong and thick as easily to repel a musket-ball; on the lower parts it is much thinner, and of a more pliable nature: the whole animal appears as if covered with the most regular and curious carved work: the colour of a full-grown crocodile is blackish-brown above, and yellowish-white beneath; the upper parts of the legs and the sides varied with deep yellow, and in some parts tinged with green. In the younger animals the colour on the upper parts is a mixture of brown and pale yellow, the under parts being nearly white: the eyes are provided with a nictitating membrane, or transparent moveable pellicle, as in birds: the mouth is of vast width, the rictus or gape having a somewhat flexuous outline, and both jaws being furnished with very numerous sharp-pointed teeth, of which those about the middle part of each jaw considerably exceed the rest in size, and seem analogous to the canine teeth in the viviparous quadrupeds or mammalia: the number of teeth in each jaw is 30, or more; and they are so disposed as to alternate with each other when the mouth is closed: on taking out the teeth and examining the alveoli, it has been found that small teeth were forming beneath, in order to supply the loss of the others when shed: the auditory foramina are situated on the top of the head, above the eyes, and are moderately large, oval, covered by a membrane, having a longitudinal slit or opening, and thus in some degree resembling a pair of closed eyes: the legs are short, but strong and muscular: the fore feet have five toes, and are unwebbed: the hind feet have only four toes, which are united towards their base by a strong web: the two interior toes on each of the fore feet, and the interior one of the hind feet, are destitute of claws: on the other toes are strong, short, and curved claws: the tail is very long, of a laterally compressed form, and furnished above with an upright process, formed by the gradual approximation of two elevated crests proceeding from the lower part of the back.

The crocodile in a young state is by no means to be dreaded, its small size and weakness preventing it from being able to injure any of the larger animals: it therefore contents itself with fish and other small prey; and such as have occasionally been brought to Europe are so far from being formidable or ferocious, that they may be generally handled with impunity, and either from weakness, or the effect of a cold climate, seem much inclined to torpidity; but in the glowing regions of Africa, where it arrives at its full strength and power, it is justly regarded as the most formidable inhabitant of the rivers. It lies in wait near the banks, and snatches dogs and other animals, swallowing them instantly, and then plunging into the flood, and seeking some retired part, where it may lie concealed till hunger again invites it to its prey. In its manner of attack it is exactly imitated by the common lacerta palustris, or water-newt, which, though not more than four or five inches long, will with the greatest ease swallow an insect of more than an inch in length; and that at one single effort, and with a motion so quick, that the eye can scarcely follow it. It poises itself in the water, and having gained a convenient distance, springs with the utmost celerity on the insect, and swallows it. If, therefore, a small lizard of four or five inches only in length can thus instantaneously swallow an animal of a fourth part of its own length, we need not wonder that a crocodile of 18, 20, or 25, feet long, should suddenly ingorge a dog or other quadruped.

Crocodiles, like the rest of the lacertæ, are oviparous: they deposit their eggs in the sand or mud near or on the banks of the rivers they frequent, and the young when hatched immediately proceed to the water; but the major part are said to be commonly devoured by other animals, as ichneumons, birds, &c. The egg of the common nilotic crocodile is not much larger than that of a goose, and in external appearance bears a most perfect resemblance to that of a bird; being covered with a calcareous shell, under which is a membrane. When the young are first excluded the head bears a much larger proportion to the body than when full-grown. The eggs, as well as the flesh of the crocodile itself, are numbered among the delicacies of some of the African nations, and are said to form one of their favourite repasts.

In the large rivers of Africa crocodiles are said to be sometimes seen swimming together in vast shoals, and resembling the trunks of so many large trees floating on the water.

The negroes will sometimes attack and kill a single crocodile, by stabbing it under the belly, where the skin, at the interstices of the scales, is soft and flexible. It is also, in some countries, the custom to hunt the crocodile by means of strong dogs, properly trained to the purpose, and armed with spiked collars. It is likewise pretended, that in some parts of Africa crocodiles are occasionally tamed; and it is said that they form an article of royal magnificence with the monarchs of those regions, being kept in large ponds or lakes appropriated to their residence. We may add, that the antient Romans exhibited these animals in their public spectacles and triumphs. Scaurus, during his ædileship, treated the people with a sight of five crocodiles, exhibited in a temporary lake; and Augustus introduced one into his triumph over Cleopatra, as well as several others, for the entertainment of the people.

2. Lacerta alligator. So very great is the general resemblance between this animal and the crocodile, that many naturalists have been strongly inclined to consider it as a mere variety, rather than a distinct species. The more accurate discrimination, however, of Blumenbach and some others seems in reality to prove that the alligator or American crocodile is specifically distinct from the nilotic, though the difference is not such as immediately to strike a general observer. The leading difference, if it be allowed to constitute a distinction of species, seems to be, that the head of the alligator is rather smooth on the upper part than marked with those very strong rugosities and hard carinated scales which appear on that of the crocodile; and that the snout is considerably flatter and wider, as well as more rounded at the extremity. The alligator arrives at a size not much inferior to that of the crocodile, specimens having been often seen of 18 or 20 feet in length.

"Though the largest and greatest numbers of alligators," says Catesby, "inhabit the torrid zone, the continent abounds with them 10 degrees more north, particularly as far as the river Neus in North Carolina, in the latitude of about 33 degrees, beyond which I have never heard of any, which latitude nearly answers to the northernmost parts of Africa, where they are likewise found. They frequent not only salt rivers near the sea, but streams of fresh water in the upper parts of the country, and in lakes of salt and fresh water, on the banks of which they lie lurking among reeds, to surprise cattle and other animals. In Jamaica, and many parts of the continent, they are found about 20 feet in length: they cannot be more terrible in their aspect than they are formidable and mischievous in their natures, sparing neither man nor beast they can surprise, pulling them down under water, that being dead, they may with greater facility, and without struggle or resistance, devour them. As quadrupeds do not so often come in their way, they almost subsist on fish; but as Providence, for the preservation, or to prevent the extinction of defenceless creatures, has in many instances restrained the devouring appetites of voracious animals, by some impediment or other, so this destructive monster, by the close connexion of his vertebræ, can neither swim nor run any other way than straight forward, and is consequently disabled from turning with that agility requisite to catch his prey by pursuit: therefore they do it by surprise in the water as well as by land; for effecting which nature seems in some measure to have recompensed their want of agility, by giving them a power of deceiving and catching their prey by a sagacity peculiar to them, as well as by the outer form and colour of their body, which on land resembles an old dirty log or tree, and in the water frequently lies floating on the surface, and there has the like appearance, by which, and his silent artifice, fish, fowl, turtle, and all other animals, are deceived, suddenly catched, and devoured.

"In Carolina they lie torpid from about October to March, in caverns and hollows in the banks of rivers, and at their coming out in the spring make an hideous bellowing noise. The hind part of their belly and tail are eaten by the Indians. The flesh is delicately white, but has so perfumed a taste and smell that I never could relish it with pleasure."

3. Lacerta gangetica. The gangetic crocodile is so strikingly distinguished both from the nilotic and the alligator by the peculiar form of the mouth, that it is hardly possible, even on a cursory view, to confound it with either of the former; the jaws being remarkably long, narrow, and perfectly straight, and the upper mandible terminated above an elevated tubercle. In a very young state the length and narrowness of the snout are still more conspicuous than in the full-grown animal. The teeth are nearly double the number of those of the common crocodile, and are of equal size throughout the whole length of the jaws. This species is a native of India, and is principally seen in the Ganges, where it arrives at a size at least equal to the nilotic crocodile.

4. Lacerta iguana. Though the lizard tribe affords numerous examples of strange and peculiar form, yet few species are perhaps more eminent in this respect than the guana, which grows to a very considerable size, and is often seen of the length of three, four, and even five feet. It is a native of many parts of America and the West Indian islands, and is also said to occur in some parts of the East Indies. Its general colour is green, but with much variation in the tinge of different individuals: it is generally shaded with brown in some parts of the body, and sometimes this is even the predominating colour. The back of the guana is very strongly serrated; and this, together with the gular pouch, which it has the power of extending or inflating occasionally to a great degree, gives a formidable appearance to an animal otherwise harmless. It inhabits rocky and woody places, and feeds on insects and vegetables. It is itself reckoned an excellent food, being extremely nourishing and delicate; but it is observed to disagree with some constitutions. The common method of catching it is by casting a noose over its head, and thus drawing it from its situation; for it seldom makes an effort to escape, but stands looking intently at its discoverer, inflating its throat at the same time in an extraordinary manner.

The guana may be easily tamed while young, and is both an innocent and beautiful creature in that state.

5. Lacerta basiliscus. The basilisk of the antients, supposed to be the most malignant of all poisonous animals, and of which the very aspect was said to be fatal, is a fabulous existence, to be found only in the representations of painters and poets.

But the animal known in modern natural history by this name is a species of lizard, of a very singular shape, and which is particularly distinguished by a long and broad wing-like process or expansion continued along the whole length of the back, and to a very considerable distance on the upper part of the tail, and furnished at certain distances with internal radii analogous to those in the fins of fishes, and still more so to those in the wings of the draco volans, or flying lizard. This process is of different elevation in different parts, so as to appear strongly sinuated and indented, and is capable of being either dilated or contracted at the pleasure of the animal. The occiput or hind part of the head is elevated into a very conspicuous pointed hood or hollow crest.

Notwithstanding its formidable appearance the basilisk is a perfectly harmless animal, and, like many other of the lizard tribe, resides principally among trees, where it feeds on insects, &c. The colour of the basilisk is a pale cinereous brown, with some darker variegations towards the upper part of the body. It is principally found in South America, and sometimes considerably exceeds the length before mentioned, measuring three feet, or even more, from the nose to the extremity of the tail. It is said to be an animal of great agility, and is capable of swimming occasionally with perfect ease, as well as of springing from tree to tree by the help of its dorsal crest, which it expands in order to support its flight.

6. Lacerta calotes. This species is considerably allied to the common guana in habit or general appearance; but is of much smaller size, rarely exceeding the length of a foot and a half from the tip of the nose to the extremity of the tail. It is also destitute of the very large gular pouch, so conspicuous in that animal; instead of which it has merely a slight inflation or enlargement on that part. In colour it occasionally varies, like most of this tribe; but it is commonly of an elegant bright blue, variegated by several broad, and somewhat irregular white or whitish transverse bands on each side of the body and tail. It is a native of the warmer regions both of Asia and Africa, and is found in many of the Indian islands, and particularly in Ceylon, in which it is common. According to the count de Cepede it is also found in Spain, &c. and is said by that author to wander about the tops of houses in quest of spiders; and he observes, that it is even reported to prey on rats, and to fight with small serpents in the manner of the common green lizard and some others. See Plate Nat. Hist. fig. 236.

7. Lacerta monitor. The monitor, or monitory lizard, is one of the most beautiful of the whole tribe, and is also one of the largest; sometimes measuring not less than four or five feet from the nose to the tip of the tail. Its shape is slender and elegant, the head being small, the snout gradually tapering, the limbs moderately slender, the tail laterally compressed, and insensibly decreasing towards the tip, which is very slender and sharp. Though the colours of this lizard are

simple, yet such is their disposition, that it is impossible to survey their general effect without admiration. In this respect, however, the animal varies perhaps more than most others of its tribe. It is commonly black, with the abdomen white, the latter colour extending to some distance up the sides, in the form of several pointed bands, besides which the whole body is generally ornamented by several transverse bands consisting of white annular spots, while the head is marked with various streaks of the same colour, the limbs with very numerous round spots, and the tail with broad, distant, transverse bands. It is a native of South America, where it frequents woody and watery places; and, if credit may be given to the reports of some authors, is of a disposition as gentle as its appearance is beautiful. It has even gained the title of monitor, salvaguarda, &c. from its pretended attachment to the human race, and it has been said that it warns mankind of the approach of the alligator by a loud and shrill whistle.

Cordyles, with either denticulated or spiny scales on the body or tail, or both.

8. Lacerta pelluma, is one of the middle-sized lizards; the total length being nearly two feet, and the length of the body and tail nearly equal. It is a native of Chili, where it is said to inhabit hollows under ground. It is covered on the upper parts with very minute scales, and is beautifully variegated with green, yellow, blue, and black: the under parts are of a glossy yellowish-green: the tail long and verticillated by rows of rhomboid scales. The skin of this lizard is said to be used by the Chilians for the purpose of a purse.

9. Lacerta stellio, is remarkable for the unusually rough or hispid appearance of its whole upper surface; both body, limbs, and tail, being covered with pointed scales, projecting here and there to a considerable distance beyond the surface, so that it appears muricated with spines: the tail is rather short than long, and is verticillated with rows of pointed scales. The general colour of the animal is a pale blueish-brown, with a few deeper and lighter transverse variegations: its general length is about eight inches. It is a native of many parts of Africa.

Lizards proper, smooth, and the greater number furnished with broad square plates or scales on the abdomen.

10. Lacerta agilis, green lizard, is found in all the warmer parts of Europe, and seems pretty generally diffused over the antient continent. It sometimes arrives at a very considerable size, measuring more than two feet to the extremity of the tail: its more general length, however, is from 10 to 15 inches. In its colours it is the most beautiful of all the European lacertæ, exhibiting a rich and varied mixture of darker and lighter green, interspersed with specks and marks of yellow, brown, blackish, and even sometimes red. The green lizard is found in various situations, in gardens, about warm walls, buildings, &c. and is an extremely active animal, pursuing with great celerity its insect prey, and escaping with great readiness from pursuit when disturbed. If taken, however, it is soon observed to become familiar, and may even be tamed to a certain degree; for which reason it is considered as a favourite animal in many of the warmer parts of Europe. It appears to run into numerous varieties both as to size and colour; but in all these states the particular characteristics of the species are easily ascertained.

11. Lacerta bullaris, red-throat lizard. This, according to Catesby, is usually six inches long, and of a shining grass-green colour. It is common in Jamaica, frequenting hedges and trees, but is not seen in houses: when approached it swells its throat into a globular form, the protruded skin on that part appearing of a bright-red colour, which disappears in its withdrawn or contracted state: this action is supposed to be a kind of menace, in order to deter its enemy; but it is incapable of doing any mischief by its bite or otherwise. See Plate Nat. Hist. fig. 235.

Chameleons, with granulated skin, missile tongue, &c.

12. Lacerta chamæleon. Few animals have been more celebrated by natural historians than the chameleon, which has been sometimes said to possess the power of changing its colour at pleasure, and of assimilating it to that of any particular object or situation. This, however, must be received with very great limitations; the change of colour which the animal exhibits varying in degree according to circumstances of health, temperature of the weather, and many other causes, and consisting chiefly in a sort of alteration of shades from the natural greenish or blueish grey of the skin into pale yellowish, with irregular spots or patches of dull red.

It is also to be observed, that the natural or usual colour of chameleons varies very considerably; some being much darker than others, and it has even been seen approaching to a blackish tinge. An occasional change of colour is likewise observable, though in a less striking degree, in some other lizards.

The general length of the chameleon, from the tip of the nose to the beginning of the tail, is about ten inches, and the tail is of nearly similar length, but the animal is found of various sizes, and sometimes exceeds the length above mentioned. It is a creature of a harmless nature, and supports itself by feeding on insects; for which purpose the structure of the tongue is finely adapted, consisting of a long, missile body, furnished with a dilated and somewhat tubular tip, by means of which the animal seizes insects with great ease, darting out its tongue in the manner of a woodpecker, and retracting it instantaneously with the prey secured on its tip. It can also support a long abstinence, and hence arose the popular idea of the chameleon being nourished by air alone. It is found in many parts of the world, and particularly in India and Africa. It is also sometimes seen in the warmer parts of Spain and Portugal.

The general or usual changes of colour in the chameleon, are from a blueish ash-colour, (its natural tinge) to a green and sometimes yellowish colour, spotted unequally with red. If the animal is exposed to a full sunshine, the unilluminated side generally appears, within the space of some minutes, of a pale yellow, with large roundish patches or spots of red-brown. On reversing the situation of the animal, the same change takes place in an opposite direction; the side which was before in the shade now becoming either brown or ash-colour, while the other side becomes yellow and red; but these changes are subject to much variety both as to intensity of colours and disposition of spots.

Besides the common chameleon, different races appear to exist, which are principally distinguished by their colour, and the more or less elevated state of the angular or crested part of the head. These, which Linnæus was content to consider as varieties, are now raised to the dignity of species, and are so distinguished in the Gmelinian edition of the Systema Naturæ.

Geckos, with granulated or tuberculated skin, lobated feet, and toes lamellated beneath.

13. Lacerta gecko. The gecko, said to be so named from the sound of its voice, which resembles the above word uttered in a shrill tone, is a native of many parts of Asia and Africa, as well as of some of the warmer regions of Europe. It is one of the middle-sized lizards, measuring, in general, about a foot in length, or rather more. It is of a thicker and stouter form than most other lizards, having a large and somewhat triangular flattish head, covered with small scales, a wide mouth, large eyes, minute teeth, and a broad flat tongue. The limbs are of moderate length, and the feet are of a broader form than the rest of the genus.

The gecko inhabits obscure recesses, caverns, old walls, trees, &c. and wanders about chiefly on the approach of rain. It is considered as of a poisonous nature, a highly acrimonious kind of fluid exuding from the lamellæ of the feet, which remaining on the surface of fruit or any other edible substance is often productive of troublesome symptoms to those who happen to swallow it. From the peculiar structure of its feet, the gecko can readily adhere to the smoothest surfaces. The general colour of the animal is pale brown, with a few irregular dusky or blueish variegations; but in those which inhabit the warmer regions of the globe, this colour seems to be exalted into a much more brilliant appearance.

14. Lacerta fimbriata. This remarkable species seems to have been first described by the count de Cepede, who informs us that it appears in some degree to connect the chameleon, the gecko, and the water-newts; the head, skin, and general form of the body, resembling those of the chameleon: the tail that of the water-newts, being of a compressed form, though in a different manner (not vertically but horizontally flattened), while the feet resemble those of the gecko. The largest specimen examined by the count de Cepede measured about eight inches and six lines in length, of which the tail measured two inches and four lines.

The colour of this animal is not constant or permanent, as in most lizards, but variable, as in the chameleon, presenting successively different shades of red, yellow, green, and blue. This variation of colour is, however, confined to the upper surface of the animal; the lower always continuing of a bright yellow. These changes, we are informed, have been observed in the living animal by Mons. Bruyeres, in his native country, viz. Madagascar, where it is not very uncommon, and where, though a harmless animal, it is held in great abhorrence by the natives, who consider it as of a poisonous nature, and fly from it with precipitation; pretending that it darts on their breast, and adheres with such force by its fringed membrane, that it cannot be separated from the skin without the assistance of a razor. The principal cause of this popular dread of the animal, is its habit of running open-mouthed towards the spectator, instead of attempting to escape when discovered. Its chief residence is on the branches of trees, where it lives on insects, holding itself secure by coiling its tail, short as it is, half round the twig on which it sits. It chiefly appears in rainy weather, when it moves with considerable agility, often springing from bough to bough. On the ground it walks but slowly, the fore legs being shorter than the hinder.

Scinks, with round fish-like scales.

15. Lacerta scincus, or officinal scink. The scink is one of the middle-sized or smaller lizards, and is a native of many of the eastern parts of the world. It abounds in Lybia, Syria, Egypt, and Arabia, frequenting moderately dry and sandy soils, and growing to the length of six or seven inches, or even sometimes more. The head of the scink is rather small than large, the body thick and round, the tail in general considerably shorter than the body. The whole animal is of a pale yellowish-brown colour, with a few broad, dusky, transverse undulations or zones, and is uniformly covered with moderately large or fish-like scales, lying extremely close and smooth, so that the surface has a glossy or oily appearance. It is an animal of harmless manners, and, like most other lizards, supports itself on the various insects which wander about the regions it inhabits.

This animal was once in high estimation as an article in the materia medica, and the flesh, particularly of the belly, was supposed to be diuretic, alexipharmic, restorative, and useful in leprous and many other cases; but whatever virtues it may possess when used fresh, it is not considered as of any importance when in its dried or imported state, and while it continued to be used in practice served only to increase the number of ingredients in that curious remnant of what Dr. Lewis happily terms the wild exuberance of medical superstition in former ages, the celebrated confectio damocratis, or mithridate.

Salamanders, Newts, or Efts.

16. Lacerta salamandra. The salamander, so long the subject of popular error, and of which so many idle tales have been recited by the more antient naturalists, is an inhabitant of many parts of Germany, Italy, France, &c. but does not appear to have been discovered in England. It delights in moist and shady places, woods, &c. and is chiefly seen during a rainy season. In the winter it lies concealed in the hollows about the roots of old trees, in subterraneous recesses, or in the cavities of old walls, &c. The salamander is easily distinguished by its colours; being of a deep shining black, variegated with large, oblong, and rather irregular patches of bright orange-yellow, which, on each side of the back, are commonly so disposed as to form a pair of interrupted longitudinal stripes: the sides are marked by many large transverse wrinkles, the intermediate spaces rising into strongly marked convexities; and the sides of the tail often exhibit a similar appearance: on each side of the back of the head are situated a pair of large tubercles, which are in reality the parotid glands: and are thus protuberant not only in some others of the lizard tribe, but in a remarkable manner in the genus rana: these parts, as well as the back and sides of the body, are beset in the salamander with several large open pores or foramina, through which exudes a peculiar fluid, serving to lubricate the skin, and which, on any irritation, is secreted in a more sudden and copious manner under the form of a whitish gluten, of a slightly acrimonious nature; and from the readiness with which the animal, when disturbed, appears to evacuate it, and that even occasionally to some distance, has arisen the long-continued popular error of the salamander's being enabled to live uninjured in the fire, which it has been supposed capable of extinguishing by its natural coldness and moisture: the real fact is, that like any of the cold and glutinous animals, as snails, &c. it, of course, is not quite so instantaneously destroyed by the force of fire as an animal of a drier nature would be. The general length of the salamander is about seven or eight inches, though it sometimes arrives at a much larger size. It is capable of living in water as well as on land, and is sometimes found in stagnant pools, &c. Its general pace is slow, and its manners torpid.

A strange error appears to have prevailed relative to the supposed poisonous nature of this animal; and the malignity of its venom has even been considered as scarcely admitting a remedy. It may be sufficient to observe, that the salamander is perfectly innoxious, and incapable of inflicting either wound or poison on any of the larger animals, though it appears, from the experiments of Laurenti, that the common small grey lizard (L. agil. var.) is poisoned by biting a salamander, and thus swallowing the secreted fluid of the skin; becoming almost immediately convulsed, and dying in a very short time afterwards.

The salamander is a viviparous species; producing its young perfectly formed, having been first hatched from internal eggs, as in the viper, and some other amphibia. It is said to retire to the water in order to deposit its young, which, at the first exclusion, are furnished with ramified branchial fins or processes on each side the neck, and which being merely temporary organs, are afterwards obliterated, as in the young of frogs and water-newts. The number of young produced at one birth by the salamander is said sometimes to amount to 30 or 40.

17. Lacerta vulgaris. This, which is the smallest of the British lizards, is altogether a terrestrial species. It is commonly seen in gardens, and not unfrequently in the neighbourhood of dunghills, &c. It also occasionally makes its way into cellars in the manner of the slug, the toad, &c.

18. Lacerta aquatica. This, which in England occurs almost in every stagnant water, is a small species. Its general length is about three inches and a half, and it very rarely exceeds that of four inches at most.

The water-newts are remarkable for a high degree of reproductive power, and have been known to exhibit the restoration of their legs, tails, and even, according to Dr. Blumenbach, of the eyes themselves, after having been deprived of them by cutting.

Snake lizards, with extremely long bodies and short legs.

19. Lacerta chalcides. The chalcides is a native of many of the warmer parts of Europe, as well as of Africa, and is found of different sizes, from the length of a few inches to that of a foot, or even more. Its general length, however, seems to be eight or nine inches. The chalcides is an animal of a harmless nature, frequenting moist shady places, moving rather slowly, and feeding on insects, small worms, &c. It is a viviparous species, and is said to produce a great many young. The serpents to which it bears the nearest alliance in point of form, are those of the genus anguis, and particularly the A. fragilis, or common slow-worm.

20. Lacerta apus. A still nearer approach is made to the snake tribe by this large and singular lizard than even by the chalcides. It is a native of Greece, the southern parts of Siberia, and doubtless of many other parts of Europe and Asia, though it seems to have been but recently known to naturalists. It is found of the length of nearly three feet, and so perfectly resembles the general form of a large snake, that it is not without a near inspection that it is ascertained to belong to the race of lizards; being furnished merely with a pair of very short and somewhat acuminated processes by way of feet, situated at a vast distance from the fore parts of the body, nearly on each side the vent: the processes have no divisions or toes, but seem to form one simple projection, with a slight indenture only. The animal frequents moist and shady places, and appears to be of a harmless character.

LACHNEA, a genus of the monogynia order, in the octandria class of plants, and in the natural method ranking under the 31st order, vepreculæ. There is no calyx; the corolla is quadrifid, with the limb unequal; there is one seed a little resembling a berry. There are two species, shrubs of the Cape.

LACHRYMALIS, FISTULA. See SURGERY.

LACHRYMATORY, in antiquity, a vessel wherein were collected the tears of a deceased person's friends, and preserved along with the ashes and urn.

LACIS, a genus of the class and order polyandria digynia. There is no calyx or corolla. The filaments are winged on both sides below; the receptacle is girt with 12 spines; capsules ovate. There is one species, an aquatic of Guiana.

LACISTEMA, a genus of the monandria digynia class and order. The calyx is the scale of the ament; corolla four-parted; filaments bifid; berry pedicelled, one-seeded. There is one species, a shrub of Jamaica.

LACK OF RUPEES, is 100,000 rupees; which, supposing them standard, or siccas, at 2*s.* 6*d.* amounts to 12,500*l.* sterling.

LACQUERS, are varnishes applied upon tin, brass, and other metals, to preserve them from tarnishing, and to improve their colour. The basis of lacquers is a solution of the resinous substance called seed-lac in spirit of wine. The spirit ought to be very much concentrated, in order to dissolve much of the lac. For this purpose, some authors direct dry potass to be thrown into the spirit. This alkali attracts the water, with which it forms a liquid that subsides distinctly from the spirit at the bottom of the vessel. From this liquid the spirit may be separated by decantation. By this method the spirit is much concentrated; but, at the same time, it becomes impregnated with part of the alkali, which depraves its colour, and communicates a property to the lacquer of imbibing moisture from the air. These inconveniences may be prevented by distilling the spirit; or, if the artist has not an opportunity of performing that process, he may cleanse the spirit, in a great measure, from the alkali, by adding to it some calcined alum; the acid of which uniting with the alkali remaining in the spirit, forms with it a vitriolated tartar, which, not being soluble in spirit of wine, falls to the bottom together with the earth of the decomposed alum. To a pint of the purified spirit, about three ounces of powdered shell-lac are to be added; and the mixture to be digested during the same day with a moderate heat. The liquor ought then to be poured off, strained, and cleared by settling. This clear liquor is now fit to receive the required colour from certain resinous colouring substances, the principal of which are gamboge and annotto; the former of which gives a yellow, and the latter an orange colour. In order to give a golden colour, two parts of gamboge are added to one of annotto; but these colouring substances may be separately dissolved in the tincture of lac, and the colour required may be adjusted by mixing the two solutions in different proportions. When silver leaf or tin is to be lacquered, a larger quantity of the colouring materials is requisite than when the lacquer is intended to be laid on brass.

LACTEAL VESSELS. See ANATOMY.

LACTIC ACID. If milk be kept for some time it becomes sour. The acid which then appears in it was first examined by Scheele, and found by him to have peculiar properties. It is called lactic acid. In the whey of milk this acid is mixed with a little curd, some phosphat of lime, sugar of milk, and mucilage. All these must be separated before the acid can be examined. Scheele accomplished this by the following process:

Evaporate a quantity of sour whey to an eighth part, and then filtrate it: this separates the cheesy parts. Saturate the liquid with lime-water, and the phosphat of lime precipitates. Filtrate again, and dilute the liquid with three times its own bulk of water; then let fall into it oxalic acid, drop by drop, to precipitate the lime which it has dissolved from the lime-water; then add a very small quantity of lime-water, to see whether too much oxalic acid has been added. If there has, oxalat of lime immediately precipitates. Evaporate the solution to the consistence of honey, pour in a sufficient quantity of alcohohol, and filtrate again; the acid passes through dissolved in the alcohol, but the sugar of milk and every other substance remain behind. Add to the solution a small quantity of water, and distil with a small heat, the alcohol passes over, and leaves behind the lactic acid dissolved in water.

This acid is incapable of crystallizing: when evaporated to dryness, it deliquesces again in the air. When distilled, water comes over first, then a weak acid resembling the tartaric, then an empyreumatic oil mixed with more of the same acid, and, lastly, carbonic acid and carbureted hydrogen gas: there remains behind a small quantity of charcoal.

The combinations which this acid forms with alkalies, earths, and metallic oxides, are called lactats, which see.

All that is known concerning these salts are the following facts, ascertained by Scheele. When saturated with fixed alkalies, it gave salts which were deliquescent and soluble in spirit of wine. It formed deliquescent salts with ammonia, with barytes, with lime, and alumina; but with magnesia it formed small crystals, which however at length deliquesced. This acid had no effect on bismuth, cobalt, antimony, tin, mercury, silver, and gold. It dissolved zinc and iron; and it produced with these metals hydrogen gas. Zinc was the only metal with which it crystallized. Copper rendered this acid first slightly blue, then green, and lastly a deep blue; but no crystals were formed. Digested upon lead it became sweet, but did not crystallize.

LACTUCA, the *lettuce*, a genus of the polygamia æqualis order, in the syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The receptacle is naked; the calyx imbricated, cylindrical, with a membranaceous margin; the pappus is simple, stipated, or stalked. There are 11 species, most of which are plants of no use, and never cultivated but in botanic gardens for variety. That commonly cultivated in the kitchen-garden is the sative, which includes the following varieties: 1. The common or garden lettuce. 2. Cabbage lettuce. 3. Silesia lettuce. 4. Dutch brown lettuce. 5. Aleppo, or sperm lettuce. 6. Imperial lettuce. 7. Green capuchin lettuce. 8. Versailles, or upright white cos lettuce. 9. Black cos. 10. Red cos. 11. Red capuchin lettuce. 12. Roman lettuce. 13. Prince lettuce. 14. Royal lettuce. 15. Egyptian cos lettuce.

The first of these sorts is very common in all gardens, and is commonly sown for cutting very young, to mix with other salad herbs in spring; and the second, or cabbage lettuce, is only this mended by culture. The first crop should be sown in February, in an open situation; the others at three weeks distance; but the later ones under covert, but not under the drippings of trees. The Silesia, imperial, royal, black, white, and upright cos lettuces, may be first sown in the latter part of February or the beginning of March, on a warm light soil, and in an open situation: when the plants are come up, they must be thinned to 15 inches distance every way; they will then require no further care than the keeping them clear of weeds; and the black cos, as it grows large, should have its leaves tied together to whiten the inner part. Succeeding crops of these should be sown in April, May, and June; and towards the latter part of August they may be sown for a winter crop, to be preserved under glasses, or in a bed arched over with hoops and covered with mats. The most valuable of all the English lettuces are the white cos, or the Versailles; the Silesia; and the Egyptian cos. The brown Dutch and the green capuchin are very hardy, and may be sown late under walls, where they will stand the winter, and be valuable when no others are to be had. The red capuchin, Roman, and prince lettuce, are very early kinds, and are sown for variety; as are also the Aleppo ones for the beauty of their spotted leaves.

The several sorts of garden lettuces are very wholesome, emollient, cooling salad herbs, easy of digestion, and somewhat loosening the belly. Most writers suppose that they have a narcotic quality; and indeed in many cases they contribute to procure rest: this they effect by abating heat, and relaxing the fibres. The seeds are in the number of the four lesser cold seeds.

LACUNAR. See ARCHITECTURE.

LADDERS, *scaling*, in the military art, are used in scaling when a place is to be taken by surprise. They are made several ways: here we make them of flat staves, so that they may move about their pins, and shut like a parallel ruler, for conveniently carrying them: the French make them of several pieces, so as to be joined together, and to be made of any necessary length: sometimes they are made of single ropes, knotted at proper distances, with iron hooks at each end, one to fasten them upon the wall above, and the other in the ground; and sometimes they are made with two ropes, and staves between them, to keep the ropes at a proper distance, and to tread upon. When they are used in the action of scaling walls, they ought to be rather too long than too short, and to be given in charge only to the stoutest of the detachment. The soldiers should carry these ladders with the left-arm passed through the second step, taking care to hold them upright close to their sides, and very short below, to prevent any accident in leaping into the ditch.

The first rank of each division, provided with ladders, should set out with the rest at the signal, marching resolutely with their firelocks slung, to jump into the ditch: when they are arrived they should apply their ladders against the parapet, observing to place them towards the salient angles rather than the middle of the curtin, because the enemy have less force there. Care must be taken to place the ladders within a foot of each other, and not to give them too much or too little slope, so that they may not be overturned or broken with the weight of the soldiers mounting upon them.

The ladders being applied, those who have carried them, and those who come after, should mount up, and rush upon the enemy sword in hand: if he who goes first happens to be overturned, the next should take care not to be thrown down by his comrade; but, on the contrary, immediately mount himself, so as not to give the enemy time to load his piece.

As the soldiers who mount first may be easily tumbled over, and their fall may cause the attack to fail, it would perhaps be right to protect their breasts with the fore parts of cuirasses; because if they can penetrate the rest may easily follow.

LADY'S SMOCK. See CARDEMINE.

LADY'S SLIPPER. See CYPRIPEDIUM.

LAETIA, a genus of the monogynia order, in the polyandria class of plants, and in the natural method ranking with those of which the order is doubtful. The corolla is pentapetalous, or none; the calyx is pentaphyllous; the fruit is unilocular and trigonal; the seeds have a pulpy arillus or coat. There are four species, natives of America. One of them, the apetala, or gum-wood, Dr. Wright informs us, is very common in the woodlands and copses of Jamaica, where it rises to a considerable height and thickness. Pieces of the trunk or branches, suspended in the heat of the sun, discharge a clear turpentine or balsam, which concretes into a white resin, and which seems to be the same as gum sandarach. Pounce is there made of it; and our author is of opinion that it might be useful in medicine like other gums of the same nature.

LAGERSTROEMIA, a genus of the monogynia order, in the polyandria class of plants. The corolla is hexapetalous, and curled; the calyx sexfid, and campanulated; there are many stamina, and of these the six exterior ones thicker than the rest, and longer than the petals. There are four species, trees of the East Indies.

LAGOECIA, a genus of the monogynia order, in the pentandria class of plants. The involucrum is universal and partial; the petals bifid; the seeds solitary, inferior. There is one species, wild cummin, an annual, of the Levant.

LAGUNEA, a genus of the class and order monadelphia polyandria. The calyx is simple, five-cusped; style simple; stigma peltated; capsule five-celled, five-valved. There are three species, shrubs of the East Indies and Surinam.

LAGURUS, a genus of the digynia order, in the triandria class of plants, and in the natural method ranking under the fourth order, gramina. The calyx is bivalved with a villous awn, the exterior petal of the corolla terminated by two awns, with a third on its back retorted. There is one species, a grass of the south of Europe.

LAKES, certain colours made by combining the colouring matter of cochineal, or of certain vegetables, with pure alumine, or with oxide of tin, zinc, &c.

LAMA, the sovereign pontiff, or rather god, of the Asiatic Tartars, inhabiting the country of Barantola. The lama is not only adored by the inhabitants of the country, but also by the kings of Tartary, who send him rich presents, and go in pilgrimage to pay him adoration, calling him lama-congiu, *i. e.* God the everlasting father of heaven. He is never to be seen but in a secret place of his palace, amidst a great number of lamps, sitting cross-legged upon a cushion, and adorned all over with gold and precious stones; where, at a distance, they prostrate themselves before him, it not being lawful for any to kiss even his feet. He is called the great lama, or lama of lamas, that is, priest of priests. And to persuade the people that he is immortal, the inferior priests, when he dies, substitute another in his stead, and so continue to cheat from generation to generation. These priests persuade the people that the lama was raised from death many hundred years ago, that he has lived ever since, and will continue to live for ever.

LAMINÆ, in physiology, the thin plates of which many substances consist.

LAMIUM, *dead-nettle*, a genus of the gymnospermia order, in the didynamia class of plants, and in the natural method ranking under the 42d order, verticillatæ. The upper lip of the corolla is entire, arched, the under lip bilobous; the throat with a dent or tooth on each side of the margin. There are 13 species, of which only two, viz. the album, white archangel or dead-nettle, and the purpureum, or red archangel, deserve notice. The flowers of the first, which appear in April and May, have been particularly celebrated in uterine fluors, and other female weaknesses, and also in disorders of the lungs; but they appear to be of very weak virtue. The young leaves of both species are boiled and eaten in some places like greens.

LAMP, a vessel containing oil, with a lighted wick; of which there an indefinite number made of various constructions for various purposes. We shall particularly notice Argand's lamp, and an improvement made upon it.

Argand's lamp is a very ingenious contrivance, and is the invention of a citizen of Geneva. The principle on which the superiority of the lamp depends, is the admission of a larger quantity of air to the flame than can be done in the common way. This is accomplished by making the wick of a circular form, by which means a current of air rushes through the cylinder on which it is placed, with great force; and, along with that which has access to the outside, excites the flame to such a degree that the smoke is entirely consumed. Thus both the light and heat are prodigiously increased, at the same time that there is a very considerable saving in the expence of oil, the consumption of the inflammable matter being exceedingly augmented by the quantity of air admitted to the flame; so that what in common lamps is dissipated in smoke is here converted into a brilliant flame.

This lamp is now very much in use, and is consequently well known.

We shall now describe an improvement of this neat invention. See Plate Lamp, &c.

The upper compartment of the Plate represents an improved construction of Argand's lamp. A, fig. 1, is the reservoir for the oil, which unscrews at B; in order to fill it the oil is poured in at a hole *a*, fig. 4, in the lower end of the reservoir, which is covered, when the lamp is not burning, by a sliding collar, *b*, drawn up by a handle, *d*, which comes through a hole in the screw *e*, by which the reservoir is screwed in the short tube, E, fig. 1: there being no vent-holes in the upper part of the reservoir, A, to admit the air as the oil runs out, a bubble of air must enter the hole *a*, fig. 4, to supply the place of every drop of oil that comes out, when the reservoir, A, is screwed to the tube, E; the collar, *b*, being down, the oil runs out (the air being admitted from without through a small hole, *f*), till E is filled above the level of the hole, *a*, which prevents more air getting in; it remains in this state till by the burning of the lamp the oil is drawn down beneath the hole *a*, when it is filled again as before; by this means the lamp is always well supplied, but never overstocked with oil. From the bottom of the tube, E, fig. 1, the oil is conveyed by a pipe, D, to the lamp, the constitution of which is best explained in fig. 2; EF is the external tube of brass, which is supplied with oil by the pipe D; in the centre of this another tube, GG, is soldered, which is open at both ends: between these tubes is a cylinder of slightly wove cotton, *gg*, called the wick; this is fastened to a small cylinder of brass, *hh* (shewn separately in fig. 3), which can be moved down and up as the wick burns. The wick is lowered or raised by turning round the cylinder, HH (shewn separately in figs. 5), by means of its rim, II, fastened to the cylinder, HH, by three small rods, *ii*; the cylinder, HH, fig. 5, has a spiral groove, *kk*, cut obliquely round it: the cylinder, *hh*, figs. 2 and 3, which goes within the cylinder, HH, has a small stub, *l*, projecting from it, which works into the groove, *kk*, fig. 5; the leaf, *l*, is long enough to project a small distance through the groove, *kk*, and when in its place takes against a small bead, *n*, fig. 2, fixed withinside the cylinder, FF, so as to prevent its turning, when HH is turned by its rim, II. By the above arrangement it is evident, that when the cylinder, HH, fig. 5, is turned round, and *h* is prevented from turning, the sides of the groove, *k*, will act as an inclined plane against the stub, *l*, and raise the cylinder *h* down or up, and the cotton wick, *gg*, with it. The rim, II, figs. 1, 2, and 5, has an ornamented border, L, round it, which serves to secure the glass chimney, *o*, from being overthrown. To prevent the cylinder, HH, from being lifted out by accident, it has a rim, *o*, figs. 2 and 5, at the lower end, cut through in one place to allow it to pass down by the bead, *n*; when it is below the end of the bead it cannot be raised, unless the notch in the rim, *o*, corresponds with the bead. When the wick, *gg*, figs. 1 and 5, is lighted, it rarefies the air in the glass chimney, O, and causes a draught through the tube, GG, to supply the inside of the wick, and also under the edge of the glass chimney to supply the outside: as the wick burns down it can be raised from time to time by turning the rim, I, as before described. The tube, FF, is always nearly full of oil, brought by the pipe, D. When it is required to put in a new wick, the glass chimney, O, is lifted off; the tube, *hh*, is screwed up to the top; by turning the rim, II, the tube, fig. 3, is then taken out, the old wick pulled off, and a new one is put round the small part, *m*, of the tube, which is then put in again, and screwed down to the proper depth for lighting the wick.

Rolling-Lamp, a machine, AB (see Pl. Miscel. fig. 145.) with two moveable circles, DE, FG, within; whose common centre of motion and gravity is at K, where their axes of motion cross one another. If the lamp, KC, made pretty heavy, and moveable about its axis, HI, and whose centre of gravity is at C, be fitted within the inner circle, the common centre of gravity of the whole machine will fall between K and C; and by reason of the pivots A, B, D, E, H, I, will be always at liberty to descend: hence, though the whole machine be rolled along the ground, or moved in any manner, the flame will always be uppermost, and the oil cannot spill.

It is in this manner they hang the compass at sea; and thus should all the moon-lanterns be made that are carried before coaches, chaises, and the like.

LAMP-BLACK, among colourmen. See BLACK.

LAMPREY. See PETROMYZON.

LAMPYRIS, *glow-worm*, a genus of insects of the order coleoptera: the generic character is, antennæ filiform; wing-sheaths flexile; thorax flat, semiorbicular, concealing and surrounding the head; abdomen with the sides pleated into papillæ; female (in most species) wingless. The lampyris noctiluca, or common glow-worm, is a highly curious and interesting animal. It is seen during the summer months as late as the close of Aug. if the season is mild, on dry banks, about woods, pastures, and hedgeways, exhibiting, as soon as the dusk of the evening commences, the most vivid and beautiful phosphoric splendour, in form of a round spot of considerable size. The animal itself, which is the female insect, measures about three quarters of an inch in length, and is of a dull earthy brown colour on the upper parts, and beneath, more or less tinged with rose-colour, with the two or three last joints of the body of a pale or whitish sulphur-colour. It is from these parts that the phosphoric light abovementioned proceeds, which is of a yellow colour, with a very slight cast of green: the body, exclusive of the thorax, consists of ten joints or divisions. The larva, pupa, and complete female insect, scarcely differ perceptibly from each other in general appearance, but the phosphoric light is strongest in the complete animal. The glow-worm is a slow-moving insect, and in its manner of walking frequently seems to drag itself on by starts, or slight efforts. The male is smaller than the female, and is provided both with wings and wing-sheaths; and it is but rarely seen.

It is certain, that in some species of this genus the male, as well as the female, is luminous; as in the lampyris Italica, which seems to be a native of our own island also, though less common here than in the warmer parts of Europe. Aldrovandus describes the winged glow-worm as having its wing-shells of a dusky colour, and at the end of the body two brilliant fiery spots like the flame of sulphur. See Plate Nat. Hist. figs. 238, 239.

In the Philosophical Transactions for the year 1684, we find a paper by a Mr. Waller, describing the English flying glow-worm as of a dark colour, with the tail part very luminous. He maintains that both male and female of this species are winged, and that the female is larger than the male: the light of this insect was very vivid, so as to be plainly perceived even when a candle was in the room. Mr. Waller observed this species at Northaw, in Hertfordshire. From the figure given by this writer it appears to be about half an inch in length, which is much smaller than the common female glow-worm.

In Italy this flying glow-worm is extremely plentiful; and we are informed by Dr. Smith and other travellers, that it is a very common practice for the ladies to stick them by way of ornament in different parts of their head-dress during the evening hours.

The common or wingless glow-worm may be very successfully kept, if properly supplied with moist turf, grass, moss, &c. for a considerable length of time; and as soon as the evening commences, will regularly exhibit its beautiful effulgence, illuminating every object within a small space around it, and sometimes the light is so vivid as to be perceived through the box in which it is kept. This insect deposits its eggs, which are small and yellowish, on the leaves of grass, &c. There are 18 species of the lampyris.

LAND, in the sea language, makes part of several compound terms: thus *land-laid*, or to lay the land, is just to lose sight of it. *Land-locked*, is when land lies all round the ship, so that no point of the compass is open to the sea: if she is at anchor in such a place, she is said to ride land-locked, and is therefore concluded to ride safe from the violence of winds and tides. *Land-mark*, any mountain, rock, steeple, tree, &c. that may serve to make the land known at sea. *Land is shut in*, a term used to signify that another point of land hinders the sight of that the ship came from. *Land to*, or the ship lies land to, that is, she is so far from shore that it can only be just discerned. *Land-turn*, is a wind that in almost all hot countries blows at certain times from the shore in the night. *To set the land*, that is, to see by the compass how it bears.

LANDSCAPE. See PAINTING.

LAND-TAX, an antient branch of the public revenue, the origin of which may be traced to the fines or commutations for military service, levied during the feudal system under the name of scutages. These are supposed to have been at first mere arbitrary compositions, as the king and the persons liable could agree; but the practice having been much abused, it was declared by Magna Charta, and afterwards repeatedly confirmed by acts of parliament, that no scutage should be imposed without the consent of the great men and commons, in parliament assembled. This tax was sometimes exacted under the name of hydage, or carrucage; but taxes on land came afterwards to be generally denominated subsidies, or assessments. During the Commonwealth, taxes on land were levied by monthly assessments; and commissioners were appointed in each county for rating the individuals. These assessments varied according to the exigencies of the times, from 35,000*l.* to 120,000*l.* a month; the assessments in Scotland were commonly 6000*l.* but sometimes 1000*l.* a month; in Ireland 9000*l.* a month. This mode of raising money was found so productive, that, with some little variations, it has under the denomination of land-tax ever since formed an important branch of the revenue.

The land-tax, till lately, differed from all the other branches of the public revenue (except part of the duties on malt), in being imposed annually, whereas other taxes have been granted either for a term of years, or, more commonly of late years, for ever; but though granted for only one year at a time, it has been regularly continued from year to year since the Revolution, having never been wholly taken off; but it has varied with respect to the rate at which it has been imposed, having been usually reduced during peace, and increased again in time of war, to answer, in part, the increased expenditure. In 1693 it was first raised to four shillings in the pound, upon a valuation given in in the preceding year, and according to which it has continued to be raised to the present time, at the following rates:

In 1698 and 1699,	at 3*s.*
1700,	at 2*s.*
1701,	at 3*s.*
1702 to 1712,	at 4*s.*
1713 to 1715,	at 2*s.*
1716,	at 4*s.*
1717 to 1721,	at 3*s.*
1722 to 1726,	at 2*s.*
1727,	at 4*s.*
1728 and 1729,	at 3*s.*
1730 and 1731,	at 2*s.*
1732 and 1733,	at 1*s.*
1734 to 1739,	at 2*s.*
1740 to 1749,	at 4*s.*
1750 to 1752,	at 3*s.*
1753 to 1755,	at 2*s.*
1756 to 1766,	at 4*s.*
1767 to 1770,	at 3*s.*
1771,	at 4*s.*
1772 to 1775,	at 3*s.*
1776 to 1798,	at 4*s.*

The sums to be raised at 4*s.* in the pound were stated, in the annual act, at 1,989,673*l.* 7*s.* 10¼*d.* for England, and 47,954*l.* 1*s.* 2*d.* for Scotland, making together 2,037,627*l.* 9*s.* 0¼*d.*; and upon credit of this assessment 2,000,000*l.* was annually borrowed of the Bank in anticipation of the tax, for which sum exchequer-bills were given them, which were to be discharged out of the produce of the tax as it came in; but the full amount of the assessment was seldom, if ever, collected, so that the nett payments into the exchequer always fell short of the sum borrowed on the credit thereof, exclusive of interest on the bills; and the deficiency was made good out of the supplies for the next year.

In 1798 the current value of the public funds having been unusually depressed for some time past, and apprehensions being entertained that the further increase of the funded debt would be attended with peculiar inconvenience, unless some mode was discovered of counteracting its effects, a project was adopted of offering the land-tax for redemption or sale. With this view an act was passed, making the land-tax a perpetual tax, from 25th March, 1799; and being thus converted into a permanent annuity, it was offered for sale to the proprietors of the lands upon which it was charged; or if they declined it, to any other person who chose to become a purchaser. In the first case it was considered as a redemption of the tax, the estate becoming in future wholly freed from it; in the latter case the purchaser became entitled to receive the land-tax regularly from the receiver-general, half-yearly, on the 16th of March and 20th of September in every year. The consideration to be given in either case was not to be in money, but stock, either in the three per cent. consols., or three per cent. reduced, to be transferred to the commissioners for the reduction of the national debt. The quantity of stock to be transferred for redemption of the tax by persons interested in the land on which it was charged, was so much capital as yielded an annuity or dividend exceeding the amount of the tax to be redeemed by one-tenth part thereof; and the stock to be transferred for purchase of the tax by persons not interested in the land, was so much capital as yielded an annuity or dividend exceeding the tax to be purchased by one-fifth part thereof. Thus the amount of three per cent. stock to be transferred for 10*l.* per annum tax was 366*l.* 13*s.* 4*d.* for redemption, or 400*l.* for purchase.

This scheme was adopted with the view of facilitating the raising of money on loan, by absorbing a large quantity of floating stock, and thus raising the current price; while at the same time it would be attended with an increase of revenue. This at least was the avowed object of the measure, which it was estimated would be the means of redeeming or taking out of the market about 80,000,000*l.* of stock; the advantages offered by it were however, by no means such as to induce a general approval of it, many persons subject to the tax declined redeeming it, and but few were inclined to become purchasers. The period first limited was several times extended, but the plan succeeded very imperfectly, and on the 1st February, 1803, the otal amount of 3 per cent. stock, which had been transferred for the redemption of land tax, was only 21,794,307*l.* 17*s.* 3*d.*

LANERIA, a genus of the hexandria monogynia class and order. The corolla is superior, woolly; the caps. three-celled. There is one species, a herb of the Cape.

LANGAYA, a genus of serpents: the generic character is, abdominal plates; caudal rings; terminal scales.

Langaya nasuta, snouted langaya. The genus langaya, consisting of a single species only, differs from all the rest of the serpent tribe in having the upper part or beginning of the tail marked into complete rings or circular divisions resembling those on the body of the amphisbena, while the extreme or terminal part is covered with small scales, as in the genus anguis.

The langaya nasuta, or long-snouted langaya, is in length about two feet eight inches, and its greatest diameter about seven lines: the head is covered with large scales, but the snout, which is extremely long and sharp, projecting to a considerable distance beyond the lower jaw, is covered with very small scales; the teeth, in shape and disposition, resemble those of a viper. The natives of Madagascar are said to hold the langaya in great dread, considering it as a highly poisonous serpent.

LANGUED, in heraldry, expresses such animals whose tongue appearing out of the mouth, is borne of a different colour from that of the body.

LANIUS, the *shrike*, or *butcher-bird*; a genus belonging to the order of accipitres, the characters of which are these: the beak is somewhat straight, with a tooth on each side towards the apex, and naked at the base; and the tongue is lacerated.

1. The excubitor, great cinereous shrike, or greater butcher-bird, is in length 10 inches. The plumage on the upper parts is of a pale ash-colour; the under, white; through the eyes there is a black stripe; the scapulars are white; the base of the greater quills is white, the rest black. The method of killing its prey is singular, and its manner of devouring it not less extraordinary: small birds it will seize by the throat, and strangle; and which probably is the reason the Germans also call this bird wurchangel, or the suffocating angel. It feeds on small birds, young nestlings, beetles, and caterpillars. When it has killed the prey, it fixes them on some thorn, and when thus spitted, pulls them to pieces with its bill. When confined in a cage, they will often treat their food in much the same manner, sticking it against the wires before they devour it. This bird inhabits many parts of Europe and North America. The female makes its nest with heath and moss, lining it with wool and gossamer, and lays six eggs, about as big as those of a thrush, of a dull olive-green, spotted at the thickest end with black. In spring and summer it imitates the voices of other birds, by way of decoying them within reach, that it may destroy them; but beyond this the natural note is the same throughout all seasons. In countries where they are plenty, the husbandmen value them, on supposition of their destroying rats, mice, and other vermin. They are supposed to live five or six years; and are often trained up for catching small birds in Russia.

2. The collurio, or lesser butcher-bird, is seven inches and a half in length. This bird is much more common than the former species. Mr. Latham suspects its being a bird of passage, never having seen it in winter. It lays six white eggs, marked with a rufous brown circle towards the large end. The nest is generally in a hedge or low bush, near which, it is said, no small bird chooses to build; for it not only feeds on insects, but also on the young of other birds in the nest, taking hold of them by the neck, and strangling them, beginning to eat them first at the brain and eyes. It is fonder of grasshoppers and beetles than of other insects, which it eats by morsels, and when satisfied, sticks the remainder on a thorn: when kept in a cage, it does the same against the wires of it, like the former species.

3. The infaustus, or rock shrike, is in length seven inches and three quarters. The bill is about an inch long, and blackish; the head and neck are of a dark ash-colour, marked with small rufous spots; the upper part of the back is a dark brown; the lower much paler, inclining to ash, especially towards the tail; the quills and wing-coverts are dusky, with pale margins; the breast, and under parts of the body, are orange, marked with small spots, some white and others brown. This species is met with in many parts of Europe, from Italy on the one hand, to Russia on the other; and is found in some parts of Germany, the Alpine mountains, those of Tyrol, and such-like places. The manners of this bird seem disputed. It has an agreeable note of its own, approaching to that of the hedge sparrow; and will also learn to imitate that of others. It makes the nest among the holes of the rocks, &c. hiding it with great art; and lays three or four eggs, feeding the young with worms and insects, on which it also feeds itself. It may be taken young from the nest, and brought up as the nightingale.

4. The faustus, or white-wreathed shrike, is about the size of a common thrush. Its bill is pale; the upper parts of the body are grey; the under ferruginous; from the eyes to the hind head there passes a whitish line, composed of numerous white feathers, rendering it truly characteristic; the wings are rounded; the quills brownish, with grey edges, which are crossed with numerous slender brown lines; the tail is rounded, brown, and crossed with numerous bars of darker brown; the legs are pale. This elegant species inhabits China, where it is known by the name of whommaj. It may be observed, among others, in Chinese paper-hangings, where the white line seems to encompass the back part of the head like a wreath.

5. The tyrannus, or tyrant shrike, is about the size of a thrush. Its bill is a blackish brown, beset with bristles at the base; the irides are brown; the upper parts of the plumage grey brown; the under white; the breast inclines to ash-colour; the head is blackish on the upper part; the base of the feathers on that part in the male is orange, but seldom visible except it erects the feathers, when there appears a streak of orange down the middle of the crown. It inhabits Virginia. There is a variety which inhabits St. Domingo and Jamaica. These birds are called titiri, pipiri, or quiquiri, from their cry, which resembles those words. All authors agree in the manners of these birds, which are ferocious to a great degree while the hen is sitting; no bird whatever dare approach their nest; they will attack the first which comes near, without reserve, and usually come off conquerors.

Many species of this genus are found in Cayenne, and other hot countries, as the lanius varius. See Plate Nat. Hist. fig. 240.

LANNIERS, or Lanniards, in a ship, are small ropes reeved into the dead-man's-eyes of all shrowds, either to slacken them or to set them tawt; the stays of all masts are also set tawt by lanniers.

LANTANA, or Indian Sage, a genus of the angiospermia order, in the didynamia class of plants, and in the natural method ranking under the 40th order, personatæ. The calyx is indistinctly quadridentated; the stigma broken, and turned back like a hoof; the fruit is a plum with a bilocular kernel. There are 19 species, consisting of shrubby exotics from Africa and America for the greenhouse or stove, growing to the height of a yard or two, and adorned with oblong, oval, and roundish simple leaves, with monopetalous, tubular, four-parted flowers of different colours. They may be propagated either by seeds or cuttings. 1. The camara, or wild sage, is remarkable for the beauty of its flowers, which are yellow, tinged with red. 2. The involucrata, or sea-side sage, has small ash-coloured leaves and a most agreeable smell. They are both natives of the West Indies, the former growing wild among the bushes, and the latter being found near the sea. Their leaves, particularly those of the sea-side sage, are used by the black people in teas for colds and complaints of the stomach. 3. The aculeata is a beautiful stove plant, remarkable for its flowers changing from yellow to red. See Plate Nat. Hist. fig. 243.

LANTERN, Magic, an optic machine, whereby little painted images are represented so much magnified, as to be accounted the effect of magic by the ignorant. See Optics.

Lantern. See Architecture.

LAPIDARY. There are various machines employed in the cutting of precious stones, according to the quality: the diamond, which is extremely hard, is cut on a wheel of soft steel, turned by a mill, with diamond-dust, tempered with olive-oil, which also serves to polish it.

The Oriental ruby, sapphire, and topaz, are cut on a copper wheel with diamond-dust, tempered with olive-oil, and are polished on another copper wheel with tripoli and water. The hyacinth, emerald, amethyst, garnets, agates, and other stones, not of an equal degree of hardness with the other, are cut on a leaden wheel with smalt and water, and polished on a tin wheel with tripoli. The turquois of the old and new rock, girasol, and opal, are cut and polished on a wooden wheel with tripoli also.

LAPIS, in general, is used to denote a stone of any kind. See MINERALOGY.

LAPIS *calcedonius*, a genus of stones consisting of silica, a small quantity of alumina, with about one-tenth of lime, and a slight trace of oxide of iron: hard, lightish, shining within, breaking into fragments with sharp edges; compact, not mouldering in the air; of a more or less perfectly conchoidal texture; never opake, tough, admitting of a high polish, and generally of a common form; not melting before the blowpipe. See Plate Nat. Hist. fig. 241.

LAPLYSIA, or SEA-HARE, a genus of marine insects belonging to the order of vermes mollusca. See Plate. The body is covered with membranes reflected. It has a shield-like membrane on the back, a lateral pore on the right side, the anus on the extremity of the back, with four feelers resembling ears. The figure represents the depilans minor, which grows to two inches and a half in length, and to more than an inch in diameter; its body approaches to an oval figure, and is soft, punctated, of a kind of gelatinous substance, and of a pale lead-colour; from the larger extremity there arise four oblong and thick protuberances: these are the tentacula; two of them stand nearly erect, two are thrown backward. It is not uncommon about our shores, especially off Anglesea. It causes, by its poisonous juice, the hair to fall off the hands of those that touch it; and is so extremely fetid as to create sickness at the stomach. The major, or greater sea-hare, grows to the length of eight inches.

LAPPAGO, a genus of the triandria digynia class and order. There is one species, a grass.

LAPSANA, *nipplewort*, a genus of the polygamia æqualis order, in the syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The receptacle is naked; the calyx calicu-lated, with all the inferior scales canaliculated or finely channelled. There are five species, which grow commonly as weeds by the sides of ditches. The young leaves of the common kind, called dock-cresses, have the taste of radishes, and are eaten raw at Constantinople as a sallad. In some parts of England the common people boil them as greens, but they have a bitter and disagreeable taste.

LAPSE, the omission of a patron to present to a church, within six months after voidable; by which neglect title is given to the ordinary to collate to such church: and in such case, the patronage devolves from the patron to the bishop, from the bishop to the archbishop, and from the archbishop to the king. A donative does not go in lapse; but the ordinary may compel the patron by ecclesiastical censures to fill up the vacancy. But if the donative has been augmented by the governors of queen Anne's bounty, it will lapse in like manner as presentative livings.

LAPSED LEGACY, is where the legatee dies before the testator; or where a legacy is given upon a future contingency, and the legatee dies before the contingency happens. As if a legacy is given to a person when he attains the age of 21 years, and the legatee dies before that age; in this case the legacy is a lost or lapsed legacy, and shall sink into the residuum of the personal estate. 2 Black. 613.

LARBOARD, among seamen, the left hand side of the ship, when you stand with your face towards the head.

LARCENY, is the felonious and fraudulent taking away of the personal goods of another; which goods, if they are above the value of 12*d.* it is called grand larceny; if of that value or under, it is petit larceny; which two species are distinguished in their punishment, but not otherwise. 4 Black. 229.

The mind only makes the taking of another's goods to be felony, or a bare trespass only; but as the variety of circumstances is so great, and the complications thereof so mingled, it is impossible to prescribe all the circumstances evincing a felonious intent, or the contrary; it must therefore be left to the due and attentive consideration of the judge and jury, wherein the best rule is, in doubtful matters, rather to incline to acquittal, than conviction. But in general it may be observed, that the ordinary discovery of a felonious intent, is, if the party do it secretly, or being charged with the goods deny it. 1 H. H. 509.

As all felony includes trespass, every indictment must have the words feloniously took, as well as carried away: whence it follows, that if the party be guilty of no trespass in taking the goods, he cannot be guilty of felony in carrying them away. 1 Haw. 89.

With respect to what shall be considered a sufficient carrying away, to constitute the offence of larceny; it seems that any the least removing of the thing taken, from the place where it was before, is sufficient for this purpose, though it be not quite carried off. 1 Haw. 93.

As grand larceny is a felonious and fraudulent taking of the mere personal goods of another above the value of 12*d.* so it is petit larceny, where the thing stolen is but of the value of 12*d.* or under. In the several other particulars above-mentioned, petit larceny agrees with grand larceny. 1 Haw. 95.

In petit larceny there can be no accessaries either before or after. 1 H. H. 530.

Larceny from the person. If larceny from the person be done privily without his knowledge, by picking of pockets or otherwise, it is excluded from the benefit of clergy by 8 Eliz. c. 4, provided the thing stolen be above the value of 12*d.* 2 H. H. 336.

But if done openly and avowedly before his face, it is within the benefit of clergy. 1 Haw. 97.

Larceny from the house. Every person who shall be convicted of the feloniously taking away in the day-time, any money or goods of the value of 5*s.* in any dwelling-house, or out-house thereunto belonging, and used to and with the same, though no person be therein, shall be guilty of felony, without benefit of clergy. 39 Eliz. c. 15.

Receiving stolen goods. Any person who shall buy or receive any stolen goods, knowing them to be stolen; or shall receive, harbour, or conceal any felons or thieves, knowing them to be so; shall be deemed accessary to the felony: and being convicted on the testimony of one witness, shall suffer death as a felon convict; but he shall be entitled to his clergy. 5 Anne c. 31.

Any person convicted of receiving or buying stolen goods, knowing them to be stolen, may be transported for fourteen years. 4 Geo. I. c. 11.

Where the principal felon is found guilty to the value of 10*d.* that is, of petit larceny only, the receiver, knowing the goods to have been stolen, cannot be transported for fourteen years, and ought not to be put upon his trial; for the acts which make receivers of stolen goods knowingly, accessaries to the felony, must be understood to make them accessaries in such cases only, where by law an accessary may be; and there can be no accessary to petit larceny. Fost. 74.

Every person who shall apprehend any one guilty of breaking open houses in a felonious manner, or of privately and feloniously stealing goods, wares, or merchandizes, of the value of 5*s.* in any shop, warehouse, coach-house, or stable, though it is not broken open, and though no person is therein to be put in fear, and shall prosecute him to conviction, shall have a certificate without fee, under the hand of the judge, certifying such conviction, and within what parish or place the felony was committed, and also that such felon was discovered and taken, or discovered or taken, by the person so discovering or apprehending; and if any dispute arise between several persons so discovering or apprehending, the judge shall appoint the certificate into so many shares, to be divided among the persons concerned, as to him shall seem just and reasonable. Leache's Cro. Law, 307. See BURGLARY.

LARK. See ALAUDA.

LARKSPUR. See DELPHINIUM.

LARVA, in natural history, a name given by Linnæus to insects in that state, called by other writers eruca, or caterpillar.

LARUS, the *gull*, a genus in the order of anseres, the characters of which are: the bill is straight, cultrated, a little crooked at the point, and without teeth; the inferior mandible is gibbous below the apex; the nostrils are linear, a little broader before, and situated in the middle of the beak. The different species are principally distinguished by their colour. The most remarkable are,

1. The marinus, or black-backed gull, in length 29 inches, in breadth five feet nine. The bill is very strong and thick, and almost four inches long; the colour a pale yellow; the head, neck, whole under-side, tail, and lower part of the back, are white; the upper part of the back and wings are black; the quill-feathers tipt with white; the legs of a pale flesh-colour. It inhabits several parts of England, and breeds on the highest cliffs. The egg is blunt at each end, of a dusky olive-colour, quite black at the greater end, and the rest of it thinly marked with dusky spots. It is also common on most of the northern coasts of Europe. It frequents Greenland, but chiefly inhabits the distant rocks. It lays there eggs in May, placing them on the heaps of dung which the birds leave there from time to time. It is said to attack other birds, and to be particularly an

enemy to the eider duck. It very greedily devours carrion, though its most general food is fish. It is common also in America, as low as South Carolina, where it is called the old-wife.

2. The cataractes, or Skua gull, is in length two feet; the extent four feet and a half; the weight three pounds; the feathers on the head, neck, back, scapulars, and coverts of the wings, are of a deep brown, marked with rust-colour (brightest in the male). The breast, belly, and vent are ferruginous, tinged with ash-colour. This bird inhabits Norway, the Ferroe isles, Shetland, and the noted rock Foula a little west of them. It is also a native of the South Sea. It is the most formidable of the gulls; its prey being not only fish, but what is wonderful in a web-footed bird, all the lesser sort of water-fowl, such as teal, &c. Mr. Schroter, a surgeon in the Ferroe isles, relates that it likewise preys on ducks, poultry, and even young lambs. The natives of the Orkneys are often very rudely treated by them while they are attending their sheep on the hills, and are obliged to guard their heads by holding up their sticks, on which the birds often kill themselves. In Foula it is a privileged bird, because it defends the flocks from the eagle, which it beats and pursues with great fury; so that even that rapacious bird seldom ventures near its quarters.

3. The parasiticus, or dung-hunter, is in length 21 inches: the upper parts of the body, wings, and tail, are black; the base of the quills white on the inner webs; and the two middle feathers of the tail are near four inches longer than the rest. This is a northern species, and very common in the Hebrides, where it breeds on heath. It comes in May, and retires in August; and if disturbed flies about like the lapwing, but soon alights. It is also found in the Orkneys; and on the coasts of Yorkshire, where it is called the feaser. This bird does not often swim, and flies generally in a slow manner, except in pursuit of other birds, which it often attacks, in order to make them disgorge the fish or other food which this common plunderer greedily catches up.

4. The canus, or common gull, is in length 16 or 17 inches; in breadth 36; weight one pound. The bill is yellow; the head, neck, under parts of the body and tail are white; the back and wings pale-grey. It is a tame species, and may be seen by hundreds on the shores of the Thames and other rivers, in the winter and spring, at low tides, picking up the various worms and small fish left by the tides; and will often follow the plough in the fields contiguous, for the sake of worms and insects which are turned up; particularly the cockchafer or dorbeetle in its larva state, which it joins with the rooks in devouring most greedily.

5. The tridactylus, or tarrock, is in length 14 inches, breadth 36; weight seven ounces. The head, neck, and under parts, are white; near each ear, and under the throat, there is a black spot; and at the hind part of the neck a crescent of black; the back and scapulars are blueish-grey; the wing-coverts dusky edged with grey, some of the larger wholly grey. This species breeds in Scotland, and inhabits other parts of northern Europe, quite to Iceland and Spitzbergen. It is observed frequently to attend the whales and seals, for the sake of the fish which the last drive before them into the shallows, when these birds dart into the water suddenly, and make them their prey.

6. The ridibundus, peewit, or black-head gull, is in length 15 inches, breadth three feet; weight ten ounces; the back and wings are of an ash-colour; the neck, all the under parts, and tail, are white; the first ten quills are white, margined, and more or less tipped with black; the others of an ash-colour. This species breeds on the shores of some of our rivers; but full as often in the inland fens of Lincolnshire, Cambridgeshire, and other parts of England. They make their nest on the ground, with rushes, dead grass, &c. and lay three eggs of a greenish brown, marked with red-brown blotches. After the breeding season, they again disperse to the sea-coasts. The young birds in the neighbourhood of the Thames are thought good eating, and are called the red legs. They were formerly more esteemed, and numbers were annually taken and fattened for the table. Whitelock, in his annals, mentions a piece of ground near Portsmouth, which produced to the owner 40*l.* a year by the sale of peewits, or this species of gull. These are the sea-gulls that in old times were admitted to the noblemen's tables. The note of these gulls is like a hoarse laugh.

7. The atricilla, or laughing gull, is in length 18 inches, breadth three feet. It is found in Russia on the river Don, particularly about Tschercask. The note resembles a coarse laugh, whence the name of the bird. It is met with also in different parts of the continent of America, and is very numerous in the Bahama islands.

There are 14 or 15 other species of this genus. See Plate Nat. Hist. fig. 242.

LARYNX. See Anatomy.

LASH, or Lace, in the sea language, signifies to bind and make fast.

LASERPITIUM, *lazar-wort*, a genus of the digynia order, in the pentandria class of plants, and in the natural method ranking under the 45th order, umbellatæ. The fruit is oblong, with eight membranaceous angles; the petals inflexed, emarginated, and patent. There are 15 species, none of which are at all remarkable for their beauty, so are only preserved in botanic gardens for the sake of variety.

LASIOSTOMA, a genus of the class and order tetrandria monogynia: the calyx is very short, five-petalled; corolla funnel-form, four-cleft; caps. orbiculate, one-celled, two-seeded. There is one species, a shrub of Guiana.

LASKETS, small lines, like loops, sewed to the bonnets and drablers of a ship, to lash or lace the bonnets to the courses, or the drablers to the bonnets.

LASKING, at sea, is much the same with going large, or veering, that is, going with a quarterly wind.

LAST, in general, signifies the burden or load of a ship. It signifies also a certain measure of fish, corn, wool, leather, &c. A last of codfish, white herrings, meal, and ashes for soap, is 12 barrels; of corn or rapeseed, 10 quarters; of gunpowder 24 barrels; of red-herrings 20 cades; of hides 12 dozen; of leather 20 dickers; of pitch and tar 14 barrels; of wool 12 sacks; of stock-fish 1000; of flax or feathers 1700 pounds.

LATH, in building, a long, thin, and narrow slip of wood, nailed to the rafters of a roof or ceiling, in order to sustain the covering. These are distinguished into three kinds, according to the different kinds of wood of which they are made, viz. heart of oak, sap-laths, and deal-laths; of which the last two are used for ceilings and partitions, and the first for tiling only. Laths are also distinguished according to their length, into five-feet, four-feet, and three-feet laths, though the statute allows but of two lengths, those of five and those of three feet, each of which ought to be an inch and a half in breadth, and half an inch in thickness, but they are commonly less.

LATHE, a very useful engine for the turning of wood, ivory, metals, and other materials. The invention of the lathe is very antient; Diodorus Siculus says, the first who used it was a grandson of Dædalus, named Talus. Pliny ascribes it to Theodore of Samos, and mentions one Thericles, who rendered himself very famous by his dextery in managing the lathe. With this instrument the antients turned all kinds of vases, many whereof they enriched with figures and ornaments in basso relievo. Thus Virgil: "Lenta quibus torno facili superaddita vitis." The Greek and Latin authors make frequent mention of the lathe; and Cicero calls the workmen who used it vascularii. It was a proverb among the antients, to say a thing was formed in the lathe, to express its delicacy and justness.

The lathe is composed of two wooden cheeks or sides, parallel to the horizon, having a groove or opening between; perpendicular to these are two other pieces called puppets, made to slide between the cheeks, and to be fixed down at any point at pleasure. These have two points, between which the piece to be turned is sustained; the piece is turned round, backwards and forwards, by means of a string put round it, and fastened above to the end of a pliable pole, and underneath to a treadle or board moved with the foot. There is also a rest which bears up the tool, and keeps it steady.

The most simple kind of lathe is too well known to require a more ample description. We shall therefore give a figure of an improved lathe manufactured by Mr. Maudslay of Margaret-street. A (Plate Miscel. fig. 138.) is the great wheel, with four grooves on the rim: it is worked by a crank B and treadle C, in the common way; the catgut which goes round this wheel passes also round a smaller wheel D, called the mandrel, which has four grooves on its circumference of different diameters for giving it different velocities, corresponding with the four grooves on the great wheel A. In order to make the same band suit when applied to all the different grooves on the mandrel D, the wheel A can be elevated or depressed by a screw *a*, and another at the other end of the axle; and the connecting rod C can be lengthened or shortened by screwing the hooks at each end of it further out of, or into it. The end M, fig. 139. of the spindle of the mandrel D, is pointed, and works in a hole in the end of a screw, put through the standard E, fig. 138.; the other end of the bearing F, fig. 139. is conical, and works in a conical socket in the standard, so that by tightening up the screw in E, the conical end F may at any time be made to fit its socket: the puppet G has a cylindric hole through its top to receive the polished pointed rod *d*, which is moved by the screw *e*, and fixed by the screw *f*; the whole puppet is fixed on the triangular prismatic bar H, by a clamp fig. 143. the two ends of which, *a*, *b*, are put through holes *b*, in the bottom of the puppet under the bar, and the whole is fixed by the screw *c* pressing against it; by this means the puppet can be taken off the bar without first taking off the standard I, as in the common lathes; and the triangular bar is found to be far preferable to the double rectangular one in common use. The rest J is a similar contrivance; it is in 3 pieces; see figs. 140, 141, 142. Fig. 141 is a piece, the opening (*a*, *b*, *c*) in which is laid upon the bar H, fig. 138.; the four legs *d d d d* of fig. 142. are then put up under the bar (into the recesses in fig. 141. which are made to receive them), so that the notches in *d d d d* may be level with the top of fig. 141.: the two beads *e f* in fig. 140. are then slid into the notches in the top of *d d d d*, to keep the whole together; the groove *i* is to receive a corresponding piece on *e f*, fig. 140., to steady it; the whole of fig. 140. has a metallic cover, to keep the chips out of the grooves. It is plain, that by tightening the screw *h* in the bottom of figs. 138. and 142., the whole will be fixed and prevented from sliding along the bar H, and fig. 140. from sliding in a direction perpendicular to the bar; the piece *l*, on which the tool is laid, can be raised or lowered at pleasure, and fixed by the screw *m*. On the end *n* of the spindle P, figs. 138. and 139., is screwed occasionally an universal chuck for holding any kind of work which is to be turned (fig. 144.). A is the female screw to receive the screw *n*, fig. 138.; near the bottom of the screw A is another BB, which is prevented from moving endways by a collar in the middle of it fixed to the screw A: one end of the screw BB is cut right-handed, and the other left-handed, so that by turning the screw one way, the two nuts EF will recede from each other, or by turning it the contrary way, they will advance towards each other; the two nuts EF pass through an opening in the plate C, and project beyond the same, carrying jaws like those of a vice, by which the subject to be turned is held.

The large lathes which Mr. Maudslay uses in his manufactory, instead of being worked by the foot, as represented in fig. 138., are worked by hand; the wheel and fly-wheel which the men turn work by a strap on another wheel, fixed to the ceiling directly over it; on the axis of this wheel is a larger one, which turns another small wheel or pulley, fixed to the ceiling, directly over the mandrel of the lathe; and this last has on its axis a larger one which works the mandrel D, by a band of catgut. These latter wheels are fixed in a frame of cast iron, moveable on a joint; and this frame has always a strong tendency to rise up, in consequence of the action of a heavy weight; the rope from which, after passing over a pulley, is fastened to the frame. This weight not only operates to keep the mandrill-band tight, when applied to any of the grooves therein, but always makes the strap between the two wheels on the ceiling fit. As it is necessary that the workman should be able to stop his lathe, without the men stopping who are turning the great wheel, there are two pulleys, or rollers, (on the axis of the wheel over the lathe) for the strap coming from the other wheel, on the ceiling; one of these pulleys, called the dead pulley, is fixed to the axis, and turns with it; and the other which slips round it, is called the live pulley: these pulleys are put close to each other, so that by slipping the strap upon the live pulley, it will not turn the axis; but if it is slipped on the other, it will turn with it: this is effected by an horizontal bar, with two upright pins in it, between which the strap passes. This bar is moved in such a direction as will throw the strap upon the live pulley, by means of a strong bell-spring; and in a contrary direction it is moved by a cord fastened to it, which passes over a pulley, and hangs down within reach of the workman's hand: to this cord is fastened a weight, heavy enough to counteract the bell-spring, and bring the strap up to the dead pulley, to turn the lathe; but when the weight is laid upon a little shelf, prepared for the purpose, the spring will act and stop it.

The following is a description of Mr. Smart's newly invented lathe for turning cylinders of wood for the purpose of tent-poles, pickets, handles for tools, &c. &c. the operations of which are so readily performed, that from octagonal bars of yellow deal, 5½ feet long (previously prepared by means of a circular saw) one man, besides two labourers to turn the wheel, will turn out 600 perfectly cylindrical poles, in the space of 12 hours. AA, fig. 6., (Plate Smart's lathe) represents the standards for supporting the great wheel, that gives motion to the lathe; these are supported by pieces of board BB spiked to the ceiling or joists above, and by others CC affixed to the floor of the workshop. The great wheel DD is grooved round the edge for receiving the endless screw B and E, E, and is put in motion by the winch-handle F F. G and H are the standards of the lathe, firmly fixed to the floor, and carrying the side-pieces or bed II; the standard G is tall enough to act as a fixed puppet, and has a screw *a* working through it, for supporting the end of the mandrel or spindle of this lathe, as in the common lathe. K, L, and M, are three other puppets that can be fixed in any place desired, by wedges beneath the bed as usual. To the puppet K is screwed a thick iron plate *b*, which has a conical socket, nicely turned and polished, for receiving the mandrel: this puppet is further steadied by a brace N, screwed to it, and to the floor of the shop. To the puppet K and L two bars *oo* are fixed by screws, and the same are further supported and steadied by three short puppets P P P. The mandrel, and its pulley Q, are nearly of the common construction, except that the end *c* has a steel point in its centre, and two shorter points for preventing the octagonal piece of wood intended to be turned from slipping or turning without the mandrel. The puppet L has a square-pointed bar *d* fitted to it; and the puppet M has a screw, worked by its handle *e*, which by means of a collar advances or draws back the bar *d*. R is a piece of wood, fixed to the bed and to the floor, for the purpose of carrying a pulley *f*, whose use is to prevent the wheel-band EE from wearing by friction at the place where it crosses. Figs. 7. and 8. represent the gouge and plane, successively used instead of the common turner's chisel, &c.: the pieces of board *aa* are screwed to the block *b*, just at the proper distance of the outsides of the bars *oo*, fig. 1., so that when the tools, figs. 7. and 8. are placed on them, they can be slid along steadily, between the puppets K and L; the holes *cc* being so adapted as to suit the mandrel and bar *c* and *d* as centres, and their diameters are sufficient to let the octagonal bar intended to be turned pass through them, without touching; *d*, fig. 7., is a piece of tempered steel, formed as a gouge, and screwed fast to the side of the block, in the proper position for roughing off the angles of the octagonal bar, as it advances, and turns through the hole *c*. *c* fig. 7., is a flat piece of steel, like a plane-iron (shewn separately at *f*), which is so fixed by a screw, that it may smooth or complete the cylindrical surface of a pole, already gouged as above, which is advanced, and turned through it. The operation is thus performed: The two tools figs. 7 and 8, are placed on the bar *oo*, fig. 6, and shoved close up to the puppet L; the square bar being long enough for its point *d*, then to project through the centres of the holes *cc*, figs. 7 and 8. The workman then takes an octagonal pole, enters the centre pin of the mandrel *c* into the centre of its end, and the point *d* into the centre of the other end, turning the handle *e* sufficiently to allow the pole to be steadily turned: the wheel D is then set in motion; the workman pushes the gouge-tool, fig. 8., forwards, towards the puppet K, which, as it advances quickly, strikes off the angles of the pole in a rough or screw-like form. When the gouge-tool, fig. 8., has advanced to the end of the pole, the finishing-tool, fig. 7., is in like manner shoved forwards by the workman; and as it advances, the pole is turned into a complete and smooth cylinder. The projection of the mandrel *bc*, fig. 6, is sufficient to admit the gouge and plane tools, to advance so as to clear the end of the pole; and by turning back the handle *e*, the same can be taken out of the lathe as soon as it is stopped. The velocity of the mandrel Q is such, as to make upwards of 1200 turns per minute.

LATHRÆA, a genus of the angiospermia order, in the didynamia class of plants, and in the natural method ranking under the 40th order, personatæ. The calyx is quadrifid; there is a depressed glandule at the base of the suture of the germen. The capsule is unilocular. There are four species.

LATHS, *cleaving of*. The lath-cleavers having cut their timbers into lengths, cleave each piece with wedges into 8, 12, or 16, according to the size of their timber; these pieces are called bolts: this is done by the felt-grain, which is that grain which is seen to run round in rings at the end of a piece of a tree. Thus they are cut out for the breadth of the laths, and this work is called felting. Afterwards they cleave the laths into their proper thicknesses with their chit, by the quarter-grain, which is that which runs in straight lines towards the pith.

LATHYRUS, *chickling vetch*, a genus of the decandria order, in the diadelphia class of plants, and in the natural method ranking under the 32d order, papilionaceæ. The stylus is plain, villous above, towards the end broader; the upper two segments of the calyx are shorter than the rest.

The species are 23, among which are: 1. The latifolius, or everlasting pea. 2. The odorata, or sweet-scented pea. 3. The tangitanus, or Tangier pea, also an annual, and well known.

LATITAT, a writ whereby all men in personal actions are called originally to the king's bench. F. N. B. 78.

A latitat may be considered either as the commencement of the action, or only as a process to bring the defendant into court, at the election of the plaintiff. Bul. N. P. 151.

If it is stated as the commencement of the action to avoid a tender, the defendant may deny that the plaintiff had any cause of action at the time of suing it out. 1 Wils. 141.

Or if it is replied to a plea of the statute of limitations, the defendant, in order to maintain his plea, may aver the real time of suing it out, in opposition to the test. 2 Burr. 950. See Impey's B. R. and C. B. Practice.

LATITUDE. See GEOGRAPHY.

LATITUDE. See ASTRONOMY.

LATTEN denotes iron plates tinned over, of which tea-canisters are made.

LATTEN-BRASS, plates of milled brass, reduced to different thickness, according to the uses it is intended for.

LATUS RECTUM, in conic sections, the same with parameter. See CONIC SECTIONS.

LATUS TRANSVERSUM, in the hyperbola, that part of the transverse diameter, intercepted between the vertices of the two opposite sections.

LAVANDULA, *lavender*: a genus of the angiospermia order, in the didynamia class of plants, and in the natural method ranking under the 42 l order, verticillatæ. The calyx is ovate, and a little dentated, supported by a bractea or floral leaf; the corolla is resupinated; the stamina within the tube.

The species are seven in number, among which are: 1. The spica, or spike lavender, has a short shrubby stalk. The varieties of this are: common narrow-leaved lavender, with blue flowers, and with white flowers; broad-leaved lavender; dwarf lavender: all of them flowering in July. This species is the common lavender; but the narrow-leaved variety, with blue flowers, is the sort commonly cultivated for its flowers for medicine. 2. The stœchas, or French lavender, has a shrubby very branchy stalk, rising two or three feet high; very narrow, spear-shaped, pointed, hoary leaves, opposite; and all the branches terminated by short bushy spikes of purple flowers in June and July, succeeded by seeds in August. There is a variety with white flowers. 3. The dentata, or dentate-leaved stœchas, has a woody stalk, branching on every side three or four feet high; leaves deeply indented in a pinnated manner; and the branches terminated by scaly four-cornered spikes of flowers, appearing most part of summer.

The first two species are proper for the kitchen-garden, and for medicinal and other family uses, and to plant in the pleasure-ground to adorn the front of small shrubbery compartments, where they will increase the variety very agreeably; and are finely scented aromatics, both when growing, and their flowers when gathered; especially those of the first species, which are in great esteem for putting among clothes, and for distilling, and other economical uses. The flowers of the first sort are gathered for use in July.

LAVATERA, a genus of the polyandria order, in the polydelphia class of plants, and in the natural method ranking under the 37th order, columniferæ. The exterior calyx is double and trifid; the arilli or seed-coats are very many and monospermous. There are 9 species, most of them herbaceous flowery annuals, or shrubby perennials, growing erect from two or three to eight or ten feet high. They are easily propagated by seed in the open ground in the spring, and thrive best when sown where they are designed to remain.

LAUDANUM. See PHARMACY.

LAUGERIA, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking among those of which the order is doubtful. The corolla is quinquefid; the fruit is a plum with a quinquelocular kernel. There are two species, shrubs of the West Indies.

LAUNCH, in the sea-language, signifies to put out: as, launch the ship, that is, put her out of the dock; launch aft, or forward, speaking of things that are stowed in the hold, is, put them more forward; launch, ho! is a term used when a yard is hoisted high enough, and signifies hoist no more.

LAUNDER, among miners, a place where they wash the powdered ore.

LAUREATION, in the universities of Scotland, signifies the act of taking the degree of master of arts, which the students are permitted to do after four years study.

LAURUS, *the bay-tree*, a genus of the monogynia order, in the enneandria class of plants, and in the natural method ranking under the 12th order, holoraceæ. There is no calyx; the corolla is calycine, or serving in place of the calyx, and sexpartite: the nectarium with three glandules, each terminated by two bristles surrounding the germen. The interior filaments furnished with glandules at the base; the fruit a monospermous plum. There are 32 species, of which the most noted are: 1. The nobilis, or evergreen bay-tree, a native of Italy, and has an upright trunk branching on every side from the bottom upward, with spear-shaped, nervous, stiff, evergreen leaves, three inches long, and two broad; and small, yellowish, quadrifid, diœcious flowers, succeeded by red berries in autumn and winter. Of this species there are varieties, with broad, narrow, striped, or waved leaves. 2. The æstivalis, or deciduous bay, grows naturally in North America. It rises with an upright stem, covered with a purplish bark, having oblong, oval, acuminated, veined, deciduous leaves, two or three inches long, and half as broad, growing opposite, with small white flowers succeeded by red berries. 3. The benzoin, or benjamin tree, is also a native of North America; grows 15 or 20 feet high, divided into a very branchy head, with oval, acute, deciduous leaves, three or four inches long, and half as broad; and small yellowish flowers, not succeeded by berries in this country. This, it is to be remarked, is not the tree which bears the gum benzoin, that being a species of hyrax. 4. The sassafras is a native of the same country. It has a shrub-like straight stem, with both oval and three-lobed, shining, deciduous leaves, of different sizes, from three to 6 inches long, and nearly as broad, with small yellowish flowers succeeded by blackish berries, but not in this country. 5. The indica, or Indian bay-tree, rises with an upright straight trunk, branching regularly 20 or 30 feet high, adorned with very large, spear-shaped, plane, nervous, evergreen leaves on reddish footstalks; and bunches of small whitish-green flowers, succeeded by large oval black berries, which do not ripen in this country. 6. The barbonia, or Carolina red bay-tree, rises with an upright straight stem, branching 15 or 20 feet high; with large, spear-shaped, evergreen leaves, transversely veined; and long bunches of flowers on red footstalks, succeeded by large blue berries sitting in red cups. 7. The camphora, or camphor-tree, grows naturally in the woods of the western parts of Japan, and in the adjacent islands. See Plate Nat. Hist. fig. 244. The root smells stronger of camphor than any of the other parts, and yields it in greater plenty. The bark of the stalk is outwardly somewhat rough; but in the inner surface smooth and mucous, and therefore easily separated from the wood, which is dry, and of a white colour. The flowers are produced on the tops of footstalks, which proceed from the armpits of the leaves; but not till the tree has attained considerable age and size. The flower-stalks are slender, branched at the top, and divided into very short pedicles, each supporting a single flower. These flowers are white, and consist of six petals, which are succeeded by a purple and shining berry of the size of a pea, and in figure somewhat top-shaped. It is composed of a soft pulpy substance, that is purple, and has the taste of cloves and camphor; and of a nucleus or kernel of the size of a pepper, which is covered with a black, shining, oily corticle, of an insipid taste. 8. The cinnamomum, or cinnamon-tree, is a native of Ceylon. It has a large root, and divides into several branches, covered with a bark, which on the outer side is of a greyish brown, and on the inside has a reddish cast. The wood of the root is hard, white, and has no smell. The body of the tree, which grows to the height of 20 or 30 feet, is covered, as well as its numerous branches, with a bark which at first is green and afterwards red. The leaf is longer and narrower than the common bay-tree; and it is three-nerved, the nerves vanishing towards the top. When first unfolded, it is of a flame-colour; but after it has been for some time exposed to the air, and grows dry, it changes to a deep green on the upper surface, and to a lighter on the lower. The flowers are small and white, and grow in large bunches at the extremity of the branches: they have an agreeable smell, something like that of the lily of the valley. The fruit is shaped like an acorn, but is not so large. 9. The cassia, or base cinnamon, has lanceolated leaves, triple-nerved. 10. The persea, avocado-pear tree, or alligator pear, rises to a considerable height, with a straight trunk, of which the bark and wood are of a greyish colour. The leaves are long, oval, pointed, of a substance like leather, and of a beautiful green colour. The flowers are produced in large knots or clusters at the extremities of the branches, and consist each of six petals disposed in the form of a star, and of a dirty-white or yellow colour, with an agreeable odour, which diffuses itself to a considerable distance. It is a native of the West Indies. The persea begins to bear two years and a half, or at most three years, after being planted; and like most of the trees in warm climates, bears twice a year.

LAW. Laws of England are divided into lex non scripta, or the common law; and lex scripta, or statute law.

The lex non scripta is not so called from its being conveyed down from former ages by word of mouth, but because the original authority of these laws is not set down in writing, and they receive their force by long usage, and by their universal reception throughout the kingdom; and it is curious to observe, that these rude maxims of our ancestors, of which no person knows clearly the origin, exceed in clearness, brevity, and authority, all that the united wisdom of the most enlightened men have produced in later ages.

The common law is divided into:

1st. General custom, which is the universal rule of the whole kingdom, and is the law by which proceedings and determinations in the courts of justice are ordinarily directed. This for the most part settles the course of inheritance, the manner and form of acquiring and transferring property, the solemnities and obligations of contracts, the rules of expounding wills, deeds, and acts of parliament; the remedies of civil injuries, the different kinds of offences with the punishments allotted to each; the institution of four superior courts of record; and many other particulars which diffuse themselves as extensively as the distribution of common justice requires, all of which are not enacted by any particular statutes (though they are acknowledged by all) but depend entirely upon the common law.

2dly. Particular customs which concern the inhabitants of some particular district.

3dly. The third branch are those laws which are adopted by certain courts and jurisdictions, as the civil and canon laws.

The civil law is understood to signify the civil law of the Roman empire. The canon law is a body of Roman ecclesiastical law relating to matters over which the church exercises a jurisdiction. The civil law is used in four courts under certain restrictions, viz. the archbishops' and bishops' courts, usually styled curiæ christianitatis; the courts martial, the courts of admiralty, and the courts of the two universities.

The second division of the laws of England are the statutes made by the king, lords, and commons, assembled in parliament. The oldest statute extant is the celebrated Magna Charta, 9 Hen. 3; though, doubtless, the records of many antecedent to that have been lost, and the maxims received as common law.

Statutes are general or special, public or private: general or public acts are those which concern the whole nation; of these the judges are obliged to take notice, though they should not be formally pleaded by the party who claims an advantage under them. Special or private acts are such as operate on private persons and concerns, which must be formally set forth by the party, or the judges are not obliged to notice them.

Statutes are either declaratory of the common law, where it is become disreputable, or fallen into disuse; or remedial, when made to supply the defects, or abridge the superfluities of the common law. These latter are subdivided into enlarging and restraining statutes, by enlarging the common law where it was too circumscribed, and restraining it where it was too luxuriant.

There is besides those grounds of the laws of England, a court of equity to moderate and explain them. (See Equity.) The courts of equity are, however, only had recourse to in matters of property; for our constitution will not permit, that in criminal cases any judge should have the power of construing the law otherwise than according to the letter. This caution, while it protects the public liberty, can never oppress the individual. A man cannot suffer more punishment than the law directs, but he may suffer less. The laws cannot be strained to inflict a penalty beyond what the letter warrants, but in cases where the letter induces any apparent hardship, the crown has power to pardon.

In treating of the laws, the best mode, and which has been adopted by sir William Blackstone in his excellent Commentaries, after the example of Wood in his Institutes, is to divide them, 1st, into the rights of persons, or the rights as to personal security, personal liberty, and private property. 2nd, The rights of things, or the rights which a man may acquire in and to such external things as are unconnected with his person. 3rd. Private wrongs, or such as are the infringement of the private rights of individuals: and 4th. public wrongs, or such as are a violation the public rights, and affect the whole community.

It is of course unnecessary, and perhaps in a work of this nature irrelevant, to recommend the study of the law; it is sufficient to add the words of the great judge Blackstone on this subject. "It is incumbent (says he) upon every man to be acquainted with the laws, lest he incur the censure as well as the inconvenience of living in society without knowing the obligations it lays him under."

LAVENIA, a genus of the class and order syngenesia polygamia æqualis. The calyx is nearly regular; style bifid; down three-awned; recept. naked. There are two species, herbs of the East and West Indies.

LAWSONIA, *Egyptian privet*, a genus of the monogynia order, in the octandria class of plants, and in the natural method ranking with those of which the order is doubtful. The calyx is quadrifid; the petals four; the stamina four, in pairs; the capsule is quadrilocular and polyspermous. There are four species, all natives of India. Some authors take the inermis to be the plant termed by the Arabians henna or alhenna, the pulverised leaves of which are much used by the Eastern nations for dyeing their nails yellow; but others, Dr. Hasselquist in particular, attribute that effect to the leaves of the other species of Egyptian privet which bears prickly branches. It is probable that neither set of writers are mistaken, and that the shrub in question is a variety only of the thorny lawsonia, rendered mild by culture.

LAY-BROTHERS, among the Romanists, those pious, but illiterate persons, who devote themselves, in some convent, to the service of the religious. They wear a different habit from that of the religious, but never enter into the choir, nor are present at the chapters; nor do they make any other vow, except of constancy and obedience. In nunneries there are also lay-sisters.

Lay-man, among painters, a small statue either of wax or wood, whose joints are so formed, that it may be put into any attitude or posture. Its principal use is for adjusting the drapery in clothing of figures.

LAYERS, in gardening, are tender shoots or twigs of trees, laid or buried in the ground, till, having struck root, they are separated from the parent tree, and become distinct plants. The propagating trees by layers is done in the following manner: the branches of the trees are to be slit a little way, and laid under the mould for about half a foot: the ground should be first made very light, and after they are laid they should be gently watered. If they will not remain easily in the position they are put in, they must be pegged down with wooden hooks: the best season for doing this is, for evergreens, toward the end of August, and for other trees in the beginning of Feb. If they are found to have taken root, they are to be cut off from the main plant the succeeding winter, and planted out. If the branch is too high from the ground, a tub of earth is to be raised to a proper height for it. Some pare off the rind, and others twist the branch before they lay it: but this is not necessary. The end of the layer should be about a foot out of the ground; and the branch may be either tied tight round with a wire, or cut upwards from a joint, or cut round for an inch or two at the place, and it is a good method to pierce several holes through it with an awl above the part tied with the wire.

LAZAR-HOUSE, or Lazaretto, a public building, in the nature of an hospital, to receive the poor and those afflicted with contagious distempers: in some places lazarettos are appointed for the performance of quarantine; in which case, those are obliged to be confined in them who are suspected to have come from places infected with the plague. This is usually a large building, at some distance from a city, whose apartments stand detached from each other, where vessels are unladen, and the crew shut up for about 40 days, more or less, according to the time and place of their departure. The lazaretto of Milan is esteemed one of the finest hospitals in Italy.

LAZULITE. This stone, which is found chiefly in the northern parts of Asia, was long known to mineralogists by the name of lapis lazuli.

Lazulite is always amorphous. Its texture is earthy. Its fracture uneven. Lustre 0. Opaque, or nearly so. Hardness 8 to 9. Specific gravity 2.76 to 2.945. Colour blue; often spotted white from specks of quartz, and yellow from particles of pyrites.

It retains its colour at 100° Wedgewood; in a higher heat it intumesces, and melts into a yellowish-black mass. With acids it effervesces a little, and if previously calcined, forms with them a jelly.

Margraff published an analysis of lazulite in the Berlin Memoirs for 1758. His analysis has since been confirmed by Klaproth, who found a specimen of it to contain

46.0	silica
14.5	alumina
28.0	carbonat of lime
6.5	sulphat of lime

3.0 oxide of iron
2.0 water

100.0

From the experiments of Morveau, it appears that the colouring matter of lazulite is sulphuret of iron.

LEAD, one of the perfect metals, appears to have been very early known. It is mentioned several times by Moses. The antients seem to have considered it as nearly related to tin. It is of a blueish-white colour; and when newly melted is very bright, but it soon becomes tarnished by exposure to the air. It has scarcely any taste, but emits on friction a peculiar smell. It stains paper or the fingers of a blueish colour. When taken internally, it acts as a poison. Its hardness is $5\frac{1}{2}$; its specific gravity is 11.3523. Its specific gravity is not increased by hammering, neither does it become harder, as is the case with other metals; a proof that the hardness which metals assume under the hammer is in consequence of an increase of density. It is very malleable, and may be reduced to very thin plates by the hammer; it may be also drawn out into wire, but its ductility is not great. Its tenacity is such, that a lead wire only $\frac{1}{120}$ inch diameter is capable of supporting 18 pounds without breaking. It melts, according to sir Isaac Newton, when heated to the temperature of 540° Fahrenheit: but Morveau makes its fusing point as high as 594°. When a very strong heat is applied, the metal boils and evaporates. If it is cooled slowly, it crystallizes. The abbé Mongez obtained it in quadrangular pyramids, lying on one of their sides. Each pyramid was composed apparently of three layers. Pajot obtained it in the form of a polyhedron with 32 sides, formed by the concourse of six quadrangular pyramids.

When exposed to the air, it soon loses its lustre, and acquires first a dirty-grey colour, and at last its surface becomes almost white. This is owing to its gradual combination with oxygen, and conversion into an oxide; but this conversion is exceedingly slow; the external crust of oxide, which forms first, preserving the rest of the metal for a long time from the action of the air.

Water has no direct action upon lead; but it facilitates the action of the external air. For when lead is exposed to the air, and kept constantly wet, it is oxidated much more rapidly than it otherwise would be. Hence the reason of the white crust which appears upon the sides of leaden vessels containing water, just at the place where the upper surface of the water usually terminates.

No less than four different combinations of lead with oxygen are at present known, though some of them have not been examined with much attention.

1. The protoxide, or first oxide of lead, may be obtained by dissolving lead in nitric acid, and boiling the crystals which that solution yields by concentration along with pieces of metallic lead. The consequence is the formation of scaly crystals of a yellow colour, brilliant, and very soluble in water. These crystals are composed of the protoxide of lead combined with nitric acid. The protoxide may be precipitated by means of potass. Its properties have not hitherto been examined. It contains but a small proportion of oxygen.

2. The deutoxide of lead may be formed by dissolving the metal in nitric acid, and pouring potass into the solution. A yellow-coloured powder is obtained, which is the deutoxide of lead. This oxide is composed of 91 parts of lead, and 9 of oxygen. When lead is kept melted in an open vessel, its surface is soon covered with a grey-coloured pellicle. When this pellicle is removed, another succeeds it; and by continuing the heat, the whole of the lead may soon be converted into this substance. If these pellicles are heated and agitated for a short time in an open vessel, they assume the form of a greenish-grey powder. Mr. Proust has shewn that this powder is a mixture of deutoxide, and a portion of lead in the metallic state. It owes its green colour to the blue and yellow powders which are mixed in it. If we continue to expose this powder to heat for some time longer in an open vessel, it absorbs more oxygen, assumes a yellow colour, and is then known in commerce by the name of massicot. The reason of this change is obvious. The metallic portion of the powder gradually absorbs oxygen, and the whole of course is converted into deutoxide.

When thin plates of lead are exposed to the vapour of warm vinegar, they are gradually corroded, and converted into a heavy white powder, used as a paint, and called white lead. This powder used formerly to be considered as a peculiar oxide of lead; but it is now known that it is a compound of the deutoxide and carbonic acid.

3. If massicot ground to a fine powder is put into a furnace, and constantly stirred while the flame of the burning coals plays against its surface, it is in about 48 hours converted into a beautiful red powder, known by the name of minium, or red lead. This powder, which is likewise used as a paint, and for various other purposes, is the tritoxide or red oxide of lead.

4. If nitric acid, of the specific gravity 1.260, is poured upon the red-coloured oxide of lead, 185 parts of the oxide are dissolved; but 15 parts remain in the state of a black, or rather deep-brown, powder. This is the peroxide, or brown oxide of lead, first discovered by Scheele. The best method of preparing it is the following, which was pointed out by Proust, and afterwards still farther improved by Vauquelin. Put a quantity of red oxide of lead into a vessel partly filled with water, and make oxymuriatic acid gas pass into it. The oxide becomes deeper and deeper coloured, and is at last dissolved. Pour potass into the solution, and the brown oxide of lead precipitates. By this process 68 parts of brown oxide may be obtained for every 100 of red oxide employed. This oxide is composed of about 79 parts of lead and 21 of oxygen. It is of a brilliant flea-brown colour. When heated it emits oxygen gas, becomes yellow, and melts into a kind of glass. When rubbed along with sulphur in a mortar, it sets the sulphur on fire, and causes it to burn with a brilliant flame. When heated on burning coals the lead is reduced. All the oxides of lead are very easily converted into glass; and in that state they oxidize and combine with almost all the other metals except gold, platinum, and silver. This property renders lead exceedingly useful in separating gold and silver from the baser metals with which they happen to be contaminated. The gold or silver to be purified is melted along with lead, and kept for some time in that state in a flat cup, called a cupel, made of burnt bones, or the ashes of wood. The lead is gradually vitrified, and sinks into the cupel, carrying along with it all the metals which were mixed with the silver and gold, and leaving these metals on the cupel in a state of purity. This process is called cupellation. The lead employed is afterwards extracted from the cupels, and is known in commerce by the name of litharge. It is a half-vitrified substance, of a high red colour, and composed of scales. It is merely an oxide of lead more or less contaminated with the oxides of other metals. But the best litharge is made by oxidizing lead directly, and then increasing the heat till the oxide is fused. The more violent the fusing heat, the whiter is the litharge.

Lead has not yet been combined with carbon, nor hydrogen; but it combines readily with sulphur and phosphorus.

1. Sulphuret of lead may be formed either by stratifying its two component parts, and melting them in a crucible, or by dropping sulphur at intervals on melted lead. The sulphuret of lead is brittle, brilliant, of a deep blue-grey colour, and much less fusible than lead. These two substances are often found naturally combined; the compound is then called galena, and is usually crystallized in cubes. Sulphuret of lead is composed, according to the experiment of Wenzel, of 86.8 parts of lead and 13.2 of sulphur.

2. Phosphuret of lead may be formed by mixing together equal parts of filings of lead and phosphoric glass, and then fusing them in a crucible. It may be cut with a knife, but separates into plates when hammered. It is of a silver-white colour with a shade of blue, but it soon tarnishes when exposed to the air. This phosphuret may also be formed by dropping phosphorus into melted lead. It is composed of about 12 parts of phosphorus, and 88 of lead.

Lead does not combine with azotic gas. Muriatic acid gradually corrodes it, and converts it into a white-coloured oxide.

Lead is capable of combining with most of the metals.

1. Lead may be easily alloyed with gold by fusion. The colour of the gold is injured, and its ductility diminished. This alloy is of no use; but it is often formed in order to purify gold by cupellation.

2. Platinum and lead unite in a strong heat: the alloy is brittle, of a purplish colour, and soon changes on exposure to the air. Many experiments have been made with this alloy, in order, if possible, to purify platinum from other metals by cupellation, as is done successfully with silver and gold: but scarcely any of the experiments have succeeded; because platinum requires a much more violent heat to keep it in fusion than can be easily given.

3. Silver is often alloyed with lead in order to purify it by cupellation. This alloy is very fusible, much softer than silver, and has much less tenacity, elasticity, and sonorousness; its colour is nearly that of lead, and its specific gravity greater than the mean density of the metals alloyed.

4. Mercury amalgamates readily with lead in any proportion, either by triturating it with lead filings, or by pouring it upon melted

lead. The amalgam is white and brilliant, and when the quantity of lead is sufficient, assumes a solid form. It is capable of crystallizing. The crystals are composed of one part of lead and one and a half of mercury.

5. Copper and lead may be easily combined by fusion. When the lead exceeds, the alloy is of a grey colour, and ductile while cold, but brittle when hot. It is employed sometimes for the purpose of making printer's types for very large characters.

6. It was formerly supposed that lead does not combine with iron; but the experiments of Guyton Morveau have proved, that when the two metals are melted together, two distinct alloys are formed. At the bottom is found a button of lead containing a little iron; above is the iron combined with a small portion of lead.

7. Lead and tin may be combined in any proportion by fusion. This alloy is harder, and possesses much more tenacity, than tin. Muschenbroeck informs us that these qualities are a maximum when the alloy is composed of three parts of tin and one of lead. What is called in this country ley pewter is often scarcely any thing else than this alloy. Tin foil too almost always is a compound of tin and lead. This alloy, in the proportion of two parts of lead and one of tin, is more soluble than either of the metals separately. It is accordingly used by plumbers as a solder.

The affinities of lead and of its oxides are as follow:

Lead.	Oxide of Lead.
Gold,	Sulphuric acid,
Silver,	Saclactic,
Copper,	Oxalic,
Mercury,	Arsenic,
Bismuth,	Tartaric,
Tin,	Muriatic,
Antimony,	Phosphoric,
Platinum,	Sulphurous,
Arsenic,	Suberic,
Zinc,	Nitric,
Nickel,	Fluoric,
Iron,	Citric,
Sulphur.	Lactic,
	Acetic,
	Boracic,
	Prussic,
	Carbonic.

Lead, *ores of.* Ores of lead occur in great abundance in almost every part of the world. They are generally in veins; sometimes in siliceous rocks, sometimes in calcareous rocks.

The following table exhibits a view of the different states in which this mineral has hitherto been observed.

I. Sulphurets.	III. Salts.
1. Galena,	1. Carbonat,
2. Blue lead ore,	2. Muriocarbonat,
3. Black ore of lead.	3. Sulphat,
	4. Phosphat,
II. Oxides.	5. Molybdat,
1. Earthy ore of lead,	6. Arseniat?
2. Arseniated protoxide.	7. Arseniophosphat?
3. Arseniated peroxide,	8. Chromat.

Of these the first species is by far the most common. From it indeed almost the whole of the lead of commerce is extracted.

LEAF. See Botany.

Leaf-gold. See Aurum, Gold, Gilding, &c.

Leaf. See Architecture.

Leaf, in clocks and watches, an appellation given to the notches of their pinions. See Clockwork.

LEAGUE, a measure of length, containing more or less geometrical paces, according to the different usages and customs of countries. A league at sea, where it is chiefly used by us, being a land-measure mostly peculiar to the French and Germans, contains three thousand geometrical paces, or three English miles. The French league sometimes contains the same measure, and in some parts of France it consists of three thousand five hundred paces: the mean or common league consists of two thousand four hundred paces, and the little league of two thousand. The Spanish leagues are larger than the French, seventeen Spanish leagues making a degree, or twenty French leagues, or sixty-nine and a half English statute miles. The Dutch and German leagues contain each four geographical miles. The Persian leagues are pretty near of the same extent with the Spanish; that is, they are equal to four Italian miles, which is pretty near to what Herodotus calls the length of the Persian parasang, which contained thirty stadia, eight of which, according to Strabo, make a mile.

LEAK, among seamen, is a hole in the ship through which the water comes in. To spring a leak is said of a ship that begins to leak; to stop a leak, is to fill it with a plug wrapt in oakum and well tarred; or putting in a tarpaulin clout, to keep the water out; or nailing a piece of sheet-lead upon the place.

LEAKAGE, the state of a vessel that leaks, or lets water, or other liquid, ooze in or out. See the preceding article. Leakage, in commerce, is an allowance of 12 per cent. in the customs, allowed to importers of wines for the waste and damage it is supposed to have received in the passage; an allowance of two barrels in twenty-two is also made to the brewers of ale and beer, by the excise-office.

LEAP, in music. This word is properly applicable to any disjunct degree, but is generally used to signify a distance consisting of several intermediate intervals.

Leap-year. See Bissextile.

LEASE, a conveyance of lands, generally in consideration of rent or other annual recompence made for life, for years, or at will, but always for a shorter term than the lessor has in the premises, otherwise it partakes more of the nature of an assignment.

By the common law, all persons seized of an estate might grant leases for any period less than their interest lasted; but statutes have been since made, some to enlarge and some to restrict it. They are divided into enabling and restricting statutes; by the enabling stat. 32 Henry VIII. c. 28. a tenant in tail may make leases to ensure for twenty-one years or three lives to bind his issue in tail, but not those in remainder or reversion. Husbands seized in right of their wives may make leases for the same period, provided the wife join in it. All persons seized of an estate of fee-simple in right of their churches, except parsons or vicars, may bind their successors under certain restrictions. 1. The lease must be by indenture; 2. It must begin from the day of making; 3. All old leases must be surrendered or be within a year of expiring; 4. It must be for three lives or twenty-one years, not both; 5. It may be for a shorter term, but must not exceed twenty-one years; 6. It must be of lands and tenements most commonly let for twenty years past; 7. The most usual rent for that time must be reserved; 8. Such leases cannot be made without impeachment of waste. It was also specified that the lease must be of corporeal hereditaments, that the lessor might resort to them to distrain; but by stat. 5 Geo. III. c. 17, a lease of tithes or other incorporeal hereditaments may be granted, and the successor shall have his remedy by an action of debt.

From the disabling statutes, we find that all colleges, cathedrals, and other ecclesiastical or eleemosynary corporations, and all parsons and vicars, are restrained from making leases unless under the following regulations: 1. They must not exceed 3 lives or 21 years: 2. The accustomed rent must at least be reserved thereon: 3. Houses in corporations or market-towns may be let for 40 years, provided they are not the mansion-houses of the lessors, or have not more than 10 acres of ground belonging to them; and provided the lessee agrees to keep them in repair, and they may be aliened in fee-simple for lands of equal value in recompence: 4. If there is an old lease which has more than 3 years to run, no new lease shall be made: 5. No lease shall be made without impeachment of waste: 6. All bonds and covenants tending to frustrate the provisions of the statutes of 13 and 18 Eliz. shall be void.

Two observations seem to present themselves concerning these statutes: 1. That they do not enable any persons to make such leases as they are by common law restrained from making; therefore, a parson or vicar, though he is restrained from making longer leases than for 21 years or 3 lives, even with the consent of the patron or ordinary, yet is not enabled to make any lease at all, to bind his successor without such consent. 2. Though leases contrary to these acts are void, yet they are good against the lessor during his life, if he is a sole corporation; and if it is an aggregate corporation, as long as the head lives: for the act was intended for the benefit of the successor alone, and it is a maxim of law that no man shall take advantage of his own wrong. With regard to college leases, one-third of the old rent must be reserved in wheat or malt, reserving a quarter of wheat for every 6*s.* 8*d.* and a quarter of malt for every 5*s.*; or the lessees must pay for the same, at the price of the market nearest the respective colleges on the market-day before the rent is due.

There are further restraining statutes which direct that if any beneficed clergyman is absent from his benefice above 80 days in the year, all leases and agreements made by him of the profits of his cure shall be void, except in the case of licensed pluralists; who are allowed to demise the living to the curate, if he is not absent more than 40 days in the year. See 13 Eliz. c. 20. 14 Eliz. c. 11. 18 Eliz. c. 11, and 43 Eliz. c. 9.

All leases except such as do not exceed

3 years from the making, whereupon the reserved rent must be at least two-thirds of the improved value, must be in writing, though no particular form of words is necessary to constitute a good lease.

They must be made to natural-born subjects of this realm, or such as have been naturalized, or to denizens, for all leases made to aliens shall be void; and there is even a statute in force, 32 Hen. VIII. c. 16, which imposes a penalty of 5*l*. on the lessor and lessee. It has however been held that an alien merchant may take a house for his own residence, but it shall not go to his executors; the reasons for these laws are evidently to prevent foreigners getting too firm a footing in the kingdom.

Lease and *release* is a conveyance which since the stat. 27 Hen. VIII. c. 10, commonly called the statute of uses, has taken place of the deed of feoffment, as it supplies the need of livery and seisin. It is made thus: A lease or bargain and sale for one year, from the tenant to the lessee, is first prepared, whereby the lessee becomes actually possessed of the lands, then by the above-mentioned statute the lessee is enabled to take a grant of the lands intended to be conveyed to him and his heirs for ever; accordingly a release is made, reciting the lease and declaring the uses. In the lease, a peppercorn is a good consideration to make the lessee capable of receiving a release. This mode of conveyance is become so usual, that it merits peculiar attention. See this matter very ably discussed by the annotator of the latter part of Coke's Commentaries, p. 271, No. I.

LEASES, *value of*. The purchaser of a lease may be considered as the purchaser of an annuity equal to the rack-rent of the estate; and the same principles, from which are deduced the present value of annuities to continue during any given term, will apply to the value of leases. The sum paid down for the grant of a lease is so much money paid in advance for the annual rents, as they may become due; or, it may be considered as a sum which put out to interest, will enable the lessor to repay himself the rack-rent of the estate, or the yearly value of his interest therein, during the given term; therefore no more money should be demanded by the lessor, for the grant of the lease, than will enable him to do this at a given rate of interest. In order to find what this sum should be it would be necessary to ascertain separately the present value of each annual rent, or the sum which, put out to interest at the given rate, will enable the landlord to repay himself the several yearly rents as they become due. Thus, if a person has 100*l*. due to him a twelvemonth hence, and he wishes to have the value of the same advanced immediately, the sum that ought to be given as an equivalent thereto, allowing 5 per cent. interest, is 95*l*. 4*s*. 9¼*d*.; for this is the sum which, put out to interest at the rate of 5 per cent., will, at the end of the year, amount to 100*l*. So also, if a person has 100*l*. due to him at the end of two years, and he wishes to have the value advanced immediately, the sum that ought to be given as an equivalent thereto, is 90*l*. 14*s*. ¾*d*. for this is the sum which put out at the same rate of interest, will, at the end of two years amount to 100*l*. In the same manner, if a person has 100*l*. due to him, at the end of three years, and he wishes to have the value of the same immediately, the sum that ought to be given as an equivalent thereto, is 86*l*. 7*s*. 8*d*. for this is the sum which put out at the same rate of interest, will, at the end of three years, amount to 100*l*. And if these three values are added together, they amount to 272*l*. 6*s*. 6*d*. which is the sum that ought to be paid down for the lease of an estate for three years, of the annual rent of 100*l*. Had the rate of interest been 6 per cent. or any higher rate, the answer would have come out less than the value above given; or, had it been 4 per cent. or any lower rate, the answer would have come out more than such value; whence it is obvious, that, in purchases of this kind, we ought previously to determine the rate of interest at which we are disposed to lay out our money. The value of leases at 5 per cent. compound interest, may be found from table 2, article Annuities; but as most persons in purchasing leases expect to make somewhat more than 5 per cent. interest of their money, the following table is more applicable to this purpose.

TABLE,

Shewing the Number of Years Purchase that ought to be given for a Lease, for any Number of Years not exceeding 100, at 6, 7, and 8 per Cent. Interest.

Years	6 per Cent.	7 per Cent.	8 per Cent.
1	.9433	.9345	.9259
2	1.8333	1.8080	1.7832
3	2.6730	2.6243	2.5770
4	3.4651	3.3872	3.3121
5	4.2123	4.1001	3.9927
6	4.9173	4.7665	4.6228
7	5.5823	5.3892	5.2063
8	6.2097	5.9712	5.7466
9	6.8016	6.5152	6.2468
10	7.3600	7.0235	6.7100
11	7.8868	7.4986	7.1389
12	8.3838	7.9426	7.5360
13	8.8526	8.3576	7.9037
14	9.2949	8.7454	8.2442
15	9.7122	9.1079	8.5594
16	10.1058	9.4466	8.8513
17	10.4772	9.7632	9.1216
18	10.8276	10.0590	9.3718
19	11.1581	10.3355	9.6035
20	11.4699	10.5940	9.8181
21	11.7640	10.8355	10.0168
22	12.0415	11.0612	10.2007
23	12.3033	11.2721	10.3710
24	12.5503	11.4693	10.5287
25	12.7833	11.6535	10.6747
26	13.0031	11.8257	10.8099
27	13.2105	11.9867	10.9351
28	13.4061	12.1371	11.0510
29	13.5907	12.2776	11.1584
30	13.7648	12.4090	11.2577
31	13.9290	12.5318	11.3497
32	14.0840	12.6465	11.4349
33	14.2302	12.7537	11.5138
34	14.3681	12.8540	11.5869
35	14.4982	12.9476	11.6545
36	14.6209	13.0352	11.7171
37	14.7367	13.1170	11.7751
38	14.8460	13.1934	11.8288
39	14.9490	13.2649	11.8785
40	15.0462	13.3317	11.9246
41	15.1380	13.3941	11.9672
42	15.2245	13.4524	12.0066
43	15.3061	13.5069	12.0432
44	15.3831	13.5579	12.0770
45	15.4558	13.6055	12.1084
46	15.5243	13.6500	12.1374
47	15.5890	13.6916	12.1642
48	15.6500	13.7304	12.1891
49	15.7075	13.7667	12.2121
50	15.7618	13.8007	12.2334
51	15.8130	13.8324	12.2532
52	15.8613	13.8621	12.2715
53	15.9069	13.8898	12.2884
54	15.9499	13.9157	12.3041
55	15.9905	13.9399	12.3186
56	16.0288	13.9625	12.3320
57	16.0649	13.9837	12.3444
58	16.0989	14.0034	12.3560
59	16.1311	14.0219	12.3669
60	16.1614	14.0391	12.3765
61	16.1900	14.0553	12.3856
62	16.2170	14.0703	12.3941
63	16.2424	14.0844	12.4020
64	16.2664	14.0976	12.4092
65	16.2891	14.1099	12.4159
66	16.3104	14.1214	12.4222
67	16.3306	14.1321	12.4279
68	16.3496	14.1422	12.4333
69	16.3676	14.1516	12.4382
70	16.3845	14.1603	12.4428
71	16.4005	14.1685	12.4470
72	16.4155	14.1762	12.4509
73	16.4297	14.1834	12.4546
74	16.4431	14.1901	12.4579
75	16.4558	14.1963	12.4610
76	16.4677	14.2022	12.4639
77	16.4790	14.2076	12.4666
78	16.4896	14.2127	12.4691
79	16.4996	14.2175	12.4713
80	16.5091	14.2220	12.4735
81	16.5180	14.2261	12.4754
82	16.5264	14.2300	12.4772
83	16.5343	14.2337	12.4789
84	16.5418	14.2371	12.4805
85	16.5489	14.2402	12.4819
86	16.5556	14.2432	12.4833
87	16.5618	14.2460	12.4845
88	16.5678	14.2486	12.4856
89	16.5734	14.2510	12.4867
90	16.5787	14.2533	12.4877
91	16.5836	14.2554	12.4886
92	16.5883	14.2574	12.4894
93	16.5928	14.2592	12.4902
94	16.5969	14.2610	12.4909
95	16.6009	14.2626	12.4916
96	16.6046	14.2641	12.4922
97	16.6081	14.2655	12.4928
98	16.6114	14.2668	12.4933
99	16.6145	14.2680	12.4938
100	16.6175	14.2692	12.4943

In order to find the value of a lease, it is first necessary to ascertain the true rack-rent of the estate, or the annual value that it may be justly estimated to be worth; otherwise it will be impossible to determine, with any degree of accuracy, the real sum which ought to be given for the purchase of the same. On this point difficulties will sometimes arise; for, the value of an estate depending very often on some real or supposed advantages, or on some local or personal recommendations, will, in many instances, occasion a difference of opinion; and in most cases, be a matter of some uncertainty. However, when all these circumstances have been taken into consideration, some annual rent equivalent thereto must be assumed, and when this is settled the value of the lease will be easily found; thus, if an estate is worth 150*l*. yearly rent, the value of a lease thereof for sixty-nine years, allowing the purchaser 6 per cent interest for his money, is 16,3676 (the number in the table) multiplied by 150, or 2455*l*. 2*s*. 9*d*. In many instances, the rent of the estate intended to be leased is charged with some annual expence, such as a reserved or quit rent, the payment of an annuity, taxes, and the like; in such cases the number of years purchase found in the table ought to be multiplied by the difference only between such annual expence and the whole estimated rent of the estate; thus if a person possesses an unexpired term of sixty years in a lease, for which he pays 100*l*. per annum rent, but which is now worth 150*l*. per annum, the gross sum which he ought to receive for the grant of such lease, will be equal to the present value of 50*l*. per annum, for the given term; or 16,1614 (the number in the table corresponding with 60 years, at 6 per cent.) multiplied by 50, which gives 808*l*. 1*s*. 4*d*.

In order to find the annual rent corresponding to any given sum paid for a lease, divide the sum paid by the number of years purchase that are found against the given term in the table, and the quotient will be the annual rent required. Example: A person has given 1000*l*. for the lease of an estate for 16 years, what annual rent is equivalent thereto in order to allow the purchaser 7 per cent. interest for his money? In the table against 16 years, and under 7 per cent. we shall find the number of years purchase to be 9.4466: therefore 1000 divided by 9.4466 gives 105*l*. 17*s*. for the annual rent required.

The values in the table are calculated on the supposition that the payments of the several rents of the estate are made yearly; if however the payments are made half-yearly or quarterly, and the purchaser can put out his money at the same rate, so as to receive his interest half-yearly or quarterly, which may commonly be done; the values will, in such cases, be somewhat more than those given in the table. The difference, however, is not very great, but if the exact value is required, it may in many cases be obtained by attending to the following remarks, viz. that "the value of a lease, the rent of which is payable half-yearly, is equal to half the value of the same lease payable yearly, calculated at half the given rate of interest, and to continue double the number of years; and that the value of a lease the rent of which is payable quarterly, is equal to one quarter the value of the same lease payable yearly, calculated at a quarter of the given rate of interest, and to continue four times the number of years."

It frequently happens that a long lease is not to be entered on or enjoyed till after the expiration of a short lease, or till the end of a given number of years; in such cases, deduct the value of the short lease, or the value set against the given number of years in the table, from the value of the longer lease, and the difference will give the true present value of the longer lease. Example: What sum ought to be given for the remainder of the lease of an estate for 56 years, after the next seven years, allowing the purchaser 6 per cent. interest for his money, the clear rent being reckoned at 70*l*. per annum? In the table against 56 years, and under 6 per cent. we find 16.0288, and in the same column against 7 years we find 5.5823; the latter value subtracted from the former leaves 10.4465, which multiplied by 70 gives 731.255 or 731*l*. 5*s*. 1*d*. for the sum required.

Leases are frequently granted during a life, or for a specified term of years subject to termination, if a given life or lives should fail or become extinct within such term; sometimes they depend on the longest of two or three lives, with liberty on the failure of one or more of the lives to nominate others on payment of a fine. The values of such leases are given in a very useful collection of tables for the purchasing and renewing of leases by F. Baily, and may in most cases be found from the tables inserted under the article LIFE ANNUITIES.

LEATHER. See CUTIS, and TANNING.

LEAVEN. See FERMENTATION.

LECHŒA, a genus of the triandria trigynia class and order. The calyx is three-leaved: petals, three-linear; capsules, three-celled, three-valved, seeds solitary. There are three species, herbaceous plants of America and China.

LECYTHIS, a genus of the polyandria monogynia class and order. The calyx is six-leaved; corolla, six-petalled; nectarine, lingulate, staminiferous; peric. circumcised, many-seeded. There are six species, trees or shrubs of Guiana.

LEDGER, the principal book wherein merchants enter their accounts. See BOOK-KEEPING.

LEDGES, in a ship, are small pieces of timber lying athwart from the waste-trees to the roof-trees: they serve to bear up the gratings or nettings over the half-deck. See SHIP-BUILDING.

LEDUM, marsh cistus, or wild rosemary; a genus of the monogynia order, in the decandria class of plants; and in the natural method ranking under the 18th order, bicornes. The calyx is quinquefid; the corolla plain and quinquepartite; the capsule quinquelocular, and opening at the base. There are three species: The palustre with very narrow leaves, grows naturally upon bogs and mosses in many parts of Yorkshire, Cheshire, and Lancashire. The flowers are produced in small clusters at the end of the branches, and are shaped like those of the strawberry-tree, but spread open wider at top. These are of a reddish colour, and in the natural places of their growth are succeeded by seed-vessels filled with small seeds which ripen in autumn.

LEE, in the sea-language, a word of various significations, though it is generally understood to mean the part opposite to the wind. Thus lee-shore, is that shore against which the wind blows. Lee-latch, or have a care of the lee-latch, is, take care that the ship don't go to the leeward, or too near the shore; a lee the helm, put it to the leeward side of the ship; to lie by the lee, or to come up to the lee, is to bring the ship so, that all her sails may lie flat against her masts and shrouds, and that the wind may come right upon her broadside.

LEE-FANG, is a rope reeved into the cringles of the courses, to hale in the bottom of the sail, that the bonnets may be laced on, or the sail taken in.

LEE-WAY, is the angle that the rhumb-line upon which the ship endeavours to sail, makes with the rhumb upon which she really sails. See NAVIGATION.

LEEA, a genus of the class and order pentandria monogynia. The calyx is one-petalled; nect. on the side of the corolla, upright, five-cleft; berry, five-seeded. There are three species, trees of the East Indies.

LEECH. See HIRUDO.

LEEK. See ALLIUM.

LEERSIA, a genus of the class and order triandria digynia. Calyx none; glume, two-valved, closed. There are three species, grasses of America.

LEET, a little court held within a manor, and called the king's court, on account that its authority to punish offences originally belonged to the crown, whence it is derived to inferior persons. See COURT.

LEETCH-LINES, small ropes made fast to the leetch of the topsails, to which they belong, and reeved into a block at the yard close by the topsail-ties. They serve to hale in the leetch of the sail when the topsails are to be taken in.

LEGACY, a bequest of a sum of money, or any personal effects of a testator: and these are to be paid by his representative, after all the debts of the deceased are discharged, as far as the assets will extend.

All the goods and chattels of the deceased, are by law vested in the representative, who is bound to see whether there be left a sufficient fund to pay the debts of the testator, and if it should prove inadequate, the pecuniary legacies must proportionately abate; a specific legacy, however, is not to abate unless there be insufficient without it.

If the legatee die before the testator, such will in general be termed a lapsed legacy, and fall into the general fund; where however, from the general import of the will, it can be collected that the testator intended such a vested legacy, it will in such case go to the representative of the deceased legatee.

If a bequest be made to a person, if or when he attains a certain age, the legacy will be lapsed, if he die before he attain that age; but if such legacy may be made payable at that age, and the legatee die before that age, such legacy will be vested in his representative.

If in the latter case, the testator devise interest to be paid in the mean time, it will nevertheless be a vested legacy.

Where a legacy is bequeathed over to another, in case the first legatee die under a certain age, or the like, the legacy will be payable immediately on the death of the first legatee; and though such legacy be not bequeathed over, yet if it carry interest, the representative will become immediately entitled to it.

In case of a vested legacy due immediately, and charged on land, or money in the funds which yields an immediate profit, interest shall be payable from the death of the testator; but if it be charged on the personal estate only of the testator, which cannot be collected in, it will carry interest only from the end of the year after the death of the testator.

If a bequest be for necessaries, and of small amount, the executor will be justified in advancing a part of the principal; but this should be done under very particular circumspection, as the executor may be compelled to pay the full legacy on the infant's attaining his majority, without deducting the sum previously advanced.

When all the debts and particular legacies are discharged, the residue or surplus must be paid to the residuary legatee, if any be so appointed in the will; but if there be none appointed or intended, it will go to the executor or next of kin.

When this residue does not go to the executor, it is to be distributed among the intestate's next of kin, according to the statute of distributions; except the same is otherwise disposable by particular customs, as those of London, York, &c. See EXECUTOR.

LEGATE, a cardinal or bishop, whom the pope sends as his ambassador to sovereign princes.

There are three kinds of legates, viz. legates a latere, legates de latere, and legates by office, or legati nati; of these the most considerable are the legates a latere, the next are the legates de latere.

Legates by office are those who have not any particular legation given them, but who by virtue of their dignity and rank in the church, become legates; such are the archbishops of Rheims and Arles; but the authority of these legates is much inferior to that of the legates a latere.

LEGATUS, in Roman antiquity, a military officer who commanded as deputy of the chief general.

LEGER-LINE, in music, one added to the staff of five lines, when the ascending or descending notes run very high or low.

LEGION, in Roman antiquity, a body of foot which consisted of ten cohorts.

The exact number contained in a legion, was fixed by Romulus at three thousand; though Plutarch assures us, that after the reception of the Sabines into Rome, he increased it to six thousand. The common number afterwards, in the first times of the free state, was four thousand; but in the war with Hannibal, it arose to five thousand, and after this it is probable that it sunk again to four thousand, or four thousand two hundred, which was the number in the time of Polybius.

LEGNOTIS, a genus of the class and order polyandria monogynia. The calyx is five-cleft; pet. 5; caps. 3-celled. There are two species, trees of Jamaica and Guiana.

LEMMA, in mathematics, a proposition which serves previously to prepare the way for the more easy apprehension of the demonstration of some theorem, or construction of some problem.

LEMNA, a genus of the monœcia diandria class and order. The male cal. is one-leaved; cor. none: female, cal. one-leaved; cor. none; style one; caps. one-celled. There are six species, known by the name of duck-weed, or duck-meat.

LEMNISEA, a genus of the class and order polyandria monogynia. The cal. is 5-toothed; cor. 6-petalled, recurved; nect. cap-shaped, girding; the germ. per. 5-celled, seeds solitary. There is 1 species, a tree of Guiana.

LEMON. See CITRUS.

LEMON, *salt of*. See OXALAT *of potass*.

LEMUR, MACAUCO, a genus of quadrupeds of the order primates: the generic character is, front-teeth in the upper jaw, four; the intermediate ones remote: in the lower jaw, six; longer, stretched forwards, compressed, parallel, approximated. Canine-teeth solitary, approximated; grinders several, sublobated; the foremost somewhat longer and sharper.

The genus lemur or macauco consists of animals approaching to monkeys in the form of their feet, which, in most species, are furnished with flat nails; but differing in their manners, and void of that mischievous and petulant disposition which so much distinguishes the monkey tribe from other quadrupeds.

In this, as in the former genus, we meet with some species without a tail, while others have that part extremely long. Of the tailless species the most remarkable is the

1. Lemur tardigradus, slow lemur. It is about the size of a small cat, measuring sixteen inches in length; its colour is an elegant pale-brown or mouse-colour; the face flattish; the nose inclining to a sharpened form; the eyes yellow-brown, large, and extremely protuberant, so as to appear in the living animal like perfect hemispheres. They are surrounded by a circle of dark brown, which also runs down the back of the animal. This species is very slow in its motions, and from this circumstance has actually been ranked by some naturalists among the sloths; though in no other respect resembling them. It is a nocturnal animal, and sleeps, or at least lies motionless, during the greatest part of the day; its voice is shrill and plaintive.

2. Lemur indri. This is a very large species; it is entirely of a black colour, except on the face, which is greyish; a greyish cast also prevails towards the lower part of the abdomen, and the rump is white. The face is of a lengthened or dog-like form; the ears shortish and slightly tufted; the hair or fur is silky and thick, and in some parts of a curly or crisped appearance: it is the largest animal of this genus, and is said by Mons. Sonnerat, its first describer, to be three feet and a half high; it is said to be a gentle and docile animal, and to be trained, when taken young, for chace, in the manner of a dog. Its voice resembles the crying of an infant. It is a native of Madagascar, where it is known by the name of Indri, which is said to signify the man of the wood. The nails in this species are flat, but pointed at the ends; and there is no appearance of a tail.

3. Lemur macaco, ruffed lemur. This is the species described by the count de Buffon, under the name of the vari, its colours often consisting of a patched distribution of black and white; though its real or natural colour is supposed to be entirely black. In size it exceeds the mongos, or brown lemur. It is said to be a fierce and almost untameable animal: it inhabits the woods of Madagascar and some of the Indian islands; and is said to exert a voice so loud and powerful as to strike astonishment into those who hear it, resembling, in this respect, the howling monkey or S. Belzebub, which fills the woods of Brasil and Guiana with its dreadful cries. When in a state of captivity, however, it seems to become as gentle as some others of this genus.

The astonishing strength of voice in this animal, depends, according to the count de Buffon, on the peculiar structure of the larynx, which widens, immediately after its divarication, into a large cavity before entering the lungs.

4. Lemur tarsier. This animal is distinguished by the great length of its hind legs. Its general length from the nose to the tail is almost six inches; and from the nose to the hind toes eleven inches and a half; the tail nine inches and a half. The face is sharp or pointed; the eyes very large and full; the ears upright, broad, naked, and rounded. Between the ears on the top of the head is a tuft of long hairs. The colour of this species is grey-brown or mouse-colour, paler beneath. It is a native of Amboina and some other East Indian islands.

5. Lemur psilodactylus, long-fingered lemur. This highly singular species has so much the general appearance of a squirrel, that it has been referred to that genus both by Mr. Pennant in the last edition of his History of Quadrupeds, and by Gmelin in his enlarged edition of the Systema Naturæ of Linnæus. The account, however, given by Mons. Sonnerat, its first describer, seems to prove it a species of lemur. It measures from fourteen to eighteen inches from the nose to the tail, which is about the same length. The general colour of the animal is a pale ferruginous-brown, mixed with black and grey; on the head, round the eyes, and on the upper parts of the body, the ferruginous brown prevails, with a blackish cast on the back and limbs; the tail is entirely black; the sides of the head, the neck, the lower jaw, and the belly, are greyish. There are also a kind of woolly hairs of this colour, and of two or three inches in length, scattered over the whole body; the thighs and legs have a reddish cast; the black prevails on the feet, which are covered with short hairs of that colour; the head is shaped like that of a squirrel; and there are two cutting-teeth in front of each jaw; the ears are large, round, and naked, resembling those of a bat, and of a black colour. The feet are long, and somewhat resemble those of the Tarsier; the thumbs or interior toes of the hind feet are short, and furnished with flat round nails, as in the macaucos; but the principal character of the animal consists in the extraordinary structure of the fore-feet, which have the two middle toes of an uncommon length, most extremely thin, and perfectly naked, except at their base; all the claws on the fore-feet are sharp and crooked. It is a timid animal, and can scarcely see distinctly by day; and its eyes, which are of an ochre colour, resemble those of an owl.

This species is a native of Madagascar, where it inhabits woods; it is extremely rare, and is supposed to feed on fruits, insects, &c.: it is fond of warmth, and has the same slow motion as the lemur tardigradus. Its native name is aye-aye, which is said to be taken from its natural voice or cry, which resembles a feeble scream.

6. Lemur volans, flying macauco, inhabits Guzurat, the Philippine and Molucca isles, is gregarious, nocturnal, feeds on fruits. See Plate Nat. Hist. fig. 249.

LENS, in dioptrics, properly signifies a small roundish glass, of the figure of a lentil; but is extended to any optic glass, not very thick, which either collects the rays of light into a point, in their passage through it, or disperses them further apart, according to the laws of refraction. See OPTICS.

LEO, in astronomy, one of the twelve signs of the zodiac, the fifth in order; containing, according to Ptolemy, thirty-two stars; according to Tycho, thirty-seven; and in the Britannic catalogue, there are no less than ninety-four. The star called the lion's-heart, cor leonis, regulus, and basilicus, is a fixed star of the first magnitude.

LEONTICE, *lion's leaf*; a genus of the monogynia order, in the hexandria class of plants; and in the natural method ranking under the 24th order, corydales. The corolla is hexapetalous; the nectarium hexaphyllous, standing on the heels of the corolla, with its limb patent; the calyx hexaphyllous, and deciduous. There are three species, natives of the southern parts of Europe, two of which are sometimes cultivated in this country. These are, 1. The chrysogonum with winged leaves; and 2. The leontopetalum with decompounded leaves. But those plants are natives of the Archipelago islands, and also grow in the corn-fields about Aleppo in Syria, where they flower soon after Christmas.

LEONTODON, *dandelion*: a genus of the polygamia æqualis order, in the syngenesia class of plants; and in the natural method ranking under the 49th order, compositæ. The receptacle is naked; the calyx imbricated, with the scales somewhat loose; the pappus feathery. There are four species, of which the only remarkable one is the taraxacum, or common dandelion, found on the road sides, in pastures, and on the banks of ditches. Early in the spring, the leaves whilst yet white and hardly unfolded are an excellent ingredient in sallads. The French eat the roots and tender leaves with bread and butter. Children that eat it in the evening experience its diuretic effects in the night, which is the reason for its vulgar appellation. When a swarm of locusts had destroyed the harvest in the island of Minorca, many of the inhabitants subsisted upon this plant. The expressed juice has been given to the quantity of four ounces three or four times a day; and Boerhaave had a great opinion of the utility of this and other lactescent plants in visceral obstructions. Goats eat it; swine devour it greedily; sheep and cows are not fond of it, and horses refuse it. Small birds are fond of the seeds.

LEONURUS, *lion's tail*; a genus of the gymnospermia order, in the didynamia class of plants: and in the natural method ranking under the 42nd order, verticillatæ. The antheræ are powdered with shining points, or small elevated globular particles.

The species are: 1. The Africana, with spear-shaped leaves, a native of Ethiopia. The flowers are produced in whorls, each of the branches having two or three of these whorls towards their ends. They are of the lip-kind, shaped somewhat like those of the dead-nettle; but are much longer, and covered with short hairs. They are of a golden scarlet colour, so make a fine appearance. 2. The nepetæfolia, with oval leaves, a native of the Cape of Good Hope. The flowers come out in whorls like those of the former sort; but are not so long nor so deep-coloured. They appear at the same season with the first, and continue as long in beauty. There are three other species, but the above are the most remarkable.

Both sorts are propagated by cuttings, which should be exposed to the air long enough to harden the shoots, and planted in the beginning of July, after which they will take root very freely. They should be planted in a loamy border to an eastern aspect: and if they are covered closely with a bell or hand glass to exclude the air, and shaded from the sun, it will forward their putting forth roots. As soon as they have taken good root, they should be taken up and planted each in a separate pot filled with soft loamy earth, and placed in the shade till they have taken new root. In October they must be removed into the greenhouse.

LEOPARD. See FELIS.

LEOPARD'S *bane*. See DORONICUM.

LEPAS, a genus of vermes testacea: the animal a triton, shell affixed at the base, and consisting of many unequal erect valves. The lepas antifera, or duck-bernacle, has the shell compressed, five-valved, smooth, seated on a bernacle. It inhabits most seas, and is found fixed in clusters to the bottom of vessels, and old pieces of floating timber, generally whitish with a blue cast, the margins of the valves yellow; sometimes marked with black; peduncle long, coriaceous, black, and much wrinkled towards the shell, and growing paler and pellucid towards the base. See Plate Nat. Hist. fig. 248.

LEPIDIUM, DITTANDER, or *pepperwort*: a genus of the siliculosæ order, in the tetradynamia class of plants; and in the natural method ranking under the 39th order, siliquosæ. The silicula is emarginated, cordated, and polyspermous, with the valves carinated contrary or broader than the partition. There are 23 species, of which the only remarkable one is the latifolium or common dittander. This is a native of many parts of England. The whole plant has a hot biting taste like pepper; and the leaves have been often used by the country-people to give a relish to their viands instead of that spice, whence the plant has got the appellation of poor man's pepper. It is reckoned an antiscorbutic, and was formerly used instead of the horseradish scurvy-grass.

LEPIDOLITE. See LILALITE.

LEPIDOPTERA, in zoology, an order of insects with four wings, which are covered with imbricated squamulæ: add to this that the mouth is commonly spiral.

Under this order are comprehended the phalæna, sphinx, and papilio genera.

LEPISMA, the name of a genus of insects of the order aptera. The generic character is, legs six, formed for running; mouth with two setaceous and two headed feelers; body imbricated with two minute scales; tail furnished with extended bristles.

The Linnæan genus lepisma is far from extensive, those enumerated by Linnæus himself in the twelfth edition of the Systema Naturæ amounting to no more than three species.

Of these the chief is the lepisma saccharina (See Plate Nat. Hist. fig. 245), frequently called in our own country, from its peculiar colour and tapering form, by the name of the wood-fish. This is an insect of great elegance. Its general length, exclusive of the caudal bristles, is about half an inch, and its colour a bright silvery grey, resembling that of pearls; this colour is owing to a covering of extremely minute oval scales, which are semitransparent, very easily detached from the animal by a slight touch; the head and thorax together form a rounded outline, the remainder of the body gradually lessening to the tail, which terminates in three long bristles, of similar appearance with the antennæ. The motions of this animal are remarkably quick, and it is often observed among various domestic articles, particularly sugar. It also occurs not unfrequently among old books and papers, which it is supposed often to injure. It is said to be originally an American animal, and to have been imported into Europe among sugars, &c. Dr. Browne, in his History of Jamaica, represents it as "extremely destructive to books and all manner of woollen clothes."

Lepisma polypus Lin. is of a dusky or brownish cast, and has a springing or leaping motion when disturbed. It is found about the sea-coast of many northern regions, under stones, &c.

LEPROSY. See MEDICINE.

LEPTURA, the name of a genus of insects of the order coleoptera: the generic character is, antennæ setaceous; wing-sheaths attenuated towards the tip; thorax subcylindric. The genus leptura, greatly allied to that of cerambyx, contains several species of considerable beauty; among which may be reckoned the leptura arcuata, of a black colour, with the wing-sheaths marked by transverse, yellow, lunated bands pointing backwards; it is found in woods during the summer months, and generally measures about three quarters of an inch in length.

Leptura arietis is of nearly similar appearance, but the second band of the wing-sheaths is directed forwards; both the above insects are by some referred to the genus cerambyx.

Leptura aquatica is so named from its being particularly found in the neighbourhood of waters, frequenting the plants which grow near the water's edge. It is about half an inch in length, and of a golden green-colour, sometimes varying into copper-colour, purple, or blue, and is distinguished by having a tooth or process on the thighs of the hind legs.

The larvæ of the lepturæ in general are probably allied to those of the cerambyces, but they are at present little known.

LEPUS, hare, a genus of quadrupeds of the order glires. The generic character is, front-teeth two both above and below, the upper pair duplicate; two small interior ones standing behind the exterior. This genus, when considered with anatomical exactness, exhibits particularities of structure, deviating somewhat from that of the glires, and making an indistinct approach to the pecora or ruminants. It has even been supposed that the common hare actually ruminates; an opinion owing not only to the peculiar motions of the mouth, which present an obscure appearance of rumination, but to the structure of the stomach, which is marked into two regions by a particular fold or ridge. Other singularities relative to internal formation may be met with in the works of comparative anatomists. The most remarkable species are,

1. Lepus timidus, common hare. The hare is an animal so familiarly known as to supersede the necessity of any very minute description. It is a native not only of every part of Europe, but of almost every part of the old continent. It may perhaps be doubted whether it is an aboriginal native of any part of America.

The favourite residence of the hare is in rich and somewhat dry and flat grounds, and it is rarely discovered in very hilly or mountainous situations. It feeds principally by night, and remains concealed during the day in its form, beneath some bush, or slight shelter.

The swiftness of this animal is proverbial, and on account of the conformation of its legs, the hinder of which are longer than the fore, it is observed to run to most advantage on slightly ascending ground.

The hare is a very prolific animal, generally producing three or four young at a time, and breeding several times in a year. The young require the assistance of the parent but for a short time, and in about three weeks are able to provide for themselves; they do not remove to any great distance from each other, but continue in the same neighbourhood for a considerable time. The hare feeds on various vegetables, but is observed to prefer those of a milky and succulent quality. It also occasionally feeds on the bark of trees, as well as on the young shoots of various shrubs, &c.

The nature of the soil in which the hare resides and feeds, is observed to influence in a considerable degree the colour and constitution of the animal. Those which feed in elevated situations are larger and darker than those which reside in the plains.

The hare is an animal proverbially timid, and flies, if disturbed when feeding by the slightest alarm; but when seated in its form, will allow itself to be approached so near as to be reached by a stick; seeming to be fascinated by fear, and instead of endeavouring to fly, continuing to squat immoveable, with its eyes fixed on its enemy. It is necessary, however, in order to conduct this manœuvre, to approach in a gradual and circling manner.

The hare, though so nearly allied to the rabbit as to make the general descriptive distinction not very easy, is yet of different habits and propensities, and never associates with the latter animal. If taken very young, the hare may be successfully tamed, and in that state shews a considerable degree of attachment to its benefactors, though it continues shy to those whose presence it has not been accustomed to. Mr. White, in his History of Selbourne, relates an instance which happened in that village, of a young leveret suckled and nursed by a cat, which received it very early under her protection, and continued to guard it with maternal solicitude till it was grown to a considerable size.

A most singular variety of this animal is sometimes found, which is furnished with rough and slightly branched horns, bearing a considerable resemblance to those of a roebuck. This particularity, as strange as it is uncommon, seems to imply a kind of indistinct approach in this animal to the order pecora.

The hare is a short-lived animal, and is supposed rarely to exceed the term of seven or eight years.

It may be proper to add, that in very severe winters, and especially in those of the more northern regions, the hare becomes entirely white, in which state it is liable to be mistaken for the following species.

2. Lepus variabilis, varying hare. This species is an inhabitant of the loftiest alpine tracts in the northern regions of the globe; occurring in Norway, Lapland, Russia, Siberia, and Kamtschatka; and in our own island on the alps of Scotland. The same species is also found to extend to America, appearing in some parts of Canada. In its general appearance it bears an extreme resemblance to the common hare, but is of smaller size, and has shorter ears and more slender legs. Its colour in summer is a tawny grey; in winter entirely white, except the tips of the ears, which are black; the soles of the feet are also black, but are very thickly covered with a yellowish fur. This animal is observed to confine itself altogether to elevated situations, and never to descend into the plains, or to mix with the common hare. The change of colour commences in the month of September, and the grey or summer coat reappears in April; but in the very severe climate of Siberia it continues white all the year round. It has been sometimes found entirely coal-black, a variety which is also known to take place occasionally in the common hare. The varying hare sometimes migrates in order to obtain food in severe seasons. Troops of five or six hundred have been seen to quit in this manner the frozen hills of Siberia, and to descend into the plains and woody districts, from which they again return in spring to the mountains.

3. Lepus Americanus, American hare. This animal is not much superior in size to a rabbit, measuring about eighteen inches. Its colour nearly resembles that of the common hare, to which it seems much allied: but the fore legs are shorter, and the hind ones longer in proportion. The belly is white; the tail black above and white beneath; the ears tipped with grey, and the legs of a pale-ferruginous colour. It is said to inhabit all parts of North America; and in the more temperate regions retains its colour all the year round, but in the colder parts becomes white in winter, when the fur grows extremely long and silvery; the edges of the ears alone retaining their former colour. It is said to be extremely common at Hudson's Bay, where it is considered as a highly useful article of food. It breeds once or twice a year, producing from five to seven at a time. It is not of a migratory nature, but always continues to haunt the same places, taking occasional refuge under the roots of trees, or in the hollows near their roots.

4. Lepus cuniculus, rabbit. The rabbit bears a very strong general resemblance to the hare, but is considerably smaller, and its fore feet are furnished with sharper and longer claws in proportion; thus enabling it to burrow in the ground, and to form convenient retreats, in which it conceals by day, and like the hare, comes out chiefly by night and during the early part of the morning to feed. Its colour, in the wild state, is a dusky brown, paler or whitish on the under parts, and the tail is black above and white below. In a domestic state the animal varies into black, black-and-white, silver-grey, perfectly white, &c.

The rabbit is a native of most of the temperate and warmer parts of the old continent, but is not found in the northern regions, and is not originally a native of Britain, but was introduced from other countries. Its general residence is in dry, chalky, or gravelly soils, in which it can conveniently burrow. It is so prolific an animal that it has been known to breed seven times in a year, and to produce no less than eight young each time. It is therefore not surprising, that in some countries it has been considered as a kind of calamity, and that various arts of extirpation have been practised against it.

5. Lepus viscaccia. This species is said to have the general appearance of a rabbit, but has a long bushy and bristly tail, like that of a fox, which the animal also resembles in colour; the fur on all parts, except the tail, is soft, and is used by the Peruvians in the manufacture of hats; it was also used by the ancient Peruvians for the fabric of garments, worn only by persons of distinction. In its manners this animal resembles the rabbit, burrowing under ground, and forming a double mansion, in the upper of which it deposits its provisions, and sleeps in the other. It appears chiefly by night, and is said to defend itself when attacked by striking with its tail.

6. Lepus alpinus, alpine hare. This is a very different species from the alpine hare described by Mr. Pennant in the British Zoology, which is no other than the varying hare. The alpine hare is a far smaller animal, scarcely exceeding a guinea-pig (cavia cobaya) in size, and measuring only nine inches in length. Its colour is a bright ferruginous grey, paler beneath; the head is long, and the ears short, broad, and rounded. See Plate Nat. Hist. fig. 246. It appears to have been first described by Dr. Pallas, who informs us that it is a native of the Altaic mountains, and extends to the Lake Baikal, and even to Kamtschatka, inhabiting rough woody tracts amidst rocks and cataracts, and forming burrows beneath the rocks, or inhabiting the natural fissures, and dwelling sometimes singly, and sometimes two or three together. In their manners they greatly resemble some of the marmots or hamsters; preparing, during the autumn, a plentiful assortment of the finest herbs and grasses, which they collect in company, and after drying with great care in the sun, dispose into heaps of very considerable size, for their winter support; and which may always be distinguished, even through the deep snow, having the appearance of so many hay-ricks in miniature, and being often several feet in height and breadth. The alpine hare varies in size according to the different regions in which it is found, being largest about the Altaic mountains, and smaller about Lake Baikal, &c.

7. Lepus ogotona, ogotona hare. This animal, says Dr. Pallas, is called by the Mongolians by the name of ogotona, and is an inhabitant of rocky mountains, or sandy plains, burrowing under the soil, or concealing itself under heaps of stones, and forming a soft nest at no great depth from the surface. It wanders about chiefly by night, and sometimes appears by day, especially in cloudy weather. In autumn it collects heaps of various vegetables for its winter food, in the same manner as the alpine hare before described, disposing them into neat hemispherical heaps of about a foot in diameter. These heaps are prepared in the month of September, and are entirely consumed by the end of winter.

The ogotona hare is about six inches or somewhat more in length, and is of a pale-brown colour above, and white beneath; on the nose is a yellowish spot, and the outsides of the limbs and space about the rump are of the same colour. It is entirely destitute of a tail. See Plate Nat. Hist. fig. 247.

8. Lepus pusillus, calling hare. In its form this species extremely resembles the ogotona hare, but is smaller, measuring near six inches, but weighing only from three ounces and a quarter to four and a half, and in winter two and a half. It is an inhabitant of the south-east parts of Russia, and about all the ridge of hills spreading southward from the Uralian chain; as well as about the Irtish, and the west part of the Altaic chain. It is an animal of a solitary disposition, and is very rarely to be seen, even in the places it most frequents.

Lepus, in astronomy, a constellation of the southern hemisphere, comprehending 12 stars according to Ptolemy; thirteen, according to Tycho; and nineteen in the Britannic catalogue.

LERCHEA, a genus of the class and order monadelphia pentandria. The cal. is five-toothed; cor. funnel-form, five-cleft; anthers, five; style, one; caps. three-celled, many-seeded. There is one species, a shrub of the East Indies.

LERNEA, in zoology; a genus of insects of the order of vermes mollusca, the characters of which are: the body fixes itself by its tentacula, is oblong, and rather tapering; there are two ovaries like tails, and the tentacula are shaped like arms. The cyprinacea has four tentacula, two of which are lunulated at the top. It is a small species, about half an inch long, and of the thickness of a small straw. It is found on the sides of the bream, carp, and roach, in many of our ponds and rivers, in great abundance. 2. The salmonea, or salmon-louse, has an ovated body, cordated thorax, and two linear arms, approaching nearly to each other. 3. The asellina, has a lunated body and cordated thorax; and inhabits the gills of the cod-fish and ling of the northern ocean.

LESKIA, a genus of the class and order cryptogamia musci; a moss of little note.

LESSOR and Lessee, in law. See Lease.

LET Fall, a word of command at sea, to put out a sail when the yard is aloft, and the sail is to come or fall down from the yard; but, in strictness, only applied to the main and fore courses, when their yards are hoisted up.

LETTER. A servant of the post-office is within the penalty of 5 Geo. III. c. 25, which makes it a capital felony to secrete a letter containing any bank-note, though he has not taken the oath required by 9 Anne c. 10. But to secrete a letter containing money, is not an offence within the statutes concerning the servants of the post-office.

Letter *of credit*, is where a merchant or correspondent writes a letter to another, requesting him to credit the bearer with a certain sum of money.

Letter *of licence*, is a written permission granted to a person under embarrassment, allowing him to conduct his affairs for a certain time without being molested. Such instrument will bind all the creditors by whom it is executed, and it generally contains certain stipulations to be observed by all parties.

Letter *of attorney*, is an instrument giving to a second person the authority to do any lawful act in the stead of the maker. They are sometimes revokable and sometimes not; in the latter case the word irrevocable is inserted. The authority must be strictly pursued: and if the attorney does less than the power it shall be void; if more, it shall be good as far as the power goes, and void as to the rest; but both these rules have many exceptions. See 1 Inst. 258.

LETTERS. The rate of postage of general-post letters is regulated by distance in the following proportions:

For every letter not exceeding 15 miles, 3*d*, 30 miles, 4*d*, 50 miles, 5*d*, 80 miles, 6*d*, 120 miles, 7*d*, 180 miles, 8*d*, 230 miles, 9*d*, 300 miles, 10*d*. Where the distance is under or above 100 miles, and more than 300 miles, an additional 1*d*, and so on for every further 100 miles; and all letters to and from Ireland conveyed by packet-boats shall be paid 2*d* above all other rates: for all letters to or from Portugal, or the British dominions in America, 1*s*; and to any places without the king's dominions, 4*d* additional; and all foreign letters must be charged with the full inland rates of postage.

No letter shall be rated higher than as a treble letter, if less than 1 oz. in weight, and if an oz. than as four single letters; and so in proportion of ¼ of an oz. as a letter. These rates were settled by 41 Geo. III. c. 7.

All letters on his majesty's business are free; also all peers and members of the house of commons may send daily 10 letters free and receive 15, not exceeding 1 oz. each in weight, provided the franked letters sent by them shall be indorsed with their name, and the date when the letters are put in written at full length, and the whole direction to be in the hand-writing of such member of parliament. Also, provided such member of parliament shall be within 20 miles of the post town, where letters are put in franked by him, or where letters are received directed to him. 43 Geo. III. c. 31.

Letters, *threatening*. To send letters threatening to accuse a person of any crime punishable with death or any infamous punishment, and knowingly to send any anonymous or fictitious letter threatening to kill any one, or set fire to their tenements or property, with a view of extorting money or valuables from them, is in the first instance punishable with fine, imprisonment, pillory, whipping, or transportation for seven years, and in the other instance is felony without benefit of clergy.

Letters *patent*. See Patents, and Exemplification of Patents.

Letters, *close*, are grants of the king specially distinguished from letters patent, in that the letters close, being not of public concern, but directed to particular persons, are closed up and sealed.

Letters *of marque*, are extraordinary commissions, granted to captains or merchants for reprisals, in order to make a reparation for those damages they have sustained, or the goods they have been deprived of by strangers at sea.

These appear to be always joined to those of reprise, for the reparation of a private injury; but under a declared war the former only are required.

LETHARGY. See Medicine.

LEVARI facias, is a writ directed to the sheriff for levying a certain sum of money upon the lands, &c. of a person who has forfeited his recognizance.

LEUCITE. This stone is usually found in volcanic productions, and is very abundant in the neighbourhood of Vesuvius. It is always crystallized. The primitive form of its crystals is either a cube or a rhomboidal dodecahedron, and its integrant molecules are tetrahedrons; but the varieties hitherto observed are all polyhedrons. The most common has a spheroidal figure, and is bounded by 24 equal and similar trapezoids; sometimes the faces are 12, 18, 36, 54, and triangular, pentagonal, &c. The crystals vary from the size of a pin's head to that of an inch.

The texture of the leucite is foliated; its fracture somewhat conchoidal; specific gravity from 2.455 to 2.490; colour white, or greyish white. Its powder causes syrup of violets to assume a green colour. Infusible by the blowpipe. Gives a white transparent glass with borax. It is composed, as Klaproth has shewn, of

54 silica
23 alumina
22 potass

99.

It was by analysing this stone that Klaproth discovered the presence of potass in the mineral kingdom, which is not the least important of the numerous discoveries of that accurate and illustrious chemist.

Leucite is found sometimes in rocks which have never been exposed to volcanic fire; and Mr. Dolomieu has rendered it probable, from the substances in which it is found, that the leucite of volcanoes has not been formed by volcanic fire, but that it existed previously in the rocks upon which the volcanoes have acted, and that it was thrown out unaltered in fragments of these rocks.

LEUCOJUM, *great snow-drop*, a genus of the monogynia order, in the hexandria class of plants, and in the natural method ranking under the ninth order, spathaceæ. The corolla is campanulated, sexpartite, the segments increased at the points, the stigma simple. The species are, 1. The vernum, or spring leucojum, has an oblong bulbous root, sending up a naked stalk, about a foot high, terminated by a spatha, protruding one or two white flowers, appearing in March. 2. The æstivum, or summer leucojum, has a large oblong bulbous root, an upright stalk, 15 or 18 inches high, terminated by many white flowers in May. 3. The autumnale has a large oblong bulbous root, narrow leaves, an upright stalk, terminated by white flowers in autumn. 4. The shumosum, with flowers white within, purplish without.

LEUCOMA. See Surgery.

LEVEL, an instrument used to make a line parallel to the horizon, and to continue it out at pleasure; and by this means to find the true level, or the difference of ascent or descent, between two or more places, for conveying water, draining fens, &c.

There are several instruments, of different contrivance and matter, invented for the perfection of levelling; but they may be reduced to the following kinds:

Water-Level, that which shews the horizontal line by means of a surface of water or other fluid, founded on this principle, that water always places itself level or horizontal.

The most simple kind is made of a long wooden trough or canal, which being equally filled with water, its surface shews the line of level.

The water-level is also made with two cups fitted to the two ends of a straight pipe, about an inch diameter, and three or four feet long, by means of which the water communicates from the one cup to the other; and this pipe being moveable on its stand by means of a ball and socket, when the two cups shew equally full of water, their two surfaces mark the line of level.

This instrument, instead of cups, may also be made with two short cylinders of glass three or four inches long, fastened to each extremity of the pipe with wax or mastic. The pipe is filled with common or coloured water, which shews itself through the cylinders, by means of which the line of level is determined; the height of the water, with respect to the centre of the earth, being always the same in both cylinders. This level, though very simple, is yet very commodious for levelling small distances.

Air-Level, that which shews the line of level by means of a bubble of air inclosed with some fluid in a glass tube of an indeterminate length and thickness, and having its two ends hermetically sealed. When the bubble fixes itself at a certain mark, made exactly in the middle of the tube, the case or ruler in which it is fixed is then level. When it is not level, the bubble will rise to one end. This glass tube may be set in another of brass, having an aperture in the middle, where the bubble of air may be observed. It should be filled with a liquid not liable to freeze nor evaporate.

There is one of these instruments with sights, being an improvement upon that last described, which, by the addition of other apparatus, becomes more exact and commodious. It consists of an air-level (Plate Miscel. fig. 146) about eight inches long, and about two-thirds of an inch in diameter, set in a brass tube 2, having an aperture in the middle C. The tubes are carried in a straight ruler, of a foot long; at the ends of which are fixed two sights 3, 3, exactly perpendicular to the tubes, and of an equal height, having a square hole, formed by two fillets of brass crossing each other at right angles; in the middle of this is drilled a very small hole, through which a point on a level with the instrument is seen. The brass tube is fastened to the ruler by means of two screws; the one of which, marked 4, serves to raise or depress the tube at pleasure, for bringing it towards a level. The top of the ball and socket is rivetted to a small ruler that springs, one end of which is fastened with springs to the great ruler, and at the other end is a screw 5, serving to raise and depress the instrument when nearly level.

But this instrument is still less commodious than the following one: for though the holes are ever so small, yet they will still take in too great a space to determine the point of level precisely.

Fig. 147. is a level with telescopic sights, first invented by Mr. Huygens. It is like the last, with this difference, that instead of plain sights it carries a telescope to determine exactly a point of level at a considerable distance. The screw 3, is for raising or lowering a little fork for carrying the hair, and making it agree with the bubble of air when the instrument is level; and the screw 4 is for making the bubble of air, D or E, agree with the telescope. The whole is fitted to a ball and socket, or otherwise moved by joints and screws. It may be observed, that a telescope may be added to any kind of level, by applying it upon, or parallel to, the base or ruler, when there is occasion to take the level of remote objects; and it possesses this advantage, that it may be inverted by turning the ruler and telescope half-round; and if then the hair cut the same point that it did before, the operation is just. Many varieties and improvements of this instrument have been made by the more modern opticians.

Dr. Desaguliers proposed a machine for taking the difference of level, which contained the principles both of a barometer and thermometer; but it is not accurate in practice.

Reflecting Level, that made by means of a pretty long surface of water, representing the same object inverted, which we see erect by the eye; so that the point where these two objects appear to meet, is on a level with the place where the surface of the water is found.

There is another reflecting level, consisting of a polished metal mirror, placed a little before the object-glass of a telescope, suspended perpendicularly. This mirror must be set at an angle of 45 degrees; in which case the perpendicular line of the telescope becomes a horizontal line, or a line of level: which is the invention of M. Cassini.

Artillery Foot-Level, is in form of a square (fig. 148.), having its two legs or branches of an equal length; at the junction of which is a small hole, by which hangs a plummet playing on a perpendicular line in the middle of a quadrant, which is divided both ways from that point into 45 degrees.

This instrument may be used on other occasions by placing the ends of its two branches on a plane; for when the plummet plays perpendicularly over the middle division of the quadrant, the plane is then level.

To use it in gunnery, place the two ends on the piece of artillery, which may be raised to any proposed height by means of the plummet, which will cut the degree above the level. But this supposes the outside of the cannon is parallel to its axis, which is not always the case; and therefore they use another instrument now, either to set the piece level, or elevate it at any angle; namely a small quadrant, with one of its radii continued out pretty long, which being put into the inside of the cylindrical bore, the plummet shews the angle of elevation, or the line of level.

Carpenter's, *Bricklayer's*, or *Pavior's* Level, consists of a long ruler, in the middle of which is fitted at right angles another broader piece, at the top of which is fastened a plummet, which when it hangs over the middle line of the second or upright piece, shews that the base or long ruler is horizontal or level. Fig. 149.

Mason's Level, is composed of three rulers, so jointed as to form an isosceles triangle, somewhat like a Roman A; from the vertex of which is suspended a plummet, which hangs directly over a mark in the middle of the base, when this is horizontal or level.

Plum or *Pendulum* Level, said to be invented by M. Picard, fig. 150. This shews the horizontal line by means of another line perpendicular to that described by a plummet or pendulum. This level consists of two legs or branches, joined at right angles, the one of which, of about 18 inches long, carries a thread and plummet; the thread being hung near the top of the branch, at the point 2. The middle of the branch where the thread passes is hollow, so that it may hang free every where: but towards the bottom, where there is a small blade of silver, on which a line is drawn perpendicular to the telescope, the said cavity is covered by two pieces of brass, with a piece of glass G, to see the plummet through, forming a kind of case, to prevent the wind from agitating the thread. The telescope, of a proper length, is fixed to the other leg of the instrument, at right angles to the perpendicular, and having a hair stretched horizontally across the focus of the object-glass, which determines the point of level, when the string of the plummet hangs against the line on the silver blade. The whole is fixed by a ball and socket to its stand.

Fig. 151. is a *Balance* Level, which being suspended by the ring, the two sights, when in equilibrio, will be horizontal, or in a level.

But the most complete level is the *Spirits* Level, invented by the late Mr. Ramsden. See Plate Spirits Level. ABD, fig. 7. are the three legs upon which it is placed; when shut up, they form one round rod, and are kept together by three rings: these legs are jointed to a brass frame E, on the top of which is a male screw, screwing into a female screw within the projection *a* of the plate F. Within the top of *a*, figs. 4 and 7, is a hemispherical cavity to contain the spherical ball, fig. 5: this ball has a male screw *d* on its top, which screws into a female screw *b*, fig. 6, in the plate G, fig. 7 and fig. 6, the ball is put up through an opening *c*, fig. 4, and screwed to the plate, fig. 6; so that the upper plate G can move in any direction within certain limits by the play of the ball in its socket; to confine the upper plate G when it is set in any direction, four screws, HHHH, figs. 4 and 7, are employed; they work in tubes firmly fixed to the plate F, and are turned by their milled heads; the upper ends of these screws act against the under side of the plate, fig. 6, as shewn in fig. 7; so that when the plate G is required to be moved in any direction, it is done by screwing up one screw and screwing down the opposite till it is brought to the proper inclination; then by screwing up both together, the plate is firmly fixed. The ball, fig. 5, has a conical hole *f* through it, to receive an axis which is screwed fast to the bottom of the compass-box I, fig. 7; a screw screwed into the end of this axis prevents its being lifted out, and at the same time leaves it at liberty to turn round independant of the ball, fig. 5. On each side of the compass-box I, is a bar KK, on the end of which are fixed two forked pieces IO, called the Y's (from their resemblance to that letter), carrying the telescope M. One of these (O) is capable of being raised or lowered by means of a milled-headed screw N, which works through a collar in the lower end of the tube g; the rest of the tube has a triangular hole through it, in which slides a bar k, which is part of the Y; O the female screw is cut within this bar, and the screw works into it, so that by turning the milled head one way, the Y is raised, and by reversing the motion, it is lowered. The axis which connects the compass-box and the other apparatus, has a collar upon it just above where it enters the ball, fig. 5, which is embraced by a clamp P, fig. 6, which is closed by a screw C, so as to hold the collar of the axis quite tight; and when the screw is turned back, its own elasticity opens it so as to allow the axis of the compass-box to turn round freely within it; on the opposite side of the clamp is a projecting arm l, carrying the nut m of the screw Q, which screw works in a stud n, fixed to the upper plate G, figs. 7 and 6; by this means, when G is loosened, the telescope can be turned quite round, but when it is fastened, it can only be moved by turning the screw Q. The level-tube Z is fastened to the under side of the telescope by a screw q at one end and a bar r at the other: the use of these are to adjust it so that it shall be exactly parallel to the axis of the telescope-tube. The level, as best explained in the section, fig. 1, is a tube of glass ss, nearly filled with spirits of wine, but so as to leave a bubble of air in it; if the tube is of exactly the same diameter in every part, the bubble will rest in the middle of the tube when it is level. In some of the best levels made by Ramsden, the inside of the tube is bent into a segment of a circle, 100 feet diameter, and the inside is ground, which causes the bubble to adhere together; if the tube is straight, it is liable to divide into several small ones. The internal parts of the telescope are explained in fig. 1: RR is the external tube of brass plate; within this slides another tube ss; it has two glasses v, w, screwed into the outer end, called object-glasses, and it has two divisions x, y, called diaphagram, with small holes in them; their use is to collect the prismatic rays with which the objects would otherwise be tinged; the tube ss has a rack t fixed nearly in the middle of it, which takes into a pinion on the axis of the milled head T, figs. 1 and 7; by turning this, the glasses v, w, can be moved nearly to, or farther from, the eye to adjust the focus; to the tube R at v are fixed the cross wires, whose intersection is exactly in the centre of the tube. The manner of fixing these is explained in fig. 3: A is a brass box, which fits into the end of the telescope-tube, and is held there by four small screws; within this box is placed a brass plate B, carrying the wires, which are fastened by screwing four screws down upon their ends; when the plate B is in the box, a ring D is screwed in upon it, which prevents its falling out, but at the same time leaves it at liberty to move about in the box; the sides of the box, and also the telescope-tube, has four rectangular holes in it, through which four screws are passed into the edges of the piece B, so as to hold it in any position: these screws come through the external tube, and have square heads, to be turned by a key, so as to adjust the interactions in the centre: the box A has a female screw in the front, into which is screwed the eye-piece W; 3 is the tube which is screwed to the telescope; within this slides a tube, containing two glasses 4, 5; by sliding the glasses in or out of the tube 3, they can be adjusted so as to adapt their focus to the cross wires. This eye-piece is convenient on account of its shortness; but as it reverses the objects, it is sometimes more convenient to use the eye-piece fig. 2, which is much longer, but does not reverse objects. a is the tube which is screwed to the telescope; within this slides another tube bb, having at one end a tube dd, containing two glasses ef, and a diaphagram g, and at the other end a tube hh, containing two glasses ik, and a diaphagram: m is a cap screwed on to the end to prevent the tubes coming out. When the instrument is to be carried, the level is unscrewed from the legs and packed in a case; the legs are shut up and kept so by the rings, as before described. The manner of using this instrument is as follows: When the difference of level between any two places is required, the observer with the level goes to the highest of the two, and his assistant goes to the lowest with the target, which is a long pole of wood with a groove in it, in which slides a small rod carrying a round piece of wood, called a sight, which is to be observed through the telescope; the observer opens the legs of the instrument, and sets them on the ground; the level is next screwed to them at E, as shewn in fig. 7; the telescope is then brought nearly to a level by the screws HHHH, as before described; the screw c is then turned so as to release the clamp P, fig. 6; and the telescope is turned about, so as to point to the target; the clamp P is then closed, the observer looks through the telescope, and by turning the nut T, the focus is adjusted: the screw Q is then turned till the cross wires are brought to coincide with the object, in an horizontal plane; he then takes his eye from the telescope, and works the screw N till he brings the bubble of air in the level-tube exactly in the middle, which shews that the telescope is perfectly horizontal; the observer then makes signals to the assistant to raise or lower the sight on the slider of the target, till it is brought to coincide with the intersection of the cross wire, which shews that the telescope and the sight of the target are on the same level; the height which the sight is from the ground where the target stands, deducted from the height the telescope stands from the ground, is the difference of level required.

LEVELLING, the art or act of finding a line parallel to the horizon at one or more stations, to determine the height or depth of one place with respect to another; for laying out grounds even, regulating descents, draining morasses, conducting water, &c.

Two or more places are on a true level when they are equally distant from the centre of the earth. Also one place is higher than another, or out of level with it, when it is farther from the centre of the earth; and a line equally distant from that centre in all its points, is called the line of true level. Hence, because the earth is round, that line must be a curve, and make a part of the earth's circumference, or at least parallel to it, or concentrical with it; as the line BCFG (Plate Misc. fig. 152), which has all its points equally distant from A, the centre of the earth, considering it as a perfect globe.

But the line of sight BDE, &c. given by the operations of levels, is a tangent, or a right line perpendicular to the semidiameter of the earth at the point of contact B, rising always higher above the true line of level, the farther the distance is, is called the apparent line of level. Thus, CD is the height of the apparent level above the true level, at the distance BC or BD; also EF is the excess of height at F, and GH at G, &c. The difference, it is evident, is always equal to the excess of the secant of the arch of distance above the radius of the earth.

The common methods of levelling are sufficient for laying pavements of walks, or for conveying water to small distances, &c.; but in more extensive operations, as in levelling the bottoms of canals, which are to convey water to the distance of many miles, and such like, the difference between the true and the apparent level must be taken into the account.

Now the difference CD between the true and apparent level, at any distance BC or BD, may be found thus: By a well-known property of the circle, 2AC + CD : BD :: BD : CD; or because the diameter of the earth is so great with respect to the line CD at all distances to which an operation of levelling commonly extends, that 2AC may be safely taken for 2AC + CD in that proportion without any sensible error, it will be 2AC : BD :: BD : CD, which therefore is $= \frac{BD^2}{2AC}$, or $\frac{BC^2}{2AC}$ nearly; that is, the difference between the true and apparent level, is equal to the square of the distance between the places, divided by the diameter of the earth; and consequently it is always proportional to the square of the distance.

Now the diameter of the earth being nearly 7958 miles; if we first take BC = 1 mile, then the excess $\frac{BC^2}{2AC}$ becomes $\frac{1}{7958}$ of a mile, which is 7.962 inches, or almost 8 inches, for the height of the apparent above the true level at the distance of one mile. Hence, proportioning the excesses in altitude according to the squares of the distances, the following Table is obtained, shewing the height of the apparent above the true level for every 100 yards of distance on the one hand, and for every mile on the other.

Dist. or BC.	Dif. of Level, or CD.	Dist. or BC.	Dif. of Level, or CD.	
Yards.	Inches.	Miles.	Feet.	Inc.
100	0.026	$\frac{1}{4}$	0	$0\frac{1}{2}$
200	0.103	$\frac{1}{2}$	0	2
300	0.231	$\frac{3}{4}$	0	$4\frac{1}{2}$
400	0.411	1	0	8
500	0.643	2	2	8
600	0.925	3	6	0
700	1.260	4	10	7
800	1.645	5	16	7
900	2.081	6	23	11
1000	2.570	7	32	6
1100	3.110	8	42	6
1200	3.701	9	53	9
1300	4.344	10	66	4
1400	5.038	11	80	3
1500	5.784	12	95	7
1600	6.580	13	112	2
1700	7.425	14	130	1

By means of tables of reductions, we can now level to almost any distance at one operation, which the antients could not do but by a great multitude; for, being unacquainted with the correction answering to any distance, they only levelled from one 20 yards to another, when they had occasion to continue the work to some considerable extent.

This table will answer several useful purposes. Thus, first, to find the height of the apparent level above the true, at any distance. If the given distance is in the table, the correction of level is found on the same line with it: thus at the distance of 1000 yards, the correction is 2·57, or two inches and a half nearly; and at the distance of 10 miles, it is 66 feet 4 inches. But if the exact distance is not found in the table, then multiply the square of the distance in yards by 2·57, and divide by 1,000,000, or cut off six places on the right for decimals; the rest are inches: or multiply the square of the distance in miles by 66 feet 4 inches, and divide by 100.

2dly, To find the extent of the visible horizon, or how far can be seen from any given height, on a horizontal plane, as at sea, &c. Suppose the eye of an observer, on the top of a ship's mast at sea, is at the height of 130 feet above the water, he will then see about 14 miles all around. Or from the top of a cliff by the sea-side, the height of which is 66 feet, a person may see to the distance of near 10 miles on the surface of the sea. Also, when the top of a hill, or the light in a lighthouse, or such like, whose height is 130 feet, first comes into the view of an eye on board a ship, the table shews that the distance of the ship from it is 14 miles, if the eye is at the surface of the water; but if the height of the eye in the ship is 80 feet, then the distance will be increased by near 11 miles, making in all about 25 miles distance.

3dly, Suppose a spring to be on one side of a hill, and a house on an opposite hill, with a valley between them, and that the spring seen from the house appears by a levelling instrument to be on a level with the foundation of the house, which suppose is at a mile distance from it; then is the spring eight inches above the true level of the house; and this difference would be barely sufficient for the water to be brought in pipes from the spring to the house, the pipes being laid all the way in the ground.

4th, If the height or distance exceed the limits of the table, then, first, if the distance be given, divide it by 2, or by 3, or by 4, &c. till the quotient come within the distances in the table; then take out the height answering to the quotient, and multiply it by the square of the divisor, that is, by 4, or 9, or 16, &c. for the height required: so if the top of a hill is just seen at the distance of 40 miles, then 40 divided by 4 gives 10, to which in the table answer 66⅓ feet, which being multiplied by 16, the square of 4, gives 1061⅓ feet for the height of the hill. But when the height is given, divide it by one of these square numbers 4, 9, 16, 25, &c. till the quotient come within the limits of the table, and multiply the quotient by the square root of the divisor, that is by 2, or 3, or 4, or 5, &c. for the distance sought: so when the top of the peak of Teneriffe, said to be almost 3 miles, or 15840 feet high, just comes into view at sea, divide 15840 by 225, or the square of 15, and the quotient is 70 nearly; to which in the table answers by proportion nearly 10$\frac{2}{7}$ miles; then multiplying 10$\frac{2}{7}$ by 15, gives 154 miles and $\frac{2}{7}$, for the distance of the hill.

The operation of levelling is as follows: Suppose the height of the point A (Plate Miscel. fig. 153.) on the top of a mountain, above that of B at the foot of it, is required. Place the level about the middle distance at D, and set up pickets, poles, or staffs at A and B, where persons must attend with signals for raising and lowering, on the said poles, little marks of pasteboard or other matter. The level having been placed horizontally by the bubble, &c. look towards the staff AE, and cause the person there to raise or lower the mark till it appears through the telescope or sights, &c. at E: then measure exactly the perpendicular height of the point E above the point A, which suppose 5 feet 8 inches, and set it down in your book. Then turn your view the other way towards the pole B, and cause the person there to raise or lower his mark, till it appears in the visual line as before at C; and measuring the height of C above B, which suppose 15 feet 6 inches, set this down in your book also, immediately above the number of the first observation. Then subtract the one from the other, and the remainder 9 feet 10 inches will be the difference of level between A and B, or the height of the point A above the point B.

If the point D, where the instrument is fixed, is exactly in the middle between the points A and B, there will be no necessity for reducing the apparent level to the true one, the visual ray on both sides being raised equally above the true level. But if not, each height must be corrected or reduced according to its distance, before the one corrected height is subtracted from the other.

When the distance is very considerable or irregular, so that the operation cannot be effected at once placing of the level, or when it is required to know if there is a sufficient descent for conveying water from the spring A to the point B (fig. 154.), this must be performed at several operations. Having chosen a proper place for the first station, as at I, fix a pole at the point A near the spring, with a proper mark to slide up and down it, as L; and measure the distance from A to I. Then the level being adjusted in the point T, let the mark L be raised or lowered till it is seen through the telescope or sights of the level, and measure the height AL. Then having fixed another pole at H, direct the level to it, and cause the mark G to be moved up or down till it appears through the instrument; then measure the height GH, and the distance from I to H, noting them down in the book. This done, remove the level forwards to some other eminence as E, from whence the pole H may be viewed, as also another pole at D; then having adjusted the level in the point E, look back to the pole H; and managing the mark as before, the visual ray will give the point F; then measuring the distance HE and the height HF, note them down in the book. Then, turning the level to look at the next pole D, the visual ray will give the point D; there measure the height of D, and the distance EB, entering them in the book as before. And thus proceed from one station to another till the whole is completed.

But all these heights must be corrected or reduced by the foregoing table, according to their respective distances; and the whole, both distances and heights, with their corrections, entered in the book in the following manner:

Back-sights. Dists. yds.	Back-sights. Hts. ft. in.	Back-sights. Cors. inc.	Fore-sights. Dists. yds.	Fore-sights. Hts. ft. in.	Fore-sights. Cors. inc.
IA 1650	AL 11 3	7.0	IH 1265	HG 19 5	4.0
EH 940	HF 10 7	2.2	EB 900	ED 8 1	2.1
2590	21 10	9.2	2165	27 6	6.1
	9.2		2590	6.1	
	21 0.8		Dist. 4755	26 11.9	
				21 0.8	
			Whole Dif. of level	5 11.1	

Having summed up all the columns, add those of the distances together, and the whole distance from A to B is 4755 yards, or two miles and three quarters nearly. Then the sums of the corrections taken from the sums of the apparent heights, leave the two corrected heights; the one of which being taken from the other, leaves 5 feet 11·1 inches for the true difference of level sought between the two places A and B, which is at the rate of an inch and a half nearly to every 100 yards, a quantity more than sufficient to cause the water to run from the spring to the house.

Or the operation may be otherwise performed, thus: Instead of placing the level between every two poles, and taking both back-sights and fore-sights, plant it first at the spring A, and from thence observe the level to the first pole; then remove it to this pole, and observe the second pole; next move it to the second pole, and observe the third pole; and so on, from one pole to another, always taking foreward sights or observations only. And then at the last, add all the corrected heights together, and the sum will be the whole difference of level sought.

Levelling-staves, instruments used in levelling, serving to carry the marks to be observed, and at the same time to measure the heights of those marks from the ground. They usually consist each of two long wooden rulers, made to slide over one another, and divide into feet, inches, &c.

LEVER. See Mechanics.

LEVIGATION. See Pharmacy.

LEVISANUS, a genus of the class and order pentandria monogynia. The flowers are aggregate; corolla one-leafed, superior, five-cleft; filaments inserted into the base of the perianthium; styles two, conjoined; seeds five or six. There are five species, shrubs of the Cape.

LEYDEN PHIAL. See Electricity.

LEYSERA, a genus of the polygamia superflua order, in the syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The receptacle is naked; the pappus paleaceous;

that of the disc plumy; the calyx scarious. There are three species, shrubs of the Cape.

LIATRIS, a genus of the class and order syngenesia polygamia æqualis. The calyx is oblong, imbricate, awnless, coloured down, feathered coloured; receptacle naked, hollow, dotted. There are eight species, herbs of America.

LIBEL, injurious reproaches or accusations written and published against the memory of one who is dead, or the reputation of one who is alive, and thereby exposing him to public hatred, contempt, and ridicule.

With regard to libels in general, there are, as in many other cases, two remedies; one by indictment or information, and the other by action. The former for a public offence; for every libel has a tendency to the breach of the peace, by provoking the person libelled to break it; which offence is said to be the same in point of law, whether the matter contained is true or false; and therefore it is that the defendant on an indictment for publishing a libel, is not allowed to allege the truth of it by way of justification. But in the remedy by action on the case, which is to repair the party in damages for the injury done him, the defendant may, as for words spoken, justify the truth of the facts, and shew that the plaintiff has received no injury at all. The chief excellence therefore of a civil action for a libel consists in this, that it not only affords a reparation for the injury sustained, but it is a full vindication of the innocence of the person traduced. 3 Black. 125.

By a late statute, the jury are acknowledged to be judges both of the law and the fact.

LIBEL, in the ecclesiastical court, is the declaration or charge drawn up in writing, on the part of the plaintiff, to which the defendant is obliged to answer.

LIBEL, in the law of Scotland, signifies an indictment.

LIBELLULA, *dragon-fly*, a genus of insects of the order neuroptera. The generic character is: mouth furnished with several jaws; antennæ very short; wings four, extended; tail (in the male) hook-forcipated.

The libellulæ, or dragon-flies, sometimes called by the very improper title of horse-stingers, exhibit an instance scarcely less striking than the butterfly of that strange dissimilitude in point of form under which one and the same animal is destined to appear in the different periods of its existence. Perhaps few persons not particularly conversant in the history of insects, would imagine that these highly brilliant and lively animals, which may be seen flying with such strength and rapidity round the meadows, and pursuing the smaller insects with the velocity of a hawk, had once been inhabitants of the water, and that they had resided for a very long space of time in that element before they assumed their flying form. Of the libellulæ there are many different species, both native and exotic. The most remarkable of the English species is the libellula varia, or great variegated libellula. This insect makes its appearance principally towards the decline of summer, and is an animal of singular beauty: its general length is about three inches from head to tail, and the wings, when expanded, measure near four inches from tip to tip; the head is very large, and affixed to the thorax by an extremely slender neck; the eyes occupy by far the greatest part of the head, and are of a pearly blue-grey cast, with a varying lustre; the front is greenish yellow; the thorax of the same colour, but marked by longitudinal black streaks; the body, which is very long, slender, and subcylindrical, is black, with rich variegations of bright blue, and deep grass-green; the wings are perfectly transparent, strengthened by very numerous black reticular fibres, and exhibit a strongly iridescent appearance, according to the various inflexions of light; each is marked near the tip by a small oblong square black spot on the outer edge; the legs are black, and the tail is terminated by a pair of black forcipated processes, with an intermediate shorter one of similar colour. Sometimes this insect varies; the spots or marks on the abdomen and thorax being red or red-brown instead of green.

The female libellula deposits or drops her eggs into the water, which sinking to the bottom, are hatched, after a certain period, into hexapode flattish larvæ or caterpillars, of a very singular and disagreeable aspect. They cast their skins several times before they arrive at their full size, and are of a dusky brown colour. The rudiments of the future wings appear on the back of such as are advanced to what may be called the pupa or chrysalis state, in the form of a pair of oblong scales or processes, and the head is armed with a most singular organ for seizing its prey, viz. a kind of proboscis, of a flattened form, and furnished with a joint in the middle, the end being much dilated, and armed with a pair of strong hooks or prongs. This proboscis, when the animal is at rest, is folded or turned up in such a manner as to lap over the face like a mask; but when the creature sees any insect which it means to attack, it springs suddenly forwards, and by stretching forth the jointed proboscis, readily obtains its prey. They continue in this their larva and pupa state for two years, when, having attained their full size, they prepare for their ultimate change; and creeping up the stem of some water-plant, and grasping it with their feet, they make an effort, by which the skin of the back and head is forced open, and the inclosed libellula gradually emerges. The wings, at this early period of exclusion, like those of butterflies, are very short, tender, and contracted, all the ramifications or fibres having been compressed within the small compass of the oblong scales on the back of the larva, or pupa; but in the space of about half an hour, they are fully expanded, and have acquired the solidity and strength necessary for flight. This curious process of the evolution or birth of the libellula generally takes place in the morning, and during a clear sunshine. The remaining part of the animal's life is but short in comparison with that which it passed in its aquatic state, the frosts of the close of autumn destroying the whole race. They are also the prey of several sorts of birds.

The libellula depressa is a smaller or shorter species than the preceding, though with a considerably broader body in proportion. The male is of a bright sky-blue, with the sides of the body yellow; the female of a fine brown or bay, with yellow sides also. The wings in both sexes are transparent, except at the shoulders, where they are each marked by a broad bed or patch of brown with a stripe of yellow; the tips of each wing have also a small oblong-square black spot on the outer margin. The larva of this species is of a shorter form than that of the preceding, and is of a greenish-brown colour.

The libellula virgo is one of the most elegant of the European insects. It is much smaller than the libellula varia, and is distinguished by its very slender, long, cylindric body, which, as well as the head and thorax, is usually either of a bright but deep golden green, or else of a deep gilded blue. The wings are transparent at the base and tips, but are each marked in the middle by a very large oval patch or bed of deep blackish or violet blue, accompanied with iridescent hues according to the direction of the light: sometimes the wings are entirely violet-black, without the least appearance of transparency either at the base or tips; and sometimes they are altogether transparent, without any appearance of the violet-black patch which distinguishes the majority of specimens; and lastly the insect sometimes appears with transparent wings, but shaded with a strong cast of gilded greenish brown, each being marked by a small white speck at the exterior edge, near the tip.

A much smaller species than the preceding, and equally common, is the libellula puella of Linnæus. This varies much in colour, but is generally of a bright and beautiful sky-blue, variegated with black bars on the joints, and with the thorax marked by black longitudinal stripes. The wings are transparent, and each marked near the tip with a small oblong-square black marginal spot.

The exotic libellulæ are very numerous. Among the most remarkable may be numbered the L. lucretia. It is a native of the Cape of Good Hope, and is distinguished by the excessive length of its slender body, which measure not less than five inches and a half in length, though scarcely exceeding the tenth of an inch in diameter. The wings are transparent, of a slender or narrow shape, as in the L. puella, to which this species is allied in form, and measure five inches and a half in extent from tip to tip. The colour of the head and thorax is brown, with a yellowish stripe on each side, and the body is of a deep mazarine-blue. See Plate Nat. Hist. figs. 250, 251.

LIBERTUS, in Roman antiquity, a person who from being a slave, had obtained his freedom. The difference between the liberti and libertini was this: the liberti were such as had been actually made free themselves, and the libertini were the children of such persons.

LIBRA, *the balance*, in astronomy, one of the twelve signs of the zodiac, the sixth in order; so called because when the sun enters it, the days and nights are equal, as if weighed in a balance.

Authors enumerate from ten to forty-nine stars in this sign.

LIBRA, in Roman antiquity, a pound weight; also a coin, equal in value to twenty denarii.

LIBRATION, in astronomy, an apparent irregularity of the moon's motion, whereby she seems to librate about her axis, sometimes from the east to the west, and now and then from the west to the east; so that the parts in the western limb or margin of the moon sometimes recede from the centre of the disk, and sometimes move towards it, by which means they become alternately visible and invisible to the inhabitants of the earth.

Libration *of the earth*, is sometimes used to denote the parallelism of the earth's axis, in every part of its orbit round the sun.

LICENCE, in law, an authority given to a person to do some lawful act.

A licence is a personal power, and therefore cannot be transferred to another. If the person licensed abuse the power given him, in that case he becomes a trespasser.

LICENTIATE, one who has obtained the degree of a licence. The greatest number of the officers of justice in Spain are distinguished by no other title but that of licentiate. In order to pass licentiate in common law, civil law, and physic, they must have studied seven years; and in divinity, ten. Among us, a licentiate usually means a physician who has a licence to practise, granted by the college of physicians, or the bishop of the diocese.

LICHEN, *liverwort*, a genus of the natural order of algæ, in the cryptogamia class of plants. The male receptacle is roundish, somewhat plain and shining. In the female the leaves have a farina or mealy substance scattered over them. There are about 216 species, all found in Britain. Among the most remarkable are the following:

1. The geographicus; it is frequent in rocks, and may be readily distinguished at a distance. The crust or ground is of a bright greenish-yellow colour, sprinkled over with numerous plain black tubercles; which frequently run into one another, and form lines resembling the rivers in a map, from which last circumstance it takes it name.

2. The calcarious, or black-nobbed dyer's lichen, is frequent on calcarious rocks; and has a hard, smooth, white, stony, or tartareous crust, cracked or tesselated on the surface, with black tubercles. Dillenius relates, that this species is used in dyeing, in the same manner as the tartareus after-mentioned.

3. The ventosus, or red spangled tartareous lichen, has a hard tartareous crust, cracked and tesselated on the surface, of a pale yellow colour when fresh, and a light olive when dry. The tubercles are of a blood-red colour at top, their margin and base of the same colour as the crust. The texture and appearance of this (according to Mr. Lightfoot) indicate that it would answer the purposes of dyeing as well as some others of this tribe, if proper experiments were made.

4. The candelarius, or yellow farinaceous lichen, is common upon walls, rocks, boards, and old pales. There are two varieties. The first has a farinaceous crust of no regular figure, covered with numerous small greenish-yellow or olive shields, and grows commonly upon old boards. The other has a smooth, hard, circular crust, wrinkled and lobed at the circumference, which adheres closely to rocks and stones. In the centre are numerous shields of a deeper yellow or orange colour, which, as they grow old, swell in the middle, and assume the figure of tubercles. The inhabitants of Smaland in Sweden scrape this lichen from the rocks, and mix it with their tallow, to make golden candles to burn on festival days.

5. The tartareus, or large yellow-saucered dyer's lichen, is frequent on rocks, both in the Highlands and Lowlands of Scotland. The crust is thick and tough, either white or greenish white, and has a rough warted surface. The shields are yellow or buff-coloured, of various sizes, from that of a pin's head to the diameter of a silver penny. Their margins are of the same colour as the crust. This lichen is much used by the Highlanders for dyeing a fine claret or pompadour colour. For this purpose, after scraping it from the rocks, and cleaning it, they steep it in urine for a quarter of a year. Then taking it out, they make it into cakes, and hang them up in bags to dry. These cakes are afterwards pulverised, and the powder is used to impart the colour with an addition of alum.

6. The parellus, or crawfish-eye lichen, grows upon walls and rocks, but is not very common. The crusts spread closely upon the place where they grow, and cover them to a considerable extent. They are rough, tartareous, and ash-coloured, of a tough coriaceous substance. The shields are numerous and crowded, having white or ash-coloured, shallow, plain discs, with obtuse margins. This is used by the French for dyeing a red colour.

7. The saxatilis, or grey-blue pitted lichen, is very common upon trunks of trees, rocks, tiles, and old wood. It forms a circle two or three inches diameter. The upper surface is of a blue grey, and sometimes of a whitish ash-colour, uneven, and full of numerous small pits or cavities; the under side is black, and covered all over, even to the edges, with short simple hairs or radicles. A variety sometimes occurs with leaves tinged of a red or purple colour. This is used by finches and other small birds in constructing the outside of their curiously formed nests.

8. The omphalodes, or dark-coloured dyer's lichen, is frequent upon rocks. It forms a thick widely expanded crust of no regular figure, composed of numerous imbricated leaves of a brown or dark-purple colour, divided into small segments. The margins of the shields are a little crisped and turned inwards, and their outside ash-coloured. This lichen is much used by the Highlanders in dyeing a reddish-brown colour. They steep it in urine for a considerable time, till it becomes soft and like a paste; then, forming the paste into cakes, they dry them in the sun, and preserve them for use in the manner already related of the tartareus.

9. The parietinus, or common yellow wall-lichen, is very common upon walls, rocks, tiles of houses, and trunks of trees. It generally spreads itself in circles of two or three inches diameter, and is said to dye a good yellow or orange-colour with alum.

10. The Islandicus, or eatable Iceland lichen, grows on many mountains both of the Highlands and Lowlands of Scotland. It consists of nearly erect leaves about two inches high, of a stiff substance when dry, but soft and pliant when moist, variously divided without order into broad distant segments, bifid or trifid at the extremities. The upper or interior surface of the leaves is concave, chesnut-colour, smooth, and shining, but red at the base; the under or exterior surface is smooth and whitish, a little pitted, and sprinkled with very minute black warts. The margins of the leaves and all the segments from bottom to top, are ciliated with small, short, stiff, hair-like spinules, of a dark chesnut-colour, turning towards the upper side. The shields are very rarely produced. Made into broth or gruel, it is said to be very serviceable in coughs and consumptions; and, according to Haller and Scopoli, is much used in these complaints in Vienna.

11. The pulmonarius, or lung-wort lichen, grows in shady woods upon the trunks of old trees. The leaves are as broad as a man's hand, of a kind of leather-like substance, hanging loose from the trunk on which it grows, and laciniated into wide angular segments. Their natural colour, when fresh, is green; but in drying, they turn first to a glaucous and afterwards to a fuscous colour. It has an astringent, bitter taste; and, according to Gmelin, is boiled in ale in Siberia, instead of hops. The antients used it in coughs and asthmas, &c. but it is not used in modern practice.

12. The calicaris, or beaked lichen, grows sometimes upon trees, but more frequently upon rocks, especially on the sea-coasts, but is not very common. It is smooth, glossy, and whitish, producing flat or convex shields, of the same colour as the leaves, very near the summits of the segments, which are acute and rigid, and, being often reflected from the perpendicular by the growth of the shields, appear from under their limbs like a hooked beak. This will dye a red colour; and promises, in that intention, to rival the famous lichen rocolla or argol, which is brought from the Canary Islands, and sometimes sold at the price of 80*l*. per ton. It was formerly used instead of starch to make hair-powder.

13. The prunastri, or common ragged hoary lichen, grows upon all sorts of trees; but it is generally most white and hoary on the sloe and old palm trees, or upon old pales. This is the most variable of the whole tribe of lichens, appearing different in figure, magnitude, and colour, according to its age, place of growth, and sex. The young plants are of a glaucous colour, slightly divided into small acute crested segments. As they grow older, they are divided like a stag's horn, into more and deeper segments, somewhat broad, flat, soft, and pitted on both sides, the upper surface of a glaucous colour, the under one white and hoary. The male plants, as Linnæus terms them, are short, seldom more than an inch high, not hoary on the under side; and have pale glaucous shields situated at the extremities of the segments, standing on short peduncles, which are only small stiff portions of the leaf produced. The female specimens have numerous farinaceous tubercles both on the edges of their leaves, and the wrinkles of their furnace. The pulverised leaves have been used as a powder for the hair, and also in dyeing yarn of a red colour.

14. The juniperinus, or common yellow tree-lichen, is common upon the trunks and branches of elms and many other trees. Linnæus says it is very common upon the juniper. The Gothland Swedes dye their yarn of a yellow colour with it, and give it as a specific in the jaundice.

15. The caninus, or ash-coloured ground liverwort, grows upon the ground among

moss, at the roots of trees in shady woods, and is frequent also in heaths and stony places. The leaves are large, gradually dilated towards the extremities, and divided into roundish elevated lobes. Their upper side, in dry weather, is ash-coloured; in rainy weather, of a dull fuscous green colour; their under-side white and hoary, having many thick downy nerves, from which descend numerous long, white, pencil-like radicles. The peltæ, or shields, grow at the extremities of the elevated lobes, shaped like the human nail; of a roundish oval form, convex above, and concave beneath; of a chocolate colour on the upper side, and the same colour with the leaves on the under. There are two varieties, the one called reddish, and the other many-fingered, ground-liverwort. The former is more common than the other. This species has been rendered famous by the celebrated Dr. Mead, who asserted that it was an infallible preventative of the dreadful consequences attending the bite of a mad dog.

16. The aphthosus, or green ground liverwort with black warts, grows upon the ground at the roots of trees in woods, and other stony and mossy places. It differs very little from the foregoing, and according to some is only a variety of it. Linnæus informs us, that the country-people of Upland in Sweden give an infusion of this lichen in milk to children that are troubled with the disorder called the thrush or aphthæ, which induced that ingenious naturalist to bestow upon it the trivial name of aphthosus. The same writer also tells us, that a decoction of it in water purges upwards and downwards, and will destroy worms.

17. The cocciferus, or scarlet-tipped cup-lichen, is frequent in moors and heaths. It has in the first state a granulated crust for its ground, which is afterwards turned into small laciniated leaves, green above, and hoary underneath. The plant assumes a very different aspect, according to the age, situation, and other accidents of its growth; but may be in general readily distinguished by its fructifications, which are fungous tubercles of a fine scarlet colour, placed on the rim of the cup, or on the top of the stalk. These tubercles, steeped in an alcaline lixivium, are said to dye a fine durable red colour.

18. The rangiferinus, or rein-deer lichen, is frequent in woods, heaths, and mountainous places. Its general height, when full-grown, is about two inches. The stalk is hollow, and very much branched from bottom to top: the branches are divided and subdivided, and at last terminated by two, three, four, or five very fine, short, nodding horns. The axillæ of the branches are often perforated. The whole plant is of a hoary white or grey colour, covered with white farinaceous particles, slight and brittle when dry, soft and elastic when moist. The fructifications are very minute, round, fuscous, or reddish-brown tubercles, which grow on the very extremities of the finest branches; but these tubercles are very seldom found. The plant seems to have no foliaceous ground for the base, nor scarcely any visible roots. Linnæus tells us, that in Lapland this moss grows so luxuriant that it is sometimes found a foot high. There are many varieties of this species, of which the principal is the sylvaticus, or brown-tipt rein-deer lichen. The most remarkable difference between them is, that the sylvaticus turns fuscous by age, while the other always continues white.

19. The plicatus, or officinal stringy lichen, grows on the branches of old trees, but is not very common. The stalks are a foot or more in length, cylindrical, rigid, and string-shaped, very irregularly branched, the branches entangled together, of a cinereous or ash-colour, brittle and stringy if doubled short, otherwise tough and pliant, and hang pendant from the trees on which they grow. The shields grow generally at the extremities of the branches, are nearly flat, or slightly concave, thin, ash-coloured above, pale-brown underneath, and radiated with fine rigid fibres. As the plant grows old, the branches become covered with a white, rough, warty crust; but the young ones are destitute of it. It was formerly used in the shops as an astringent to stop hæmorrhages, and to cure ruptures; but is out of the modern practice. Linnæus informs us, that the Laplanders apply it to their feet to relieve the excoriations occasioned by much walking.

20. The barbatus, or bearded lichen, grows upon the branches of old trees in thick woods and pine-forests. The stalks or strings are slightly branched and pendulous, from half a foot to two feet in length, little bigger than a taylor's common sewing-thread; cylindrically jointed towards the base; but surrounded every where else with numerous horizontal capillary fibres, either simple or slightly branched. Their colour is a whitish green. This has an astringent quality like the preceding. When steeped in water, it acquires an orange colour; and, according to Dillenius, is used in Pennsylvania for dyeing that colour.

21. The vulpinus, or gold wiry lichen, grows upon the trunks of old trees, but is not very common. It is produced in erect tufts, from half an inch to two inches in height, of a fine yellow or lemon-colour, which readily discovers it. The filaments which compose it are not cylindrical, but a little compressed and uneven in the surface, variously branched, the angles obtuse, and the branches straggling and entangled one with another. Linnæus informs us, that the inhabitants of Smaland in Sweden dye their yarn of a yellow colour with this lichen; and that the Norwegians destroy wolves by stuffing dead carcases with this moss reduced to powder, and mixed with pounded glass, and so exposing them in the winter-season to be devoured by those animals.

LICONIA, in botany; a genus of the digynia order, belonging to the pentandria class of plants. There are five petals inlaid in the pit of the nectarium at its base; the capsule is bilocular and seed-bearing.

LICUALA, a genus of the nat. order of palmæ. The flowers are all hermaphrodite; cal. and cor. three-parted; nect. sertiform drupe. There is one species.

LIEUTENANTS, *Lords, of counties*, are officers who, upon any invasion or rebellion, have power to raise the militia, and to give commissions to colonels and other officers, to arm and form them into regiments, troops, and companies. Under the lords-lieutenants, are deputy-lieutenants, who have the same power; these are chosen by the lords-lieutenants, out of the principal gentlemen of each county, and presented to the king for his approbation.

LIFE ANNUITIES, annual payments, to continue during any given life or lives. The present value of a life annuity is the sum which would be sufficient (allowing for the chance of the life failing) to pay the annuity without loss; and supposing money to bear no interest, the value of an annuity of 1*l.* is equal to the expectation of the life. Thus it will be found by the table given under the article EXPECTATION OF LIFE, that the expectation of a life aged forty, is twenty-three years; or, in other words, that a set of lives at this age, will, one with another, enjoy twenty-three years each of existence, some of them enjoying a duration as much longer as others fall short of it. Therefore, supposing money to bear no interest, 23*l.* in hand for each life would be sufficient to pay to any number of such lives 1*l.* per annum, for their whole duration; or, in other words, 23*l.* is, on this supposition, the value of a life aged forty. But if any improvement is made of money by putting it out to interest, the sum just mentioned will be more than the value, because it will be more than sufficient to pay the annuity; and it will be as much more than sufficient as the improvement or the interest is greater. If, for instance, money may be so improved by being put out to interest, at 5*l.* per cent. as to double itself in fourteen years, the seller of such an annuity, on putting out *half* the purchase money to interest, will at the end of fourteen years find himself in possession of 20*l.* 10*s.* or of 11*l.* 10*s.* more than is sufficient to pay the remainder of the annuities, though he should make no further improvement of the purchase money. At whatever rate of interest the money is improved, there must be a surplus; and if it is fully improved at 5*l.* per cent., it will be found that 11*l.* 16*s.* 8*d.* for each annuity, will be sufficient (instead of 23*l.*) to make all the annual payments; or, if money can be improved at 6*l.* per cent., 10*l.* 14*s.* 1*d.* will be sufficient.

Many persons have fallen into an error with respect to the value of life-annuities, by considering it the same as the value of an annuity certain for a term of years equal to the expectation of the life. The inaccuracy of this mode of computation arises from the difference between the value of a certain number of payments to be made every year regularly till the term is completed, and the value of the same number of payments to be made at greater distances of time from one another, and not to be all made till many years after the expiration of the term equal to the expectation.

The true method of computing the values of life-annuities cannot be more clearly expressed than as it is given in "The Doctrine of Annuities and Assurances on Lives and Survivorships," by William Morgan.—"Was it *certain* that a person of a given age would live to the end of a year, the value of an annuity of 1*l.* on such a life would be the present sum that would increase in a year to the value of a life one year older, together with the value of the single payment of 1*l.* to be made at the end of a year; that is, it would be 1*l.* together with the value of a life aged one year older than the given life, multiplied by the value of 1*l.* payable at the end of a year. Call the value of a life one year older than the given life N, and the value of 1*l.*

payable at the end of a year $\frac{1}{r}$; then will the value of an annuity on the given life, on the supposition of a *certainty*, be $\frac{1}{r} + \frac{1}{r} \times N = \frac{1}{r} \times \overline{1 + N}$. But the fact is, that it is *uncertain* whether the given life will exist to the end of the year or not. this last value therefore, must be diminished in the proportion of this uncertainty; that is, it must be multiplied by the probability that the given life will survive one year, or supposing $\frac{b}{a}$ to express this probability, it will be $\frac{b}{ar} \times \overline{1 + N}$. In the same manner the values of annuities on the *joint continuance* of lives may be found: Call the value of any two joint lives M, the probability that two lives one year younger will exist a year $\frac{bd}{ac}$, and $\frac{1}{r}$ as above, the value of 1*l*., payable at the end of the year. Then, by reasoning as before, the value of the joint continuance of two lives one year younger will be expressed by $\frac{bd}{acr} \times \overline{1 + M}$."

By these theorems, tables may be calculated of the values of single or joint lives, according to any table of the probabilities of life, and by the use of logarithms, and computing upwards, from the oldest to the youngest life, the labour of forming such tables is not very great; few persons, however have occasion to undertake it, as the tables published by Dr. Price, Mr. Morgan, and Mr. Maseres, shew the values of life-annuities as accurately as the present knowledge of the decrements and duration of human life will admit, and are sufficient for almost every useful purpose.

TABLE I.

Shewing the Value of an Annuity of £.1 on a Single Life at every Age according to the probabilities of the duration of Human Life at Northampton, reckoning Interest at 5 per Cent.

Ages.	Value.	Age	Value.	Age.	Value.
Birth.	8.863	33	12.740	66	7.034
1 year	11.563	34	12.623	67	6.787
2	13 420	35	12.502	68	6.536
3	14.135	36	12 377	69	6.281
4	14.613	37	12..49	70	6.023
5	14.827	38	12.116	71	5.764
6	15.041	39	11.979	72	5.504
7	15.166	40	11.837	73	5.245
8	15 226	41	11.695	74	4.990
9	15.210	42	11.551	75	4.744
10	15.139	43	11.407	76	4.511
11	15 043	44	11.258	77	4.277
12	14.937	45	11.105	78	4.035
13	14.826	46	10.947	79	3.776
14	14.710	47	10.784	80	3.515
15	14.588	48	10.616	81	3.263
16	14.460	49	10.443	82	3.020
17	14.334	50	10.269	83	2.797
18	14.217	51	10.097	84	2.627
19	14 108	52	9.925	85	2.471
20	14.007	53	9.748	86	2.328
21	13 917	54	9.567	87	2.193
22	13 833	55	9.382	88	2.080
23	13.746	56	9.193	89	1.924
24	13.658	57	8.999	90	1.723
25	13.567	58	8.801	91	1.447
26	13.473	59	8.599	92	1.153
27	13.377	60	8.392	93	0.816
28	13.278	61	8.181	94	0.524
29	13.177	62	7.966	95	0.238
30	13.072	63	7.742	96	0.000
31	12.965	64	7.514		
32	12.854	65	7.276		

These values suppose the payments to be made *yearly*, and to begin at the end of the first year; if the payments are to be made *half-yearly*, the value in the table will be increased about one-fifth of a year's purchase.

In order to find the present value of an annuity during any given life, it is only necessary to multiply the value in the table corresponding with the age, by the given annuity.

Example. What should a person, aged 45, give, to purchase an annuity of 50*l*. during his life?

The value in the table against 45 years is 11.105, which multiplied by 50, gives the answer 555*l*. 5*s*.

TABLE II.

Shewing the Value of an Annuity during the joint contińuance of Two Lives, according to the probabilities of Life at Northampton; reckoning Interest at 5 per Cent.

Ages.	Value.	Ages.	Value.	Ages	Value.
5–5	11.984	20–25	10.989	40–45	8.643
5–10	12.315	20–30	10.707	40–50	8.177
5–15	11.954	20–35	10.363	40–55	7.651
5–20	11.561	20–40	9.937	40–60	7.015
5–25	11.281	20–45	9.448	40–65	6.240
5–30	10.959	20–50	8.861	40–70	5.298
5–35	10.572	20–55	8.216	40–75	4.272
5–40	10.102	20–60	7.463	40–80	3.236
5–45	9.571	20–65	6.576	45–45	8.312
5–50	8.941	20–70	5.532	45–50	7.891
5–55	8.256	20–75	4.424	45–55	7.411
5–60	7.466	20–80	3.325	45–60	6.822
5–65	6.546	25–25	10.764	45–65	6.094
5–70	5.472	25–30	10.499	45–70	5.195
5–75	4.362	25–35	10.175	45–75	4.206
5–80	3.238	25–40	9.771	45–80	3.197
10–10	12.665	25–45	9.304	50–50	7.522
10–15	12.302	25–50	8.739	50–55	7.098
10–20	11 906	25–55	8.116	50–60	6.568
10–25	11.627	25–60	7.383	50–65	5.897
10–30	11.304	25–65	6.515	50–70	5 054
10–35	10.916	25–70	5.489	50–75	4.112
10–40	10.442	25–75	4 396	50–80	3.140
10–45	9.900	25–80	3.308	55–55	6.735
10–50	9.260	30–30	10.255	55–60	6.272
10–55	8.560	30–35	9.954	55–65	5.671
10–60	7.750	30–40	9.576	55–70	4.893
10–65	6.803	30–45	9.135	55–75	4.006
10–70	5.700	30–50	8 596	55–80	3.076
10–75	4.522	30–55	7.999	60–60	5.888
10–80	3.395	30–60	7.292	60–65	5.372
15–15	11.960	30–65	6.447	60–70	4.680
15–20	11.585	30–70	5.442	60–75	3.866
15–25	11.324	30–75	4.365	60–80	2.992
15–30	11.021	30–80	3.290	65–65	4.960
15–35	10.655	35–35	9.680	65–70	4.378
15–40	10.205	35–40	9.331	65–75	3.665
15–45	9.690	35–45	8 921	65–80	2.873
15–50	9.076	35–50	8.415	70–70	3.930
15–55	8 403	35–55	7.849	70–75	3.347
15–60	7.622	35–60	7 174	70–80	2.675
15–65	6.705	35–65	6.360	75–75	2.917
15–70	5.631	35–70	5.382	75–80	2 381
15–75	4.495	35–75	4.327	80–80	2.018
15–80	3.372	35–80	3 268	85–85	1.256
20–20	11.232	40–40	9.016	90–90	0.909

It is unnecessary to insert a Table of the values of the longest of two lives, as it may be easily found from the values given in the above tables by the following general rules:

"From the sum of the values of the single lives subtract the value of an annuity on the joint lives, and the remainder will give the value of an annuity on the continuance of the longest of two such lives."

Example. What is the value of an annuity on the longest of two lives whose ages are thirty and forty?

By Table I. the value of a single life of 30 is 13.072, and by the same Table the value of a single life of 40 is 11.837. Their sum therefore is 24.909, from which 9 576 (the value of the joint lives of 30 and 40 by Table II.) being subtracted, gives 15.333 for the number of years purchase required.

The value of an annuity on three joint lives may be found from the preceding tables, by the following rule:

"Let A be the youngest, and C the oldest of the three proposed lives. Take the value of the two joint lives B and C, and find the age of a single life D of the same value. Then find the value of the joint lives A and D, which will be the answer."

Example. Let the three given lives be 20, 30, and 40. The value of the two oldest joint lives B and C will (by Table II.) be 9.576, answering in Table I. to a single life D of 54 years; and the value of the joint lives A and D, or the ages in the Table which come nearest to them, gives 8.216 for the value sought.

The value of three joint lives being known, the value of the longest of any three lives may be computed by the following rule:

"From the sum of the values of all the single lives, subtract the sum of the values of all the joint lives combined two and two. Then to the remainder add the value of the three joint lives; and this last sum will be the value of the longest of the three lives."

Example. The sum of the values of three single lives whose ages are 20, 30, and 40, is (by Table I.) 38.916. The value of two joint lives, whose ages are 20 and 30, is (by Table II.) 10.707; of two joint lives whose ages are 20 and 40, is 9.937, and two joint lives whose ages are 30 and 40 is 9.576; the sum of these three values is 30.220. This sum subtracted from 38.916, leaves 8.696, which remainder added to 8.216 (the value of the three joint lives in the last example), gives 16.912, the value of the longest of the three lives. The answers in this and the preceding example are not quite exact, in consequence of the table of joint lives being confined to the combinations of every fifth year of age; those who have occasion to make such computations, will find more extensive tables of the values of joint lives in Dr. Price's excellent Treatise on Reversionary Payments; but a general table of the values of two joint lives for every possible difference of age, at different rates of interest, has long been very desirable.

The solutions of the following Problems, in addition to the rules already given, will comprehend all the cases which most commonly occur relating to the values of annuities on lives or survivorship.

Prob. I. To detemine the value of an annuity on a given life for any number of years.

Solution. Find the value of a life as many years older than the given life as are equal to the term for which the annuity is proposed. Multiply this value by 1*l*., payable at the end of this term, and also by the probability that the life will continue so long. Subtract the product from the present value of the given life, and the remainder multiplied by the annuity will be the answer.

Example. Let the annuity be 20*l*. the age of the given life 35 years, and the term proposed 14 years. The value of a life aged 49 years (or 14 years older than the given life), appears by Table I. to be 10.443. The value of 1*l.* payable at the end of 14 years (see COMPOUND INTEREST), is .505068, and the probability that the life will exist so long, (See EXPECTATION OF LIFE) is $\frac{2936}{4010}$. These three values multiplied into each other are equal to 3.861, which being subtracted from 12.502 (the present value of the given life by Table I.), we have 8.641, and this remainder multiplied by 20, gives 162*l.* 16*s.* 4*d.* for the value required.

In a similar manner the value of an annuity for any given term, upon two joint lives, may be determined.

PROB. II. To find the value of an annuity certain for a given term after the extinction of any given life or lives.

Solution. Subtract the value of the life or lives from the perpetuity, and reserve the remainder. Then say, as the perpetuity, is to the present value of the annuity certain, so is the said reserved remainder, to a fourth proportional, which will be the number of years purchase required.

Example. A and his heirs are entitled to an annuity certain for 14 years, to commence at the death of B, aged 35. What is the present value of A's interest in this annuity?

By Table I. the value of the life of B is 12.502, which subtracted from 20, the perpetuity, leaves 7.498 for the remainder to be reserved. Then, as 20, is to 9.898 (the value of an annuity certain for 14 years), so is 7.498 (the reserved remainder), to 3.7107, the number of years purchase required.

PROB. III. To find the value of an annuity for a term certain, and also for what may happen to remain of a given life or lives after the expiration of this term.

Solution. Find the value of a life or lives as many years older than the given life or lives as are equal to the term for which the annuity certain is proposed. Multiply this value by 1*l.* payable at the end of the given term, and also by the probability that the given life or lives will continue so long. Add the product to the value of the annuity certain for the given term, and the sum will be the answer.

Example. Let the value be required of an annuity certain for 14 years, and also for the remainder of a life now aged 35 after the expiration of this term. By Table I. the value of a life aged 49 (or 14 years older than the given life) is 10.443. The value of 1*l.* payable at the end of 14 years, is .505068, and the probability that the life will exist so long is $\frac{2936}{4010}$. These three numbers multiplied into each other, produce 3.861, which being added to 9.898, the value of an annuity certain for 14 years (see ANNUITIES), becomes equal to 13.759, the number of years purchase required.

PROB. IV. To determine what annuity any given sum will purchase during the joint lives of two persons of given ages, and also during the life of the survivor, on condition that the annuity shall be reduced one-half at the extinction of the joint lives.

Solution. Let twice the given sum be divided by the sum of the two single lives, and the quotient will give the annuity to be paid during the joint lives; one-half of which is therefore the annuity to be paid during the remainder of the surviving life.

Example. A aged 27, and B aged 35, are desirous of sinking 1000*l.* in order to receive an annuity during their joint lives, and also another annuity of half the value during the remainder of the surviving life. It is required to determine what annuities should be granted them under those circumstances. By Table I. the value of a life of 27 is 13.377, and the value of a life of 35 is 12.502. 2000*l.* (or twice the given sum) being divided by 25.879 (the sum of the values of the two lives), gives 77.282*l.* for the annuity to be granted during the joint continuance of the lives; and its half, or 38.641*l.* is the annuity to be paid during the life of the survivor.

PROB. V. B, who is of a given age, will, if he lives till the decease of A, whose age is also given, become possessed of a perpetual annuity, or of an estate of a given yearly value; to find the worth of his expectation in present money.

Solution. Find the value of an annuity on two equal joint lives whose common age is equal to the age of the oldest of the two proposed lives, which value subtract from the perpetuity, and take half the remainder: then say, as the expectation of duration of the younger of the two lives, is to that of the older, so is the said half remainder, to a fourth proportional; which will be the number of years purchase required when the life of B in expectation is the older of the two: but if B be the younger, then add the value so found to that of the joint lives A and B, and let the sum be subtracted from the perpetuity, and you will also have the answer in this case.

Example. Suppose the age of B to be 30, and that of A 20 years, and the value of the estate 50*l.* per annum. Then the value of two equal joint lives, aged 30, is, by Table II. 10.255, and the perpetuity being 20, the difference will be 9.745, the half of which is 4.872. Therefore as 33.43, the expectation of A, is to 28.27, the expectation of B, so is 4.872, to 4.119, which being multiplied by 50, the given annuity, we have 205.95*l.* for the required value of B's expectation.

If the age of B had been 20, and that of A 30 years, then to 4.119, the value just found, add the value of the joint lives, which, by Table II. is 10.707, and the sum is 14.826, which subtracted from 20, the perpetuity, and the remainder multiplied by 50, gives 258.7*l.* for the required value in this case.

LIFE ESTATES are of two kinds, such as are created by the act of the parties, or such as are created by the operation of the law, as estates by curtesy or dower. 2 Black. 120.

Estates for life, created by deed or grant, are, where a lease is made of lands or tenements to a man, to hold for the term of his own life, or for that of another person, or for more lives than one; in any of which cases, he is called tenant for life: only when he holds the estate by the life of another, he is usually termed tenant pur auter vie, for another's life.

Estates for life may be created not only by the express terms before-mentioned, but also by a general grant, without defining or limiting any specific estate. 2 Black. 121.

If such persons, for whose life any estate shall be granted, shall absent themselves seven years, and no proof made of the lives of such persons, in any action commenced for the recovery of such tenements by the lessors or reversioners, the persons upon whose lives such estate depended, shall be accounted as dead; and the judges shall direct the jury to give their verdict as if the person absenting himself was dead. 19 Car. II. c. 6.

LIGAMENT. See ANATOMY.

LIGATURE. See SURGERY.

LIGHT. See OPTICS.

LIGHTS: stopping lights of any house is a nuisance, for which an action will lie, if the house is an antient house, and the lights antient lights: but stopping a prospect is not, being only matter of delight, not of necessity; and a person may have either an assize of nuisance against the persons erecting any such nuisance, or he may stand on his own ground and abate it. 2 Salk. 247.

LIGHTFOOTIA, a genus of the class and order polygamia dioecia. The cal. is four-leaved; cor. none; fem. and her. stigma sessile; berry umbilicated. There are three species, shrubs of the E. Indies.

LIGHTNING. See ELECTRICITY.

LIGUSTICUM, lovage; a genus of the digynia order, in the pentandria class of plants; and in the natural method ranking under the 45th order, umbellatæ. The fruit is oblong, and quinquesulcated on each side; the florets are equal; the petals involuted or rolled inwards, and entire. There are eight species, of which the most remarkable are, the levisticum, or common, and the Scoticum, or Scots, lovage. The first is a native of the Appenine mountains in Italy. The second is a native of Scotland, and grows near the sea in various parts of the country.

The root of the first species agrees nearly in quality with that of angelica: the principal difference is, that the lovage-root has a stronger smell, and a somewhat less pungent taste, accompanied with a more durable sweetness, the seeds being rather warmer than the root; but although certainly capable of being applied to useful purposes, this root is not regarded in the present practice. The leaves of the second are sometimes eaten raw as a salad, or boiled as greens, by the inhabitants of the Hebrides. They give an infusion of the leaves in whey to calves, to purge them.

LIGUSTRUM, *privet*, a genus of the monogynia order, in the diandria class of plants; and in the natural method ranking under the 44th order, sepiariæ. The corolla is quadrifid; the berry tetraspermous. There are three species; of the common there are two varieties, the deciduous and the evergreen. They are hardy plants, rising from ten to fifteen feet high. They are easily propagated by seed, layers, suckers, or cuttings. They are used for making hedges. The purple colour upon cards is prepared from the berries. With the addition of alum, these berries are said to dye wool and silk of a good and durable green; for which purpose they must be gathered as soon as they are ripe. The leaves are bitter and slightly astringent. Oxen, goats, and sheep, eat the plant; horses refuse it.

LIKE, in geometry, &c. denotes the same with similar. See SIMILAR.

LILAC, in botany, a genus of trees, otherwise called syringa. See SYRINGA.

LILALITE. This stone appears to have been first observed by the abbé Poda, and to have been then described by De Born. Hitherto it has only been found in Moravia in Germany, and Sudermania in Sweden. There it is mixed with granite in large amorphous masses. It is composed of thin plates, easily separated, and not unlike those of mica. Not easily pulverised. Specific gravity 2.8549. Colour of the mass, violet-blue; of the thin plates, silvery white. Powder white, with a tint of red. Before the blowpipe, it froths, and melts easily into a white semitransparent enamel, full of bubbles. Dissolves in borax with effervescence, and communicates no colour to it. Effervesces slightly with soda, and melts into a mass spotted with red. With microcosmic salts it gives a pearl-coloured globule.

This stone was first called lilalite from its colour, that of the lily. Klaproth, who discovered its component parts, gave it the name of lepidolite.

It is composed of	53	silica
	20	alumina
	18	potass
	5	fluat of lime
	3	oxide of manganese
	1	oxide of iron
	100.	

LILIUM, the *lily*; a genus of the monogynia order, in the hexandria class of plants; and in the natural method ranking under the 10th order, coronariæ. The corolla is hexapetalous, and campanulated, with a longitudinal nectariferous line or furrow; the capsules connected by small cancellated hairs. There are eleven species; all of them bulbous-rooted, herbaceous, flowery perennials, rising with erect annual stalks three or four feet high, garnished with long narrow leaves, and terminated by fine clusters of large, bell-shaped, hexapetalous flowers of great beauty, of white, red, scarlet, orange, purple, and yellow colours.

All the species are propagated by sowing the seeds; and if care is taken to preserve these seeds from good flowers, very beautiful varieties are often produced.

The roots of the white lily are emollient, maturating, and suppurative, and are used externally in cataplasms for these purposes with success. The common form of applying them is, boiled and bruised. Gerard recommends them internally against dropsies.

The Kamtschatence, or Kamtschatka lily, called there saranne, makes a principal part of the food of Kamtschatkans. Its roots are gathered by the women in August, dried in the sun, and laid up for use: they are the best bread of the country; and after being baked are reduced to powder, and serve instead of flour in soups and several dishes. They are sometimes washed, and eaten as potatoes; are extremely nourishing, and have a pleasant bitter taste. Our navigators boiled and ate them with their meat. The natives often parboil, and beat it up with several sorts of berries, so as to form of it a very agreeable confection. Providentially it is an universal plant there, and all the grounds bloom with its flower during the season. Another happiness remarked there is, that while fish are scarce, the saranne is plentiful; and when there is a dearth of this, the rivers pour in their provisions with redoubled profusion. It is not to the labours of the females alone that the Kamtschatkans are indebted for these roots. A species of mouse saves them a great deal of trouble. The saranne forms part of the winter provisions of that little animal: they not only gather them in the proper season, and lay them up in their magazines, but at times have the instinct of bringing them out in sunny weather to dry them, lest they should decay. The natives search for their hoards; but with prudent tenderness leave part for the owners, being unwilling to suffer such useful caterers to perish.

LIMAX, the *slug*, or naked snail; a genus of insects belonging to the order of vermes mollusca. The body is oblong, fitted for crawling, with a kind of muscular coat on the upper part, and the belly is plain. They have four tentacula, or horns, situated above the mouth, which they extend or retract at pleasure. This reptile is always destitute of shell; but besides that its skin is more clammy, and of a greater consistency, than that of the snail, the black naked slug has a furrowed cloak, almost as thick and as hard as leather, under which it withdraws its head as within a shell. The head is distinguished from the breast by a black line. It is in its head and back that the snail-stone is found; which is a small pearled and sandy stone, of the nature of limestones: according to a popular opinion, it cures the tertian ague, if fastened to the patient's arm. These slugs move on slowly, leaving every where clammy and shining marks of their passage. They deposit their eggs in the earth. There are eight species, distinguished entirely by their colour; as the black slug, the white slug, the reddish slug, the ash-coloured slug, &c. The black slug is hermaphrodite. A black slug, powdered over with snuff, salt, or sugar, falls into convulsions, casts forth all its foam, and dies.

LIME, one of those earthy substances, which exist in every part of the known world. It is found purest in limestone, marble, and chalk. None of these substances are lime, but are capable of becoming so by burning in a white heat.

Lime may be also obtained perfectly pure by burning those crystallized limestones called calcareous spars, which are perfectly white and transparent, and also by burning some pure white marbles. It may be procured also in a state of purity by dissolving oyster-shells in muriatic acid, filtring the solution, mixing it with ammonia as long as a white powder continues to fall, and filtring again. The liquid is now to be mixed with a solution of carbonat of soda: the powder which falls being washed and dried, and heated violently in a platinum crucible, is pure lime.

Pure lime is of a white colour, moderately hard, but easily reduced to a powder. It has a hot burning taste, and in some measure corrodes and destroys the texture of those animal bodies to which it is applied. Its specific gravity is 2.3. It tinges vegetable blues green, and at last converts them to yellow.

If water be poured on newly burnt lime, it swells and falls to pieces, and is soon reduced to a very fine powder. In the mean time so much heat is produced, that part of the water flies off in vapour. If the quantity of lime slacked (as this process is termed) be great, the heat produced is sufficient to set fire to combustibles. In this manner, vessels loaded with lime have sometimes been burnt. When great quantities of lime are slacked in a dark place, not only heat but light also is emitted, as Mr. Pelletier has observed. When slacked lime is weighed, it is found to be heavier than it was before. This additional weight is owing to the combination of part of the water with the lime; which water may be separated again by the application of a red heat; and by this process the lime becomes just what it was before being slacked. Hence the reason of the heat evolved during the slacking of lime. Part of the water combines with the lime, and thus becomes solid; of course it parts with its caloric of fluidity, and probably also with a considerable quantity of caloric, which exists in water even when in the state of ice: for when two parts of lime and one part of ice (each at 32°) are mixed, they combine rapidly, and their temperature is elevated to 212°. The elevation of temperature during the slacking of barytes and strontian is owing to the same cause.

The smell perceived during the slacking of lime is owing to a part of that earth being elevated along with the vapour of the water; as evidently appears from this circumstance, that vegetable blues exposed to this vapour are converted to green.

Limestone and chalk, though they are capable of being converted into lime by burning, posesses hardly any of the properties of that active substance. They are tasteless, scarcely soluble in water, and do not perceptibly act on animal bodies. Now, to what are the new properties of lime owing? What alteration does it undergo in the fire?

It had been long known, that limestone loses a good deal of weight by being burned or calcined. It was natural to suppose, therefore, that something is separated from it during calcination. Dr. Black, of Edinburgh, published in 1756, those celebrated experiments on this subject, which form so brilliant an era in the history of chemistry. He first ascertained, that the quantity of water separated from limestone during its calcination is not nearly equal to the weight which it lost. He concluded in consequence, that it must have lost something else than mere water. What this could be, he was at first at a loss to conceive; but recollecting that Dr. Hales had proved, that limestone, during its solution in acids, emits a great quantity of air, he conjectured that this might probably be what it lost during calcination. He calcined it accordingly, and applied a pneumatic apparatus to receive the product. He found his conjecture verified; and that the air and water which separated from the lime were together precisely equal to the loss of weight which it had sustained. Lime, therefore, owes its new properties to the loss of air; and limestone differs from lime merely in being combined with a certain quantity of air: for he found that, by restoring again the same quantity of air to lime, it was converted into limestone. This air, because it existed in lime in a fixed state, he called fixed air. It was afterwards examined by Dr. Priestley and other philosophers; found to possess peculiar properties, and to be that species of gas now known by the name of carbonic acid gas. Lime then is a simple substance, and limestone is composed of carbonic acid and lime. Heat separates the carbonic acid, and leaves the lime in a state of purity. See Air.

When lime is exposed to the open air, it gradually attracts moisture, and falls to powder; after which it soon becomes saturated with carbonic acid, and is again converted into carbonat of lime or unburnt limestone.

Water, at the common temperature of the atmosphere, dissolves about 0.002 parts of its weight of lime. This solution is called lime-water. It is limpid, has an acrid taste, and changes vegetable blue colours to green. One ounce troy of lime-water contains about one grain of lime. It is usually formed by throwing a quantity of lime in powder into pure water, allowing it to remain for some time in a close vessel, and then decanting the transparent solution from the undissolved lime. When lime-water is exposed to the air, a stony crust soon forms on its surface, composed of carbonat of lime; when this crust is broken it falls to the bottom and another succeeds it; and in this manner the whole of the lime is soon precipitated, by absorbing carbonic acid from the air.

Lime is not acted on by light, neither does it combine with oxygen. Sulphur and phosphorus are the only simple combustibles with which it unites.

Sulphuret of lime may be formed by mixing its two component parts, reduced to a powder, and heating them in a crucible. They undergo a commencement of fusion, and form an acrid taste. When it is exposed to the air, or moistened with water, its colour becoming greenish-yellow, sulphureted hydrogen is formed, and the sulphuret is converted into a hydrogenated sulphuret, which exhales a very fetid odour of sulphureted hydrogen gas. This hydrogenated sulphuret may be formed also by boiling a mixture of lime and sulphur in about ten times its weight of water, or by sprinkling quicklime with sulphur and then moistening it: the heat occasioned by the slacking of the lime is sufficient to form the combination. When this hydrogenated sulphuret is exposed to the air, it imbibes oxygen; which combines at first with the hydrogen, and afterwards with the sulphur, and converts the compound into sulphat of lime.

Phosphuret of lime may be formed by the following process: put into the bottom of a glass tube, close at one end, one part of phosphorus; and, holding the tube horizontally, introduce five parts of lime in small lumps, so that they shall be about two inches above the phosphorus. Then place the tube horizontally among burning coals, so that the part of it which contains the lime may be made red-hot, while the bottom of the tube containing the phosphorus remains cold. When the lime becomes red-hot, raise the tube, and draw it along the coals till that part of it which contains the phosphorus is exposed to a red heat. The phosphorus is immediately volatilized, and passing through the hot lime combines with it. During the combination the mass becomes of a glowing red heat, and a quantity of phosphurated hydrogen gas is emitted, which takes fire when it comes into the air.

Lime does not combine with azote; but it unites readily with muriatic acid, and forms muriat of lime. It facilitates the oxidizement of several of the metals, and it combines with several of the metallic oxides, and forms salts which have not hitherto been examined, if we except the compounds which it forms with the oxides of mercury and lead, which have been described by Berthollet.

The red oxide of mercury, boiled with lime-water, is partly dissolved, and the solution yields by evaporation small transparent yellow crystals. This compound has been called by some mercuriat of lime.

Lime-water also dissolves the red oxide of lead, and (still better) litharge. This solution, evaporated in a retort, gives very small transparent crystals, forming prismatic colours, and not more soluble in water than lime. It is decomposed by all the alkaline sulphats, and by sulphureted hydrogen gas. The sulphuric and muriatic acids precipitate the lead. This compound blackens wool, the nails, the hair, and white of eggs; but it does not affect the colour of silk, the skin, the yolk of egg, nor animal oil. It is the lead which is precipitated on these coloured substances in the state of oxide; for all acids can dissolve it. The simple mixture of lime and oxide of lead blackens these substances; a proof that the salt is easily formed.

Lime does not combine with alkalies. The affinities of lime are arranged by Bergman in the following order:

Oxalic acid	Arsenic
Sulphuric	Lactic
Tartaric	Citric
Succinic	Benzoic
Phosphoric	Sulphurous
Saclactic	Acetic
Nitric	Boracic
Muriatic	Carbonic
Suberic	Prussic
Fluoric	

One of the most important uses of lime is, in the formation of mortar as a cement in building. Mortar is composed of quicklime and sand reduced to a paste with water. When dry it becomes as hard as stone, and as durable; and adhering very strongly to the surfaces of the stones which it is employed to cement, the whole wall becomes in fact nothing else than one single stone. But this effect is produced very imperfectly unless the mortar is very well prepared.

The lime ought to be pure, completely free from carbonic acid, and in the state of a very fine powder: the sand should be free from clay, and partly in the state of fine sand, partly in that of gravel: the water should be pure; and if previously saturated with lime, so much the better. The best proportions, according to the experiments of Dr. Higgins, are three parts of fine sand, four parts of coarse sand, one part of quicklime recently slacked, and as little water as possible.

The stony consistence which mortar acquires, is owing partly to the absorption of carbonic acid, but principally to the combination of part of the water with the lime. This last circumstance is the reason that if to common mortar one-fourth part of lime, reduced to powder without being slacked, is added, the mortar, when dry, acquires much greater solidity than it otherwise would do. This was first proposed by Loriot; and a number of experiments were afterwards made by Morveau. The proportions which this philosopher found to answer best are the following:

Fine sand - -	0.3
Cement of well-baked bricks	0.3
Slacked lime - -	0.2
Unslacked lime - -	0.2
	1.0

The same advantages may be attained by using as little water as possible in slacking the lime.

Higgins found that the addition of burnt bones improved mortar by giving it tenacity, and rendering it less apt to crack in drying; but they ought never to exceed one-fourth of the lime employed.

When a little manganese is added to mortar, it acquires the important property of hardening under water; so that it may be employed in constructing those edifices which are constantly exposed to the action of water. Limestone is often combined with manganese: in that case it becomes brown by calcination.

LIMESTONE. See Salts, *calcareous*.

Limestone, *primitive* and *secondary*. See Rocks.

LIMEUM, a genus of the class and order heptandria digynia. The cal. is five-leaved; pet. five, equal; caps. globular, two-celled. There are three species, herbaceous plants of the Cape.

LIMIT, in a restrained sense, is used by mathematicians for a determinate quantity to which a variable one continually approaches; in which sense the circle may be said to be the limit of its circumscribed and inscribed polygons. In algebra, the term limits is applied to two quantities, one of which is greater, and the other less, than another quantity; and in this sense it is used in speaking of the limits of equations, whereby their solution is much facilitated.

Let any equation, as $x^3 - px^2 \times qx - r = 0$ be proposed; and transform it into the following equation:

$$\left.\begin{array}{r} y^3 + 3ey^2 + 3e^2y + e^3 \\ - py^2 - 2pey - pe^2 \\ + qy + qe \\ - r \end{array}\right\} = 0,$$

where the values of y are less than the respective values of x, by the difference e. If you suppose e to be taken such as to make all the co-efficients of the equation of y positive, viz. $e^3 - pe^2 + qe - r$, $3e^2 - 2pe + q$, $3e - p$; then there being no variation of the signs in the equation, all the values of y must be negative; and consequently the quantity e, by which the values of x are diminished, must be greater than the greatest positive value of x: and, consequently, must be the limit of the roots of the equation $x^3 - px^2 + qx - r = 0$.

It is sufficient, therefore, in order to find the limit, to enquire what quantity substituted for x, in each of these expressions $x^3 - px^2 + qx - r$, $3x^2 - 2px + q$, $3x - p$, will give them all positive; for the quantity will be the limit required.

Having found the limit that surpasses the greatest positive root, call it m. And if you assume $y = m - x$, and for x substitute $m - y$, the equation that will arise will have all its roots positive; because m is supposed to surpass all the values of x, and consequently $m - x$ ($= y$) must always be affirmative. And, by this means, any equation may be changed into one that shall have all its roots affirmative.

Or, if $-n$ represent the limit of the negative roots, then by assuming $y = x + n$, the proposed equation shall be transformed into one that shall have all its roots affirmative; for, $+n$ being greater than any negative value of x, it follows that $y = x - n$ must be always positive.

What is here said of the above cubic equation, may be easily applied to others; and of all such equations, two limits are easily discovered, viz. o, which is less than the least; and e, found as above, which surpasses the greatest root of the equation. But besides these, other limits still nearer the roots may be found; for the method of doing which, the reader may consult Maclaurin's Algebra.

LIMITATION, a certain time prescribed by statute, within which an action must be brought. The time of limitation is twofold; first in writs, by divers acts of parliament; secondly to make a title to any inheritance, and that is by the common law.

Limitation on penal statutes.—All actions, suits, bills, indictments, or informations, which shall be brought for any forfeiture upon any statute penal, made or to be made, whereby the forfeiture is or shall be limited to the queen, her heirs or successors only, shall be brought within two years after the offence committed, and not after two years; and all actions, suits, bills, or informations, which shall be brought for any forfeiture upon any penal statute, made or to be made, except the statutes of tillage, the benefit and suit whereof is or shall be by the said statute limited to the queen, her heirs or successors, and to any other that shall prosecute in that behalf, shall be brought by any person that may lawfully sue for the same, within one year next after the offence committed; and in default of such pursuit, then the same shall be brought for the queen's majesty, her heirs or successors, any time within the two years, after that year is ended: and it is provided, that where a shorter time is limited by any penal statute, the prosecution must be within that time. 31 Eliz. c. 5.

Limitation in regard to personal actions of assault and battery, and actions arising upon contract and trespass.

All actions of trespass, of assault, battery, wounding, imprisonment, or any of them, shall be commenced and sued within four years next after the cause of such actions or suits, and not after. 21 Jac. I. c. 16.

Actions of account, &c.—All actions of trespass quare clausum fregit, all actions of trespass, detinue, trover, and replevin, all actions of account, and upon the case (other than such accounts as concern the trade of merchandize, between merchant and merchant), all actions of debt grounded upon any lending, or contract without specialty, (that is, not being by deed or under seal) all actions of debt for arrearages of rent, and all actions of assault, menace, battery, wounding, and imprisonment, shall be commenced within the time and limitation as followeth, and not after; that is to say, the said actions upon the case (other than for slander), and the said actions for trespass, debt, detinue, and replevin, and the said actions for trespass, debt, detinue, and replevin, and the said acts for trespass quare clausum fregit, within six years, after the cause of such action. 21 Jac. c. 16.

Exception in relation to infants.—It has been holden, that if an infant during his infancy, by his guardian bring an action, the defendant cannot plead the statute of limitation, although the cause of action accrued six years before; and the words of the statute are, that after his coming of age, &c.

Exception in relation to merchants' accounts.—As to this exception, it has been matter of much controversy, whether it extends to all actions and accounts relating to merchants and merchandize, or to actions of account open and current only. But it is now settled, that accounts open and current only are within the statute; and that therefore, if an account be stated and settled between merchant and merchant, and a sum certain agreed to be due to one of them, if in such case, he to whom the money is due, do not bring his action within the limited time, he is barred by the statute. 2 Mod. 312.

Exception in relation to persons beyond sea.—It seems to have been agreed that the exception as to persons being beyond sea, extends only where the creditors or plaintiffs are so absent, and not to debtors or defendants, because the first only are mentioned in the statute; and this construction has the rather prevailed, because it was reputed the creditor's folly, that he did not file an original, and outlaw the debtor, which would have prevented the bar of the statutes.

Executor or administrator.—If A receives money belonging to a person who afterwards died intestate, and to whom B takes out administration, and brings an action against A, to which he pleads the statute of limitations, and the plaintiff replies, and shews that administration was committed to him such a year, which was within six years; though six years are expired since the receipt of the money, yet not being so since the administration committed, the action is not barred by the statute. 1 Salk. 421.

Where a debt barred by the statute shall be revived.—Any acknowledgment of the existence of the debt, however slight, will take it out of the statute, and the limitation will then run from that time: and where an expression is ambiguous, it shall be left to the consideration of the jury, whether it amounts or not to such acknowledgment. 2 Durnf. & East, 760.

It is clearly agreed, that if after the six years, the debtor acknowledges the debt, and promise payment, that this revives it, and brings it out of the statute: as if a debtor by promissory note, or simple contract, promises within six years of the action brought, that he will pay the debt; though this was barred by the statute, yet it is revived by the promise; for as the note itself was at first but an evidence of the debt, so that being barred the acknowledgment and promise is a new evidence of the debt, and being proved, will maintain an assumpsit for recovery of it. 1 Salk. 28.

LIMITS of a planet, its greatest excursion from the ecliptic, or which is the same thing, the points of its greatest latitude.

LIMITED PROBLEM, a problem that admits but of one solution, as to make a circle pass through three given points, not lying in the same right line.

LIMOSELLA, a genus of the didynamia angiospermia class of plants: the flower consists of one erect petal, divided into five segments; fruit is an unilocular capsule, with a great many seeds. Two species, annuals of the Cape.

LIMODORUM, a genus of the gynandria diandria class of plants, the flower of which consists of five oblong petals, and the nectarium hollow, and formed of a single leaf: the fruit is a columnar unilocular capsule, containing a great number of very small seeds. There are thirteen species, bulbs of America, &c.

LIMONIA, a genus of the decandria monogynia class and order. The cal. is five-parted; pet. five-berry, three-celled. Seeds solitary. There are seven species, trees of the East Indies, &c.

LINCONIA, a genus of the class and order pentandria digynia. The pet. are five; caps. two-celled. There is one species, a shrub of the Cape.

LINDERA, a genus of the class and order hexandria monogynia. The cor. is six-petalled; caps. There is one species, a shrub of Japan.

LINDERNIA, a genus of the class and order didynamia angiospermia. The cal. is five-parted; caps. one-celled. There are three species, annuals of America.

LINE, in geometry, a quantity extended in length only, without any breadth or thickness. It is formed by the flux or motion of a point: see FLUXION, and GEOMETRY. Right lines are all of the same species, but curves are of an infinite number of different species. We may conceive as many as there may be different ratios between their ordinates and abscisses.

Curve lines are usually divided into geometrical and mechanical; the former are those which may be found exactly in all their points; the latter are those, some or all of whose points are not to be found precisely, but only tentatively, or nearly.

Curve lines are also divided into the first order, second order, third order, &c. See CURVE.

Lines considered as to their positions, are either parallel, perpendicular, or oblique, the construction and properties whereof see under PARALLEL, &c.

Euclid's second book treats mostly of lines, and of the effects of their being divided and again multiplied into one another.

LINES, in perspective, are, 1. Geometrical line, which is a right line drawn in any manner on the geometrical plane. 2. Terrestrial line, or fundamental line, is a right line wherein the geometrical plane, and that of the picture or draught, intersect one another. See PERSPECTIVE.

LINES. See DIALLING.

LINE of direction on the earth's axis, in the Pythagorean system of astronomy, the line connecting the two poles of the ecliptic and of the equator, when they are projected on the plane of the former.

LINE of direction. See MECHANICS.

LINE of gravitation of any heavy body, a line drawn through its centre of gravity, and according to which it tends downwards.

LINE of the swiftest descent of a heavy body, is the cycloid. See CYCLOID.

LINES on the plain scale, are the line of chords, line of sines, line of tangents, line of secants, line of semitangents, line of leagues; the construction and application of which see under the words SCALE, SAILING, INSTRUMENTS, &c.

LINES on Gunter's scale. See GUNTER'S SCALE.

LINES of the sector. See INSTRUMENTS.

LINES, in fortification, are those of approach, capital, defence, circumvallation, contravallation of the base, &c.

To LINE a work, signifies to strengthen a rampart with a firm wall; or to encompass a parapet or moat with good turf, &c.

LINE, in the art of war, is understood of the disposition of an army, ranged in order of battle, with the front extended as far as may be, that it may not be flanked.

LINE of battle, is also understood of the disposition of a fleet on the day of engagement.

Ship of the LINE, a vessel large enough to be drawn up in the line, and to have a place in a sea-fight.

LINE, also denotes a French measure, containing the twelfth part of an inch, or the hundred and forty-fourth part of a foot. Geometricians conceive the line subdivided into six points. The French line answers to the English barleycorn.

LINEAR NUMBERS, in mathematics, such as have relation to length only; such is a number which represents one side of a plane figure. If the plane figure be a square, the linear number is called a root.

LINEAR PROBLEM, that which may be solved geometrically, by the intersection of two right lines. This is called a simple problem, and is capable but of one solution.

LINEN, in commerce, a well-known kind of cloth, chiefly made of flax. See LINUM, and WEAVING.

LING. See GADUS.

LINIMENT. See PHARMACY.

LINNÆA, a genus of the class and order didynamia angiospermia. The cal. is double; the cor. bell-shaped; the berry dry, three-celled. There is one species, a herb of Sweden.

LINNET. See FRINGILLIA.

LINSEED, the seed of the plant linum. See LINUM.

LINSPINS, in the military art, small pins of iron, which keep the wheel of a cannon or waggon on the axletree; for when the end of the axletree is put through he nave, the linspin is put in, to keep the wheel from falling off.

LINT, the scrapings of linen; which is used in dressing wounds, and is made up in various forms, as tents, dossils, pledgets, &c. See SURGERY.

LINUM, FLAX; a genus of the pentagynia order, in the pentandria class of plants; and in the natural method ranking under the 14th order, gruinales. The calyx is pentaphyllous; the petals are five; the capsule is quinquevalved and decemlocular; and the seeds are solitary. There are 25 species, of which the most remarkable are,

1. The usitatissimum, or common annual flax. 2. The perenne, or perennial Siberian flax, with umbellate clusters of large blue flowers. 3. The catharticum, or purging flax, a very small plant, not above four or five inches high; found wild upon chalky hills and in dry pleasure-grounds.

The first species is cultivated in the fields for the use of the manufacturers. The second sort is chiefly ornamental. The virtue of the third species is expressed in its title: an infusion in water or whey of a handful of the fresh leaves, or a dram of them in substance when dried, is said to purge without inconvenience.

Of the cultivation of flax. A skilful flax-raiser always prefers a free, open, deep loam; and all grounds that produced the preceding year a good crop of turnips, cabbages, potatoes, barley, or broad clover; or have been formerly laid down rich, and kept for some years in pasture.

If the linseed is sown early, and the flax not allowed to stand for seed, a crop of turnips may be got after the flax that very year; the second year a crop of rye or barley may be taken; and the third year, grass-seeds are sometimes sown along with the linseed. Of preceding crops, potatoes and hemp are the best preparation for flax. If the ground is free and open, it should be but once ploughed, and that as shallow as possible, not deeper than two and a half inches. It should be laid flat, reduced to a fine garden mould by good harrowing, and all stones and sods should be carried off. Except a little pigeon's dung for cold or sour ground, no other dung should be used preparatory for flax; because it produces too many weeds, and throws up the flax thin and poor upon the stalk. Before sowing, the bulky clods should be broken, or carried off the ground; and stones, quickenings, and every other thing that may hinder the growth of the flax, should be carefully taken away. The brighter in colour, and heavier the seed is, so much the better; that which when bruised appears of a light or yellowish green, and fresh in the heart, oily, and not dry, and smells and tastes sweet, and not fusty, may be depended upon. Dutch seed of the preceding year's growth, for the most part, answers best; but it seldom succeeds if kept another year. It ripens sooner than any other foreign seed. Philadelphia seed produces fine lint and few bolls, because sown thick, and answers best in wet cold soils.

The quantity of linseed sown should be proportioned to the condition of the soil; for if the ground is in good heart, and the seed sown thick, the crop will be in danger of falling before it is ready for pulling. The time for sowing linseed is from the middle of March to the end of April, as the ground and season answer; but the earlier the seed is sown, the less the crop interferes with the corn harvest. Late-sown linseed may grow long, but the flax upon the stalk will be thin and poor.

Flax ought to be weeded, when the crop is about four inches long. If longer deferred, the weeders will also much break and bend the stalks, and they will perhaps never recover their straightness again; and when the flax grows crooked, it is more liable to be hurt in the rippling and swingling. Quicken grass should be taken up; for, being strongly rooted, the pulling of it always loosens a great deal of the lint. If there is an appearance of a settled drought, it is better to defer the weeding, than by that operation to expose the tender roots of the flax to the drought.

When the crop grows so short and branchy as to appear more seed than flax, it ought not to be pulled before it is thoroughly ripe; but if it grows long and not branchy, the seed should be disregarded, and all the attention given to the flax. In the last case it ought to be pulled after the bloom has fallen, when the stalk begins to turn yellow, and before the leaves fall, and the bolls turn hard and sharp-pointed. When the stalk is small, and carries few bolls, the flax is fine; but the stalk of coarse flax is gross, rank, branchy, and carries many bolls. When the flax has fallen, and lies, such as lies ought to be immediately pulled, whether it has grown enough or not, as otherwise it will rot altogether. When parts of the same field grow unequally, so that some parts are ready for pulling before other parts, only what is ready should be pulled, and the rest should be suffered to stand till it ripens. The flax-raiser ought to be at pains to pull and keep by itself, each different kind of lint which he finds in his field; what is both long and fine, by itself; what is both long and coarse, by itself; what is both short and fine, by itself; what is both short and coarse by itself; and in like manner every other kind by itself that is of the same size and quality.

If the flax is more valuable than the seed, it ought by no means to be stacked up; for its own natural juice assists it greatly in the watering; whereas, if kept long unwatered, it loses that juice, and the harle adheres so much to the boon, that it requires longer time to water, and even the quality of the flax becomes harsher and coarser. Besides, the flax stacked up is in great danger from vermin and other accidents; the water in spring is not so soft and warm as in harvest; and near a year is lost of the use of the lint; but if the flax is so short and branchy as to appear most valuable for seed, it ought, after pulling, to be stacked and dried upon the field, as is done with corn; then stacked up for winter, rippled in spring; and the seed should be well cleaned from bad seeds, &c.

If the flax is to be regarded more than the seed, it should, after pulling, be allowed to lie some hours upon the ground to dry a little, and so gain some firmness, to prevent the skin or harle, which is the flax, from rubbing off in the rippling; an operation which ought by no means to be neglected, as the bolls, if put into the water along with the flax, breed vermin there, and otherwise spoil the water. The bolls also prove very inconvenient in the grassing and breaking. The handfuls for rippling should not be great, as that endangers the lint in the rippling comb. After rippling, the flax-raiser will perceive, that he is able to assort each size and quality of the flax by itself more exactly than he could before.

In watering, a running stream wastes the lint, makes it white, and frequently carries it away. Lochs, by the great quantity and motion of the water, also waste and whiten the flax, though not so much as running streams. Both rivers and lochs water the flax quicker than canals. The greater way the river or brook has run, the softer, and therefore the better, will the water be. Springs, or short runs from hills, are too cold, unless the water is allowed to stand long in the canal. Water from coal or iron is very bad for flax. A little of the powder of galls thrown into a glass of water will discover if it comes from minerals of that kind, by turning it into a dark colour, more or less tinged in proportion to the quantity of metal it contains. When the water is brought to a proper heat, small plants will be rising quickly in it, numbers of small insects and reptiles will be generating there, and bubbles of air rising on the surface. If no such signs appear, the water is scarcely warm enough, or is otherwise unfit for flax. Moss-holes, when neither too deep nor too shallow, frequently answer well for watering flax, when the water is proper, as before described. The proper season for watering flax is from the end of July to the end of August. The doing this as soon as possible after pulling is very advantageous. The flax being sorted after rippling, as before mentioned, should next be put in beets, never larger than a man can grasp with both his hands, and tied very slack with a band of a few stalks. Dried rushes answer exceedingly well for binding flax, as they do not rot in the water, and may be dried and kept for use again. The beets should be put into the canals slope-ways, or half-standing upon end, the root end uppermost. Upon the crop ends, when uppermost, vermin frequently breed, destructive of the flax, which are effectually prevented by putting the crop end downmost. The whole flax in the canal ought to be carefully covered from the sun with divots; the grassy side of which should be next the flax, to keep it clean. If it is not thus covered, the sun will discolour the flax, though quite covered with water. If the divots are not weighty enough to keep the flax entirely under water, a few stones might be laid above them; but the flax should not be pressed to the bottom.

When the flax is sufficiently watered, it feels soft to the gripe, and the harle parts easily with the boon or show, which last is then become brittle, and looks whitish. When these signs are found, the flax should be taken out of the water, beet after beet; each gently rinsed in the water, to cleanse it of the filth which has gathered about it in the canal; and as the lint is then very tender, and the beet slackly tied, it must be carefully and gently handled. Great care ought to be taken that no part be overdone: and as the coarsest waters soonest, if different kinds are mixed together, a part will be rotted, when the rest is not sufficiently watered. When lint taken out of the canal is not found sufficiently watered, it may be laid in a heap for twelve, eighteen, or twenty-four hours, which will have an effect like more watering; but this operation is nice, and may prove dangerous in unskilful hands. After the flax is taken out of the canal, fresh lint should not be put a second time into it, until the former water is run off, and the canal cleaned, and supplied with a fresh quantity of water.

Short heath is the best field for grassing flax; as, when wet, it fastens to the heath, and is thereby prevented from being blown away by the wind. The heath also keeps it a little above the earth, and so exposes it more equally to the weather. When such heath is not to be got, links or clean old lea-ground is the next best. Long-grass grounds should be avoided, as the grass growing through the lint frequently spots, tenders, or rots it; and grounds exposed to violent winds should also be avoided. The flax, when taken out of the water, must be spread very thin upon the ground; and being then very tender, it must be gently handled. The thinner it is spread the better, as it is then more equally exposed to the weather. But it ought never to be spread during a heavy shower, as that would wash and waste the harle too much, which is then excessively tender, but soon after becomes firm enough to bear the rains, which, with the open air and sunshine, cleans, softens, and purifies the harle to the degree wanted, and makes it blister from the boon. In short, after the flax has got a little firmness by being a few hours spread in dry weather, the more rain and sunshine it gets the better. If there is little danger of high winds carrying off the flax, it will be much the better for being turned about once a week. If it is not to be turned, it ought to be very thin spread. The spreading of flax and hemp, which requires a great deal of ground, enriches it greatly. The flax-raiser should spread his first row of flax at the end of the field opposite to the point whence the most violent wind commonly comes, placing the root ends foremost. He makes the root ends of every other row overlap the crop ends of the former row three or four inches, and binds down the last row with a rope; by which means the wind does not easily get below the lint to blow it away; and as the crop ends are seldom so fully watered as the root ends, the overlapping has an effect like giving the crop ends more watering.

A dry day ought to be chosen for taking up the flax; and if there is no appearance of high wind, it should be loosed from the heath or grass, and left loose for some hours, to make it thoroughly dry.

As a great quantity of flax can scarcely be all equally watered and grassed, and as the different qualities will best appear at lifting the flax off the grass; therefore at that time each different kind should be gathered together, and kept by itself; that is, all of the same colour, length, and quality.

The smaller the beets lint is made up in, the better for drying, and the more convenient for stacking, housing, &c. and in making up these beets, as in every other operation upon flax, it is of great consequence that the lint be laid together as it grew, the root ends together, and the crop ends together. The profit on five acres of flax raised in Shropshire, was 46*l*. 4*s*. 5*d*.

LION. See FELIS.

LIPARIA, a genus of the diadelphia decandria class and order. The cal. is five-cleft; cor. wings two-lobed, below; stam. the larger, with three shorter teeth; legume ovate. There are four species, shrubs of the Cape.

LIPPIA, a genus of the didynamia gymnospermia class and order. The cal. is four-toothed; the caps. one-celled, three-valved, two-seeded; seed one, two-celled. There are five species, shrubs of America.

LIQUEFACTION. See FLUIDITY.

LIQUIDS, expansion of. See EXPANSION.

LIQUIDAMBAR, SWEET-GUM TREE, a genus of the polyandria order, in the monœcia class of plants; and in the natural method ranking with those of which the order is doubtful. The male calyx is common and triphyllous; there is no corolla, but numerous filaments; the male calyces are collected into a spherical form, and tetraphyllous; there is no corolla; but seven styles, and many bivalved and monospermous capsules, collected into a sphere. There are only two species, both deciduous, viz. 1. The styraciflua, or the Virginia or maple-leaved liquidambar; a native of the rich moist parts of Virginia and Mexico. It will shoot in a regular manner to thirty or forty feet high, having its young twigs covered with a smooth light-brown bark, while those of the older are of a darker colour. The flowers are of a kind of saffron-colour: they are produced at the ends of the branches the beginning of April, and sometimes sooner; and are succeeded by large round brown fruit, which looks singular, but is thought by many to be no ornament to the tree. 2. The peregrinum, Canada liquidambar, or spleenwort-leaved gale, is a native of Canada and Pennsylvania. The young branches of this species are slender, tough, and hardy. The flowers come out from the sides of the branches, like the former; and they are succeeded by small roundish fruit, which seldom ripens in England. These may be propagated either by seeds or layers.

The leaves of this tree emit their odoriferous particles in such plenty as to perfume the circumambient air; nay, the whole tree exudes such a fragrant transparent resin, as to have given occasion to its being taken for the sweet storax. (See STYRAX.) These trees, therefore, are very proper to be planted singly in large opens, that they may amply display their fine pyramidal growth, or to be set in places near seats, pavilions, &c. The resin was formerly of great use as a perfume, and is at present no stranger in the shops.

LIQUORICE. See GLYCIRRHIZA, and MATERIA MEDICA.

LIRIODENDRON, the TULIP-TREE, a genus of the polygynia order, in the polyandria class of plants; and in the natural method ranking under the 52d order, coadunatæ. The calyx is triphyllous; there are nine petals; and the seeds imbricated in such a manner as to form a cone. There are two species; the tulipfera, is best known here, and is a deciduous tree, native of most part of America. It rises with a large upright trunk, branching forty or fifty feet high. The trunk, which often attains to a circumference of thirty feet high, is covered with a grey bark. The leaves grow irregularly on the branches, on long footstalks. They are of a particular structure, being composed of three lobes, the middlemost of which is shortened in such a manner that it appears as if it had been cut off and hollowed at the middle. The two others are rounded off. They are about four or five inches long, and as many broad. The flowers are produced with us in July, at the ends of the branches. The number of petals of which each is composed, like those of the tulip, is six; and these are spotted with green, red, white, and yellow. The flowers are succeeded by large cones, which never ripen in England.

LISIANTHUS, a genus of the pentandria monogynia class and order. The cal. is keeled; cor. with ventricose tube and recurved division; stigma two-plated; caps. two-valved, two-celled. There are 9 species, herbs of the West Indies.

LITA, a genus of the class and order pentandria monogynia. The cal. is five-cleft; cor. salver-shaped, long tube, five-cleft; caps. one-celled, two-valved; seeds numerous. There are two species, herbs of Guiana.

LITHOPHILA, a genus of the diandria monogynia class and order. The cal. is three-leaved; cor. three-petalled; nect. two-leaved. There is one species, of no note.

LITHARGE, an oxide of lead. See LEAD.

LITHOPHYTA, the name of Linnæus's third order of vermes.

LITHOSPERMUM, GROMWELL: a genus of the monogynia order, in the pentandria class of plants; and in the natural method ranking under the 41st order, asperifoliæ. The corolla is funnel-shaped, with the throat perforated and naked; the calyx quinquepartite. There are 12 species; but the only remarkable ones are the officinale or common gromwell, and the arvense or bastard alkanet. Both these are natives of Britain; the former growing in dry gravelly soil, the latter in corn-fields.

LITHOTOMY. See SURGERY.

LITTORELLA, a genus of the monœcia tetrandria class and order. The male cal. is four-leaved; cor. four-cleft; stam. long. No female cal.; cor. four-cleft; seed a nut. There is one species.

LIVER. See ANATOMY.

LIVERY *of seisin*, in law, signifies delivering the possession of lands, &c. to him who has a right to them. There are two kinds of livery and seisin; livery in law, where the feoffer being in view of the land, house, or other thing granted, says to the feoffee, on delivery of the deed, "I give to you yonder land, &c. to hold to you and to your heirs, so go into the same, and take possession accordingly." And livery in deed, is where the parties, or the attorneys by them authorised, coming to the door of the house, or upon some part of the land, declare the occasion of their meeting before witnesses, read the deed, or its contents, and in case it be made by attorney, the letter of attorney is also read, after which, if the delivery is of a house, the grantor, or his attorney, takes the ring, key, or latch belonging to the door, or if it be a land, a turf, or clod of earth, and a twig of one of the trees, and delivering them with the deed to the grantee or his attorney, says, "I A. B. do hereby deliver to you possession and seisin of this message or tenement, &c. to hold to you, your heirs and assigns, according to the purport, true intent, and meaning of this indenture, or deed of feoffment." After which the grantee enters first alone, and shutting the door, and then opening it, lets in others.

Since the making the statute of uses, livery and seisin are not so much used as formerly; for a lease and release, a bargain and sale by deed inrolled, are sufficient to vest the grantee with possession, without the formality of livery.

LIVERYMEN of London, are a number of men selected from among the freemen of each company. Out of this body, the common council, sheriff, and other superior officers for the government of the city are elected, and they alone have the privilege of giving their votes for members of parliament; from which the rest of the citizens are excluded.

LIVES, or insurance of Lives. See INSURANCE, and LIFE.

LIXIVIUM. See PHARMACY.

LIZARD. See LACERTA.

LOAD, or LODE, in mining, a word used especially in the tin-mines, for any regular vein or course, whether metallic or not; but most commonly load means a metallic vein. It is to be observed, that mines in general are veins within the earth, whose sides receding from or approaching to each other, make them of unequal breadths in different places, sometimes forming large spaces, which are called holes; these holes are filled like the rest with substances, which, whether metallic, or of any other nature, are called loads. When the substances forming these loads are reducible to metal, the loads are by the English miners said to be alive, otherwise they are termed dead loads.

The load is frequently intercepted by the crossing of a vein of earth or stone, or some other metalline substance; in which case it generally happens, that one part of the load is moved to a considerable distance on one side. This load is by the miners termed a flooking, and the part of the load which is moved, is by them said to be heaved. This fracture or heave of a load, according to Mr. Price, is produced by a subsidence of the strata from their primary positions, which he supposes to have been horizontal or parallel to the surface of the earth, and therefore should more properly be called a depression than a heave. This heaving of the load would be an inexpressible loss to the miner, did not experience teach him that as the loads always run on the sides of the hills, so the part heaved is always moved toward the descent of the hill; so that the miner, working toward the ascent of the hill, and meeting a flooking, considers himself as working in the heaved part; wherefore, cutting through the flooking, he works upon its back up the ascent of the hill, till he recovers the load, and vice versa.

LOAMS. See HUSBANDRY.

LOANS, in political economy, sums of money, generally of large amount, borrowed from individuals or public bodies, for the service of the state. They are either compulsory, in which case they may be more properly termed requisitions; or voluntary, which is the only mode that can be frequently resorted to with advantage. Loans are sometimes furnished by public companies as a consideration for peculiar privileges secured to them; but are much more commonly advanced by individuals on a certain interest being allowed for the use of the money, either for a term of years, or until the principal shall be repaid.

The practice of borrowing money, for defraying part of the extraordinary expences in time of war, had been adopted in other countries long before it was introduced into Great Britain; but it has been carried to a far greater extent here than by any other state: and the facility with which the government has been enabled to raise the largest sums, has arisen entirely from the strict punctuality with which it has constantly made good all pecuniary engagements. The chancellor of the exchequer is the officer who usually conducts negotiations of this kind on the part of the government, and the agreement is afterward confirmed by parliament; the governor and company of the bank of England, have of late years been usually appointed receivers of the contributions, for which they have an allowance, at a certain rate per million; and the sums received by them are paid into the exchequer in the name of the chief cashier of the bank. The money appropriated to pay the interest or annuities, is issued at the receipt of the exchequer to the chief cashier of the bank upon account, and he is enjoined to pay the annuities, and render his account in due course. The bank detain their allowance for receiving the contributions out of the sum received, and likewise what they have allowed as discount to those subscribers who advanced their money before the times fixed for the several instalments.

When the parliament has voted the supplies, and the extent of the loan found necessary is determined, a communication is usually made to the bank or stock exchange stating the particular stock on which the loan is to be made, and fixing a day for those who intend to bid for it to wait on the minister with their proposals; in the mean time each person forms his list of friends who are to take different proportions with him in case he succeeds. When the day comes, each party offers as low as he thinks he can venture with a fair prospect of profit, and the lowest offer is generally accepted. The only step to be taken by those who are not of the number just mentioned, and who may wish to take a share in the transaction, is to apply to one of the subscribers for a part of his subscription, which at first may sometimes be had without any premium, or for a very small one, for it cannot be presumed that any small number of men, who have subscribed for the whole sum to be raised, intend, or can keep it, but that they propose to include in their subscriptions a great number of their connections and acquaintance. Sometimes the subscription lies open to the public at the bank, as in the instance of the loan of eighteen millions for the service of the year 1797, and then every person is at liberty to subscribe what he thinks proper; and if upon casting up the whole, there is a surplus subscribed, which has generally been the case, the sum each person has subscribed, is reduced in an equal proportion, so as to make in the whole the sum fixed by parliament.

As soon as conveniently may be, after the subscription is closed, receipts are made out, and delivered to the subscribers, for the several sums by them subscribed; and for the conveniency of sale, every subscriber of a considerable sum has sundry receipts for different proportions of his whole sum, by which means he can readily part with what sum he thinks proper; and a form of assignment is drawn upon the back of the receipt, which being signed and witnessed, transfers the property to any purchaser. The deposit is generally ten per cent. and is made at or about the time of subscribing; the second payment is about a month after, and so on till the whole is paid in, each instalment being usually either ten or fifteen per cent. Those subscribers who choose to pay the whole sum before the appointed days of payment, are allowed discount at an agreed rate per cent. on the sum paid in advance, from the time of such payment to the period when the whole is required to be paid in by instalments. Those who do not complete the payment of the sum they have subscribed for, forfeit the part they have paid; and this is the case according to the acts of parliament, if the money is not paid by the days appointed; but payments are sometimes received after the appointed days on paying certain fees to the clerk.

Loans are usually raised upon either redeemable or irredeemable annuities. The former are those which according to the conditions of the acts by which they are created, government may redeem without the consent of the proprietors, by discharging the debt at par; the latter are such as being granted for specific terms, cannot be redeemed without the consent of the proprietors. The various debts that have been incurred at different periods by loans on either of these species of annuities, constitute the funded debt of the nation; that is, the debt which has been secured upon certain funds, created by parliament, and appropriated to the payment of the annual interest on the sums borrowed. The constant hope of being able at a future period to redeem the debts contracted, has induced the government generally to prefer raising money on annuities redeemable at par; and the disadvantage which might arise to the stockholder from being paid off at par, if his principal bore a high rate of interest, has always made those who advance money on loans prefer a large capital bearing a low rate per cent. though it may actually produce a somewhat less annual interest than would have been given on a capital equal to the sum advanced: the great speculations which are carried on in the public funds are also a strong inducement to prefer advancing money on these conditions, which have contributed so much to increase the nominal magnitude of the national debt.

The terms of all the public loans which have been raised from the commencement of the funding system, have been collected by Mr J. J. Grellier, who observes, that "the economy or extravagance of every transaction of this kind depends on its correspondence or disagreement with the price of the public funds, and the current rate of interest at which money could be obtained on good security at the time the bargain was concluded; and consequently, a loan on which the highest interest is paid, may have been obtained on the best terms that could possibly be made at the time it was negotiated." The interest paid, however, forms the real burthen of each loan to the country, and is the circumstance to be chiefly attended to in all comparisons of the advantage or disadvantage of the terms on which the public debts have been contracted at different periods.

From the difference in the terms of the loan, with respect to the capital created, the rate of interest it bears, and the different periods of the terminable annuities which have been granted with most of the loans, it is evident, that in order to form a proper comparison of the rate of interest paid for the money borrowed at different periods, the various conditions must be brought into some degree of uniformity; and the most obvious mode of doing this is, by converting that part of the interest which consists of terminable annuities into equivalent perpetual annuities; that is, into the additional interest, which must have been paid in lieu of such terminable annuities.

The rate of interest at which such conversion is made affects the result in some instances very materially; thus, the perpetual annuity, which is equal to an annuity of 10*l.* for 21 years, is, at 3 per cent. 4*l.* 12*s.* 5*d.* but at 5 per cent. 6*l.* 8*s.* 2*d.*; and the perpetual annuity equal to an annuity of 10*l.* for 60 years, which at 3 per cent. is 8*l.* 6*s.* is at 5 per cent. 9*l.* 9*s.* 3*d.* from which it is evident, that, if the terminable annuities, granted at different periods, are all valued at the same rate of interest, the comparison will by no means be just; for if a high rate is adopted, the loans which have been obtained at the lowest interest will be set in an unfavourable view; and if, on the contrary, they are all valued at a low rate, the charge of those loans, for which the highest interest is paid, will appear less than it really is. Nor is a medium or average rate more proper for exhibiting the real difference in the terms on which the several loans have been obtained. The least objectionable mode appears to be to convert the terminable annuities into perpetual annuities, according to the current rate of interest at the time when the annuities were granted, as it is upon the rate of interest that the proportionate value of an annuity for a certain term to the perpetuity depends; and in forming the following statements, the conversion has been made at the interest produced by money invested in the three per cents. according to the price of this stock at the times when the terms of the respective loans were settled: for, though by this means, the rate is, in each case, rather lower than it would have been had the interest produced by 4 or 5 per cent. stock been adopted, it is most probable, from the nature of the principal loans, that the stock which must have been given in lieu of a long annuity, would chiefly have been three per cents.; and, therefore, the interest equivalent to the long annuity should be found according to the interest produced by this stock. It may also be proper to remark, that, as the terminable annuities have mostly been granted for a long term, and form but a small part of the whole interest, particularly on the loans of the last war, the difference of a quarter or even half per cent. in the rate at which they are valued has in general but little effect on the whole rate per cent. of the loan. Thus, if the long annuity of the loan of 14,500,000*l.*, in 1797, is valued at 6 per cent. (being the interest produced by 3 per cents. at that time) it makes the whole rate per cent. 6*l.* 6*s.* 10*d.*; but, if the long annuity is valued at $5\frac{3}{4}$ per cent. it will be 6*l.* 6*s.* $9\frac{3}{4}$*d.*; at $5\frac{1}{2}$ per cent. 6*l.* 6*s.* $9\frac{1}{4}$*d.*; and, at 5 per cent. 6*l.* 6*s.* $8\frac{1}{2}$*d.* On the loan of 1798, the difference would be still less.

Till the last war, the lottery generally formed part of the terms of the loan; every subscriber of a certain sum towards the latter being entitled to a certain number of tickets, at 10*l.* each, the price at which the lottery-scheme is usually formed. As the whole profits of the lotteries were thus given up to the subscribers, a part of the money advanced must be considered as equivalent to the sum which government would otherwise have received for the lottery, and is therefore to be deducted from the whole sum advanced on the loan. This profit is variable, but has generally been taken at the average of 2*l.* 10*s.* per ticket; making, on a lottery of 50,000 tickets, 125,000*l.* to be deducted from the sum advanced, in estimating the rate of interest paid thereon.

There are some other circumstances which affect the interest paid: such as the discount allowed for prompt payment, the different periods of the instalments, and the times from which the annuities commence; but as these drawbacks do not in general amount to any considerable sum, in comparison with the whole amount of the loan, they do not materially augment the rate of interest; and as they more or less affect all the loans, they are of still less importance in a comparative view. In the following statement, however, a deduction is made on the loans of 18,000,000*l.* in 1796 and 1797, on account of the advantage allowed with respect to the time from which the annuities commenced, being greater than usual.

It is unnecessary to enter into a particular investigation of the interest paid for the money borrowed in the infancy of the funding system, as the first loans differed materially from those of subsequent periods, in being raised wholly on terminable annuities, and in having a particular fund assigned for each loan, by the supposed adequateness or insufficiency of which the interest required by the lenders was frequently influenced, as well as by other causes, which have since ceased to exist.

During the reign of queen Anne, loans were chiefly raised on annuities for 99 years, till 1711, when, by the establishment of the South Sea company, a variety of debts were consolidated and made a permanent capital, bearing 6 per cent. interest. About this period lotteries were also frequently adopted for raising money for the public service, under which form a considerable premium was given, in addition to a high rate of interest. This mode of raising money was followed in 1712, 1713, and 1714. In the latter year, though the interest paid was equal to only 5*l.* 7*s.* 2*d.* per cent. on the sum borrowed, the premium allowed was upwards of 34*l.* per cent.; but as peace was restored, and the legal rate of interest had been reduced to 5 per cent. it seems that a larger premium was allowed, for the sake of appearing to borrow at a moderate rate of interest.

In the reign of George I. the interest on a considerable part of the public debts was reduced to 5 per cent. and the few loans that were raised were comparatively of small amount: that of the year 1720 was obtained at little more than 4 per cent. interest.

About 1730 the current rate of interest was 3½ per cent.; and in 1736, government was enabled to borrow at 3 per cent. per annum. The extraordinary sums necessary for defraying the expences of the war which began in 1739, were at first obtained from the sinking fund and the salt duties; a payment from the bank, in 1742, rendered only a small loan necessary in that year, which was obtained at little more than 3 per cent. interest. In the succeeding years the following sums were raised by loans:

	Sum borrowed.	Interest.
1743	£1,800,000	£3 8 4
1744	1,800,000	3 6 10
1745	2,000,000	4 0 7
1746	2,500,000	5 5 1
1747	4,000,000	4 8 0
1748	6,300,000	4 8 0
Loans of the seven years war.		
1756	2,000,000	3 12 0
1757	3,000,000	3 14 3
1758	5,000,000	3 6 5
1759	6,600,000	3 10 9
1760	8,000,000	3 13 7
1761	12,000,000	4 1 11
1762	12,000,000	4 10 9
1763	3,500,000	4 4 2
Loans of the American war.		
1776	2,000,000	3 9 8
1777	5,000,000	4 5 2
1778	6,000,000	4 18 7
1779	7,000,000	5 18 10
1780	12,000,000	5 16 8
1781	12,000,000	5 11 1
1782	13,500,000	5 18 1
1783	12,000,000	4 13 9
1784	6,000,000	5 6 11
Loans of the war with the French republic.		
1793	4,500,000	4 3 4
1794	11,000,000	4 10 7
1795	18,000,000	4 15 8
1796	18,000,000	4 14 9
1796	7,500,000	4 12 2
1797	18,000,000	5 14 1
1797	14,500,000	6 6 10
1798	17,000,000	6 4 9
1799	3,000,000	5 12 5
1799	15,500,000	5 5 0
1800	20,500,000	4 14 2
1801	28,000,000	5 5 5
Loans of the war with the French empire.		
1803	12,000,000	5 2 0
1804	14,500,000	5 9 2
1805	22,500,000	5 3 2
1806	20,000,000	4 19 7

LOASA, a genus of the polyandria monogynia class and order. The cal. is five-leaved; cor. five-petalled; nect. five-leaved; caps. turbinate, one-celled, three-valved, many-seeded. There is one species, an annual of South America.

LOBE. See Anatomy.

LOBELIA, cardinal-flower, a genus of the monogamia order, in the syngenesia class of plants, and in the natural method ranking under the 29th order, campanaceæ. The calyx is quinquefid; the corolla monopetalous and irregular; the capsule inferior, bilocular or trilocular. There are 42 species, but only four of them are cultivated in our gardens, two of which are hardy herbaceous plants for the open ground, and two shrubby plants for the stove. They are all fibrous-rooted perennials, rising with erect stalks from two to five or six feet high, ornamented with oblong, oval, spear-shaped, simple leaves, and spikes of beautiful monopetalous, somewhat ringent, five-parted flowers, of scarlet, blue, and violet colours. They are easily propagated by seeds, offsets, and cuttings of their stalks. The tender kinds require the common treatment of other exotics. They are natives of America, from which their seeds must be procured.

The root of the species called the syphilitica (see Plate Nat. Hist. fig. 252.) is an article of the materia medica. This species grows in most places in Virginia, and bears our winters. It is perennial, has an erect stalk three or four feet high, blue flowers, a milky juice, and a rank smell. The root consists of white fibres about two inches long, resembles tobacco in taste, which remains on the tongue, and is apt to excite vomiting. It is used by the North American Indians as a specific in the venereal disease. The benefit, however, to be derived from this article has not, as far as we know, been confirmed either in Britain or by the practitioners in Virginia.

LOCAL, in law, something fixed to the freehold, or tied to a certain place: thus, real actions are local, since they must be brought in the country where they lie, and local customs are those peculiar to certain countries and places.

Local problem, among mathematicians, such a one as is capable of an infinite number of different solutions, by reason that the point which is to resolve the problem may be indifferently taken within a certain extent, as suppose any where within such a line, within such a plane figure, &c. which is called a geometric locus, and the problem is said to be a local or indetermined one.

A local problem may be either simple, when the point sought is in a right light; plane, when the point sought is in the circumference of a circle; solid, when the point required is in the circumference of a conic section; or lastly, sursolid, when the point is in the perimeter of a line of the second gender, or of a higher kind, as geometers call it.

LOCHIA. See Midwifery.

LOCK, a well-known instrument, and reckoned the masterpiece in smithery; a great deal of art and delicacy being required in contriving and varying the wards, springs, bolts, &c. and adjusting them to the places where they are to be used, and to the various occasions of using them. From the various structure of locks, accommodated to their different intentions, they acquire various names. Those placed on outer doors are called stock-locks; those on chamber-doors, spring-locks; those on trunks, trunk-locks, padlocks, &c. Of these the spring-lock is the most considerable, both for its frequency and the curiosity of its structure.

A treatise upon this subject has been published by Mr. Joseph Bramah, who begins with observing, that the principle on which all locks depend, is the application of a lever to an interior bolt, by means of a communication from without; so that, by means of the latter, the lever acts upon the bolt, and moves it in such a manner as to secure the lid or door from being opened by any pull or push from without. The security of locks in general, therefore, depends on the number of impediments we can interpose betwixt the lever (the key) and the bolt which secures the door; and these impediments are well known by the name of wards, the number and intricacy of which alone are supposed to distinguish a good lock from a bad one. If these wards, however, do not in an effectual manner preclude the access of all other instruments besides the proper key, it is still possible for a mechanic of equal skill with the lock-maker to open it without the key, and thus to elude the labour of the other. "As nothing (says Mr. Bramah) can be more opposite in principle to fixed wards than a lock which derives its properties from the motion of all its parts, I determined that the construction of such a lock should be the subject of my experiment." In the prosecution of this experiment, he had the satisfaction to find that the least perfect of all his models fully ascertained the truth and certainty of his principle. The exclusion of wards made it necessary to cut off all communication between the key and the bolt; as the same passage which (in a lock simply constructed) would admit the key, might give admission likewise to other instruments. The office, therefore, which in other locks is performed by the extreme point of the key, is here assigned to a lever, which cannot approach the bolt till every part of the lock has undergone a change of position. The necessity of this change to the purposes of the lock, and the absolute impossibility of effecting it otherwise than with the proper key, are the points to be ascertained.

Plate Lock and Loom, fig. 4, represents a mortice lock, made under the patent which Mr. Stansbury took out in 1805, for various improvements in locks, in which A is the spring-latch, as in common; the end B of this is bent, and has a frame D screwed to it, carrying a roller E; against this roller a wedge F called a pusher, shewn separately in fig. 5, acts; the spindle G on which this pusher is fixed, slides through holes in the side-plate of the lock, so as to have no shake, and on each end is fastened a handle; by this arrangement it is plain that when the handle of the wedge is pushed from without the door, its wedge E will act against the roller E, fig. 4, draw back the bolt A, and release the door; a continuation of the same motion opens it. The operations from within the room are the same, except that the handle of the pusher must be pulled instead of pushed; but as it is on the other end of the spindle, the operation on the wedge and bolt is the same. For the convenience of persons not acquainted with the new method, the bolt may be drawn back by turning the handle, as in the common lock. H is a piece of metal, figs. 4 and 5, which has a round collar *a* above, and another *b* beneath, which work in holes in the two side-plates of the lock, so as to turn easily round; this piece has a hole through it, large enough to admit the pusher to move up and down; and an opening in one side thereof admits the wedge F; so that when the spindle is turned round, one of the two arms *d e* of this piece, acts against the arm B of the bolt A, fig. 4, and draws back the bolt when the handle is turned, as in the common way. In order to reduce the friction against the bolt, in shutting the door, a small roller *a*, fig. 1, is applied to it. In lieu of the slip-bolt of common locks, Mr. Stansbury uses a piece I, which has a spindle going through the plate of the lock, and projecting from the door with a handle on it, by which its arm *f* can be moved up and down, when the door is to be bolted; this handle is turned so that the knob *g* on the arm *f* may fall in the notch cut in the bolt to receive it; this prevents the bolt being moved back by the pusher, till the arm *f* is first removed. There is a spring at the back of this arm, which pressing against the plate of the lock, by its friction keeps it from falling by accident. K is the main bolt of the lock; it is kept steady by a rectangular opening, through which a screw passes. The bolt is moved by a circular iron plate, moving round a pin *h*, which is riveted into a circular bridge N, screwed to the plate shewn separately in fig. 3; this bridge has a circular opening *i* in it, through which a pin *e*, riveted to the plate L, moves; this pin takes into a notch in the bolt, so as to move it backwards and forwards, when the plate is turned round its centre. The locking part is performed thus: the wheel L has a certain number of holes drilled in it, as at *m*; the bridge has the same number of similar holes in it, and in the same position; each hole in the bridge has a small pin in it, which is pushed in by a slight spring *n n n*, fig. 3; when the holes in the plate coincide with the holes in the bridge, the springs *n n n* push up the pins through the plate, and lock them both together. The key, fig. 2, has the same number of pins projecting from its lower end, as the pin-holes in the bridge, and in the same position; the length of the pins is the same as the thickness of the plate L, fig. 4. When it is to be unlocked, the key is introduced, and as it is turned round, it is pushed gently forward against the plate; when the pins and key come opposite the pin-holes and pins, the force applied overcomes the resistance of the springs *n n n*, the pins are pushed out, and the key gets hold of the plate L, when being turned round, it draws the bolt back by the pin *b*, fig. 3.

LOCUS GEOMETRICUS, denotes a line by which a local or indeterminate problem is solved.

A locus is a line, any point of which may equally solve an indeterminate problem. Thus, if a right line suffice for the construction of the equation, it is called *locus ad rectum*; if a circle, *locus ad circulum*; if a parabola, *locus ad parabolam*; if an ellipsis, *locus ad ellipsin*; and so of the rest of the conic sections. The loci of such equations as are right lines, or circles, the ancients called plane loci; and of those that are parabolas, hyperbolas, &c. solid loci. But Wolfius, and others among the moderns, divide the loci more commodiously into orders, according to the number of dimensions to which the indeterminate quantities rise. Thus, it will be a locus of the first order, if the equation is $x = \frac{ay}{c}$; a locus of the second or quadratic order, if $y^2 = ax$, or $y^2 = a^2 - x^2$; a locus of the third or cubic order, if $y^3 = a^2x$, or $y^3 = ax^2 - x^3$, &c.

All equations whose loci are of the first order, may be reduced to some one of the four following formulas: 1. $y = \frac{bx}{a}$. 2. $y = \frac{bx}{a} + c$. 3. $y = \frac{bx}{a} - c$. 4. $y = c - \frac{bx}{a}$: where the unknown quantity y, is supposed always to be freed from fractions, and the fraction that multiplies the other unknown quantity x, to be reduced to this expression $\frac{b}{a}$, and all the known terms to c.

All loci of the second degree are conic sections, viz. either the parabola, the circle, ellipsis, or hyperbola: if an equation, therefore, is given, whose locus is of the second degree, and it is required to draw the conic section which is the locus thereof, first draw a parabola, ellipsis, or hyperbola, so as that the equations expressing the natures thereof may be as compound as possible, in order to get general equations or formulas, by examining the peculiar properties whereof we may know which of these formulas the given equation ought to have regard to; that is, which of the conic sections will be the locus of the proposed equation. This known, compare all the terms of the proposed equation with the terms of the general formula of that conic section, which you have found will be the locus of the given equation; by which means you will find how to draw the section which is the locus of the equation given.

If an equation, whose locus is a conic section, is given, and the particular section whereof it is the locus is required; all the terms of the given equation being brought over to one side, so that the other is equal to nothing, there will be two cases.

Case I. When the rectangle xy is not in the given equation. 1. If either yy or xx is in the same equation, the locus will be a parabola. 2. If both xx and yy are in the equation with the same signs, the locus will be an ellipsis or a circle. 3. If xx and yy have different signs, the locus will be an hyperbola, or the opposite sections regarding their diameters.

Case II. When the rectangle xy is in the given equation. 1. If neither of the squares xx or yy, or only one of them, is in the same, the locus of it will be an hyperbola between the asymptotes. 2. If yy and xx is therein, having different signs, the locus will be an hyperbola regarding its diameters. 3. If both the squares xx and yy are in the equation, having the same signs, you must free the square yy from fractions; and then the locus will be an hyperbola, when the square of $\frac{1}{2}$ the fraction multiplying xy, is equal to the fraction multiplying xx; an ellipsis, or circle, when the same is less; and an hyperbola, or the opposite sections, regarding their diameters, when greater.

LOCUST. See GRYLLUS.

LODGMENT, in military affairs, is a work raised with earth, gabions, fascines, woolpacks, or mantelets, to cover the besiegers from the enemy's fire, and to prevent their losing a place which they have gained, and are resolved, if possible, to keep. For this purpose, when a lodgment is to be made on the glacis, covered way, or in the breach, there must be great provision made of fascines, sand-bags, &c. in the trenches; and during the action, the pioneers with fascines, sand-bags, &c. should be making the lodgment, in order to form a covering in as advantageous a manner as possible from the opposite bastion, or the place most to be feared.

LOEFLINGIA, a genus of the class and order triandria monogynia. The calyx is five-leaved; corolla five-petalled; capsule one-celled, three-valved. There is one species, an annual of Spain.

LOESELIA, a genus of the didynamia angiospermia class of plants, the flower of which is monopetalous and quinquefid at the limb; the fruit is a trilocular capsule, with several angulated seeds in each cell. There is one species, a herb of South America.

LOG, in naval affairs, is a flat piece of wood, shaped somewhat like a flounder, with a piece of lead fastened to its bottom, which makes it stand or swim upright in the water. To this log is fastened a long line, called the log-line; and this is commonly divided into certain spaces 50 feet in length by knots, which are pieces of knotted twine inreeved between the strands of the line; which shew, by means of a half-minute glass, how many of these spaces or knots are run out in half a minute. They commonly begin to be counted at the distance of about 10 fathoms or 60 feet from the log; so that the log, when it is hoven overboard, may be out of the eddy of the ship's wake before they begin to count: and for the ready discovery of this point of commencement, there is commonly fastened at it a red rag.

The log being thus prepared, and hoven overboard from the poop, and the line veered out by the help of a reel, as fast as the ship sails from it, will shew how far the ship has run in a given time, and consequently her rate of sailing.

Hence it is evident, that as the distance of the knots bears the same proportion to a mile as half a minute does to an hour, whatever number of knots the ship runs in half a minute, the same number of miles she will run in an hour, supposing her to run with the same degree of velocity during that time; and therefore, in order to know her rate of sailing, it is the general way to heave the log every hour; but if the force or direction of the wind varies, and does not continue the same during the whole hour, or if there has been more sail set, or any sail handed in, by which the ship has sailed faster or slower than she did at the time of heaving the log, there must then be an allowance made for it accordingly.

LOG-BOARD, a table generally divided into five columns, in the first of which is entered the hour of the day; in the second the course steered; in the third, the number of knots run off the reel each time of heaving the log; in the fourth, from what point the wind blows; and in the fifth, observations on the weather, variation of the compass, &c.

LOG-BOOK, a book ruled in columns like the log-board, into which the account on the log-board is transcribed every day at noon; whence, after it is corrected, &c. it is entered into the journal. See NAVIGATION.

LOG-WOOD, in commerce. See HÆMATOXYLUM.

Logwood is used by dyers for dying blacks and blues.

LOGARITHMIC, in general, something belonging to logarithms. See LOGARITHMS.

LOGARITHMIC CURVE. If on the line AN (Plate Miscel., fig. 155.) both ways indefinitely extended, be taken, AC, CE, EG, GI, IL, on the right hand, and A*g*, *g*P, &c. on the left, all equal to one another; and if at the points P, *g*, A, C, E, G, I, L, be erected to the right line AN, the perpendiculars PS, *gd*, AB, CD, EF, GH, IK, LM, which let be continually proportional, and represent numbers, viz. AB, 1; CD, 10; EF, 100, &c. then shall we have two progressions of lines, arithmetical and geometrical: for the lines AC, AE, AG, &c. are in arithmetical progression, or as 1, 2, 3, 4, 5, &c. and so represent the logarithms to which the geometrical lines AB, CD, EF, &c. do correspond. For since AG is triple of the right line AC, the number GH shall be in the third place from unity, if CD is in the first; so likewise shall LM be in the fifth place, since AL = 5 AC. If the extremities of the proportionals S, *d*, B, D, F, &c. are joined by right lines, the figure SBML will become a polygon, consisting of more or less sides, according as there are more or less terms in the progression.

If the parts AC, CE, EG, &c. are bisected in the points *c*, *e*, *g*, *i*, *l*, and there are again raised the perpendiculars *cd*, *ef*, *gh*, *ik*, *lm*, which are mean proportionals between AB, CD; CD, EF, &c. then there will arise a new series of proportionals, whose terms beginning from that which immediately follows unity, are double of those in the first series, and the difference of the terms is become less, and approaches nearer to a ratio of equality, than before. Likewise, in this new series, the right lines AL, A*c*, express the distances of the terms LM, *cd*, from unity, viz. since AL is ten times greater than A*c*, LM shall be the tenth term of the series from unity; and because A*e* is three times greater than A*c*, *ef* will be the third term of the series if *cd* is the first, and there shall be two mean proportionals between AB and *ef*; and between AB and LM there will be nine mean proportionals. And if the extremities of the lines B*d*, D*f*, F*h*, &c. are joined by right lines, there will be a new polygon made, consisting of more but shorter sides than the last.

If, in this manner, mean proportionals are continually placed between every two terms, the number of terms at last will be made so great, as also the number of the sides of the polygon, as to be greater than any given number, or to be infinite; and every side of the polygon so lessened, as to become less than any given right line; and consequently the polygon will be changed into a curve-lined figure: for any curve-lined figure may be conceived as a polygon whose sides are infinitely small and infinite in number. A curve described after this manner, is called logarithmical.

It is manifest, from this description of the logarithmic curve, that all numbers at equal distances are continually proportional. It is also plain, that if there are four numbers, A B, C D, I K, L M, such that the distance between the first and second, is equal to the distance between the third and fourth, let the distance from the second to the third be what it will, these numbers will be proportional. For because the distances A C, I L, are equal, A B shall be to the increment D *s*, as I K is to the increment M T. Wherefore, by composition, A B : D C :: I K : M L. And contrariwise, if four numbers are proportional, the distance between the first and second shall be equal to the distance between the third and fourth.

The distance between any two numbers, is called the logarithm of the ratio of those numbers; and, indeed, does not measure the ratio itself, but the number of terms in a given series of geometrical proportionals, proceeding from one number to another, and defines the number of equal ratios by the composition whereof the ratios of numbers are known.

LOGARITHMS are numbers so contrived and adapted to other numbers, that the sums and differences of the former shall correspond to, and shew, the products and quotients of the latter.

Or, more generally, logarithms are the numerical exponents of ratios; or a series of numbers in arithmetical progression, answering to another series of numbers in geometrical progression. Thus,

0, 1, 2, 3, 4, 5, Indices, or logarithms.
1, 2, 4, 8, 16, 32, Geometric progression.

Or,

0, 1, 2, 3, 4, 5, Indices, or logarithms.
1, 3, 9, 27, 81, 243, Geometric progression.

Or,

0, 1, 2, 3, 4, 5, Ind. or log.
1, 10, 100, 1000, 10000, 100000, Geo. prog.

Where it is evident that the same indices serve equally for any geometric series; and consequently there may be an endless variety of systems of logarithms to the same common numbers, by only changing the second term, 2, 3, or 10, &c. of the geometrical series.

It is also apparent, from the nature of these series, that if any two indices be added together, their sum will be the index of that number which is equal to the product of the two terms, in the geometric progression, to which those indices belong.

Thus, the indices 2 and 3, being added together, are = 5; and the numbers 4 and 8, or the terms corresponding with those indices, being multiplied together, are = 32, which is the number answering to the index 5.

And, in like manner, if any one index be subtracted from another, the difference will be the index of that number, which is equal to the quotient of the two terms to which those indices belong.

Thus the index 6, minus the index 4, is = 2; and the terms corresponding to those indices are 64 and 16, whose quotient is = 4; which is the number answering to the index 2.

For the same reason, if the logarithm of any number are multiplied by the index of its power, the product will be equal to the logarithm of that power.

Thus, the index or logarithm of 4, in the above series, is 2; and if this number is multiplied by 3, the product will be = 6; which is the logarithm of 64, or the third power of 4.

And, if the logarithm of any number is divided by the index of its root, the quotient will be equal to the logarithm of that root.

Thus, the index or logarithm of 64 is 6; and if this number is divided by 2, the quotient will be = 3; which is the logarithm of 8, or the square root of 64.

The logarithms most convenient for practice are such as are adapted to a geometric series increasing in a tenfold proportion, as in the last of the above forms; and are those which are to be found, at present, in most of the common tables upon this subject.

The distinguishing mark of this system of logarithms is, that the index, or logarithm, of 1 is 0; that of 10, 1; that of 100, 2; that of 1000 3, &c. And in decimals the logarithm of .1 is − 1; that of .01, − 2; that of .001, − 3, &c.

From whence it follows that the logarithm of any number between 1 and 10 must be 0 and some fractional parts, and that of a number between 10 and 100 will be 1 and some fractional parts; and so on for any other number whatever.

And since the integral part of a logarithm is always thus readily found, it is usually called the index, or characteristic; and is commonly omitted in the tables; being left to be supplied by the operator himself, as occasion requires.

Of the Making of Logarithms. Whatever arithmetical progression we apply to a geometrical one, the terms of it are logarithms only to that series to which we apply them, and answer the end proposed only for those particular numbers; so that if we had logarithms adapted only to particular geometrical series, they would be but of little use. The great end and design of these numbers is the ease and expedition which they afford in long calculations, by saving the laborious work of multiplication, division, and the extraction of roots: but this end would never be completely answered, unless logarithms could be adapted to the whole system of numbers, 1, 2, 3, 4, &c. And as here lie the chief excellence and merit of the contrivance, so also the difficulty. For the natural system of numbers, 1, 2, 3, 4, &c. being an arithmetical, and not a geometrical series, seems rather fit to be made logarithms of, than to have logarithms applied to it. But this difficulty may be easily removed, by considering,

That though the whole system of natural numbers, 1, 2, 3, 4, &c. is not in geometrical progression, and cannot, by any means, be made to agree with such a series, yet it may be brought so near it, as to be within any assignable degree of approximation; which may be conceived, in general, thus: suppose a fraction indefinitely small to be represented by x, and a geometrical series arising from 1, in the ratio of 1 to $1 + x$, to be 1, $(1 + x)^1$, $(1 + x)^2$, $(1 + x)^3$, $(1 + x)^4$, &c. Then some of these terms must come indefinitely near to all the natural numbers, 1, 2, 3, 4, &c.; because, amongst numbers which arise by extremely small increments, some of them must exceed, or fall short of, any determinate number, by an indefinitely little excess or defect.

If, therefore, in the places of the terms of this series, which approach indefinitely near to any of the natural numbers, we suppose these natural numbers themselves to be substituted, then will this series be in geometrical progression, to an exactness which may be called indefinite; because the approximation of its terms to the natural numbers can never end but goes on *in infinitum*.

And since this imagined geometric series comprehends, indefinitely near, the whole system of natural numbers, 1, 2, 3, 4, &c. so the indices of its terms comprehend a whole system of logarithms, which are adapted to this system of numbers, and may be extended to any length we please. For though the natural system of numbers make not, by themselves, a complete geometrical series, yet they are conceived as a part of such a series, and their logarithms are the indices of their distances from unity in that series; or, more generally, they are the corresponding terms of an arithmetical series applied to that geometrical one.

But, again, it must be observed, that an indefinitely small fraction cannot be assigned: and, therefore, in the actual construction of logarithms, we must be content with a determinate degree of approximation. Whence, according as we take x, in the series 1, $(1 + x)^1$, $(1 + x)^2$, $(1 + x)^3$, $(1 + x)^4$, &c. the approximation of its terms to the natural numbers will be in different degrees of exactness: for the less x is, the nearer will be the approximation; but then the more are the number of involutions of $1 + x$, necessary to come within any determinate degree of nearness to the natural number assigned.

Thus then we may conceive the possibility of making logarithms to all the natural numbers, 1, 2, 3, 4, &c. to any determinate degree of exactness; viz. by assigning a very small fraction for x, and actually raising a series, in the ratio of 1 to $1 + x$, and taking for the natural numbers such terms of that series as are nearest to them, and their indices for the logarithms. But then, to construct logarithms in this manner, to such an extent of numbers, and degree of exactness, as would be necessary to make them of any considerable use, is next to impossible, because of the almost infinite labour and time it would require. This, however, is an introduction for understanding the method of the noble inventor, who undoubtedly first took the hint of making logarithms from the consideration of the indices of a geometrical series; and by means of the principles and known properties of these progressions he first formed his tables, and adapted them to the practical purposes intended.

To find the logarithm of any of the natural numbers, 1, 2, 3, 4, *&c. according to the method of* Napier.—1. Take the geometrical series, 1, 10, 100, 1000, 10,000, &c. and apply to it the arithmetical series 1, 2, 3, 4, &c. as logarithms. 2. Find a geometric mean between 1 and 10, 10 and 100, or any other two adjacent terms of the series betwixt which the number proposed lies. 3. Between the mean, thus found, and the nearest extreme, find another geometrical mean, in the same manner; and so on, till you are arrived within the proposed limit of the number whose logarithm is sought. 4. Find as many arithmetical means, in the same order as you found the geometrical ones, and the last of these will be the logarithm answering to the number required.

Examples. Let it be required to find the logarithm of 9.

Here the numbers between which 9 lies are 1 and 10.

First, then, the log. of 10 is 1, and the log. of 1 is 0; therefore $\frac{1+0}{2} = .5$ is the arithmetical mean, and $\sqrt{(1 \times 10)} = \sqrt{10} = 3.1622777 =$ geometric mean: whence the logarithm of 3.1622777 is .5.

Secondly, the log. of 10 is 1, and the log. of 3.1622777 is .5; therefore $\frac{1+.5}{2} = .75 =$ arithmetical mean, and $\sqrt{(10 \times 3.1622777)} = 5.6234132 =$ geometric mean: whence the log. of 5.6234132 is .75.

Thirdly, the log. of 10 is 1, and the log. of 5.6234132 is .75; therefore $\frac{1+.75}{2} = .875 =$ arithmetical mean, and $\sqrt{(10. \times 5.6234132)} = 7.4989421 =$ geometric mean: whence the log. of 7.4989421 is .875.

Fourthly, the log. of 10 is 1, and the log. of 7.4989421 is .875; therefore $\frac{1+.875}{2} = .9375 =$ arithmetical mean, and $\sqrt{(10 \times 7.4989421)} = 8.6596431 =$ geometric mean: whence the log. of 8.6596431 is .9375.

Fifthly, the log. of 10 is 1, and the log. of 8.6596431 is .9375; therefore $\frac{1+.9375}{2} = .96875 =$ arithmetical mean, and $\sqrt{(10 \times 8.6596431)} = 9.3057204 =$ geometric mean: whence the log. of 9.3057204 is .96875.

Sixthly, the log. of 8.6596431 is .9375, and the log. of 9.3057204 is .96875; therefore $\frac{.9375+.96875}{2} = .953125 =$ arith. mean, and $\sqrt{(8.6596431 \times 9.3057204)} = 8.9768713 =$ geometric mean: whence the log. of 8.9768713 is .953125.

And, proceeding in this manner, after 25 extractions, the logarithm of 8.9999998 will be found to be .9542425; which may be taken for the logarithm of 9, because it differs from it only by $\frac{1}{5000000}$, and is therefore sufficiently exact for all practical purposes.

And in the same manner the logarithms of almost all the prime numbers were found; a work so incredibly laborious, that the unremitted industry of several years was scarcely sufficient for its accomplishment.

To determine the hyperbolic logarithm (L) *of any given number* (N). The hyperbolic logarithm of any number is the index of that term of the logarithmic progression, which agrees with the proposed number multiplied by the excess of the common ratio above unity.

Let, therefore, $(1+x)^n$ be that term of the logarithmical progression, 1, $(1+x)^1$, $(1+x)^2$, $(1+x)^3$, $(1+x)^4$, &c. which is equal to the required number (N).

Then will $(1+x)^n = N$, and $1+x = N^{\frac{1}{n}}$; and if $1+y$ be put $= N$, and $m = \frac{1}{n}$, we shall have $1+x = N^{\frac{1}{n}} = (1+y)^m = 1 + my + m \times \frac{m-1}{2} y^2 + m \times \frac{m-1}{2} \times \frac{m-2}{3} y^3$, &c.

And, consequently, $x = my + m \times \frac{m-1}{2} y^2 + m \times \frac{m-2}{2} \times \frac{m-2}{3} y^3$, &c. where m being rejected in the factors $m-1$, $m-2$, $m-3$, &c. being indefinitely small in comparison of 1, 2, 3, &c. the equation will become $x = my - \frac{my^2}{2} + \frac{my^3}{3} - \frac{my^4}{4}$, &c.

Hence $\frac{x}{m}$ $(nx = L) = y - \frac{y^2}{2} + \frac{y^3}{3} - \frac{y^4}{4} + \frac{y^5}{5}$, &c. $=$ hyperbolic logarithm of N, as was required.

The hyperbolic logarithm (L) *of a number being given, to find the number* (N) *itself, which answers to it.* Let $(1+x)^n$ be that term of the logarithmic progression, 1, $(1+x)^1$, $(1+x)^2$, $(1+x)^3$, $(1+x)^4$, &c. which is equal to the required number N.

Then, because $(1+x)^n$ is universally $= 1 + nx + n \times \frac{n-1}{2} x^2 + n \times \frac{n-1}{2} \times \frac{n-2}{3} x^3$, &c. we shall have $1 + nx + n \times \frac{n-1}{2} x^2 + n \times \frac{n-1}{2} \times \frac{n-2}{3} x^3$, &c. $= N$.

But since n, from the nature of the logarithms, is here supposed indefinitely great, it is evident that the numbers connected to it by the sign — may all be rejected, as far as any assigned number of terms.

For as 1, 2, 3, &c. are indefinitely small in comparison to n, the rejecting of those numbers can very little affect the values to which they belong.

If, therefore, 1, 2, 3, &c. be thrown out of the factors $\frac{n-1}{2}$, $\frac{n-2}{3}$, $\frac{n-3}{4}$, &c. we shall have $1 + nx + \frac{n^2x^2}{2} + \frac{n^3x^3}{2.3} + \frac{n^4x^4}{2.3.4}$, &c. $= N$.

But nx $(= L)$ is the hyperbolic logarithm of $(1+x)^n$, or N, by what has been before specified; and therefore $1 + L + \frac{L^2}{2} + \frac{L^3}{2.3} + \frac{L^4}{2.3.4}$, &c. $= N =$ number required.

Of the Method of using a Table of Logarithms.—Having explained the method of making a table of the logarithms of numbers greater than unity, the next thing to be done is, to shew how the logarithms of fractional quantities may be found. And, in order to this, it may be observed, that as we have hitherto supposed a geometric series to increase from an unit on the right hand, so we may now suppose it to decrease from an unit towards the left; and the indices, in this case, being made negative, will still exhibit the logarithms of the terms to which they belong.

Thus Log.	-3	-2	-1	0	$+1$	$+2$	$+3$,	&c.
Num.	$\frac{1}{1000}$	$\frac{1}{100}$	$\frac{1}{10}$	1	10	100	1000,	&c.

Whence $+1$ is the logarithm of 10, and -1, the logarithm of $\frac{1}{10}$; $+2$ the logarithm of 100, and -2 the logarithm of $\frac{1}{100}$, &c.

And from hence it appears that all numbers, consisting of the same figures, whether they be integral, fractional, or mixed, will have the decimal parts of their logarithms the same.

Thus, the logarithm of 5874 being 3.7689339, the logarithm of $\frac{1}{10}$, $\frac{1}{100}$, $\frac{1}{1000}$, &c. part of it will be as follows:

Num.	Logarithms.
5874	3.7689339
587.4	2.7689339
58.74	1.7689339
5.874	0.7689339
.5874	— 1.7689339
.05874	— 2.7689339
.005874	— 3.7689339

From this it also appears, that the index, or characteristic, of any logarithm, is always one less than the number of figures which the natural number consists of: and this index is constantly to be placed on the left hand of the decimal part of the logarithm.

When there are integers in the given number, the index is always affirmative; but when there are no integers, the index is negative, and is to be marked by a line drawn before it, like a negative quantity in algebra.

Thus, a number having 1, 2, 3, 4, 5, &c. integer places, the index of its log. is 0, 1, 2, 3, 4, &c. And a fraction having a digit in the place of primes, seconds, thirds, fourths, &c. the index of its logarithm will be -1, -2, -3, -4, &c.

It may also be observed, that though the indices of fractional quantities are negative, yet the decimal parts of their logarithms are always affirmative; and all operations are to be performed by them in the same manner as by negative and affirmative quantities in algebra.

In taking out of a table the logarithm of any number not exceeding 10000, we have the decimal part by inspection; and if to this the proper characteristic be affixed, it will give the complete logarithm required.

But if the number, whose logarithm is required, be above 10000, then find the logarithm of the two nearest numbers to it that can be found in the table, and say, as their difference : the difference of their logarithms :: the difference of the nearest number and that whose logarithm is required : the difference of their logarithms, nearly; and this difference being added to, or subtracted from, the nearest logarithm, according as it is greater or less than the required one, will give the logarithm required, nearly.

Thus, let it be required to find the logarithm of 367182.

The decimal part of 3671 is by the table .5647844; and of 3672 is .5649027;

∴ The log. of { 367100 is 5.5647844 ; 367200 is 5.5649027 }

Their diff. 100 .0001183 diff.

Nearest No. 367200
Given No. 367182

18 diff.

Therefore 100 : .0001183 :: 18 : .0000212.

And 5.5649027 — .0000212 = 5.5648815 = logarithm of 367182, nearly.

If the number consists both of integers and fractions, or is entirely fractional, find the decimal part of the logarithm as if all its figures were integral; and this, being prefixed to the proper characteristic, will give the logarithm required.

And if the given number is a proper fraction, subtract the logarithm of the denominator from the logarithm of the numerator, and the remainder will be the logarithm sought; which, being that of a decimal fraction, must always have a negative index.

And, if it is a mixed number, reduce it to an improper fraction, and find the difference of the logarithms of the numerator and denominator, in the same manner as before.

In finding the number answering to any given logarithm, the index, if affirmative, will always shew how many integral places the required number consists of; and, if negative, in what place of decimals the first, or significant figure, stands; so that, if the logarithm can be found in the table, the number answering to it will always be had by inspection.

But, if the logarithm cannot be exactly found in the table, find the next greater, and the next less, and then say, As the difference of these two logarithms : the difference of the numbers answering to them :: the difference of the given logarithm, and the nearest tabular logarithm : a fourth number; which added to, or subtracted from, the natural number answering to the nearest tabular logarithm, according as that logarithm is less or greater than the given one, will give the number required, nearly.

Thus, let it be required to find the natural number answering to the logarithm 5.5648815.

The next less and greater logarithms, in the table, are

5.5647844	The numbers	367100
5.5649027	answering	367200
Their diff. .0001183		100

And 5.5649027 — 5.5648815 = .0000212.

Therefore .0001183 : 100 :: .0000212 : 18 nearly.

Whence 367200 — 18 = 377182 = number required.

The Use and Application of Logarithms.—It is evident, from what has been said of the construction of logarithms, that addition of logarithms must be the same thing as multiplication in common arithmetic; and subtraction in logarithms the same as division; therefore, in multiplication by logarithms, add the logarithms of the multiplicand and multiplier together, their sum is the logarithm of the product.

		num.	logarithms.
Example.	Multiplicand	8.5	0.9294189
	Multiplier	10	1.0000000
	Product	85	1.9294189

And in division, subtract the logarithm of the divisor from the logarithm of the dividend, the remainder is the logarithm of the quotient.

		num.	logarithms.
Example.	Dividend	9712.8	3.9873444
	Divisor	456	2.6589648
	Quotient	21.3	1.3283796

To find the Complement of a Logarithm.—Begin at the left hand, and write down what each figure wants of 9, only what the last significant figure wants of 10; so the complement of the logarithm of 456, viz. 2.6589648, is 7.3410352.

In the Rule of Three. Add the logarithms of the second and third terms together, and from the sum subtract the logarithm of the first, the remainder is the logarithm of the fourth. Or, instead of subtracting a logarithm, add its complement, and the result will be the same.

To raise Powers by Logarithms.—Multiply the logarithm of the number given, by the index of the power required, the product will be the logarithm of the power sought.

Example. Let the cube of 32 be required by logarithms. The logarithm of 32 = 1.5051500, which multiplied by 3, is 4.5154500, the logarithm of 32768, the cube of 32. But in raising powers, viz. squaring, cubing, &c. of any decimal fraction by logarithms, it must be observed, that the first significant figure of the power be put so many places below the place of units. as the index of its logarithm wants of 10, 100, &c. multiplied by the index of the power.

To extract the Roots of Powers by Logarithms.—Divide the logarithm of the number by the index of the power, the quotient is the logarithm of the root sought.

To find Mean Proportionals between any two numbers.—Subtract the logarithm of the least term from the logarithm of the greatest, and divide the remainder by a number more by one than the number of means desired; then add the quotient to the logarithm of the least term (or subtract it from the logarithm of the greatest) continually, and it will give the logarithms of all the mean proportionals required.

Example. Let three mean proportionals be sought, between 106 and 100.

Logarithm of 106 = 2.0253059
Logarithm of 100 = 2.0000000

Divide by 4)0.0253059(0.0063264.75

Log. of the least term 100 added		2.0000000
Log. of the 1st mean	101.4673846	2.0063264.75
Log. of the 2d mean	102 9563014	2.0126529.5
Log. of the 3d mean	104.4670483	2.0189794.25
Log. of the greatest term 106.		2.0253059.

LOGIC. The professed business of logic is to explain the nature of the human mind, and the proper manner of conducting its several powers, in order to the attainment of truth and knowledge.

Those, therefore, who have treated expressly of this subject, have endeavoured first to define and describe the several faculties and operations of the human mind, as perception, judgment, memory, invention, &c. They next proceed to lay down rules for correct reasoning and argument. Every act of the judgment they term a *proposition*, and all propositions are either affirmative or negative. All questions or arguments they reduce to syllogisms, that is, from two axioms or propositions (called *terms*, in the technical language) laid down, they deduce a third, or conclusion, and the previous propositions they divide into major and minor. Thus, let the question be, *Whether God is an intelligent being?* Here the major or principal proposition proceeds from the word intelligent, and the minor respects God. They would then arrange the syllogism as follows:

Maj. To dispose things in right and perfect order is the work of an intelligent Being:
Min. But God has disposed creation in right and perfect order;
Conclusion. Therefore God is an intelligent Being.

They next class or arrange the different kinds of syllogisms according to the nature of them. Propositions are not only affirmative and negative, but they are also particular or universal. Hence syllogisms will vary not only as the major or minor proposition is negative or affirmative, but as either is an universal or particular affirmative, &c. Hence they dispose the several kinds of propositions into modes, and the syllogisms into figures, according as they affect the subject or the predicate. The modes are indicated by the letters *a, e, i, o*, as they are affirmative or negative, universal or particular. There are nineteen modes and four figures. The first figure is when the middle term is the subject of the major, and the predicate of the minor: as,

No work of God is bad:
But the natural passions and appetites of men are the work of God;
Therefore they are not bad.

This figure includes four modes, denoted by the words,

"Barbara, celarent, Darii, ferio;"

referring to the vowels which each syllable contains.

The second figure is when the middle term is the predicate of both major and minor: as,

Whatever is bad is not the work of God:
But the natural passions, &c. are the work of God;
Therefore they are not bad.

This figure includes four modes, denoted by the words,

"Cæsare, camestres, festino, baroco."

The third figure is when the middle term is the subject of both major and minor, as,

All Africans are black:
But all Africans are men;
Therefore some men are black.

This figure includes six modes, denoted by the words,

"Darapti, felapton, disamis, datisi, bocardo, ferison."

In the fourth figure it is the predicate of the major, and the subject of the minor, as,

The only being who ought to be worshipped is the Creator of the world:
But the Creator of the world is God;
Therefore God is the only being who ought to be worshipped.

There are five modes of this figure denoted by the words,

"Barbari, Calentes, Dibatis, fessamo, fresisom."

Such is the scheme proposed by the schoolmen as the only guide to truth and wisdom; but how little it has been able to effect may be seen from the labours of those who have practised it most, those very schoolmen themselves. The truth is, if logic is the art of reasoning, the best materials to form a logician, that is a reasoner, are a sound understanding, an extensive and accurate knowledge of facts, and an unprejudiced disposition; and every attempt to reduce the operations of the human mind to mechanical rules, to bring genius to a level with dulness, must be futile and vain. The various terms and figures of logic will be found in their respective places. See MODE.

LOLIUM, *darnel-grass*, a genus of the digynia order, in the triandria class of plants, and in the natural method ranking under the 4th order, gramina. The calyx is monophyllous, fixed, and uniflorous. There are five species. The most remarkable are,

1. The perenne, red darnel, or rye-grass. This is very common in roads and dry pastures. It makes excellent hay upon dry,

chalky, or sandy soils. It is advantageously cultivated along with clover, and springs earlier than other grasses, supplying food for cattle at a time when it is most difficult to be obtained. Cows, horses, and sheep, eat it; goats are not fond of it.

2. The temulentum, or white darnel, grows spontaneously in ploughed fields. If the seeds of this species are malted with barley, the ale soon occasions drunkenness; mixed with bread-corn, they produce but little effect, unless the bread is eaten hot.

LONCHITIS, *spleenwort*, a genus of the cryptogamia filices class of plants, the fructifications of which are arranged into lunulated series, and disposed separately under the sinuses of the leaves. There are five species. The leaves of this plant are of use in healing wounds, and in preventing inflammations of them: they are also used against the spleen. The root is aperient and diuretic.

LONGEVITY, long life. The duration of human life is a subject so universally interesting, that instances of persons who have considerably exceeded the usual term of life have at all times attracted notice, although very few attempts have been made to ascertain the circumstances under which life may be prolonged to its greatest extent. Buffon, Haller, Dr. Fothergill, Dr. Barton, Dr. Hufeland, and a few others who have noticed this subject, appear to have considered but a very small number of the instances of longevity which have occurred. Mr. J. Easton, in order to supply better materials for others, published, a few years since, a much greater collection of instances of this kind, though probably but a small part of what have actually occurred. His list consists of 1712 persons, who are stated to have died at the following ages:

Ages.	Persons.
From 100 to 110 years	1310
110 to 120	277
120 to 130	84
130 to 140	26
140 to 150	7
150 to 160	3
160 to 170	2
170 to 185	3
	1712

Such a number of instances would furnish many useful conclusions; but most accounts of this kind contain little more than the name, age, and place of the death of the person mentioned, from which of course little information can be gained. Sir J. Sinclair, in an Essay on Longevity, has endeavoured to excite a more general interest on this subject, which has by no means been investigated with the attention it deserves.

That longevity depends principally on conformity of conduct to the laws of nature, appears an indisputable fact; but from all the observations which have been made, it likewise appears, that there are other circumstances which have considerable influence: of these perhaps the most certain is descent from long-lived ancestors. Dr Rush, of Philadelphia, remarks, that he has not found a single instance of a person who had lived to be 80 years old, of whom this was not the case; and the accounts collected by others strongly confirm this observation.

The climate of some countries has been supposed to be much more favourable to longevity than others: thus Mr. Whitehurst asserted, that Englishmen in general were longer-lived than North Americans; and Mr. W. Barton has since endeavoured to prove the contrary: but whatever inferences of this kind national partiality may attempt to support, more extensive observations will in general confirm the conclusion, that although longevity evidently prevails more in certain districts than in others, and those regions which lie within the temperate zones are best adapted to promote long life, yet it is by no means confined to any particular nation or climate, as remarkable instances of it may be produced both from very hot and very cold countries. It is highly probable that the human frame is so constituted as to adapt itself easily to the atmosphere and peculiarities of the country in which it receives life, or even into which it is afterwards removed. Thus France and Sweden are countries differing materially in soil and climate: the general mode of life of the inhabitants is likewise very different; yet the usual rate of mortality has been found nearly the same in both. Men can live equally well under very different circumstances. It is sudden changes that are injurious; and temperate climates being less liable to such changes, are found to be most favourable to the continuance of life. There are, however, in almost every country, particular districts more favourable to the health of the inhabitants than others; and the cause of this superiority is chiefly a free circulation of air, uncontaminated with the noxious vapours and exhalations which destroy its purity in other parts; thus hilly districts are almost universally found more healthy than low and marshy places, or than close and crowded cities.

From a list of 145 persons who are recorded to have lived to the age of 120 years and upwards, it appears, that more than half were inhabitants of Great Britain, viz.

63 of England and Wales,
23 of Scotland,
29 of Ireland,
30 of other countries.

The number of instances in Scotland, compared with those of England, appears by this account to have been more than twice the proportion of the population, which certainly seems to shew that the climate of the former is very favourable to long life. The great proportion of inhabitants of Great Britain and Ireland, though perhaps arising in some measure from instances of great age not being so generally noticed and recorded in other places, at least shews, that these countries are not unfavourable to longevity.

It is a fact pretty well established, that more males are born than females; it is also well known, that in almost every form which animal life assumes, the male appears to possess a somewhat superior degree of bodily strength to the female. From these circumstances it might be expected that the number of males living would be found greater than that of the females, and that in general they would enjoy a greater duration of life; the contrary, however, has been asserted, and evidence produced which appeared to justify such an opinion; but it seems probable, that in forming the accounts from which the number of females living appeared greater than that of the males, sufficient attention was not paid to the number of males engaged chiefly abroad in the army and navy, and of the emigrations to foreign parts being chiefly of males. That the male constitution is naturally more durable than that of females, may be inferred from the list before referred to of 145 persons, who have attained unusually great age, more than two-thirds of the number being males. Dr. Hufeland remarks, that the equilibrium and pliability of the female body seems, for a certain time, to give it more durability, and to render it less susceptible of injury from destructive influences than that of men; but that male strength is, without doubt, necessary to arrive at a very great age. More women, therefore, become old, but fewer very old; and if the registers of mortality, from which tables of the probability of the duration of human life are formed, were more extensive, and comprehended a greater number of years, so as to include the instances of great longevity, the difference between the value of male and female lives would appear less than it is supposed to be, and probably the sum of life of the whole of each sex approaches very nearly to equality.

The form of the individual appears to be of considerable importance: moderate-sized and well-proportioned persons have certainly the best chance of long life. There are, however, a few instances of persons of a different description having attained considerable age. Mary Jones, who died in 1783, at Wern, in Shropshire, aged 100 years, was only two feet eight inches in height, very deformed and lame; and James M'Donald, who died near Cork in the year 1760, aged 117, was seven feet six inches high.

Matrimony, if not entered into too early, appears to be very conducive to health and long life, the proportion of unmarried persons attaining great age, being remarkably small; Dr. Rush says, that in the course of his enquiries, he met with only one person beyond eighty years of age, who had never been married. This is a very limited remark; Mrs. Malton, who died in 1733, aged 105; Ann Kerney, who died the same year, aged 110; Martha Dunridge, who died in 1752, in the 100th year of her age; and Mrs. Warren, who died in 1753, aged 104, had never been married: and in the list prefixed to sir John Sinclair's Essay on Longevity, of pensioners in Greenwich hospital, who were upwards of eighty years of age, there are sixteen who never were married: the same list, however, contains five times as many persons who had been married, and other accounts are in a still greater proportion.

The Chinese erect triumphal or honorary arches to the memory of persons who have lived a century, thinking, that without a sober and virtuous life it is impossible to attain so great an age. Temperance is certainly the best security of health; and no man can reasonably expect to live long who impairs the vital powers by excess, which converts the most natural and beneficial enjoyments into the most certain means of destruction. The few instances of individuals who, notwithstanding their licentious mode of life, have attained considerable age, cannot be put in comparison with the immense number whose lives have been materially shortened by such indulgences. Dr. Fothergill observes, that "the due regulation of the passions perhaps contributes more to health and longevity than any of the other nonnaturals."

The cheerful and contented are certainly more likely to enjoy good health and long life than persons of irritable and fretful dispositions; therefore whatever tends to promote good humour and innocent hilarity, must have a beneficial influence in this respect; and persons whose attention is much engaged on serious subjects should endeavour to preserve a relish for cheerful recreations.

LONGITUDE *of a star*, in astronomy, an arch of the ecliptic, intercepted between the beginning of Aries and the point of the ecliptic cut by the star's circle of longitude.

LONGITUDE *of a place*. See GEOGRAPHY.

LONGITUDE, in navigation, the distance of a ship or place, east or west, from another, reckoned in degrees of the equator.

As the discovery of a method to find the longitude would render voyages safe and expeditious, and also preserve ships and the lives of men, the following rewards have been offered as an encouragement to any person who shall discover a proper method for finding it out:—In the year 1714, the British parliament offered a reward for the discovery of the longitude: the sum of 10,000*l.* if the method determined the longitude to 1° of a great circle, or to 60 geographical miles; of 15,000*l.* if it determined it to 40 miles; and of 20,000*l.* if it determined it to 30 miles; with this proviso, that if any such method extend no further than 30 miles adjoining to the coast, the proposer should have no more than half the rewards. The act also appoints the first lord of the admiralty, the speaker of the house of commons, the first commissioner of trade, the admirals of the red, white, and blue squadrons, the master of the Trinity-house, the president of the royal society, the royal astronomer at Greenwich, the two Savilian professors at Oxford, and the Lucasian and Plumian professors at Cambridge, with several other persons, as commissioners for the longitude at sea. The Lowndian professor at Cambridge was afterwards added. After this act of parliament, several other acts passed in the reigns of George II. and III. for the encouragement of finding the longitude. At last, in 1774, an act passed, repealing all other acts, and offering separate rewards to any person who should discover the longitude, either by the watch keeping true time within certain limits, or by the lunar method, or by any other means. The act proposes as a reward for a timekeeper, the sum of 5000*l.* if it determine the longitude to 1° or 60 geographical miles; the sum of 7500*l.* if it determine it to 40 miles; and the sum of 10,000*l.* if it determine it to 30 miles, after proper trials specified in the act. If the method is by improved solar and lunar tables, constructed upon sir Isaac Newton's theory of gravitation, the author shall be entitled to 5000*l.* if such tables shall show the distance of the moon from the sun and stars, within fifteen seconds of a degree, answering to about seven minutes of longitude, after allowing half a degree for the errors of observation. And for any other method, the same rewards are offered as those for timekeepers, provided it gives the longitude true within the same limits, and is practicable at sea. The commissioners have also a power of giving smaller rewards, as they shall judge proper, to any one who shall make any discovery for finding the longitude at sea, though not within the above limits; provided, however, that if such person or persons shall afterwards make any further discovery as to come within the above-mentioned limits, such sum or sums as they may have received shall be considered as part of such greater reward, and deducted therefrom accordingly.

To find the longitude by a time-keeper. The sun appears to move round the earth from east to west, or to describe 360°, in 24 hours, and therefore he appears to move 15° in an hour. If therefore the meridians of two places make an angle of 15° with each other, or if the two places differ 15° in longitude, the sun will come to the eastern meridian one hour before he comes to the western meridian, and therefore when it is twelve o'clock at the former place, it is only eleven at the latter; and in general, the difference between the times by the clock at any two places, will be the difference of their longitudes, converted into time at the rate of 15° for an hour, the time at the eastern place being the forwardest. If, therefore, we can tell what o'clock it is at any two places at the same instant of time, we can find the difference of their longitudes, by allowing 15° for every hour that the clocks differ.

Let, therefore, the timekeeper be well regulated and set to the time at Greenwich, that being the place from which we reckon our longitude; then if the watch neither gains nor loses, it will always show the time at Greenwich, wherever you may be. Now to find the time by the clock at any other place, take the sun's altitude, and thence find the time; now the time thus found is apparent time, or that found by the sun, which differs from the time shown by the clock by the equation of time. We must, therefore, apply the equation of time to the time found by the sun, and we shall get the time by the clock; and the difference between the time by the clock so found, and the time by the timekeeper, or the time at Greenwich, converted into degrees at the rate of 15° for an hour, gives the longitude of the place from Greenwich. For example: let the time by the timekeeper, when the sun's altitude was taken, be 6h. 19′, and let the time deduced from the sun's altitude be 9h. 27′, and suppose at that time the equation of time to be 7′, showing how much the sun is that day behind the clock, then the time by the clock is 9h. 34′, the difference between which and 6h. 19′, is 3h. 15′; and this converted into degrees, at the rate of 15° for 1 hour, gives 48° 45′, the longitude of the place from Greenwich; and as the time is forwarder than that at Greenwich, the place lies to the east of Greenwich. Thus the longitude could be very easily determined, if you could depend upon the timekeeper. But as a watch will always gain or lose, before the timekeeper is sent out, its gaining or losing every day for some time, a month for instance, is observed; this is called the rate of going of the watch, and from thence the mean rate of going is thus found:

Suppose I examine the rate of a watch for 30 days; on some of those days I find it has gained, and on some it has lost; add together all the quantities it has gained, and suppose they amount to 17″; add together all the quantities it has lost, and suppose they amount to 13″; then upon the whole, it has gained 4″ in 30 days; and this is called the mean rate for that time; and this divided by 30, gives 0″,133 for the mean daily rate of gaining; so that if the watch had gained regularly 0″,133 every day, at the end of the 30 days it would have gained just as much as it really did gain, by sometimes gaining and sometimes losing. Or you may get the mean daily rate thus: Take the difference between what the clock was too fast or too slow on the first and last days of observation, if it be too fast or too slow on each day; but take the sum, if it is too fast on one day and too slow on the other, and divide by the number of days between the observations, and you get the mean daily rate. Thus, if the watch was too fast on the first day 18″, and too fast on the last day 32″, the difference 14″ divided by 30, gives 0″,466, the mean daily rate of gaining. But if the watch was too fast on the first day 7″, and too slow on the last day 10″, the sum 17″ divided by 30, gives 0″,566, the mean daily rate of losing. After having thus got the mean daily rate of gaining or losing, and knowing how much the watch was too fast or too slow at first, you can tell, according to that rate of going, how much it is too fast or too slow at any other time. In the first case, for instance, let the watch have been 1′ 17″ too fast at first, and I want to know how much it is too fast 50 days after that time: now it gains 0″,133 every day; if this is multiplied by 50, it gives 6″,65 for the whole gain in 50 days; therefore, at the end of that time, the watch would be 1′. 23″,65 too fast. This would be the error, if the watch continued to gain at the above rate; and although, from the different temperatures of the air, and the imperfection of the workmanship, this cannot be expected, yet the probable error will by this means be diminished, and it is the best method we have to depend upon. In watches which are under trial at the Royal Observatory at Greenwich, as candidates for the rewards, this allowance of a mean rate is admitted, although it is not mentioned in the act of parliament: the commissioners, however, are so indulgent as to grant it, which is undoubtedly favourable to the watches.

As the rate of going of a watch is subject to vary from so many circumstances, the observer, whenever he goes ashore, and has sufficient time, should compare his watch for several days with the true time found by the sun, by which he will be able to find its rate of going. And when he comes to a place whose longitude is known, he may then set his watch to Greenwich time; for when the longitude of a place is known, you know the difference between the time there and at Greenwich. For instance, if he go to a place known to be 30° east longitude from Greenwich, his watch should be two hours slower than the time at that place. Find therefore the true time at that place, by the sun, and if the watch is two hours slower, it is right; if not, correct it by the difference, and it again gives Greenwich time.

In the year 1726, Mr. John Harrison produced a timekeeper of his own construction, which did not err above one second in a month for ten years together; and in the year 1736 he had a machine tried in a voyage to and from Lisbon, which was the means of correcting an error of almost a degree and a half in the computation of the ship's reckoning. In consequence of this success, Mr. Harrison received public encouragement to proceed, and he made three other timekeepers, each more accurate than the former, which were finished successively in the years 1739, 1758, and 1761; the last of which proved so much to his own satisfaction, that he applied to the commissioners of the longitude to have this instrument tried in a voyage to some port in the West Indies, according to the directions of the statute of the 12th of Anne above cited. Accordingly, Mr. William Harrison, son of the inventor, embarked in November 1761, on a voyage for Jamaica, with this fourth timekeeper or watch; and on his arrival there, the longitude, as shewn by the timekeeper, differed but one geographical mile and a quarter from the true longitude, deduced from astronomical observations. The same gentleman returned to England with the timekeeper, in March 1762, when he found that it had erred in the four months, no more than $1' 54''\frac{1}{2}$ in time, or $28\frac{5}{8}$ minutes of longitude; whereas the act requires no greater exactness than 30 geographical miles, or minutes of a great circle, in such a voyage. Mr. Harrison now claimed the whole reward of 20,000*l.* offered by the said act: but some doubts arising in the minds of the commissioners concerning the true situation of the island of Jamaica, and the manner in which the time at that place had been found, as well as at Portsmouth; and it being farther suggested by some, that although the timekeeper happened to be right at Jamaica, and after its return to England, it was by no means a proof that it had been always so in the intermediate time; another trial was therefore proposed, in a voyage to the island of Barbadoes, in which precautions were taken to obviate as many of these objections as possible. Accordingly the commissioners previously sent out proper persons to make astronomical observations on that island, which, when compared with other corresponding ones made in England, would determine, beyond a doubt, its true situation; and Mr. William Harrison again set out with his father's timekeeper, in March 1764, the watch having been compared with equal altitudes at Portsmouth before he set out, and he arrived at Barbadoes about the middle of May; where, on comparing it again by equal altitudes of the sun, it was found to shew the difference of longitude between Portsmouth and Barbadoes to be 3h. 55m. 3s.; the true difference of longitude between these places, by astronomical observations, being 3h. 54m. 20s.; so that the error of the watch was 43s., or $10' 45''$ of longitude. In consequence of this and the former trials, Mr. Harrison received one moiety of the reward offered by the 12th of queen Anne, after explaining the principles on which his watch was constructed, and delivering this, as well as the three former, to the commissioners of the longitude for the use of the public: and he was promised the other moiety of the reward, when other timekeepers should be made on the same principles, either by himself or others, performing equally well with that which he had last made. In the mean time, this last timekeeper was sent down to the Royal Observatory at Greenwich, to be tried there under the direction of the Rev. Dr. Maskelyne, the astronomer-royal. But it did not appear, during this trial, that the watch went with the regularity that was expected; from which it was apprehended that the performance even of the same watch was not at all times equal; and consequently that little certainty could be expected in the performance of different ones. Moreover the watch was now found to go faster than during the voyage to and from Barbadoes by 18 or 19 seconds in 24 hours; but this circumstance was accounted for by Mr. Harrison, who informs us that he had altered the rate of its going by trying some experiments, which he had not time to finish before he was ordered to deliver up the watch to the board. Soon after this trial, the commissioners of longitude agreed with Mr. Kendal, one of the watch-makers appointed by them to receive Mr. Harrison's discoveries, to make another watch on the same construction with this, to determine whether such watches could be made from the account which Mr. Harrison had given, by other persons as well as himself. The event proved the affirmative; for the watch produced by Mr. Kendal, in consequence of this agreement, went considerably better than Mr. Harrison's did. Mr. Kendal's watch was sent out with captain Cook, in his second voyage towards the south pole and round the globe, in the years 1772, 1773, 1774, and 1775; when the only fault found in the watch was, that its rate of going was continually accelerated; though in this trial of three years and a half it never amounted to $14''\frac{1}{2}$ a day. The consequence was, that the house of commons, in 1774, to whom an appeal had been made, were pleased to order the second moiety of the reward to be given to Mr. Harrison, and to pass the act above-mentioned. Mr. Harrison had also at different times received some other sums of money, as encouragements to him to continue his endeavours, from the board of longitude, and from the India company, as well as from many individuals. Mr. Arnold and some other persons have since also made several very good watches for the same purpose, and have been remunerated for their skill and labour.

Others have proposed various astronomical methods for finding the longitude. These methods chiefly depend on having an ephemeris or almanac suited to the meridian of some place, as Greenwich for instance, to which the Nautical Almanac is adapted, which shall contain for every day computations of the times of all remarkable celestial motions and appearances, as adapted to that meridian. So that if the hour and minute is known when any of the same phenomena are observed in any other place whose longitude is desired, the difference between this time and that to which the time of the said phenomenon was calculated and set down in the almanac, will be known, and consequently the difference of longitude also becomes known between that place and Greenwich, allowing at the rate of fifteen degrees to an hour.

Now it is easy to find the time at any place, by means of the altitude or azimuth of the sun or stars, which time it is necessary to find by such means, both in these astronomical modes of determining the longitude, and in the former by a timekeeper; and it is the difference between that time, so determined, and the time at Greenwich, known either by the timekeeper or by the astronomical observations of celestial phenomena, which gives the difference of longitude at the rate above-mentioned. Now the difficulty in these methods lies in the fewness of proper phenomena, capable of being thus observed; for all slow motions, such as belong to the planet Saturn, for instance, are quite excluded, as affording too small a difference, in a considerable space of time, to be properly observed; and it appears that there are no phenomena in the heavens proper for this purpose, except the eclipses or motions of Jupiter's satellites, and the eclipses or motions of the moon, viz. such as her distance from the sun or certain fixed stars lying near her path, or her longitude or place in the zodiac, &c. Now of these methods,

1st. That by the eclipses of the moon is very easy, and sufficiently accurate, if they did but happen often, as every night. For at the moment when the beginning or middle or end of an eclipse is observed by a telescope, there is no more to be done but to determine the time by observing the altitude or azimuth of some known star; which time being compared with that in the tables, set down for the happening of the same phenomenon at Greenwich, gives the difference in time, and consequently of longitude sought. But as the beginning or end of an eclipse of the moon cannot generally be observed nearer than one minute, and sometimes two or three minutes of time, the longitude cannot certainly be determined by this method, from a single observation, nearer than one degree of longitude. However, by two or more observations, as of the beginning and end, &c. a much greater degree of exactness may be attained.

2d. The moon's place in the zodiac is a phenomenon more frequent than her eclipses; but then the observation of it is difficult, and the calculus perplexed and intricate, by reason of two parallaxes; so that it is hardly practicable to any tolerable degree of accuracy.

3d. But the moon's distances from the sun or certain fixed stars, are phenomena to be observed many times in almost every night, and afford a good practical method of determining the longitude of a ship at almost any time; either by computing from thence the moon's true place, to compare with the same in the almanac; or by comparing her observed distance itself with the same as there set down.

From the great improvements made by Newton in the theory of the moon, and more lately by Euler and others on his principles, professor Mayer, of Gottingen, was enabled to calculate lunar tables more correct than any former ones; having so far succeeded as to give the moon's place within one minute of the truth, as has been proved by a comparison of the tables with the observations made at the Greenwich observatory by Dr. Bradley, and by Dr. Maskelyne, the late astronomer-royal; and the same have been still farther improved under his direction, by the late Mr. Charles Mason, by several new equations, and the whole computed to tenths of a second. These tables, when compared with the above-mentioned series of observations, a proper allowance being made for the unavoidable error of observation, seem to give always the moon's longitude in the heavens correctly within 30 seconds of a degree; which greatest error, added to a possible error of one minute in taking the moon's distance from the sun or a star at sea, will at a medium only produce an error of 42 minutes of longitude. To facilitate the use of the tables, Dr. Maskelyne proposed a nautical ephemeris, the scheme of which was adopted by the commissioners of longitude, and first executed in the year 1767, since which time it has been regularly continued. But as the rules that were given in the appendix to one of those publications, for correcting the effects of refraction and parallax, were thought too difficult for general use, they have been reduced to tables. So that, by the help of the ephemeris, these tables, and others that are also provided by the board of longitude, the calculations relating to the longitude, which could not be performed by the most expert mathematician in less than four hours, may now be completed with great ease and accuracy in half an hour.

As this method of determining the longitude depends on the use of the tables annually published for this purpose, those who wish for farther information are referred to the instructions that accompany them, and particularly to those that are annexed to the tables requisite to be used with the Astronomical and Nautical Ephemeris.

4th. The phenomena of Jupiter's satellites have commonly been preferred to those of the moon, for finding the longitude; because they are less liable to parallaxes than these are, and besides they afford a very commodious observation whenever the planet is above the horizon. Their motion is very swift, and must be calculated for every hour.

Now, to find the longitude by these satellites: with a good telescope observe some of their phenomena, as the conjunction of two of them, or of one of them with Jupiter, &c. and at the same time find the hour and minute, from the altitudes of the stars, or by means of a clock or watch, previously regulated for the place of observation; then, consulting tables of the satellites, observe the time when the same appearance happens in the meridian of the place for which the tables are calculated; and the difference of time, as before, will give the longitude.

The eclipses of the first and second of Jupiter's satellites are the most proper for this purpose; and as they happen almost daily, they afford a ready means of determining the longitude of places at land, having indeed contributed much to the modern improvements in geography; and if it were possible to observe them with proper telescopes, in a ship under sail, they would be of great service in ascertaining its longitude from time to time. To obviate the inconvenience to which these observations are liable from the motions of the ship, Mr. Irwin invented what he called a marine chair: this was tried by Dr. Maskelyne, in his voyage to Barbadoes, when it was found that no benefit could be derived from the use of it. And indeed, considering the great power requisite in a telescope proper for these observations, and the violence as well as irregularities in the motion of a ship, it is to be feared that the complete management of a telescope on shipboard will always remain among the desiderata in this part of nautical science. And farther, since all methods that depend on the phenomena of the heavens, have also this other defect, that they cannot be observed at all times, this renders the improvement of timekeepers of the greater importance.

LONICERA, *honeysuckle*, a genus of the monogynia order, in the pentandria class of plants. The corolla is monopetalous and irregular; the berry polyspermous, bilocular, and inferior. There are 19 species, of which the most remarkable are,

1. The alpigena, or upright red-berried honeysuckle, rises with a shrubby, short, upright stem, four or five feet high.

2. The cærulea, or blue-berried honeysuckle, with a shrubby upright stem, three or four feet high, and many white flowers proceeding from the sides of the branches.

3. The nigra, or black-berried upright honeysuckle, with a shrubby stem three or four feet high, and white flowers succeeded by single and distinct black berries.

4. The tartarica, or Tartarian honeysuckle, with a shrubby upright stem, three or four feet high, heart-shaped opposite leaves, and whitish erect flowers succeeded by red berries, sometimes distinct, and sometimes double.

5. The diervilla, or yellow-flowered Arcacadian honeysuckle, with shrubby upright stalks, to the height of three or four feet, and clusters of pale yellow flowers, appearing in May and June, and sometimes continuing till autumn, but rarely ripening seeds here.

6. The xylosteum, or fly honeysuckle, with a strong shrubby stem, branching erect to the height of seven or eight feet, and erect white flowers proceeding from the sides of the branches.

7. The symphoricarpos, or shrubby St. Peter's-wort, with a shrubby rough stem, four or five feet high, and small greenish flowers.

8. The periclymenum, or common climbing honeysuckle, has two principal varieties, viz. the English wild honeysuckle, or woodbine of our woods and hedges, and the Dutch or German honeysuckle, with a shrubby declinated stalk, and long trailing purplish branches, furnishing large beautiful red flowers of a fragrant odour, appearing in June and July.

9. The caprifolium, or Italian honeysuckle, with shrubby declinated stalks, sending out long slender trailing branches, terminated by verticillate or whorled bunches of close-sitting flowers, very fragrant, and white, red, and yellow colours.

10. The sempervirens, or evergreen trumpet-flowered honeysuckle, with a shrubby declinated stalk, sending out long slender trailing branches, terminated by naked verticillate spikes, of long, unreflexed, deep-scarlet flowers, very beautiful, but of little fragrance.

LOOF, in the sea language, is a term used in various senses; thus the loof of a ship is that part of her aloft which lies just before the chest-tree; hence the guns which lie there are called loof-pieces: keep your loof, signifies, keep the ship near to the wind: to loof into a harbour, is to sail into it close by the wind: loof up, is to keep nearer the wind: to spring the loof, is when a ship that was going large before the wind, is brought close by the wind.

Loof-tackle, is a tackle in a ship which serves to lift goods of small weight in or out of her.

LOOKING-GLASSES. See Optics.

LOOM, the weaver's frame, a machine whereby several distinct threads are woven into one piece. Looms are of various structures, accommodated to the various kinds of materials to be woven, and the various manner of weaving them, viz. for woollens, silks, linens, cottons, cloths of gold, and other works, as tapestry, ribands, stockings, &c. See Weaving.

The weaver's loom-engine, otherwise called the Dutch loom-engine, was brought into use from Holland to London, in or about the year 1676.

The lower compartment of Plate Lock and Loom, represents a loom for weaving silks or other plain work. A, fig. 6, is a roll called the cloth-beam, on which the cloth is wound as it is wove; at one end it has a racket-wheel *a*, and a click to prevent its running back; at the same end it has also four holes in it, and is turned by putting a stick in these holes: at the other end of the loom is another roll B, on which the yarn is wound; this has two small cords *bb* wrapped round it, the ends of which are attached to a bar *d*, which has a weight D hung to it; by this means a friction is caused, which prevents the roll B turning by accident. EF are called lambs; they are composed of two sticks *efhi*, between which are fastened a great number of threads; to the bar *e* are fastened two cords *gh*, which pass over pulleys, and are fastened to the bar *h* of the lamb F; the lower bars of each lamb are connected by cords with the treadles GH; the workman sits on the seat K, and places his feet upon these treadles; as they are connected together by the cords *gh*, when he presses down one, it will raise the other, and the lambs with them; a great number of threads, according to the width of the cloth, are wound round the yarn-beam B, and are stretched to the cloth-beam A; the middle of the threads which compose the lamb EF, have loops (called eyes) in them, through which the threads between the rolls AB, which are called the warp, are passed; the first thread of the warp goes through the loops of the lambs E, the next attached to the lamb F, and so on alternately; by this means, when the weaver presses down one of the treadles with his foot, and raises the other, one lamb draws up every other thread, and the other sinks all the rest, so as to make an opening between the sets of thread: LL is a frame moving on a centre at the top of the frame of the loom; the lower part of this frame is shewn in fig. 8; LL are the two uprights of the frame, *l* is the bar that connects them, M is a frame carrying a great number of pieces of split reed or sometimes fine wire at equal distances; between these the threads of the warp are passed; the frame M is supported by a piece of wood *m* called the shuttle-race, which is fastened into the front of the pieces LL; each end of this piece has boards nailed to the sides, so as to form troughs NO; at a small distance above these are fixed two very smooth wires *no*; their use is to guide the two pieces *pq*, call-peckers or drivers; to each of these pieces a string is fastened, and these strings are tied to a piece of wood P, which the weaver holds in his hand, and by snatching the stick to either side, draws the pecker forwards very quick, and gives the shuttle, fig. 7. (which is to be laid in the trough before the pecker) a smart blow, and drives it along across the race *m* into the other trough, where it pushes the pecker along to the end of the wire, ready for the next stroke which throws it back again, and so on. Fig. 7. represents the under side of the shuttle on a larger scale; its ends are pointed with iron; it has a large mortise through the middle of it, in which is placed a quill *a* containing the yarn; *b* is a piece of glass, called the eye of the shuttle, with a hole in it, through which comes the end of the thread; *dd* are two small wheels to make it run easily on the race. The operations are as follow: the workman sitting upon the seat K, holds the stick P in his right hand, and takes hold of one of the bars of the frame LL with his left; presses his foot on one of the treadles GH, which by means of the lambs EF, as before described, divides the warp; he then snatches the stick P, and by that means throws the shuttle, fig. 7, which unwinds the thread in it, and leaves it lying in between the threads of the warp; he then relieves the treadle he before kept down, and presses down the other; while he is doing this, he with his left hand draws the frame LL towards him, and then returns it. The use of this is to beat the last thread thrown by the shuttle close up to the one that was thrown before it by the split reeds M, fig. 8. As soon as he has brought the frame LL back to its original position, and again divided the warp by the treadle, he throws the shuttle again: when he has in this manner finished about 12 or 14 inches of cloth, he winds it up by turning the roll A with the stick, as before described. Some very expert weavers will throw the shuttle and perform the other operations at the rate of 120 times per minute.

Loom, in the sea language. When a ship appears big when seen at a distance, they say she looms.

Loom-gale, a gentle easy gale of wind, in which a ship can carry her topsails atrip.

LOOP, in the iron works, denotes a part of a sow or block of cast iron, broken or melted off from the rest.

LOPHIUS, *fishing-frog*, *toad-fish*, or *sea-devil*, a genus of the branchiostegious order of fishes, whose head is in size equal to all the rest of the body. There are three species, the most remarkable of which is the piscatorius, or common fishing-frog, an inhabitant of the British seas. This singular fish grows to a large size, some being between four and five feet in length; and Mr. Pennant mentions one taken near Scarborough, whose mouth was a yard wide. The fishermen on that coast have a great regard for this fish, from a supposition that it is a great enemy to the dog-fish; and whenever they take it with their lines, set it at liberty. The head of this fish is much larger than the whole body, is round at the circumference, and flat above; the mouth of a prodigious wideness. The under jaw is much longer than the upper; the jaws are full of slender sharp teeth; in the roof of the mouth are two or three rows of the same. On each side the upper jaw are two sharp spines, and others are scattered about the upper part of the head. The body grows slender near the tail, the end of which is quite even. The colour of the upper part of this fish is dusky; the lower part white; the skin smooth.

LORANTHUS, a genus of the monogynia order, in the hexandria class of plants, and in the natural method ranking under the 48th order, aggregatæ. The germen is inferior; there is no calyx; the corolla is sexfid and revoluted; the stamina are at the tops of the petals; the berry is monospermous. There are 18 species, natives of America.

LORD. See Peer.

LORD'S DAY. All persons not having a reasonable excuse, shall resort to their parish church or chapel (or some congregation of religious worship allowed by the toleration act) on every Sunday, on pain of punishment by the censures of the church, and of forfeiting 1*s*. to the poor for every offence; to be levied by the churchwardens by distress, by warrant of one justice.

The hundred shall not be answerable for any robbery committed on the Lord's day.

No carrier shall travel, or drover drive cattle, on the Lord's day, under the penalty of 20*l*.

No person upon the Lord's day shall serve or execute any writ, process, warrant, order, judgment, or decree (except in cases of treason, felony, or breach of the peace), but the service thereof shall be void.

LOTTERIES are declared to be public nuisances, 5 Geo. I. c. 9.; but for the public service of the government, lotteries are frequently established by particular statutes, and managed by special officers and persons appointed.

By stat. 42 Geo. III. c. 54, lottery-office keepers are to pay 50*l*. for every licence in London, Edinburgh, and Dublin, or within 20 miles of either, and 10*l*. for every licence for every other office; and licensed persons shall deposit 30 tickets with the receiver-general of the stamp-duties, or licence to be void.

By stat. 22 Geo. III. c. 47, lottery-office keepers must take out a licence; and offices are to be open only from eight in the morning to eight in the evening, except the Saturday evening preceding the drawing. The sale of chances and shares of tickets, by persons not being proprietors thereof, is prohibited under penalty of 50*l*.; and by 42 Geo. III. c. 119, all games or lotteries called *little goes*, are declared public nuisances, and all persons keeping any office or place for any game or lottery, not authorized by law, shall forfeit 500*l*. and be deemed rogues and vagabonds. The proprietor of a whole ticket may nevertheless insure it for its value only, with any licensed office for the whole time of drawing from the time of insurance, under a bona fide agreement without a stamp.

LOTUS, or *bird's-foot trefoil*, a genus of the decandria order, in the diadelphia class of plants, and in the natural method ranking under the 32d order, papilionaceæ. The legumen is cylindrical, and very erect, the alæ closing upwards longitudinally; the calyx is tubulated. There are 23 species, but only five or six are usually cultivated in our gardens.

1. The siliquosus, or winged pea, has trailing, slender, branchy stalks, about a foot long, with trifoliate oval leaves, and from the axillas of the branches, large, papilionaceous, red flowers, one on each footstalk, succeeded by tetragonous solitary pods, having a membranous wing or lobe, running longitudinally at each corner. It flowers in June and July, and the seeds ripen in autumn. 2. The creticus, or Cretan silvery lotus. 3. The Jacobæus, or black lotus of St. James's island. 4. The hirsutus, or hairy Italian lotus. 5. The dorcynium, white Austrian lotus, or shrub trefoil of Montpelier. 6. The edulis, with yellow flowers.

The first species is a hardy annual. The other species may be propagated either by seeds or cuttings, but require to be kept in pots in the greenhouse during the winter season.

LOUIS, or Knights of St. Louis, the name of a military order in France, instituted by Louis XIV. in 1693.

LOUSE. See Pediculus.

LOXIA, a genus of birds of the order of passeres, the distinguishing characters of which are: the bill is strong, convex above and below, and very thick at the base; the nostrils are small and round; the tongue is as if cut off at the end; the toes are four, placed three before and one behind, excepting one species, which has only two toes before and one behind. The most remarkable are:

1. The curvirostra, or common cross-bill, is about the size of a lark, is known by the singularity of its bill, both mandibles of which curve opposite ways and cross each other: the general colour of the plumage in the male is of a red-lead, inclining to rose-colour, and more or less mixed with brown; the wings and tail are brown; the legs black. The female is of a green colour, more or less mixed with brown in those parts where the male is red. This species is a constant inhabitant of Sweden, Germany, Poland, Switzerland, Russia, and Siberia, where it breeds; but migrates sometimes in vast flocks into other countries, as is now and then the case in respect to England; for though in some years a few are met with, yet in others it has been known to visit us by thousands, fixing on such spots as are planted with pines, for the sake of the seeds, which are its natural food: it is observed to hold the cone in one claw like the parrot, and to have all the actions of that bird when kept in a cage. It is also found in North America and Greenland; and is said to make its nest in the highest parts of the fir-trees, fastening it to the branch with the resinous matter which exsudes from the trees.

2. The coccothraustes, or hawfinch, is in length seven inches. This species is ranked among the British birds; but only visits these kingdoms occasionally, and for the most part in winter, and is never known to breed here. It is more plenty in France. It feeds on berries, kernels, &c. and from the great strength of the bill, it cracks the stones of the fruit of the haws, cherries, &c. with the greatest ease.

3. The pyrrhula, or bullfinch, is so generally known as almost to supersede description. This species is common in most parts of the continent of Europe, and throughout Russia and Siberia, at which last places it is caught for the table. In winter it approaches gardens and orchards, and has been generally stigmatised for making havock among the buds of trees. From some late observations, however, it would appear, that the object of these birds is not the bud, but "the worm in the bud;" and that this species, in conjunction with various other species of small birds, are the frequent means of defending the embryo fruits, and thence promoting their growth to maturity; for the warmth that swells the buds, not only hatches eggs of unnumbered tribes of insects, whose parent flies, by an unerring instinct, laid them there, but brings forward a numerous race already in a caterpillar state, that now issue from their concealments, and make their excursion along the budding branches, and would probably destroy every hope of fruitage, but for those useful instruments for its preservation, whose young are principally fed by eating caterpillars. The bullfinch, in its wild state, has only a plain note; but when tamed, it becomes remarkably docile, and may be taught any tune after a pipe, or to whistle any notes in the best manner; it seldom forgets what it has learned; and will become so tame as to come at call, perch on its master's shoulders, and (at command) go through a difficult musical lesson. They may be also taught to speak, and some thus instructed are annually brought to London from Germany.

4. The cardinalis, or cardinal grossbeak, is near eight inches in length. The bill is stout, and of a pale-red colour; the irides are hazel; the head is greatly crested, the feathers rising up to a point when erect; round the bill, and on the throat, the colour is black: the rest of the bird of a fire-red. The female differs from the male, being mostly of a reddish brown. This species is met with in several parts of North America, and has attained the name of Virginia nightingale, from the fineness of its song, the note of which resembles that of the nightingale.

5. The orix, or grenadier grossbeak, is about the size of a house-sparrow. The forehead, sides of the head, and chin, are black; the breast and belly the same; the wings are brown, with pale edges; and the rest of the body of a beautiful red colour. These birds are inhabitants of Saint Helena; they are also in plenty at the Cape of Good Hope, where they frequent watery places that abound with reeds, and among which they are supposed to make their nest. If, as is supposed, this is the same with Kolben's finch, he says that the nest is of a peculiar contrivance, made with small twigs, interwoven very closely and tightly with cotton, and divided into two apartments with but one entrance, the upper for the male, the lower for the female, and is so tight as not to be penetrated by any weather. He adds, that the bird is scarlet only in summer, being in the winter wholly ash-coloured. These birds, seen among the green reeds, are said to have a wonderful effect: for, from the brightness of their colours, they appear like so many scarlet lilies. See Plate Nat. Hist. fig. 253.

6. The pensilis, or pensile grossbeak, (the toddy-bird of Fryer) is about the size of the house-sparrow: the bill is black; the irides are yellow; the head, throat, and fore-part of the neck, the same; from the nostrils springs a dull green stripe, which passes through the eye and beyond it, where it is broader; the hind part of the head and neck, the back, rump, and wing-coverts, are of the same colour; the quills are black, edged with green; the belly is deep grey, and the vent of a rufous red; the tail and legs are black. This species is found at Madagascar; and fabricates a nest of a curious construction, composed of straw and reeds interwoven in shape of a bag, the opening beneath. It is fastened above to a twig of some tree; mostly to those growing on the borders of streams. On one side of this, within, is the true nest. The bird does not form a new nest every year, but fastens a new one to the end of the last; and often as far as five in number, one hanging from another. These build in society, like rooks, often five or six hundred being seen on one tree. They have three young at each hatch. See Plate Nat. Hist. fig. 254.

7. The bengalensis, or Bengal gros-beak, is a trifle bigger than a house-sparrow. The female lays three or four eggs.

8. The socia, or sociable grossbeak, is about the size of a bullfinch; the general colour of the body above is a rufous brown, the under parts yellowish. It inhabits the interior country at the Cape of Good Hope, where it was discovered by colonel Paterson. These birds, according to our author, live together in large societies, and their mode of nidification is extremely uncommon. They build in a species of mimosa which grows to an uncommon size. In one described by col. Paterson, there could be no less a number than from 800 to 1000 residing under the same roof. He calls it a roof, because it perfectly resembles that of a thatched house; and the ridge forms an angle so acute and so smooth, projecting over the entrance of the nest below, that it is impossible for any reptile to approach them. The industry of these birds "seems almost equal (says our author) to that of the bee: throughout the day they appear to be busily employed in carrying a fine species of grass, which is the principal material they employ for the purpose of erecting this extraordinary work, as well as for additions and repairs. Though my short stay in the country was not sufficient to satisfy me by ocular proofs, that they added to their nest as they annually increased in numbers, still from the many trees which I have seen borne down with the weight, and others which I have observed with their boughs completely covered over, it would appear that this is really the case. When the tree which is the support of this aerial city is obliged to give way to the increase of weight, it is obvious that they are no longer protected, and are under the necessity of rebuilding in other trees. One of these deserted nests I had the curiosity to break down, so as to inform myself of the internal structure of it, and found it equally ingenious with that of the external. There are many entrances, each of which forms a regular street, with nests on both sides, at about two inches distant from each other.

9. The tridactyla, or three-toed grossbeak, (the guifso balito of Buffon) has only three toes, two before and one behind. The bill is toothed on the edges; the head, throat, and fore-part of the neck, are of a beautiful red; the upper part of the neck, back, and tail, are black; the wing-coverts brown, edged with white; quills brown, with greenish edges; and legs a dull red; the wings reach half-way on the tail. This species inhabits Abyssinia, where it frequents woods, and is a solitary species.

According to Linnæus there are 48 species of the loxia.

LOZENGE, Lozange, *rhombus*, in geometry, a quadrilateral figure, consisting of four equal and parallel sides, two of whose opposite angles are acute, and the other two obtuse; the distance between the two obtuse ones being always equal to the length of one side: when the sides are unequal, this figure is called a rhomboides.

Lozenge, in heraldry, a rhombus, or figure of equal sides, but unequal angles.

Lozenge, in pharmacy, the same with what is otherwise called troche.

LUCANUS, *stag chaffer*, a genus of insects of the order coleoptera: the generic character is, antennæ clavated, with compressed tip, divided into lamellæ on the inner side; jaws stretched forwards, exserted, and toothed. The principal species is the lucanus cervus, commonly known by the name of the stag-beetle, or stag-chaffer. It is the largest of all the European coleopterous insects, sometimes measuring nearly two inches and a half in length, from the tips of the jaws to the end of the body. Its general colour is a deep chesnut, with the thorax and head, which is of a squarish form, of a blacker cast; and the jaws are often of a brighter or redder chesnut-colour than the wing-shells; the legs and under-parts are coal-black, and the wings, which, except during flight, are concealed under the shells, are large, and of a fine pale yellowish-brown. This remarkable insect is chiefly found in the neighbourhood of oak-trees, delighting in the sweet exsudation or honey-dew so frequently observed on the leaves. Its larva, which perfectly resembles that of the genuine beetles, is also found in the hollows of oak-trees, residing in the fine vegetable mould usually seen in such cavities, and feeding on the softer parts of the decayed wood. It is of very considerable size, of a pale-yellowish or whitish-brown colour; and when stretched out at full length, measures nearly four inches. When arrived at its full size, which, according to some, is hardly sooner than the fifth or sixth year, it forms, by frequently turning itself, and moistening it with its glutinous saliva, a smooth oval hollow in the earth, in which it lies, and afterwards remaining perfectly still for the space of near a month, divests itself of its skin, and commences pupa or chrysalis. It is now of a shorter form than before, of a rather deeper colour, and exhibits in a striking manner the rudiments of the large extended jaws and broad head so conspicuous in the perfect insect: the legs are also proportionally larger and longer than in the larva state. The ball of earth in which this chrysalis is contained is considerably larger than a hen's egg, and of a rough exterior surface, but perfectly smooth and polished within. The chrysalis lies about three months before it gives birth to the complete insect, which usually emerges in the months of July and August. The time, however, of this insect's growth and appearance in all its states varies much, according to the difference of seasons. It is not very uncommon in many parts of England.

The commonly supposed female differs so much in appearance from the male, that it has by some authors been considered as a distinct species. It is not only smaller than the former, but totally destitute of the long and large ramified jaws, instead of which it has a pair of very short curved ones, slightly denticulated on their inner side: the head is also of considerably smaller diameter than the thorax. In point of colour it resembles the former.

The exotic species of this genus are mostly natives of America, and one in particular, frequently found in Virginia, is so nearly allied to the English stag-beetle as hardly to differ, except in having fewer denticulations or divisions on the jaws.

A highly elegant species has lately been discovered in New Holland. This differs from the rest in being entirely of a beautiful golden-green colour, with short, sharp-pointed, denticulated jaws of a brilliant copper-colour. The whole length of the insect is rather more than an inch. There are seven species of the lucanus.

LUCIDA, in astronomy, an appellation given to several fixed stars on account of their superior brightness; as the lucida coronæ, a star of the second magnitude in the northern crown; the lucida hydræ, or cor hydræ; and the lucida lyræ, a star of the first magnitude in that constellation.

LUDWIGIA, a genus of the monogynia order, in the tetrandria class of plants, and in the natural method ranking under the 17th order, calycanthemæ. The corolla is tetrapetalous; the calyx quadripartite, superior; the capsule tetragonal, quadrilocular, inferior, and polyspermous. There are four species, annuals of the West Indies.

LUES. See MEDICINE.

LUMBAGO. See MEDICINE.

LUMBRICUS, the *worm*, in zoology; a genus of insects belonging to the order of vermes intestina. The body is cylindrical, annulated, with an elevated belt near the middle, and a vent-hole on its side. There are two species of this animal: 1. Lumbricus terrestris, the earth or dew worm, Mr. Barbut observes, differs extremely in colour and external appearance in the different periods of its growth, which has occasioned people little acquainted with the variations of this kind of animals to make four or five different species of them. The general colour is a dusky red. They live under ground, never quitting the earth but after heavy rains, or at the approach of storms. The method to force them out is, either to water the ground with infusions of bitter plants, or to trample on it. The bare motion on the surface of the soil drives them up, in fear of being surprised by their formidable enemy, the mole. The winding progression of the worm is facilitated by the inequalities of its body, armed with small, stiff, sharp-pointed bristles: when it means to insinuate itself into the earth, there oozes from its body a clammy liquor, by means of which it slides down. It never damages the roots of vegetables. Its food is a small portion of earth, which it has the faculty of digesting. The superfluity is ejected by way of excrement, under a vermicular appearance. Earth-worms are hermaphrodites. 2. The marinus, marine worm, or lug, (see Plate Nat. Hist. fig. 255.) is of a pale red colour, and the body is composed of a number of annular joints; the skin is scabrous, and all the rings or joints are covered with little prominences, which render it extremely rough to the touch. It is an inhabitant of the mud about the sea-shores, and serves for food to many kinds of fish. The fishermen bait their hooks and nets with it.

LUNAR CAUSTIC. } See SILVER, CHEMISTRY, and SALTS, *Detonating*.
LUNA CORNEA. }

LUNARIA, SATIN-FLOWER, MOONWORT, or HONESTY, a genus of the siliculosa order, in the tetradynamia class of plants, and in the natural method ranking under the 39th order, siliquosæ. The silicula is entire, elliptical, compressed-plane, and pedicellated; with the valves equal to the partition, parallel, and plane; the leaves of the calyx are alternately fritted at the base. There are three species. This plant is famous in some parts of the kingdom for its medicinal virtues, though it has not the fortune to be received in the shops. The people in the northern countries dry the whole plant in an oven, and give as much as will lie on a shilling for a dose twice a day in hemorrhages of all kinds, and with great success. The Welsh, among whom it is not uncommon, Dr. Needham informs us, make an ointment of it, which they use externally, and pretend it cures dysenteries.

LUNATIC. See IDIOT.

LUNGS. See ANATOMY, and PHYSIOLOGY.

LUPINUS, *lupin*, a genus of the decandria order, in the diadelphia class of plants, and in the natural method ranking under the 32d order, papilionaceæ. The calyx is bilabiated; there are five oblong and five roundish antheræ; the legumen is coriaceous. There are ten species, chiefly hardy herbaceous flowery annuals, rising with upright stalks from one to three or four feet high, ornamented with digitate or fingered leaves, and terminated by long whorled spikes of papilionaceous flowers, white, blue, yellow, and rose-coloured. They are all easily raised from seed, and succeed in any open borders, where they make a fine variety.

LUPUS, in astronomy, a southern constellation, consisting of 19, or, according to Flamsteed, of 24 stars.

LUSTRATION, in antiquity, sacrifices or ceremonies by which the antients purified their cities, fields, armies, or people, defiled by any crime or impurity.

LUSTRE, a term signifying the gloss or brightness which appears on the external surface of a mineral, or on the internal surface when newly broken. The first is called the external, the second internal lustre. Two particulars respecting lustre require attention, viz. the degree, and the kind.

1. With respect to degree, Dr. Thomson gives five terms of comparison, viz. 1. very brilliant; 2. brilliant; 3. sub-brilliant; 4. glimmering, that is, having only certain parts brilliant; 5. dull, or without lustre.

2. With respect to kind, the lustre is either metallic or common. The common lustre is subdivided into vitreous or glossy, silky, waxy or greasy, mother of pearl, diamond, and semi-metallic.

LUTE, a stringed instrument formerly much in use; antiently containing only five rows of strings, but to which six, or more, were afterwards added. The lute consists of four parts, viz. the table; the body, which has nine or ten sides; the neck, which has as many stops or divisions; and the head, or cross, in which screws for tuning it are inserted. In playing this instrument, the performer strikes the strings with the fingers of the right hand, and regulates the sounds with those of the left hand. The origin of this instrument is not known, though generally believed to be of very early date. Indeed, authors are not agreed as to the country to which we are indebted for its invention. Some give it to Germany, and derive its name from the German word laute, which signifies the same thing, while others ascribe it to the Arabians, and trace its name from the Arabic alland.

LUTES. In many chemical operations the vessels must be covered with something to preserve them from the violence of the fire, from being broken or melted; and also to close exactly their joinings to each other, in order to retain the substances which they contain, when they are volatile, and reduced to vapour.

The coating used for retorts, &c. to defend them from the action of the fire, is usually composed of nearly equal parts of coarse sand, and refractory clay. These matters ought to be well mixed with water and a little hair, so as to form a liquid paste, with which the vessels are covered, layer upon layer, till it is of the required thickness. The sand mixed with the clay is necessary to prevent the cracks which are occasioned by the contracting of the clay during its drying, which it always does when pure. The hair serves also to bind the parts of the lute, and to keep it applied to the vessel; for, notwithstanding the sand which is introduced into it, some cracks are always formed, which would occasion pieces of it to fall off.

The lutes with which the joinings of vessels are closed, are of different kinds, according to the nature of the intended operations, and of the substances to be distilled in these vessels.

When vapours of watery liquors, and such as are not corrosive, are to be contained, it is sufficient to surround the joining of the receiver, to the nose of the alembic, or of the retort, with slips of paper or linen, covered with flour paste. In such cases also, slips of wet bladder are very conveniently used.

When more penetrating and dissolving vapours are to be contained, a lute is to be employed of quick-lime, slacked in air, and beaten into a liquid paste with whites of eggs. This paste is to be spread upon linen slips, which are to be applied exactly to the joining of the vessel. This lute is very convenient, easily dries, becomes solid, and sufficiently firm.

Lastly, when saline, acid, and corrosive vapours are to be contained, we must then have recourse to the lute called fat-lute. This lute is made by forming into a paste some dried clay finely powdered, sifted through a silken searce, and moistened with water; and then, by beating this paste well in a mortar with boiled linseed-oil, that is, oil which has been rendered dry by litharge dissolved in it, this lute easily takes and retains the form given to it. It is generally rolled into cylinders of a convenient size. These are to be applied, by flattening them, to the joinings of the vessels, which ought to be perfectly dry; because the least moisture would prevent the lute from adhering. When the joinings are closed with this fat-lute, the whole is to be covered with slips of linen spread with a lute of lime and whites of eggs. These slips are to be fastened with packthread. The second lute is necessary to keep on the fat-lute, because the latter remains soft, and does not become solid enough to stick on alone.

Ground linseed made into a paste with water makes also a very useful lute for most occasions.

LUTHERANS, the christians who follow the opinions of Martin Luther, one of the principal reformers of the church in the sixteenth century. See Gregory's Church History, vol. ii.

LUXATION. See SURGERY.

LYCHNIS, *campion*, a genus of the pentagynia order, in the pentandria class of plants, and in the natural method ranking under the 22d order, caryophylleæ. The calyx is monophyllous, oblong, and smooth; there are five unguiculated petals, with the segments of the limbs almost bifid; the capsule quinquelocular. There are 12 species, the principal are, 1. The chalcedonica, or chalcedonian scarlet. Of this there are varieties, with single scarlet flowers, with large double scarlet flowers of exceeding beauty and elegance, with pale red flowers, and with white flowers. Of these varieties the double scarlet lychnis is superior to all for size and elegance, the flowers being large, very double, and collected into a very large bunch, exhibit a charming appearance; the single scarlet kind is also very pretty, and the others effect an agreeable variety with the scarlet kinds. 2. The diurna: the varieties are, the common single red-flowered bachelor's button, double red, double white, and single white-flowered. The double varieties are exceedingly ornamental in their bloom; the flowers large, very double, and continue long in blow; the single red sort grows wild by ditch-sides and other moist places in many parts of England; from which the doubles were accidentally obtained by culture in gardens. 3. The viscaria, or viscous German lychnis, commonly called catch-fly. Of this also there are varieties with single red flowers, with double red flowers, and with white flowers. The double variety is considerably the most eligible for general culture, and is propagated in plenty by parting the roots. All the varieties of this species emitting a glutinous liquid matter from their stalks, flies happening to light on them sometimes stick and entangle themselves, whence the plant obtains the name catch-fly. 4. The flos cuculi, cuckoo-flower lychnis. The flowers having each petal deeply quadrifid in a torn or ragged-like manner, the plant obtained the name of ragged robin. There are varieties with single and double flowers. The double sort is a large flower; it is an improved variety of the single, which grows wild in most of our moist meadows, and is rarely cultivated; but the double, being very ornamental, merits culture in every garden.

LYCIUM, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 28th order, luridæ. The corolla is tubular, having its throat closed up with the beard of the filaments; the berry is bilocular. There are eight species, natives of various countries, and chiefly shrubs.

LYCOPERDON, a genus of the natural order of fungi, belonging to the cryptogamia class of plants. The fungus is roundish, and full of farinaceous seeds. Dr. Withering reckons 25 species, of which the following are the most remarkable: 1. The tuber, truffles, or subterraneous puff-balls, is a native of woods both in England and Scotland. It is a subterraneous fungus, growing generally in clusters 3 or 4 inches under ground, without any visible root. The figure of it is nearly spherical, the size that of a potatoe; the exterior coat at first white, afterwards black, and studded with pyramidical or polyhedrous tubercles; the internal substance solid and callous, of a dirty-white or pale-brown colour, grained like a nutmeg with serpentine lines; in which, according to Micheli, are imbedded minute oval capsules, containing each from 2 to 4 round warted seeds. The truffles of Great Britain seldom exceed 3 or 4 ounces in weight; but in Italy, and some other parts of the continent, they are said to have been found of the enormous size of 8, and even 14 pounds. They have a volatile and somewhat urinous smell, and are reputed to be aphrodisiacal. 2. The bovista, or common puff-ball, is frequent in meadows and pastures in the autumn. It varies exceedingly in size, figure, superficies, and colour. In general, it consists of a sack or bag, having a root at its base, and the bag composed of 3 membranes, an epidermis, a tough white skin, and an interior coat which adheres closely to the central pith. The pith in the young plants is of a yellowish colour, at first firm and solid, but soon changes into a cellular spongy substance, full of a dark dull-green powder, which discharges itself through an aperture at the top of the fungus, which aperture is formed of lacerated segments, in some varieties reflexed. The powder is believed to be the seeds, which through a microscope appear of a spherical form, and to be annexed to elastic hairs.

LYCOPODIUM, or CLUB-MOSS, a genus of the natural order of musci, belonging to the cryptogamia class of plants. The antheræ are bivalved and sessile; there are no calyptra. There are 29 species, of which the following are the most remarkable: 1. The clavatum, or common club-moss, is common in dry and mountainous places, and in fir forests. The stalk is prostrate, branched, and creeping from a foot to two or three yards long; the radicles woody. The leaves are numerous, narrow, lanceolated, acute, often incurved at the extremity, terminated with a long white hair, and every where surround the stalk. The peduncles are erect, firm, and naked, (except being thinly set with lanceolet scales), and arise from the ends of the branches. They are generally two or three inches long, and terminated with two cylindrical yellowish spikes, imbricated with oval-acute scales, finely lacerated on the edges, and ending with a hair. In the ala or bosom of the scale is a kidney-shaped capsule, which bursts with elasticity when ripe, and throws out a light-yellow powder, which, blown into the flame of a candle, flashes with an explosion.

LYCOPSIS, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 41st order, asperifoliæ. The corolla has an incurvated tube. There are eight species, chiefly annuals.

LYCOPUS, a genus of the monogynia order, belonging to the diandria class of plants, and in the natural method ranking under the 42d order, verticillatæ. The corolla is quadrifid, with one of the segments emarginated; the stamina standing asunder, with four retuse seeds. There are three species, of which the water-horehound might probably be of use in dyeing.

LYGEUM, a genus of the monogynia order, in the triandria class of plants, and in the natural method ranking under the fourth order, gramina. The spatha or sheath is monophyllous; there are a pair of corollæ upon the same germen; the nut is bilocular. There is one species, a grass of Spain.

LYDIAN STONE, in mineralogy, is commonly intersected by veins of quartz. Fracture even, and sometimes inclining to conchoidal. Specific gravity 2.6 nearly. Powder black, or greyish black. This stone, or one similar to it, was used by the antients as a touchstone. They drew the metal to be examined along the stone, and judged of its purity by the colour of the metallic streak. On this account it was called Βασανος, the trier. It was called the Lydian stone, as being found in the river Tmolus in Lydia.

LYMPH. See ANATOMY, and PHYSIOLOGY.

LYNX. See FELIS.

LYRE, LYRA, a musical instrument of the string kind, much used by the antients.

LYRE, *lyra*, in astronomy, a constellation of the northern hemisphere, the number of whose stars, in Ptolomy's and Tycho's catalogues, are only 10, but 19 in the Britannic catalogue.

LYRIC. See POETRY.

LYSIMACHIA, *loosestrife*, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 20th order, rotaceæ. The corolla is rotaceous; the capsule globular, beaked, and ten-valved. There are 12 species, but only four are commonly cultivated in gardens. These are hardy herbaceous perennials and biennials, rising with erect stalks from 18 inches to two or three feet high, and terminated by spikes and clusters of monopetalous, rotated, five-parted spreading flowers of white and yellow colours. The nummulana, or yellow moneywort, or herb jevoperee, is particularly beautiful.

LYTHRUM, *purple loosestrife*, a genus of the monogynia order, in the decandria class of plants, and in the natural method ranking under the 17th order, calycanthemæ. The calyx is cleft in 12 parts; and there are six petals inserted into it; the capsule is bilocular and polyspermous. There are 18 species, of which the most remarkable are, 1. The salicaria, or common purple loosestrife, with oblong leaves, is a native of Britain, and grows naturally by the sides of ditches and rivers. 2. The hispanum, or Spanish loosestrife, with a hyssop leaf, grows naturally in Spain and Portugal. The flowers are larger than those of the common sort, and make a fine appearance in the month of July, when they are in beauty.

M.

M, the twelfth letter of our alphabet. As a numeral it stands for mille, a thousand; and with a dash over it, thus $\overline{M}$, for a thousand times a thousand, or 1000000. Used as an abbreviature M. signifies Manlius, Marcus, Martius, Mucius; and M. Manius; M. B. mulier bona; Mag. Eq. magister equitum; Mag. Mil. magister militum; M. M. P. manu mancipio potestate; M. A. magister artium; MS. manuscript, and M.SS. manuscripts, in the plural. In the prescriptions of physicians, M. stands for manipulus, a handful; and sometimes for misce, or mixtura.

MABA, a genus of the triandria order, in the diœcia class of plants. The perianthium of the male is trifid; that of the female is as in the male; the fruit is a plum two-celled, superior. There is one species, a tree of the Friendly islands.

MABEA, a genus of the monoecia polyandria class and order. The calyx is one-leaved; corolla none. There are two species, called pipewood, shrubs of the West Indies.

MACARONIC, or MACARONIAN, an appellation given to a burlesque kind of poetry, made up of a jumble of words of different languages, and words of the vulgar tongue latinized.

MACE, the second coat or covering of the kernel of the nutmeg, is a thin and membranaceous substance, of an oleaginous nature and a yellowish colour; being met with in flakes of an inch and more in length, which are divided into a multitude of ramifications. It is of an extremely fragrant, aromatic, and agreeable flavour, and of a pleasant, but acrid and oleaginous taste. See MYRISTICA.

MACERATION, in pharmacy, is an infusion of, or soaking ingredients in, water, or any other fluid, in order either to soften them or draw out their virtues.

MACHINE. See MECHANICS.

MACKREL. See SCOMBER.

MACROCNEMON, a genus of the class and order pentandria monogynia. The cor. is bell-shaped; the capsule two-celled, two-valved; seeds imbricate. There are three species, small trees of the West Indies.

MACROLOBIUM, a genus of the class and order triandria monogynia. The calyx is double, pet. five, germ. pedicelled legume. There are three species, trees of Guiana.

MACULÆ, in astronomy, are dark spots appearing on the luminous surfaces of the sun and moon, and even some of the planets. The solar maculæ are dark spots of an irregular and changeable figure, observed in the face of the sun. These were first observed in November and December of the year 1610, by Galileo in Italy, and Harriot in England, unknown to, and independant of, each other, soon after they had made or procured telescopes.

There have been various observations made of the phenomena of the solar maculæ, and hypotheses invented for explaining them. Many of these maculæ appear to consist of heterogeneous parts; the darker and denser being called, by Hevelius, nuclei, which are encompassed as it were with atmospheres, somewhat rarer and less obscure; but the figure, both of the nuclei and entire maculæ, is variable. These maculæ are often subject to sudden mutations. In 1644 Hevelius observed a small thin macula, which in two days time grew to ten times its bulk, appearing also much darker, and having a larger nucleus: the nucleus began to fail sensibly before the spot disappeared; and before it quite vanished, it broke into four, which reunited again two days after. Some maculæ have lasted 2, 3, 10, 15, 20, 30, but seldom 40 days; though Kirchius observed one in 1681, that was visible from April 26th to the 17th of July. It is found that the spots move over the sun's disc with a motion somewhat slacker near the edge than in the middle parts; that they contract themselves near the limb, and in the middle appear larger; that they often run into one in the disc, though separated near the centre; that many of them first appear in the middle, and many disappear there; but that none of them deviate from their path near the horizon; whereas Hevelius, observing Mercury in the sun near the horizon, found him too low, being depressed 27″ beneath his former path.

From these phenomena are collected the following consequences:

1. That since Mercury's depression below his path arises from his parallax, the maculæ, having no parallax from the sun, are much nearer him than that planet.

2. That since they rise and disappear again in the middle of the sun's disc, and undergo various alterations with regard both to bulk, figure, and density, they must be formed de novo, and again dissolved about the sun; and hence some have inferred, that they are a kind of solar clouds, formed out of his exhalations; and if so, the sun must have an atmosphere.

3. Since the spots appear to move very regularly about the sun, it is hence inferred, that it is not that they really move, but that the sun revolves round his axis, and the spots accompany him, in the space of 27 days, 12 hours, 20 minutes.

4. Since the sun appears with a circular disc in every situation, his figure, as to sense, must be spherical.

The magnitude of the surface of a spot may be estimated by the time of its transit over a hair in a fixed telescope. Galileo estimates some spots as larger than both Asia and Africa put together; but if he had known more exactly the sun's parallax and distance, as they are known now, he would have found some of those spots much larger than the whole surface of the earth. For in 1612 he observed a spot so large as to be plainly visible to the naked eye, and therefore it subtended an angle of about a minute. But the earth, seen at the distance of the sun, would subtend an angle of only about 17″; therefore the diameter of the spot was to the diameter of the earth, as 60 to 17, or $3\frac{1}{2}$ to 1 nearly; and consequently the surface of the spot, if circular, to a great circle of the earth, as $12\frac{1}{4}$ to 1, and to the whole surface of the earth, as $12\frac{1}{4}$ to 4, or nearly 3 to 1. Gassendus observed a spot whose breadth was $\frac{1}{20}$ of the sun's diameter, and which therefore subtended an angle at the eye of above a minute and a half, and consequently its surface was above seven times larger than the surface of the whole earth. He says he observed above 40 spots at once, though without sensibly diminishing the light of the sun.

In the year 1779 there was a spot on the sun which was large enough to be seen by the naked eye. It was divided into two parts, and must have been 50,000 miles in diameter.

Various opinions have been formed concerning the nature, origin, and situation of the solar spots; but the most probable seems to be that of Dr. Wilson, professor of practical astronomy in the university of Glasgow. By attending particularly to the different phases presented by the umbra, or shady zone, of a spot of an extraordinary size that appeared on the sun, in the month of November 1769, during its progress over the solar disc, Dr. Wilson was led to form a new and singular conjecture on the nature of these appearances; which he afterwards greatly strengthened by repeated observations. The results of these observations are, that the solar maculæ are cavities in the body of the sun; that the nucleus, as the middle or dark part has usually been called, is the bottom of the excavations; and that the umbra, or shady zone surrounding it, is the shelving sides of the cavity. Dr. Wilson, besides having satisfactorily ascertained the reality of these immense excavations in the body of the sun, has also pointed out a method of measuring the depth of them. He estimates, in particular, that the nucleus or bottom of the large spot above-mentioned, was not less than a semidiameter of the earth, or about 4000 miles below the level of the sun's surface; while its other dimensions were of a much larger extent. He observed that a spot near the middle of the sun's disc is surrounded equally on all sides with its umbra; but that when, by its apparent motion over the sun's disc, it comes near the western limb, that part of the umbra which is next the sun's centre gradually diminishes in breadth, till near the edge of the limb it totally disappears; whilst the umbra on the other side of it is little or nothing altered. After a semi-revolution of the sun on his axis, if the spot appear again, it will be on the opposite side of the disc, or on the left hand, and the part of the umbra which had before disappeared is now plainly to be seen; while the umbra on the other side of the spot seems to have vanished in its turn, being hid from the view by the upper edge of the excavation, from the oblique position of its sloping sides with respect to the eve. But as the spot advances on the sun's disc, this umbra, or side of the cavity, comes in sight; at first appearing narrow, but afterwards gradually increasing in breadth, as the spot moves towards the middle of the disc. These appearances perfectly agree with the phases that are exhibited by an excavation in a spherical body, revolving on its axis; the bottom of the cavity being painted black, and the sides lightly shaded.

Dr. Herschel supposes that the spots in the sun are mountains on its surface, which considering the great attraction exerted by the sun upon bodies placed at its surface, and the slow revolution it has about its axis, he thinks may be more than 300 miles high. He says, that in August 1792 he examined the sun with several powers, from 90 to 500; and it appeared that the black spots are the opaque ground or body of the sun, and that the luminous part is an atmosphere which being broken, gives a glimpse of the sun itself.

MADDER. See Rubia.

MADNESS. See Medicine.

MADREPORA, in natural history, the name of a genus of submarine substances, the characters of which are, that they are almost of a stony hardness, resembling the corals, and are usually divided into branches, and pervious by many holes or cavities, which are frequently of a stellar figure.

In the Linnæan system, this is a genus of lithophyta: the animal that inhabits it is a medusa; it comprehends 39 species. According to Donati, the madrepora is like the coral as to its hardness, which is equal to bone or marble; the colour is white when polished; its surface is lightly wrinkled, and the wrinkles run lengthwise of the branches; in the centre there is a sort of cylinder, which is often pierced through its whole length by two or three holes. From this cylinder are detached about 17 laminæ, which run to the circumference in straight lines; and are transversely intersected by other laminæ, forming many irregular cavities; the cellules, which are composed of these laminæ ranged into a circle, are the habitations of little polypes, which are extremely tender animals, generally transparent, and variegated with beautiful colours. M. de Peyssonel observes, that those writers who only considered the figures of submarine substances, denominated that class of them which seemed pierced with holes, pora; and those the holes of which were large they called madrepora. He defines them to be all those marine bodies which are of a stony substance, without either bark or crust, and which have but one apparent opening at each extremity, furnished with rays that proceed from the centre to the circumference. He observes that the body of the animal of the madrepora, whose flesh is so soft that it divides upon the gentlest touch, fills the centre; the head is placed in the middle, and surrounded by several feet or claws, which fill the intervals of the partitions observed in this substance, and are at pleasure brought to its head, and are furnished with yellow papillæ. He discovered that its head or centre was lifted up occasionally above the surface, and often contracted and dilated itself like the pupil of the eye: he saw all its claws moved, as well as its head or centre. When the animals of the madrepora are destroyed, its extremities become white. In the madrepora, he says, the animal occupies the extremity, and the substance is of a stony but more loose texture than the coral. This is formed, like other substances of the same nature, of a liquor which the animal discharges: and he farther adds, that there are some species of the polype of the madrepora which are produced singly, and others in clusters. See Plate Nat. Hist. figs. 256 and 257; and Zoophytes.

MADREPORITE, a mineral found in the valley of Russback in Salzburg, and which obtained its name from its resemblance to madrepore. Colour in some parts black, in others dark-grey. Found in large round masses. Fracture even passing to the conchoidal. Lustre greasy, passing to the silky. Brittle: moderately heavy. Streak grey; it is composed of 93.00 carbonat of lime

0.50 carbonat of magnesia
7.25 carbonat of iron
0.50 charcoal
4.50 silica in sand.

99.75

MADRIER, in the military art, a long and broad plank of wood, used for supporting the earth in mining and carrying on a sap, and in making coffers, caponiers, galleries, and for many other uses at a siege. Madriers are also used to cover the mouths of petards after they are loaded, and are fixed with the petards to the gates or other places designed to be forced open.

MÆMACTERION, the fourth month of the Athenian year, consisting of only 29 days, and answering to the latter part of September and the beginning of October.

MAGAZINE, a place in which stores are kept, or arms, ammunition, provisions, &c. Every fortified town ought to be furnished with a large magazine, which should contain stores of all kinds, sufficient to enable the garrison and inhabitants to hold out a long siege, and in which smiths, carpenters, wheelwrights, bakers, &c. may be employed in making every thing belonging to the artillery, as carriages, waggons, &c.

Magazine, *powder*, is that place where the powder is kept in very large quantities. Authors differ greatly both in regard to situation and construction; but all agree, that they ought to be arched, and bomb-proof. In fortifications they are frequently placed in the rampart; but of late they have been built in different parts of the town. The first powder-magazines were made with Gothic arches; but M. Vauban, finding them too weak, constructed them in a semicircular form, whose dimensions are 60 feet long within, 25 broad; the foundations are eight or nine feet thick, and eight feet high from the foundation to the spring of the arch; the floor is two feet from the ground, which keeps it from dampness.

One of our engineers of great experience, some time since, had observed, that after the centres of semicircular arches are struck, they settle at the crown, and rise up at the haunches, even with a straight horizontal extrados; and still much more so in powder-magazines, whose outside at top is formed like the roof of a house, by two inclined planes joining in an angle over the top of the arch, to give a proper descent to the rain; which effects are exactly what might be expected agreeable to the true theory of arches. Now, as this shrinking of the arches must be attended with very ill consequences, by breaking the texture of the cement after it has been in some degree dried, and also by opening the joints of the voussoirs at one end, so a remedy is provided for this inconvenience, with regard to bridges, by the arch of equilibration in Dr. Hutton's book on bridges; but as the ill effect is much greater in powder-magazines, the same ingenious gentleman proposed to find an arch of equilibration for them also, and to construct it when the span is 20 feet, the pitch or height 10 (which are the same dimensions as the semicircle), the inclined exterior walls at top forming an angle of 113 degrees, and the height of their angular point above the top of the arch equal to seven feet.

MAGI, or Magians, an antient religious sect in Persia, and other Eastern countries, who maintained, that there were two principles, the one the cause of all good, the other the cause of all evil; and abominating the adoration of images, worshipped God only by fire, which they looked upon as the brightest and most glorious symbol of Oromasdes, or the good God: as darkness is the truest symbol of Arimanius, or the evil God. This religion was reformed by Zoroaster. The sect still subsists in Persia, under the denomination of gaurs.

MAGIC Lantern. See Optics.

Magic Square, in arithmetic, a square figure made up of numbers in arithmetical proportion, so disposed in parallel and equal ranks, that the sums of each row, taken either perpendicularly, horizontally, or diagonally, are equal: thus,

Natural square.

1	2	3
4	5	6
7	8	9

Magic square.

2	7	6
9	5	1
4	3	8

Magic squares seem to have been so called, from their being used in the construction of talismans.

MAGNA CHARTA, the great charter of the liberties of England, and the basis of our laws and privileges.

This charter may be said to derive its origin from king Edward the Confessor, who granted several privileges to the church and state, by charter; these liberties and privileges were also granted and confirmed by king Henry I., by a celebrated great charter now lost; but which was confirmed or re-enacted by king Henry II. and king John. Henry III., the successor of this last prince, after having caused twelve men to make enquiry into the liberties of England in the reign of Henry I., granted a new charter, which was the same as the present Magna Charta; this he several times confirmed, and as often broke; till in the thirty-seventh year of his reign, he went to Westminster-hall, and there in the presence of the nobility and bishops, who held lighted candles in their hands, Magna Charta was read, the king all the while holding his hand to his breast, and at last solemnly swearing faithfully and inviolably to observe all the things therein contained, &c.; then the bishops extinguishing the candles, and throwing them on the ground, cried out, "Thus let him be extinguished, and stink in hell, who violates this charter." It is observed, that notwithstanding the solemnity of this confirmation, king Henry, the very next year, again invaded the rights of his people, till the barons entered into a war against him; when, after various success, he confirmed this charter, and the charter of the forest, in the fifty-second year of his reign. This excellent charter, so equitable and beneficial to the subject, is the most antient written law in the kingdom: by the 25 Edw. I. it is ordained, that it shall be taken as the common law; and by the 43 Edw. III. all statutes made against it are declared to be void.

MAGNESIA. About the beginning of the eighteenth century, a Roman canon exposed a white powder to sale at Rome as a cure for all diseases. This powder he called magnesia alba. He kept the manner of preparing it a profound secret; but in 1707 Valentini informed the public that it might be obtained by calcining the lixivium which remains after the preparation of nitre; and two years after, Slevogt discovered that it might be precipitated by potass from the mother-ley of nitre. This powder was generally supposed to be lime, till Frederic Hoffman observed that it formed very different combinations with other bodies. But little was known concerning its nature, and it was even confounded with lime by most chemists, till Dr. Black made his celebrated experiments on it in 1755. Margraff published a dissertation on it in 1759, and Bergman another in 1775, in which he collected the observations of these two philosophers, and which he enriched also with many additions of his own. Butini of Geneva likewise published a valuable dissertation on it in 1779.

As magnesia has never yet been found native in a state of purity, it may be prepared in the following manner: sulphat of magnesia, a salt composed of this earth and sulphuric acid, exists in sea-water, and in many springs, particularly in some about Epsom; from which circumstance it was formerly called Epsom salt. This salt is to be dissolved in water, and half its weight of potass added. The magnesia is immediately precipitated, because potass has a stronger affinity for sulphuric acid. It is then to be washed with a sufficient quantity of water, and dried.

Magnesia thus obtained is a very soft white powder, which has very little taste, and is totally destitute of smell. Its specific gravity is about 2.3. It converts delicate vegetable blues (paper for instance, stained with the petals of the mallow) to green.

It is not melted by the strongest heat which it has been possible to apply; but M. Darcet observed that, in a very high temperature, it became somewhat agglutinated. When formed into a cake with water, and then exposed to a violent heat, the water is gradually driven off, and the magnesia contracts in its dimension; at the same time, it acquires the property of shining in the dark when rubbed upon a hot iron plate.

It is almost insoluble in water; for, according to Mr. Kirwan, it requires 7900 times its weight of water at the temperature of 60° to dissolve it. It is capable, however, of combining with water in a solid state; for 100 parts of magnesia, thrown into water, and then dried, are increased in weight to 118 parts. Even when combined with carbonic acid (for which it has a strong affinity) it is capable of absorbing and retaining $1\frac{1}{2}$ times its own weight of water without letting go a drop; but on exposure to the air, this water evaporates, though more slowly than it would from lime.

Magnesia has never yet been obtained in a crystallized form.

When exposed to the air, it attracts carbonic acid gas and water; but exceedingly slowly. Butini left a quantity of it for two years in a porcelain cup merely covered with paper; its weight was only increased $\frac{1}{144}$ part.

Magnesia does not combine with oxygen; nor is it altered by any of the compounds into which oxygen enters. The only one of the simple combustibles with which it can be united is sulphur. No person has hitherto succeeded in forming a phosphuret of magnesia. The sulphuret of magnesia may be formed by exposing a mixture of two parts of magnesia and one part of sulphur, to a gentle heat in a crucible. The result is a yellow powder, slightly agglutinated, which emits very little sulphureted hydrogen gas, when thrown into water. A moderate heat is sufficient to drive off the sulphur.

Magnesia does not combine with azote, but it unites with muriatic acid, and forms a compound called muriat of magnesia. It has no action upon the metals: nor does it combine, as far as is known at present, with the metallic oxides, unless some intermediate substance is present. It does not combine with the fixed alkalies, neither are its properties altered by these bodies; but it has a strong propensity to enter into triple compounds with ammonia.

There seems to be little affinity between magnesia and barytes; at least no mixture of the two earths is fusible in the strongest heat which it has been possible to apply.

Mr. Kirwan has shown that there is but little affinity between strontian and magnesia. They do not melt when exposed to a strong heat, at least when the strontian exceeds or equals the magnesia.

Equal parts of lime and magnesia, mixed together, and exposed by Lavoisier to a very violent heat, did not melt; neither did they melt when Mr. Kirwan placed them in the temperature of 150° Wedgewood.

The affinities of magnesia, according to Bergman, are as follows:

Oxalic acid,	Tartaric,
Phosphoric,	Citric,
Sulphuric,	Lactic,
Fluoric,	Benzoic,
Arsenic,	Acetic,
Saclactic,	Boracic,
Succinic,	Sulphurous,
Nitric,	Carbonic,
Muriatic,	Prussic.

Magnesia is used in medicine, to remove acidities.

MAGNETISM. The natural magnet, or loadstone, is a hard mineral body of a dark brown, or almost black colour, and when examined, is found to be an ore of iron. It is met with in various countries, generally in iron mines, and of all sizes and forms.

This singular substance was known to the antients; and they had remarked its peculiar property of attracting iron, though it does not appear that they were acquainted with the wonderful property which it also has, of turning to the pole when suspended, and left at liberty to move freely.

Upon this remarkable circumstance the mariner's compass depends, an instrument which gives us such infinite advantages over the antients. It is this which enables the mariners to conduct their vessels through vast oceans out of the sight of land, in any given direction; and this directive property also guides the miners in their subterranean excavations, and the traveller through deserts otherwise impassable.

It is not precisely known when and by whom this directive property of the magnet was discovered. The most probable accounts seem to prove, that it was known early in the 13th century; and that the person who first made mariner's compasses, at least in Europe, was a Neapolitan of the name of Flavio, or John de Gioga, or Giova, or Gira.

The natural loadstone has also the quality of communicating its properties to iron and steel; and when pieces of steel properly prepared are touched, as it is called, by the loadstone, they are denominated artificial magnets.

These artificial magnets are even capable of being made more powerful than the natural ones; and as they can be made of any form, and are more convenient, they are now universally used, so that the loadstone or natural magnet is only kept as a curiosity.

All magnets, whether natural or artificial, are distinguished from other bodies by the following characteristics, which appear to be inseparable from their nature; so that no body can be called a magnet, unless it is possessed of all these properties:

1. A magnet attracts iron.

2. When a magnet is placed so as to be at liberty to move freely in every direction, its ends point towards the poles of the earth, or very nearly so; and each end always points to the same pole. This is called the polarity of the magnet; the ends of the magnet are called poles; and they are called north and south poles of the magnet, according as they point to the north or south pole of the earth. When a magnet places itself in this direction, it is said to traverse.

3. When the north pole of one magnet is presented to the south of another magnet, these ends attract each other; but if the south pole of one magnet is presented to the south pole of another, or the north pole of one to the north pole of another, these ends will repel each other.

From these criteria, it is easy to determine the names of the poles of a magnetical bar, by applying it near a suspended magnet whose poles are known.

4. When a magnet is situated so as to be at liberty to move itself with sufficient freedom, its two poles do not lie in a horizontal direction, but it generally inclines one of them towards the horizon, and of course it elevates the other pole above it. This is

called the inclination or dipping of the magnet.

5. Any magnets may, by proper methods, be made to impart those properties to iron or steel.

A plane perpendicular to the horizon, and passing through the poles of a magnet when standing in their natural direction, is called the magnetic meridian; and the angle which the magnetic meridian makes with the meridian of the plane where the magnet stands, is called the declination of the magnet at that place.

Of magnetic attraction and repulsion.—When a piece of iron is brought within a certain distance of one of the poles of a magnet, it is attracted by it; and if the iron is at liberty to move, it adheres to the magnet, and cannot be separated without some force. It appears at first sight, that the attraction lies only in the magnet, but experiment proves this attraction to be mutual; the iron attracting the magnet as much as the magnet attracts the iron. Place the magnet and the iron upon two separate pieces of cork, or wood, floating upon water, at a little distance from each other, and it will be found that the iron moves towards the magnet, as well as the magnet towards the iron; but if the iron is kept steady, the magnet will move towards it.

This attraction is strongest at the poles of a magnet, and diminishes in proportion to the distance of any part from the poles, so that in the middle between the poles there is no attraction. This may be easily perceived by presenting a piece of iron to various parts of the surface of a magnet.

The intensity of the attractive power diminishes also, according to the distance from the magnet. If the magnet and iron touch each other, it requires a certain degree of force to separate them; if the iron is removed a little way from the magnet, an attraction will be plainly perceived, but not so powerful; and by increasing this distance the attraction will be much diminished.

The law of diminution of this attraction is not yet known. Some have imagined that it diminishes in proportion to the square of the distance, others as the cube of the distance. But either from the difficulty of the subject, or on account of the experiments having been made without sufficient accuracy, the question remains yet undecided; it is only known that the attractive force decreases faster than the simple ratio of the distances.

As magnetic attraction takes place only between poles of different names of different magnets; that is, the north pole of one magnet attracts the south pole of another; consequently magnetic repulsion acts only between poles of the same name of different magnets. Thus, if the north pole of one magnet is opposed to the north pole of another magnet, or if the south pole be opposed to the south pole of the other, then those magnets will repel each other, and that nearly with as much force as the poles of different names would attract each other.

But it frequently happens, that though magnets are placed with the same poles towards each other, yet they either attract each other, or shew a perfect indifference. This, at first, seems to contradict the above-mentioned general law; but this difficulty is removed by the following considerations:

When a piece of iron is brought within a certain distance of a magnet, it becomes, in fact, itself a magnet, having the polarity, the attractive and repulsive properties for other iron, &c.; that part of it which is nearest to the south pole of the magnet, becoming a north pole, and the opposite part a south pole, or vice versa, according to the end of the magnet presented. Thus if A B, Plate Magnetism, fig. 1, be an oblong piece of iron, and be brought near the north pole N of the magnet N S, then this piece of iron while standing within the magnet's sphere of action, will have all the properties of a real magnet, and its end A will be found to be a south pole, while the end B is a north pole.

Soft iron, when placed within the influence of a magnet, easily acquires these properties; but they last only while the iron remains in that situation, and when it is removed its magnetism vanishes immediately. But with iron containing carbon, and particularly with steel, the case is very different; and the harder the iron or the steel is, the more permanent is the magnetism which it acquires from the influence of a magnet; but it will be in the same proportion more difficult to render it magnetic.

If a piece of soft iron, and a piece of hard steel, both of the same shape and size, are brought within the influence of a magnet at the same distance, it will be found that the iron is attracted more forcibly, and appears more powerfully magnetic, than the steel; but if the magnet is removed, the soft iron will instantly lose its acquired properties, whereas the hard steel will preserve them for a long time, having become an artificial magnet.

Neither the magnetic attraction nor repulsion is in the least diminished, or at all affected, by the interposition of any sort of bodies, except iron, or such bodies as contain iron.

The properties of the magnet are not affected either by the presence or by the absence of air. Heat weakens the power of a magnet, and subsequent cooling restores it, but not quite to its former degree. A white heat destroys it entirely, or very nearly so; and hence it appears, that the powers of magnets must be varying continually. Cavallo observes, that iron in a full red heat, or white heat, is not attracted by the magnet; but the attraction commences as soon as the redness begins to appear.

The attractive power of a magnet may be considerably improved by suspending a weight of iron to it by its power of attraction, which may be gradually increased; and also by keeping it in a proper situation, viz. with its north pole towards the north, and its south pole, consequently, towards the south. On the contrary, this power is diminished by an improper situation, and by keeping too small a piece of iron, or no iron at all, appended to it.

In these northern parts of the world, the north pole of a magnet has more power than its south pole; whereas, the contrary effect has been said to take place in the southern parts.

Amongst the natural magnets, the smallest generally possess a greater attractive power in proportion to their size than those of a larger size.

It frequently happens, that a natural magnet, cut off from a larger loadstone, will be able to lift a greater weight of iron than the original loadstone itself.

As both magnetic poles together attract a much greater weight than a single pole; and as the two poles of a magnet generally are in opposite parts of its surface, in which case it is almost impossible to adapt the same piece of iron to them both at the same time; therefore it has been commonly practised to adapt two broad pieces of soft iron to the poles of the stone, and to let them project on one side of the stone; for those pieces become themselves magnetic while thus situated, and to them the piece of iron or weight may be easily adapted. Those two pieces of iron are generally fastened upon the stone by means of a brass or silver box. The magnet in this case is said to be armed, and the two pieces of iron are called the armature.

Fig. 2. represents an armed magnet, where A B is the loadstone; C D, C D, are the armature, or the two pieces of soft iron, to the projections of which D D the iron weight F is to be applied. The dots E C D C D represent the brass box, with a ring at E, by which the armed magnet may be suspended.

Artificial magnets, when straight, are sometimes armed in the same manner; but they are frequently made in the shape of a horse-shoe, having their poles at the truncated extremities, as at N and S, fig. 3, in which shape it is evident that they want no armature.

Most probably the magnet attracts iron only; but when it is considered how universally iron is dispersed throughout nature, it is evident that a vast number of bodies must on that account be attracted by the magnet more or less forcibly, in proportion to the quantity and quality of the iron they contain. Indeed, it is wonderful to observe what a small portion of iron will render a body subject to the influence of the magnet.

The polarity of the magnet.—Every magnet has a south and a north pole, which are at opposite ends; and a line drawn from one end to the other, passes through the centre of the magnet. Here it must not be understood, that the polarity of a magnet resides only in two points of its surface; for in reality, it is the one half of the magnet that is possessed of one kind of polarity, and the other half of the other kind of polarity; the poles, then, are those points in which that power is the strongest.

The line drawn from one pole to the other, is called the axis of the magnet; and a line formed all round the surface of the magnet, by a plane which divides the axis into two equal parts, and is perpendicular to it, is called the equator of the magnet.

It is the polarity of the magnet that renders it so useful to navigators. When a magnet is kept suspended freely, so that it may turn north and south, the pilot, by looking at the position of it, can steer his course in any required direction. Thus, if a vessel is steered towards a certain place which lies exactly westward of that from which it set out, the navigator must direct it so, that its course may be always at right angles with the direction of the magnetic needle of his compass, keeping the north end of the magnet on the right-hand side, and of course, the south end on the left-hand side of the vessel; for as the needle points north and south, and the direction is east and west, the intended course of the vessel is exactly perpendicular to the position of the magnet. A little reflection will shew how the vessel may be steered in any other direction.

An artificial magnet fitted up in a proper box, for the purpose of guiding the direction of a traveller, is called a magnetic needle, and the whole together is called the mariner's compass.

Although the north pole of the magnet in every part of the world, when suspended, points towards the northern parts, and the south pole towards the southern parts, yet its ends seldom point exactly towards the poles of the earth. The angle in which it deviates from due north and south, is called the angle of declination, or the declination of the magnetic needle, or the variation of the compass; and this declination is said to be east or west, according as the north pole of the needle is eastward or westward of the astronomical meridian of the place.

This deviation from the meridian is not the same in all parts of the world, but is different in different places, and it is even continually varying in the same place. For instance, this declination is not the same in London as at Paris, or as in India; and the declination in London, or in any other place, is not the same at this time as it was some years ago. This declination from the meridian is so variable, that it may be observed to change, even in one or two hours time; and this is not owing to the construction of the magnetic needle; for in the same place, and at the same time, all true magnetic needles point the same way.

The declination from the meridian, and the variation of this in different parts of the world, are very uncertain, and cannot be foretold; actual trial is the only method of ascertaining them. This circumstance forms a great impediment to the improvement of navigation. It is true, that great pains have been taken by navigators and other observers, to ascertain the declination in various parts of the world, and such declinations have been marked in maps, charts, books, &c.; but still, on account of the constant change to which this variation is liable, these can only serve for a few years; nor has the law of this variation or fluctuation been yet discovered, though various hypotheses have been formed for that purpose. When the variation was first observed, the north pole of the magnetic needle declined eastward of the meridian of London; but it has since that time been changing continually towards the west; so that in the year 1657 the magnetic needle pointed due north and south. At present, it declines about 24½° westward, and it seems to be still advancing towards the west.

Before volcanic eruptions and earthquakes, the magnetic needle is often subject to very extraordinary movements.

It is also agitated before and after the appearance of the aurora borealis.

The magnetic inclination, or dip of the needle.—If a needle which is accurately balanced, and suspended so as to turn freely in a vertical plane, is rendered magnetical, the north pole will be depressed, and the south pole elevated above the horizon: this property is called the inclination, or dip of the needle, and was discovered by Robert Norman, about the year 1576.

Take a globular magnet, or, which is more easily procured, an oblong one, like S N, fig. 4; the extremity N of which is the north pole, the other extremity S is the south pole, and A is its middle or equator; place it horizontally upon a table C D: then take another small oblong magnet *n s* (viz. a bit of steel wire, or a small sewing-needle magnetized) and suspend it by means of a fine thread tied to its middle, so as to remain in an horizontal position, when not disturbed by the vicinity of iron, or other magnet. Now if the same small magnet, being held by the upper part of the thread, be brought just over the middle of the large magnet, within two or three inches of it, the former will turn its south pole *s*, towards the north pole, N, of the large magnet; and its north pole *n*, towards the south pole, S, of the large one. It will be farther observed, that the small magnet, whilst kept just over the middle A of the large one, will remain parallel to it; for since the poles of the small magnet are equally distant from the contrary poles of the large magnet, they are equally attracted. But if the small magnet be moved a little nearer to one end than to the other of the large magnet, then one of its poles, namely, that which is nearest to the contrary pole of the large magnet, will be inclined downwards, and of course the other pole will be elevated above the horizon. It is evident that this inclination must increase according as the small magnet is placed nearer to one of the poles of the large one, because the attraction of the nearest pole will have more power upon it. If the small magnet be brought just opposite to one of the poles of the large magnet, it will turn the contrary pole towards it, and will place itself in the same straight line with the axis of the large magnet.

This simple experiment will enable the reader to comprehend easily the phenomena of the magnetic inclination, or of the dipping needle, upon the surface of the earth; for it is only necessary to imagine that the earth is a large magnet (as in fact in appears to be), and that any magnet, or magnetic needle, commonly used, is the small magnet employed in the above-mentioned experiment; for, supposing that the north pole of the earth is possessed of a south magnetic polarity, and that the opposite pole is possessed of a north magnetic polarity, it appears evident, and it is confirmed by actual experience, that when a magnet, or magnetic needle, properly shaped and suspended, is kept near the equator of the earth (since neither the magnetic equator, nor the magnetic poles of the earth, coincide with its real equator and poles), it must remain in a horizontal situation: if the magnet is removed nearer to one of the magnetic poles of the earth, it must incline to one of its extremities, namely, that which is possessed of the contrary polarity; and this inclination must increase in proportion as the needle recedes from the magnetic equator of the earth. Lastly, when the needle is brought exactly over one of the magnetic poles of the earth, it must stand perpendicular to the horizon of that place.

A magnetic needle constructed for the purpose of shewing this property, is called a dipping-needle, and its direction in any place is called the magnetical line. When it was said, that the north pole of the earth possessed south polarity, it was only meant that it had a polarity contrary to that end of the magnetic needle which is directed towards it.

If the geographical poles of the earth (that is, the ends of its axis), coincided with its magnetic poles; or even if the magnetic poles were constantly at the same distance from them; the inclination of the needle, as well as its declination, would always be the same; and hence, by observing the direction of the magnetic needle in any particular place, the latitude and longitude of that place might be ascertained; but this is not the case, for the magnetic poles of the earth do not coincide with its real poles, and they are also constantly shifting their situations; hence the magnetic needle changes continually and irregularly, not only in its horizontal direction, but likewise in its inclination, according as it is removed from one place to another, and also while it remains in the very same place.

This change of the dip in the same place, however, is very small. In London, about 1576, the north pole of the dipping needle stood 71° 50′ below the horizon; and in 1775, it stood at 72° 3′; the whole change of inclination, during so many years, amounting to less than a quarter of a degree.

There are various methods of giving the magnetic property to steel or iron. In some cases, it appears to be acquired without the use of another magnet.

If you take a bar of iron three or four feet long, and hold it in a vertical position, you will find that the bar is magnetic, and will act upon another magnet; the lower extremity of the bar attracting the south pole, and repelling the north pole. If you invert the bar, the polarity will be instantly reversed; the extremity which is now lowest, will be found to be a north pole, and the other extremity will be a south pole.

A bar of hard iron, or steel, will not answer for the above experiment, the magnetism of the earth not being sufficient to magnetise it.

Bars of iron that have stood in a perpendicular position, are generally found to be magnetical; as fire-irons, bars of windows, &c.

If a long piece of hard iron is made red-hot, and then left to cool in the direction of the magnetical line, it becomes magnetical.

Striking an iron bar with a hammer, or rubbing it with a file, while held in this direction, likewise renders it magnetical. An electric shock produces the same effect; and lightning often renders iron magnetic.

A magnet cannot communicate a degree of magnetism stronger than that which itself possesses; but two or more magnets, joined together, may communicate a greater power to a piece of steel, than either of them possesses singly: hence we have a method of constructing very powerful magnets, by first constructing several weak artificial magnets, and then joining them together to form a compound magnet, and to act more powerfully upon a piece of steel.

1. Place two magnetic bars, A, B, fig. 5. in a line with the north, or marked end of one, opposed to the south, or unmarked end of the other; but at such a distance from each other, that the magnet to be touched may rest with its marked end on the unmarked

end of A, and its unmarked end on the marked end of B; then apply the north end of the magnet E, and the south end of D, to the middle of the bar C, the opposite ends being elevated as in the figure; draw E and D asunder along the bar C, one towards A, the other towards B, preserving the same elevation; remove E and D a foot or two from the bar when they are off the ends, then bring the north and south poles of these magnets together, and apply them again to the middle of the bar C as before: repeat the same process five or six times, then turn the bar, and touch the opposite surface in the same manner, and afterwards the two remaining surfaces; by this means the bar will acquire a strong fixed magnetism.

2. Place the two bars which are to be touched parallel to each other; and then unite the ends by two pieces of soft iron, called supporters, in order to preserve, during the operation, the circulation of the magnetic matter; the bars are to be placed so that the marked end D (fig. 6), may be opposite the unmarked end B; then place the two attracting poles G and I on the middle of one of the bars to be touched, raising the ends, so that the bars may form an obtuse angle of 100 or 120 degrees; the ends G and I of the bars are to be separated two or three tenths of an inch from each other. Keeping the bars in this position, move them slowly over the bar A B, from one end to the other, going from end to end about fifteen times. Having done this, change the poles of the bars (*i.e.* the marked end of one is always to be against the unmarked end of the other), and repeat the same operation on the bar C D, and then on the opposite faces of the bars. The touch thus communicated may be further increased, by rubbing the different faces of the bars with sets of magnetic bars, disposed as in fig. 7.

In these operations all the pieces should be well polished, the sides and ends made quite flat, and the angles quite square.

A magnet bent so that the two ends almost meet, is called a horse-shoe magnet, fig. 3. To render it magnetic, place a pair of magnetic bars against the ends of the horse-shoe, with the south end of the bar against that of the horse-shoe which is intended to be the north, and the north end of the bar to that which is to be the south; the contact, or lifter of soft iron, to be placed at the other end of the bars. Also rub the surfaces of the horse-shoe with a pair of bars placed in the form of a compass, or with another horse-shoe magnet, turning the poles properly to the poles of the horse-shoe magnet; being careful that these bars never touch the ends of the straight bars. If the bars are separated suddenly from the horse-shoe magnet, its force will be considerably diminished; to prevent this, slip on the lifter, or support, to the end of the horse-shoe magnet, but in such a manner, however, that it may not touch the bars; the bars may then be taken away, and the support slid to its place.

Magnetism is best communicated to compass-needles by the two following methods:

Procure a pair of magnetic bars, not less than six inches in length. Fasten the needle down on a board, and with a magnet in each hand draw them from the centre upon the needle outwards; then raise the bars to a considerable distance from the needle, and bring them perpendicularly down upon the centre, and draw them over again. This operation repeated about twenty times will magnetize the needle, and its ends will point to the poles contrary to those that touched them.

Over one end of a combined horse-shoe magnet, of at least two in number, and six inches in length, draw from its centre that half of the needle which is to have the contrary pole to the end of the magnet: raise the needle to a considerable distance, and draw it over the magnet again; this repeated about twenty times at least, and the same for the other half, will sufficiently communicate the power.

A set of bars are exceedingly useful for magnetizing other bars, or needles of compasses, &c. their power may also be increased when lost or impaired by mismanagement, &c. A set of such bars, viz. six bars and the two iron conductors, may be preserved in a box; taking care to place the north pole of one contiguous to the south pole of the next, and that contiguous to the north pole of the third, &c. as shewn in fig. 8.

After what has been said above, we need not describe how a knife, or any piece of steel, &c. may be rendered magnetic, or in what manner a weak magnet may be rendered more powerful. But it may perhaps be necessary to say something concerning the communication of magnetism to crooked bars like A B C, fig. 9.

Place the crooked bar flat upon a table, and to its extremities apply the magnetic bars D F, E G; joining their extremities F G, with the conductor or piece of soft iron F G; then to its middle apply the magnetic bars placed at an angle: or you may use two bars only, placed as shewn in fig. 9, and stroke the crooked bar with them from end to end, following the direction of that bent bar; so that on one side of it the magnetic bars may stand in the direction of the dotted representation L K. In this manner, when the piece of steel A B C has been rubbed a sufficient number of times on one side, it must be turned with the other side upwards, &c.

In communicating magnetism, it is best to use weak magnets first, and those that are stronger afterwards; but you must be very careful not to use weak after strong magnets.

A magnet loses nothing of its own power by communicating to other substances, but is rather improved.

Every kind of violent percussion weakens the power of a magnet. A strong magnet has been entirely deprived of its virtue, by receiving several smart strokes of a hammer; indeed, whatever deranges or disturbs the internal pores of a magnet will injure its magnetic force.

Fill a small dry glass tube with iron filings, press them in rather close, and then touch the tube as if it was a steel bar, and the tube will attract a light needle; shake the tube, so that the situation of the filings may be disturbed, and the magnetic virtue will vanish.

Magnets should never be left with two north or two south poles together; for when they are thus placed, they diminish and destroy each other's power. Magnetic bars should therefore be always left with the opposite poles laid against each other, or by connecting their opposite poles by a bar of iron. The power of a magnet is increased by letting a piece of iron remain attached to one or both of its poles. A single magnet should therefore be always thus left.

The difference of steel in receiving magnetism is very great, as is easily proved by touching in the same manner, and with the same bars, two pieces of steel of equal size, but of different kinds. With some sorts of steel, a few strokes are sufficient to impart to them all the power they are capable of receiving; other sorts require a longer operation; sometimes it is impossible to give them more than a small degree of magnetism.

A piece of spring-tempered steel will not retain as much magnetism as hard steel; soft steel still less, and iron retains scarcely any. Iron when oxydated loses its magnetism.

The construction and the use of the principal magnetical instruments, &c.—The magnetical instruments may be reduced to three principal heads; viz. 1st. the magnets or magnetic bars, which are necessary to magnetize needles of compasses, or such pieces of steel, iron, &c. as may be necessary for divers experiments; and which have already been sufficiently explained in the preceding pages: 2dly, the compasses, such as are used in navigation, and for other purposes, which are only magnetic needles justly suspended in boxes, and which, according to the purposes for which they are particularly employed, have several appendages, or differ in size, and in accuracy of divisions, &c. whence they derive the different names of pocket compasses, steering compasses, variation compasses, and azimuth compasses: and 3dly, the dipping-needle.

The magnetic needles which are commonly used at sea, are between four and six inches long; but those which are used for observing the daily variation, are made a little longer, and their extremities point the variation upon an arch or circle properly divided and affixed to the box.

The best shape of a magnetic needle is represented in figs. 10 and 11; the first of which shews the upper side, and the second shews a lateral view of the needle, which is of steel, having a pretty large hole in the middle, to which a conical piece of agate is adapted by means of a brass piece O, into which the agate-cap (as it is called) is fastened. Then the apex of this hollow cap rests upon the point of a pin F, which is fixed in the centre of the box, and upon which the needle, being properly balanced, turns very nimbly. For common purposes, those needles have a conical perforation made in the steel itself, or in a piece of brass which is fastened in the middle of the needle.

A mariner's compass, or compass generally used on board of ships, is represented in fig. 12. The box, which contains the card or fly with the needle, is made of a circular form, and either of wood, or brass, or copper. It is suspended within a square wooden box, by means of two concentric circles, called gimbalds, so fixed by cross axes *a*, *a*, *a*, *a*, to the two boxes (see the plan, fig. 13), that the inner one, or compass-box, shall retain a horizontal position in all motions of the ship, whilst the outer or square box is fixed with respect to the ship. The compass box is covered with a pane of glass, in order that the motion of the card may not be disturbed by the wind. What is called the card (fig. 14), is a circular piece of paper, which is fastened upon the needle, and moves with it. Sometimes there is a slender rim of brass, which is fastened to the extremities of the needle, and serves to keep the card stretched. The outer edge of this card is divided into 360 equal parts or degrees, and within the circle of those divisions it is again divided into 32 equal parts, or arcs, which are called the points of the compass, or rhumbs, each of which is often subdivided into quarters. The initial letters N, N E, &c. are annexed to those rhumbs, to denote the north, north-east, &c The middlemost part of the card is generally painted with a sort of star, whose rays terminate in the above-mentioned divisions. To avoid confusion those letters, &c. are not drawn in the figure.

The azimuth compass is nothing more than the above-mentioned compass, to which two sights are adapted, through which the sun is to be seen, in order to find its azimuth, and from thence to ascertain the declination of the magnetic needle at the place of observation; see fig. 15. The particulars in which it differs from the usual compass, are the sights F, G; in one of which, G, there is an oblong aperture with a perpendicular thread or wire stretched through its middle; and in the other sight F, there is a narrow perpendicular slit. The thread or wire H I is stretched from one edge of the box to the opposite. The ring A B of the gimbalds rests with its pivots on the semicircle C D, the foot E of which turns in a socket, so that whilst the box K L M is kept steady, the compass may be turned round, in order to place the sights F, G, in the direction of the sun.

The pivots of the gimbalds of this, as well as of the common sort of compasses, should lie in the same plane with the point of suspension of the needle, in order to avoid as much as possible the irregularity of the vibrations.

There are, on the inside of the box, two lines drawn perpendicularly along the sides of the box, just from the points where the thread H I touches the edge of the box. These lines serve to shew how many degrees the north or south pole of the needle is distant from the azimuth of the sun; for which purpose, the middle of the apertures of the sights F, G, the thread H I, and the said lines, must be exactly in the same vertical plane. The use of the thread H I, which is often omitted in instruments of this sort, is likewise to shew the degrees between the magnetic meridian and the azimuth, when the eye of the observer stands perpendicularly over it. On the side of the box of this sort of compasses, there generally is a nut or stop, which, when pushed in, bears against the card and stops it, in order that the divisions of the card which coincide with the lines in the box, may be more commodiously read off.

The dipping-needle, though of late much improved, is however still far from perfection. The general mode of constructing it is to pass an axis quite through the needle, to let the extremities of this axis, like those of the beam of a balance, rest upon its supports, so that the needle may move itself vertically round, and when situated in the magnetic meridian, it may place itself in the magnetic line. The degrees of inclination are shewn upon a divided circle, in the centre of which the needle is suspended. Fig. 16 represents a dipping-needle of the simplest construction; A B is the needle, the axis of which F E rests upon the middle of two lateral bars C D, C D, which are made fast to the frame that contains the divided circle A I B K. This machine is fixed on a stand G; but, when used at sea, it is suspended by a ring H, so as to hang perpendicularly. When the instrument is furnished with a stand, a spirit-level O is generally annexed to it, and the stand has three screws, by which the instrument is situated so that the centre of motion of the needle, and the division of 90° on the lower part of the divided circle, may be exactly in the same line, perpendicular to the horizon. See Level.

The few experiments which follow, are principally intended to illustrate the theory.

Ex. 1. The method of discovering whether a body is attractable by the magnet or not, and whether it has any polarity or not, or which is its south, and which its north pole, is so easily performed as not to require many words; for by approaching a magnet to the body in question (which, if necessary, may be set to swim upon water), or by presenting the body in question to either extremity of a suspended magnetic needle, the desired object may be obtained.

Ex. 2. Tie two pieces of soft iron wire, A B, A B, fig. 17 and 18, each to a separate thread, A C, A C, which join at top, and forming them into a loop, suspend them so as to hang freely. Then bring the marked end D fig. 19, which is the north, of a magnetic bar just under them, and the wires will immediately repel each other, as shewn in fig. 18; and this divergency will increase to a certain limit, according as the magnet is brought nearer, and vice versa. The reason of this phenomenon is, that by the action of the north magnetic pole D, both the extremities B, B, of the wires, acquire the same, viz. the south polarity; consequently they repel each other; and the extremities, A, A, acquire the north polarity, in consequence of which they also repel each other.

If instead of the north pole D, you present the south pole of the magnetic bar, the repulsion will take place as before; but now the extremities B, B, acquire the north, and the extremities A, A, acquire the south polarity.

On removing the magnet, the wires, if of soft iron, will soon collapse, having lost all their magnetic power; but if steel wires, or common sewing-needles be used, they will continue to repel each other after the removal of the magnet; the magnetic power being retained by steel.

Ex. 3. Lay a sheet of paper flat upon a table, strew some iron filings upon the paper, place a small magnet among them; then give a few gentle knocks to the table, so as to shake the filings, and you will find that they dispose themselves about the magnet N S, as shewn in fig. 20; the particles of iron clinging to one another, and forming themselves into lines, which at the very poles N, S, are in the same direction with the axis of the magnet; a little sideway of the poles they begin to bend, and then they form complete arches, reaching from some point in the northern half of the magnet, to some other point in the southern half.

Ex. 4. Place a magnetic bar A B, fig. 21, so that one of its poles may project a short way beyond the table, and apply an iron weight C to it; then take another magnetic bar, D E, like the former, and bring it parallel to, and just over the other, at a little distance, and with the contrary poles towards each other; in consequence of which the attraction of B will be diminished, and the iron C, if sufficiently heavy, will drop off, the magnet A B being then only able to support a smaller piece of iron. By bringing the magnets still nearer to each other, the attraction of B will be diminished still farther; and, when the two magnets come quite into contact (provided they are equal in power), the attraction between B and C will vanish entirely; but if the experiment be repeated with this difference, viz. that the homologous poles of the magnets be brought towards each other, then the attraction between B and C, instead of being diminished, will be increased.

MAGNITUDE, whatever is made up of parts locally extended, or that has several dimensions; as a line, surface, solid, &c. The apparent magnitude of a body is that measured by the visual angle, formed by rays drawn from its extremes to the centre of the eye; so that whatever things are seen under the same or equal angles, appear equal; and vice versa.

MAGNOLIA, a genus of the polygynia order, belonging to the polyandria class of plants; and in the natural method ranking under the 52nd order, coadnatæ. The calyx is triphyllous; there are nine petals; the capsules bivalved and imbricated; the seeds pendulous, and in the form of a berry. There are seven species: the principal are,

1. The glauca, or small magnolia, a native of Virginia, Carolina, and other parts of North America. In moist places it rises from seven or eight to fifteen or sixteen feet high, with a slender stem. The wood is white and spongy, the flowers are produced at the extremities of the branches, are white, composed of six concave petals, and have an agreeable scent. 2. The grandiflora, or great magnolia, is a native of Florida and South Carolina. It rises, to the height of eighty feet or more, with a straight trunk upwards of two feet diameter, having a regular head. The leaves resemble those of the laurel, but are larger, and continue green throughout the year. The flowers are produced at the ends of the branches, and are of a purplish-white colour. 3. The tripetala, or umbrella tree, is a native of Carolina; it rises, with a slender trunk, to the height of sixteen or twenty feet; the wood is soft and spongy; the leaves remarkably large, and produced in horizontal circles, somewhat resembling an umbrella, whence the inhabitants of those countries have given it this name. The flowers are composed of ten or eleven white petals, that hang down without any order. The leaves drop off at the beginning of winter. 4. The acuminata, with oval, spear-shaped, pointed leaves, is a native of the inland parts of North America. The leaves are near eight inches long, and five broad, ending in a point. The flowers come out early in the spring, and are composed of twelve white

petals; the wood is of a fine grain, and an orange colour.

MAHERNIA, a genus of the class and order pentandria pentagynia. The cal. is 5-toothed: petals 5; nect. 5 obcordate, placed under the filaments; caps. 5-celled. There are three species, shrubs of the Cape. The incisa is a beautiful little shrub for the greenhouse.

MAIL, or *coat of* MAIL, a piece of defensive armour for the body, made of small iron rings, interwoven in the manner of a net.

MAIM, MAIHEM, or MAYHEM, in law. It is enacted, by the statute of 22 and 23 Car. II. that if any person from malice aforethought, shall disable any limb or member of any of the king's subjects with an intent to disfigure him, the offender, with his aiders and abettors, shall be guilty of felony without benefit of clergy; though no such attainder shall corrupt the blood, or occasion forfeiture of lands, &c.

If a man attack another with an intent to murder him, and he does not murder the man, but only maim him, the offence is nevertheless within the statute 22 and 23 Car. II. c. 1, usually called the Coventry act. 1 Haw. 112.

MAINPRISE, the taking or receiving a man into friendly custody, that otherwise is or might be committed to prison, upon security given for his forthcoming at a day assigned. See BAIL BOND.

MAINTENANCE, is the unlawful taking in hand, or upholding, of a cause or person: this offence bears a near resemblance to barratry, being a person's intermeddling in the suit of another, by maintaining or assisting him with money, or otherwise, to prosecute or defend it. A man may maintain the suit of his near kinsman, servant, or poor neighbour, out of charity or compassion, without being guilty of maintenance. By the common law, persons guilty of maintenance may be prosecuted by indictment, and be fined and imprisoned, or be compelled to make satisfaction by action, &c.; and a court of record may commit a man for an act of maintenance done in the face of the court. 1 Int. 368.

MAJOR, in logic, the first proposition of a syllogism.

MAJOR and MINOR, in music, signify imperfect concords, which differ from each other by a semitone minor.

MALACHODENDRUM, a genus of the class and order monadelphia polyandria. The cal. is simple; germ. pear-shaped, pentagonal; styles, 5; caps. 5, one-seeded: one species, of no note.

MALACHOA, a genus of the class and order monadelphia polyandria. The cal. is common, 3-leaved, many-flowered, longer; arils 5, 1-seeded. There are five species, herbs of the West Indies.

MALACHITE, green carbonat of copper. This ore is often amorphous, but often crystallized in long slender needles.

Colour green. Brittle. Specific gravity 3.571 to 3.653. Effervesces with nitric acid, and gives a blue colour to ammonia. Before the blowpipe it decrepitates and blackens, but does not melt. Tinges borax yellowish green. Tinges flame green.

Variety 1. Fibrous malachite.—Texture fibrous. Opaque when amorphous; when crystallized it is partly transparent is 2. Colour generally grass-green.

Variety 2. Compact malachite.—Texture compact. Opaque. Colour varies from the dark emerald-green to blackish green.

A specimen of malachite from Siberia, analysed by Klaproth, contained

58.0 copper
18.0 carbonic acid
12.5 oxygen
11.5 water
——
100.

This species is sometimes mixed with clay, chalk, and gypsum, in various proportions; it is then known by the name of common mountain-green. Its colour is verdigris-green. Brittle. Texture earthy. Effervesces feebly with acids. Before the blowpipe it exhibits the same phenomena as malachite.

A comparison of the analysis of Klaproth with that of Pelletier seems to prove that malachite contains copper oxidized to a greater degree than blue copper ore.

MALACOLITE. This mineral was first observed in Sweden in the silver-mine of Sahla in Westermania; afterwards in Norway. Colour green. Found massive and crystallized in six-sided prisms, having two opposite edges truncated. Waxy. Texture lamellated. Feel soft. Specific gravity 3.2307. Melts before the blowpipe into a porous glass. According to the analysis of Vauquelin, it is composed of

53 silica
20 lime
19 magnesia
3 alumina
4 oxides of iron and manganese
—
99.

MALATS, in chemistry. This genus of salts is almost unknown, owing chiefly to the difficulty of procuring pure malic acid. The following are the only facts hitherto ascertained.

Malat of potass.
Malat of soda.
Malat of ammonia.

These salts were formed by Scheele. They are deliquescent and very soluble.

Malat of barytes. When malic acid is dropt into barytes water, a white powder precipitates, which is malat of barytes. According to Scheele, the properties of this salt resemble those of malat of lime.

Malat of strontian. Malic acid occasions no precipitate in strontian water. Hence it follows, that malat of strontian is more soluble than malat of barytes.

When malic acid is neutralized with lime, it forms a salt scarcely soluble in water, which may be obtained in crystals, by allowing the supermalat of lime to evaporate spontaneously. Crystals of neutral malat are formed in the solution. But this acid has a strong tendency to combine in excess with lime, and to form a supermalat of lime. This salt is formed when carbonat of lime is thrown into malic acid, or into any liquid containing it. This supersalt exists in various vegetables, especially the sempervivum tectorum, and some of the sedums.

Supermalat of lime has an acid taste. It yields a precipitate with alkalies, sulphuric acid, and oxalic acid. Lime-water saturates the excess of acid, and throws down a precipitate of malat of lime. When the supermalat of lime is evaporated to dryness, it assumes exactly the appearance of gum arabic; and if it has been spread thin upon the nail or wood, it forms a varnish. It is not so soluble in water as gum arabic, and the taste readily distinguishes the two. Supermalat of lime is insoluble in alcohol.

Malat of magnesia. This salt is very soluble in water, and when exposed to the air deliquesces.

Malat of alumina. This salt is almost insoluble in water. Of course it precipitates when malic acid is dropt into a solution containing alumina. Mr. Chenevix has proposed this acid to separate alumina from magnesia; which earths, as is well known, have a strong affinity for each other.

MALAXIS, a genus of the class and order gynandria diandria. The nect. is one-leaved, concave, cordate; acumina, pale, bifid in front. There are two species, bulbs of Jamaica.

MALIC *acid*, obtained from the juice of apples; it is also extracted from the juice of common house-leek, where it exists combined with lime. The process is as follows: To the juice of the house-leek add acetat of lead as long as any precipitate takes place. Wash the precipitate, and decompose it by means of diluted sulphuric acid in the manner directed by Scheele.

Malic acid may be formed also by the action of nitric acid or sugar. If nitric acid is distilled with an equal quantity of sugar, till the mixture assumes a brown colour (which is a sign that all the nitric acid has been abstracted from it), this substance will be found of an acid taste; and after all the oxalic acid which may have been formed is separated by lime-water, there remains another acid, which may be obtained by the following process: saturate it with lime, and filtre the solution; then pour upon it a quantity of alcohol, and a coagulation takes place. This coagulum is the acid combined with lime. Separate it by filtration, and edulcorate it with fresh alcohol; then dissolve it in distilled water, and pour in acetat of lead till no more precipitation ensues. The precipitate is the acid combined with lead, from which it may be separated by diluted sulphuric acid.

Malic acid, thus obtained, is a liquid of a reddish-brown colour and a very acid taste. When evaporated it becomes thick and viscid like a mucilage or syrup, but it does not crystallize. When exposed to a dry atmosphere in thin layers, it dries altogether, and assumes the appearance of varnish. When heated in the open fire it becomes black, swells up, exhales an acrid fume, and leaves behind it a very voluminous coal. When distilled, the products are an acid water, a little carbureted hydrogen gas, and a large proportion of carbonic acid. It is very soluble in water. It gradually decomposes spontaneously, by undergoing a kind of fermentation in the vessels in which it is kept. Sulphuric acid chars it, and nitric acid converts it into oxalic acid. Hence it is evident that it is composed of oxygen, hydrogen, and carbon, though the proportions of these substances have not been ascertained.

Malic acid combines with alkalies, earths, and metallic oxides, and forms salts known by the name of Malats, which see.

Its affinities have not yet been ascertained.

This acid bears a strong resemblance to the citric, but differs from it in the following particulars: 1. The citric acid shoots into fine crystals, but this acid does not crystallize. 2. The salt formed from the citric acid with lime is almost insoluble in boiling water; whereas the salt made with malic acid and the same basis is readily soluble by boiling water. 3. Malic acid precipitates mercury, lead, and silver, from the nitrous acid, and also the solution of gold when diluted with water; whereas citric acid does not alter any of these solutions. 4. Malic acid seems to have a less affinity than citric acid for lime; for when a solution of lime in the former is boiled a minute, with a salt formed from volatile alkali and citric acid, a decomposition takes place, and the latter acid combines with the lime, and is precipitated.

MALLEABLE, a property of metals, whereby they are capable of being extended under the hammer.

MALOPE, a genus of the class and order monadelphia polyandria. The calyx is double, outer three-leaved; arils glomerate, one-seeded. There are two species, herbs of Tuscany, &c.

MALPIGHIA, *Barbadoes cherry*, a genus of the trigynia order, in the decandria class of plants, and in the natural method ranking under the 23d order, trihilatæ. The calyx is pentaphyllous, with melliferous pores on the outside at the base. There are five petals, roundish and unguiculated: the berry unilocular and trispermous. There are 18 species, all of them shrubby evergreens of the warm parts of America, rising with branchy stems from 8 or 10 to 15 or 20 feet high, ornamented with oval and lanceolate entire leaves, and large pentapetalous flowers, succeeded by red, cherry-shaped, eatable berries, of an acid and palatable flavour; and which in the West Indies, where they grow naturally, are used instead of cherries. Three of the species are reared in our gardens, and make a fine variety in the stove. They retain their leaves all the year round; and begin to flower about the end of autumn, continuing in constant succession till the spring; after which they frequently produce and ripen their fruit, which commonly equals the size of a small cherry. The flowers are of a pale-red or purple colour.

MALT, is barley prepared, to fit it for making a potable liquor called beer, or ale, by stopping it short at the beginning of vegetation.

In making malt from barley, the usual method is to steep the grain in a sufficient quantity of water, for two or three days, till it swells, becomes plump, somewhat tender, and tinges the water of a bright-brown, or reddish colour. Then this water being drained away, the barley is removed from the steeping cistern to the floor, where it is thrown into what is called the wet couch; that is, an even heap, rising to the height of about two feet. In this wet couch the capital part of the operation is performed; for here the barley spontaneously heats, and begins to grow, shooting out first the radicle; and if suffered to continue, then the plume, spire, or blade. But the process is to be stopped short at the eruption of the radicle, otherwise the malt would be spoiled. In order to stop it, they spread the wet couch thin over a large floor, and keep turning it once in four or five hours, for the space of two days, laying it somewhat thicker each time. After this, it is again thrown into a large heap, and there suffered to grow sensibly hot to the hand, as it usually will in 20 or 30 hours time; then being spread again, and cooled, it is thrown upon the kiln, to be dried crisp without scorching.

MALTA, KNIGHTS OF, otherwise called *hospitalers of St. John of Jerusalem*, a religious military order, whose residence is in the island of Malta. The order consists of three estates, the knights, chaplains, and servants at arms: there are also priests who officiate in the churches, friar-servants who assist at the offices, and donnes or demicrosses; but these are not reckoned constituent parts of the body: the government of the order is mixt, being partly monarchical, and partly aristocratical: the grand master is sovereign. The knights formerly consisted of eight different languages, but now only seven, the English having withdrawn themselves. None are admitted into this order but such as are of noble birth: the knights are of two sorts, those who have a right to be candidates for the dignity of grand-master, called grand-crosses, and those who are only knights assistants: they never marry. The knights are received into this order, either by undergoing the trials prescribed by statutes, or by dispensation.

MALTHA, in antiquity, a kind of cement of which there were two sorts, native and factitious; one of the latter sort, much in use, consisted of pitch, wax, plaister, and grease. Another kind used by the Romans in their aqueducts, was made of lime slacked in wine, incorporated with melted pitch, and fresh figs. Natural maltha is a kind of bitumen, with which the Asiatics plaister their walls; and which being once set on fire, water makes it burn more fiercely. See BITUMEN.

MALVA, the *mallow*, a genus of the polyandria order, in the monadelphia class of plants, and in the natural method ranking under the 37th order, columniferæ. The calyx is double; the exterior one triphyllous; the arilli numerous and monospermous. There are 34 species, consisting of herbaceous perennials, biennials, and annuals, for medical, economical, and ornamental uses.

The leaves of the common mallow are reckoned the first of the four emollient herbs: they were formerly in some esteem as food; at present decoctions of them are sometimes employed in dysenteries, heat, and sharpness of urine, and in general for obtunding acrimonious humours: their principal use is in emollient glysters, cataplasms, and fomentations. The leaves enter the officinal decoction for glysters, and a conserve is prepared from the flowers. Several pieces of malva, macerated like hemp, afford a thread superior to hemp for spinning, and which is said to make more beautiful cloths and stuffs than even flax. These species are the crispa, Peruviana, and Maurisiana. From the former, which affords stronger and longer fibres, cords and twine have also been made. From the malvæ likewise a new sort of paper has been fabricated by M. de l'Isle.

MAMMÆ, in anatomy, the breasts of a female.

MAMMALIA, in natural history, the first class of animals in the Linnæan system, divided into seven orders. See ZOOLOGY.

MAMMEA, *mammee-tree*, a genus of the monogynia order, in the polyandria class of plants, and in the natural method ranking with those of which the order is doubtful. The corolla is tetrapetalous; the calyx diphyllous; the berry very large and tetraspermous. There is one species, a large evergreen tree of the hot parts of America and Asia, and retained here in hot-houses for variety; adorned with large, oval, oblong, stiff leaves, and large quadripetalous flowers, succeeded by large, round, eatable fruit, of a most exquisitely rich flavour. They are propagated by seed, which is to be sowed in small pots of light earth, and kept in the stove.

MAMMILLARY. See ANATOMY.

MANATI, in zoology. See TRICHECUS.

MANCA, was a square piece of gold coin, commonly valued at 30 pence; and mancusa was as much as a mark of silver, having its name from manu cusa, being coined with the hand (Leg. Canut.). But the manca and mancusa were not always of that value; for sometimes the former was valued at six shillings, and the latter, as used by the English Saxons, was equal in value to our half-crown.

MANDAMUS, is a writ issuing in the king's name out of the court of king's bench, and directed to any person, corporation, or inferior court of judicature, commanding to some particular thing therein specified, as appertaining to their office and duty.

A writ of mandamus is a high prerogative writ, of a most extensive remedial nature, and may be issued in some cases where the injured party has also another more tedious method of redress, as in the case of admission or restitution to an office; but it issues in all cases where the party has a right to have any thing done, and has no other specific means of compelling its performance. 3 Black. 100.

And this general jurisdiction and superintendance of the king's bench over all inferior courts to restrain them within their bounds, and to compel them to execute their jurisdiction, whether such jurisdiction arises from a modern charter, subsists by custom, or is created by act of parliament, yet being in subsidium justitiæ, has of late been exercised in a variety of instances.

Mandamus was also a writ that lay after the year and a day (where, in the mean time, the writ called diem clausit extremum had not been sent out) to the escheator, commanding him to enquire of what lands holden by knight-service the tenant died seized, &c. F. N. B. 561.

Mandamus was also a writ to charge the sheriff to take into the king's hands all the lands and tenements of the king's widow, who, against her oath formerly given, marries without the king's consent. Reg. 295.

MANETTIA, a genus of the class and order tetrandria monogynia. The calyx is eight-leaved; corolla four-cleft; capsule inferior, two-valved, one-celled; seeds imbricate, unilocular. There are three species, shrubs of the West Indies.

MANGANESE. I. The dark-grey or brown mineral called manganese has been long known and used in the manufacture of glass. A mine of it was discovered in England by Mr. Boyle. A few experiments were made upon this mineral by Glauber in 1656, and by Waitz in 1705; but chemists in general seem to have paid but very little attention to it. The greater number of mineralogists, though much puzzled what to make of it, agreed in placing it among iron ores: but Pott, who published the first chemical examination of this mineral in 1740, having ascertained that it often contains scarcely any iron, Cronstedt, in his System of Mineralogy, which appeared in 1758, assigned it a place of its own, on the supposition that it consisted chiefly of a peculiar earth. Rinman examined it anew in 1765; and in the year 1770 Kaim published at Vienna a set of experiments, in order to prove that a peculiar metal might be extracted from it. The same idea had struck Bergman about the same time, and induced him to request of Scheele, in 1771, to undertake an examination of manganese. Scheele's dissertation on it, which appeared in 1774, is a masterpiece of analysis, and contains some of the most important discoveries of modern chemistry. Bergman himself published a dissertation on it the same year; in which he demonstrates that the mineral, then called manganese, is a metallic oxide. He accordingly made several attempts to reduce it, but without success; the whole mass either assuming the form of scoriæ, or yielding only small separate globules attracted by the magnet. This difficulty of fusion led him to suspect that the metal he was in quest of bore a strong analogy to platinum. In the mean time Dr. Gahn, who was making experiments on the same mineral, actually succeeded in reducing it by the following process: he lined a crucible with charcoal-powder moistened with water, put into it some of the mineral formed into a ball by means of oil, then filled up the crucible with charcoal-powder, luted another crucible over it, and exposed the whole for about an hour to a very intense heat. At the bottom of the crucible was found a metallic button, or rather a number of small metallic globules, equal in weight to one-third of the mineral employed. It is easy to see by what means this reduction was accomplished. The charcoal attracted the oxygen from the oxide, and the metal remained behind. The metal obtained, which is called manganese, was farther examined by Ilseman in 1782, Hielm in 1785, and Bindheim in 1789.

Manganese, when pure, is of a greyish-white colour, and has a good deal of brilliancy. Its texture is granular. It has neither taste nor smell. Its hardness is equal to that of iron. Its specific gravity is 7.000. It is very brittle; of course it can neither be hammered, nor drawn out into wire. Its tenacity is unknown. It requires, according to Morveau, the temperature of 160° Wedgewood to melt it; so that, platinum excepted, it is the most infusible of all the metals. When reduced to powder it is attracted by the magnet, owing probably to a small portion of iron from which it can with difficulty be parted.

II. Manganese, when exposed to the air, attracts oxygen more rapidly than any other body, phosphorus excepted. It loses its lustre almost instantly, becomes grey, violet, brown, and at last black. These changes take place still more rapidly if the metal is heated in an open vessel.

This metal seems capable of combining with three different proportions of oxygen, and of forming three different oxides, the white, the red, and the black.

The protoxide or white oxide may be obtained by dissolving the black oxide of manganese in nitric acid by adding a little sugar. The sugar attracts oxygen from the black oxide, and converts it into the white, which is dissolved by the acid. Into the solution pour a quantity of potass; the protoxide precipitates in the form of a white powder. It is composed, according to Bergman, of 80 parts of manganese and 20 of oxygen. When exposed to the air it soon attracts oxygen, and is converted into the black oxide.

The deutoxide or red oxide may be obtained by dissolving the black oxide in sulphuric acid, without the addition of any combustible substance. When black oxide of manganese, made into a paste with sulphuric acid, is heated in a retort, a great quantity of oxygen gas comes over, while the oxide, thus deprived of part of its oxygen, dissolves in the acid. Distil to dryness, and pour water upon the residuum, and pass it through a filtre. A red-coloured solution is obtained, consisting of the sulphat of manganese dissolved in water. On the addition of an alkali a red substance precipitates, which is the red oxide of manganese. According to Bergman it is composed of 74 parts of manganese and 26 of oxygen. This oxide likewise attracts oxygen when exposed to the atmosphere, and is converted into the black oxide.

The peroxide of black oxide of manganese exists abundantly in nature; indeed it is almost always in this state that manganese is found. It was to the black oxide that the appellation manganese itself was originally applied. It may be formed very soon by exposing the metal to the air. This oxide, according to Fourcroy, is composed of 60 parts of manganese and 40 of oxygen. When heated to redness in an earthen retort it gives out abundance of oxygen gas, which may be collected in proper vessels. By this operation it is reduced nearly to the state of red oxide. If it is exposed to the air, and moistened occasionally, it absorbs a new dose of oxygen; and thus the same process may again be repeated. No oxygen gas can be obtained from the white oxide: a proof that its oxygen is retained by a stronger affinity than the additional dose of oxygen which constitutes the black oxide. Seguin has observed, that in some cases the black oxide of manganese emits, before it becomes red, a quantity of azotic gas. When long exposed to a strong heat it assumes a green colour. In that state it is whitened by sulphuric acid, but not dissolved. A very violent heat fuses this oxide, and converts it into a green-coloured glass.

III. Manganese does not combine with hydrogen. When dissolved in sulphuric acid a black spongy mass of carburet of iron is left behind. Hence it has been supposed capable of combining with carbon; but it is more probable that the carbon is combined with the iron, which is almost always present in manganese. It seems pretty clear, however, that carburet of iron is capable of combining with this metal, and that it always forms a part of steel.

Bergman did not succeed in his attempt to combine manganese with sulphur; but he formed a sulphureted oxide of manganese, by combining eight parts of the black oxide with three parts of sulphur. It is of a green colour, and gives out sulphureted hydrogen gas when acted on by acids. It cannot be doubted, however, that sulphur is capable of combining with manganese; for Proust has found native sulphuret of manganese in that ore of tellurium which is known by the name of gold ore of Nagyag.

Phosphorus may be combined with manganese by melting together equal parts of the metal and of phosphoric glass; or by dropping phosphorus upon red-hot manganese. The phosphuret of manganese is of a white colour, brittle, granulated, disposed to crystallize, not altered by exposure to the air, and more fusible than manganese. When heated the phosphorus burns, and the metal is oxidized.

IV. Manganese does not combine with either of the simple combustibles.

V. Manganese combines with many of the metals, and forms with them alloys which have been but very imperfectly examined.

It unites readily with copper. The compound, according to Bergman, is very malleable, its colour is red, and it sometimes becomes green by age. Gmelin made a number of experiments to see whether this alloy could be formed by fusing the black oxide of manganese along with copper. He partly succeeded, and proposed to substitute this alloy instead of the alloy of copper and arsenic, which is used in the arts.

It combines readily with iron; indeed it has scarcely ever been found quite free from some mixture of that metal. Manganese gives iron a white colour, and renders it brittle. It combines also with tin, but scarcely with zinc.

It does not combine with mercury nor with bismuth. Gmelin found that manganese cannot be alloyed with bismuth without great difficulty; and that it unites to antimony very imperfectly. Chemists have not attempted to combine it with gold, platinum, silver, nickel, nor cobalt.

VI. The affinities of manganese, and of its white and red oxides, are, according to Bergman, as follows:

Manganese.	*Oxide of manganese.*
Copper,	Oxalic acid,
Iron,	Citric,
Gold,	Phosphoric,
Silver,	Tartaric,
Tin.	Fluoric,
	Muriatic,
	Sulphuric,
	Nitric,
	Saclactic,
	Succinic,
	Tartaric,
	Lactic,
	Acetic,
	Prussic,
	Carbonic.

MANGIFERA, the *mango-tree*, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking with those of which the order is doubtful. The corolla is pentapetalous; the plum kidney-shaped. There are three species, the principal of which is a native of many parts of the East Indies, whence it has been transplanted to Brazil, and other warm parts of America. It grows to a large size;

the wood is brittle; the bark rough when old; the leaves are seven or eight inches long, and more than two inches broad. The flowers are produced in loose panicles at the ends of the branches, and are succeeded by large oblong kidney-shaped plums. This fruit, when fully ripe, is greatly esteemed in the countries where it grows; but in Europe we have only the unripe fruit brought over in pickle. All attempts to propagate the plant have hitherto proved ineffectual; and Mr. Millar is of opinion that the stones will not vegetate unless they are planted soon after they are ripe.

MANICHEES, in church history, a sect of christian heretics in the third century, the followers of Manes, who made his appearance in the reign of the emperor Probus; pretending to be the Comforter, whom our Saviour promised to send into the world. He taught that there are two principles, or gods, coeternal and independant on each other; the one the author of all evil, and the other of all good: a doctrine which he borrowed from the Persian magi. He held that our souls were made by the good principle, and our bodies by the evil one; and that the souls of his followers passed through the elements to the moon, and from thence to the sun, where being purified, they then went to God, and became united with his essence; but as for the souls of other men, they either went to hell, or were united to other bodies.

MANILLE, in commerce, a large brass ring, in the form of a bracelet, either plain or engraven, flat or round. Manilles are the principal commodities which the Europeans carry to the coast of Africa, and exchange with the natives for slaves. These people wear them as ornaments on the small of the leg, and on the thick part of the arm above the elbow. The great men wear manilles of gold and silver, but these are made in the country by the natives themselves.

MANIPULUS, in Roman antiquity, a body of infantry, consisting of 200 men, and constituting the third part of a cohort. See COHORT.

MANIS, a genus of quadrupeds of the order of bruta. The generic character is, teeth none; tongue cylindric and extensile; mouth narrowed into a snout; body covered with scales. The genus manis presents an appearance not less extraordinary than that of dasypus or armadillo; being covered on every part, except on the belly, with extremely strong and large horny scales, constituting a suit of armour still more powerful than in the following genus, and capable of defending the animals, when rolled up, from the assaults of the most ferocious enemies. This external covering, together with the uncommon length of the body and tail, gives an aspect so much resembling that of a lizard, that these creatures are commonly known by the title of scaly lizards: they may be allowed, however, in a general view of the animal kingdom, to form a kind of shade or link of approximation between the proper viviparous quadrupeds and the lizards.

They are animals of a harmless nature, and feed in the same manner as the ant-eaters, by thrusting out their very long tongue into the nests of ants and other insects, and swallowing their prey by suddenly retracting it, having no teeth, and differing from the ant-eaters in scarcely any other circumstance than that of their scaly integument. They are found in India and the Indian islands.

1. Manis tetradactyla, long-tailed manis. This animal, known in India by the name of the phatagen, is of a very long and slender form: the head is small; the snout narrow; the whole body, except beneath, covered with broad, but sharp-pointed, scales, which are striated throughout their whole length: the tail is more than twice the length of the body, and tapers gradually to the tip. The legs are very short, scaled like the body, and on each of the feet are four claws, of which those on the fore feet are stronger than those of the hind. The colour of the whole animal is an uniform deep-brown, with a cast of yellowish, and with a glossy or polished surface. The manis tetradactyla grows to the length of five feet, measuring from the tip of the nose to the extremity of the tail.

2. Manis pentadactyla, short-tailed manis, differs from the former, in being of a much thicker and shorter form; the tail, in particular, differs greatly in proportion from that of the preceding, being not so long as the body, very thick at the base, and thence gradually tapering, but terminating very obtusely. The head is small as in the former; the ears small and rounded; the feet furnished with five toes each, of which those on the fore feet are extremely strong, except the exterior one, which is much smaller than the rest. The whole animal is covered with most extremely thick, strong, and large scales, which in the full-grown specimens are perfectly smooth, but in those which are smaller are slightly striated about half way from the base. Sometimes a few bristles appear between the scales, but in others this is not observable. The scales differ in shape from those of the preceding, being much wider and larger in proportion to the body and tail. The colour of the whole animal is a very pale yellow-brown, and the surface is glossy, as in the former species. In India it is called the pangoelling. In the neighbourhood of Bengal it is named vajracite, or the thunderbolt reptile, from the excessive hardness of the scales, which are said to be capable even of striking fire like a flint. It is said to walk slowly; but, when pursued, rolls itself up, and is then so securely armed, that even a leopard attacks it in vain. It is also said sometimes to destroy the elephant, by twisting itself round the trunk, and thus compressing that tender and sensible organ with its hard scales. We are told in the Asiatic Researches that the Malabar name of this animal is alungu; and that the natives of Bahar call it bajar-cit, or the stone vermin; and in the stomach of the one examined and described in the above work was found about a teacupful of small stones, which it is supposed to have swallowed for the purpose of facilitating digestion. It was only 34 inches long from the nose to the end of the tail; and a young one was found in it.

Specimens of the manis pentadactyla have sometimes been seen of the length of six feet from the nose to the tip of the tail. See Pl. Nat. Hist. fig. 258.

MANNA, in natural history. This substance exudes from the fraxinus ornus, in the months of June and July, from the stem and branches. It is at first liquid, but gradually becomes solid. It is collected in Sicily and the southern parts of Italy. It is in form of oblong globules of a whitish-yellow colour, and somewhat transparent. It is very light. Its taste is sweet, and it leaves a nauseous bitter impression in the mouth. Its properties have not been examined by chemists. It acts as a mild cathartic. See MATERIA MEDICA.

MANOMETER, or MANOSCOPE, an instrument to shew or measure the alterations in the rarity or density of the air. The manometer differs from the barometer in this, that the latter only serves to measure the weight of the atmosphere, or of the column of air over it, but the former the density of air in which it is found; which density depends not only on the weight of the atmosphere, but also on the action of heat and cold, &c. Authors, however, generally confound the two together; and Mr. Boyle himself gives us a very good manometer of his contrivance, under the name of a statical barometer, consisting of a bubble of thin glass, about the size of an orange, which, being counterpoised when the air was in a mean state of density, by means of a nice pair of scales, sunk when the atmosphere became lighter, and rose as it grew heavier. See METEOROLOGY.

MANOR, was a district of ground held by lords or great personages, who kept in their own hands so much land as was necessary for the use of their families, which were called terræ dominicales, or demesne lands, being occupied by the lord, or dominus manerii, and his servants. The other lands they distributed among their tenants, which the tenants held under divers services. The residue of the manor being uncultivated was termed the lord's waste, and served for common of pasture to the lord and his tenants. All manors existing at this day must have existed as early as king Edward the First. 2 Black. 90. See COURT BARON.

MANSLAUGHTER, is unlawfully killing a man without any malice prepense, or forethought. The English law very humanely makes a distinction between a hasty and deliberate act: as when two persons on a sudden quarrel, fight, and one is killed; yet as it is done in a sudden heat of passion, and not with any premeditated malice, it is manslaughter, and not murder. See MURDER.

This crime may be either voluntary, as on a sudden loss of temper; as if a man is greatly provoked, and kills the aggressor, it is manslaughter; but if it appears that there was a sufficient cooling time for the heat of anger to subside, this shews deliberate revenge, and amounts to murder. Or it may be involuntary, but in the commission of some unlawful act; in which latter respect it differs from homicide per infortunium: as if one shoots off a gun in a highway, and where people often meet, and kills a man; or if he is shooting at game, and is not qualified or licensed, and kills another, it is manslaughter. And, in general, when an involuntary killing happens, in consequence of an unlawful act, it will be murder or manslaughter, according to the act which occasioned it.

It is evident from the nature of this crime that there can be no accessaries, because it must be done without premeditation; but when two men once fell out, and immediately fought, and the sword of one was broken, and his friend lent him another, with which he killed his antagonist, it was made manslaughter in both. Again: there were two men in a room quarreling; a brother of one of them standing at the door, who could not get in, cried out to his brother to make him sure, and the brother killed his antagonist: it was likewise manslaughter in both.

But if any person shall stab another, not having his weapon drawn, or not strucken first, so that he dies within six months, although it be not of malice aforethought, it is felony without benefit of clergy.

This crime, though felony, is within benefit of clergy; and the offender shall be burnt in the hand, and forfeit all his goods and chattels; but by stat. 19 Geo. III. c. 74, it is made lawful for the court to commute this punishment for a moderate fine and imprisonment.

MANTELETS, in the art of war, a kind of moveable parapets, made of planks about three inches thick, nailed one over another, to the height of almost six feet, generally cased with tin, and set upon little wheels, so that in a siege they may be driven before the pioneers, and serve as blinds to shelter them from the enemy's small shot.

MANTIS, a genus of insects of the order hemiptera. The generic character is, head unsteady, armed with jaws, and furnished with palpi or feelers; antennæ setaceous; thorax linear; wings four, membranaceous, convoluted, the lower pair pleated; fore legs, in most species, compressed, serrated beneath, and armed with a single claw and a setaceous, lateral, jointed foot; hind legs smooth, formed for walking. This is one of the most singular genera in the whole class of insects; and imagination itself can hardly conceive shapes more strange than those exhibited by some particular species. See Pl. Nat. Hist. fig. 259.

The chief European kind is the mantis oratoria of Linnæus, or camel cricket, as it is often called. This insect, which is a stranger to the British isles, is found in most of the warmer parts of Europe, and is entirely of a beautiful green colour. It is nearly three inches in length, of a slender shape, and in its general sitting posture is observed to hold up the two fore legs, slightly bent, as if in an attitude of prayer: for this reason the superstition of the vulgar has conferred upon it the reputation of a sacred animal; and a popular notion has often prevailed, that a child or traveller having lost his way would be safely directed by observing the quarter to which the animal pointed when taken into the hand. In its real disposition it is very far from sanctity, preying with great rapacity on any of the smaller insects which fall in its way, and for which it lies in wait with anxious assiduity in the posture at first mentioned, seizing them with a sudden spring when within its reach, and devouring them. It is also of a very pugnacious nature; and when kept with others of its own species in a state of captivity, will attack its neighbour with the utmost violence, till one or the other is destroyed in the contest.

Among the Chinese this quarrelsome property in the genus mantis is turned into a similar entertainment with that afforded by fighting cocks and quails.

The mantis precaria is a native of many parts of Africa, and is the supposed idol of the Hottentots, which those superstitious people are reported to hold in the highest veneration, the person on whom the adored insect happens to light being considered as favoured by the distinction of a celestial visitant, and regarded ever after in the light of a saint. This species is of the same general size and shape with the M. oratoria, and is of a beautiful green colour, with the thorax ciliated or spined on each side, and the upper wings each marked in the middle by a semitransparent spot.

Of all the mantes perhaps the most singular in its appearance is the mantis gongylodes of Linnæus, which, from its thin limbs, and the grotesque form of its body, especially in its dried state, seems to resemble the conjunction of several fragments of withered stalks. There are 14 species of this genus.

MANTLE, or MANTLING, in heraldry, that appearance of folding of cloth, flourishing, or drapery, that is in any achievement drawn about the coat of arms.

MANURE, any thing used for fattening and improving land. See HUSBANDRY.

MAP, a plane figure, representing the surface of the earth, or a part thereof.

In maps these three things are essentially requisite. 1. That all places have the same situation and distance from the great circles therein, as on the globe, to shew their parallels, longitudes, zones, climates, and other celestial appearances. 2. That their magnitudes be proportionable to their real magnitudes on the globe. 3. That all places have the same situation, bearing, and distance, as on the earth itself.

The true chart performs the first and last of these very exactly, but fails extravagantly in the second; and indeed no kind of projection yet found can exhibit more than two of them at once, by reason of the great difference between a plane and convex superficies.

Maps are not always to be used as they lie before us, for sometimes any part is uppermost; but, generally, the top is the north part, the bottom the south, the right hand the east, and the left hand the west, and marked with these words, or Latin ones of the same import. There is also inscribed a compass, pointing to all the quarters of the world, the north one being marked with a flower-de-luce.

The degrees of longitude are always numbered at top and bottom, and the degrees of latitude on the east and west sides. In all right-lined and general circular maps, except those of Wright's projection, the degrees of latitude on the sides are of an equal breadth; and in all circular and right-lined maps, except the said Wright's, and the plane charts, the degrees of longitude are unequal.

In general maps the circles corresponding to those in the heavens are inscribed, viz. the equator is expressed by a straight east and west line; and the first meridian, the polar circles, the tropics, and the other meridians and parallels, which are drawn at every five or ten degrees, intersect each other at right angles.

The most natural method of representing a sphere upon a plane seems to be, to divide it into two equal parts, and inscribe each of them in a circle: but as the equator, and the polar axis, which intersects that circle at right angles, and makes one of the meridians, must be supposed equal in length to the half of the periphery (which is not quite two-thirds), it follows of course, that the countries delineated upon, or near, these lines, must be reduced to somewhat less than two-thirds of the size of the countries of equal extent, which lie at the extremity of the circle; and that the lines drawn to measure the latitude, which are parallel to each other, or nearly so, must, in order to preserve as nearly as possible their proportional angles at the points of intersection with the meridians, form segments of circles, of which no two are parallel or concentric.

There may be as many different projections as there are points of view in which a globe can be seen, but geographers have generally chosen those which represent the poles at the top and bottom of the map; these, from the delineation of the lines of latitude and longitude, are called the stereographic, orthographic, and globular projections.

We do not propose to detain the reader with a description of all the projections, some of which are so erroneous (for the purpose of constructing of maps) as to deserve being consigned entirely to oblivion. But as the projection of maps is a pleasing and instructive exercise, and indeed indispensably necessary to the right understanding of geography to students, we shall describe the manner of constructing the map of the world. With regard to the stereographic projection it may be observed, that among the various positions assignable to the eye there are chiefly two that have been adopted, wherein the eye is placed either in the points D, fig. 1, or removed to an infinite distance; and hence this projection is liable to the great error of distorting the form of the countries represented upon it much more than is necessary. The only advantage is, that the lines of latitude and longitude intersect each other at right angles.

This being observed by that excellent astronomer, M. de la Hire, he invented a remedy for the inconvenience, by assigning to the eye a position at the point O, fig. 1, the distance of which from the globe at D is equal to the right sine of 45 degrees; and hence the right line GO, which bisects the quadrant BC, also bisects the radius EC, and produces the similar triangles OFG, and OEI; and thus the other parts of the quadrant EC, and in like manner of the whole semicircle AEC, are represented in the projection nearly proportionable to each other, and to sense perfectly so. The delineation of the earth and sea upon this projection (which, as coming the nearest to a true representation of the globe, is called the globular projection), is equal to the stereographic in point of facility, and vastly superior to it in point of truth.

Geometrical construction of the globular projection.—From the centre C, fig. 2, with any radius, as CB, describe a circle; draw the diameters AB, and 90, 90, at perfect right angles to one another, and divide them into nine equal parts; likewise divide each quadrant into nine equal parts, each of which contains ten degrees; if the scale admits of it, every one of these divisions may be subdivided into degrees: next, to draw the meridians, suppose the meridian 80° W. of Greenwich, we have given the two poles 90, 90, and the point 80 in the equator, or diameter AB; describe a circle to pass through the three given points as follows: with the radius 90 set one foot of the compasses on the point 90, and describe the semicircles XX and ZZ, then remove the compasses to the point 80 on the equator, and describe the arcs 1, 1, and 2, 2; where they intersect the semicircle make the point, as at 1 and 2, and draw lines from 2 through the point 1 till they intersect the diameter BA continued in E: then will E be the centre from whence the meridian 90, 80, 90, must be drawn, and will express the meridian of 80° W. longitude from Greenwich; the same radius will draw the meridian expressing 140° W. longitude, in like manner: draw the next meridian with the radius CB, set one foot of the compasses in the point *d*, and describe the arcs *aa* and *bb*, then draw lines as before, which will give the point D, the centre of 90° W. longitude; so of all the rest.

The parallels of latitude are drawn in the same manner, with this difference, that the semicircles XX and ZZ must be drawn from the points A and B, the extremities of the equator.

In the manner above described, with great labour and exactness, Mr. Arrowsmith, to whom we are indebted for a part of this article, drew all the meridians and parallels of latitude to every degree on two hemispheres, which laid the foundation of his excellent map of the world.

We shall now proceed to shew how the same thing may be done mechanically, both with regard to the globular and stereographic projection.

(1) *The Globular Projection of the Sphere on the Plane of a Meridian.*

Draw the circle WNES, fig. 3, draw the two diameters NS and WE at right angles with each other.

Divide the are of eaeh quadrant into nine equal parts.

Divide the radii also in the same manner into ninety equal parts each.

The diameter NS is the meridian, and the diameter WE is the equator.

The other meridians are arcs of circles, for each of which, as we have seen, there are three given points through which it must pass, and those are the two poles NS, and a division on the semi-diameter WC, viz. either *a*, *b*, *c*, *d*, *e*, *f*, *g*, or *h*. The centres for these arcs will be in the line CE produced; and the centres for those on the other side, will be on the line CW produced.

For the arc		the radius		
SaN.	the radius	*aa*	=	90,61
— SbN.	—	*bb*	=	92,82
— ScN.	—	*cc*	=	97,32
— SdN.	—	*dd*	=	106
— SeN.	—	*ee*	=	121,1
— SfN.	—	*ff*	=	149,7
— SgN.	—	*gg*	=	215.6
— ShN.	—	*hh*	=	410,7

Of the = parts of which the radius contains 90.

And for each of the arcs representing the parallels of lat also there are three given points; viz. one of the divisions *k*, *l* *m*, *n*, *o*, *p*, *q*, or *r*, upon the meridian SN, and the two corresponding divisions of the circumference. The centres for these arcs will fall on the line SN, produced both ways, and the following table shews the length of the radius of each equal part, in equatorial degrees, as in the former ease.

For the arc

80	*r* 80	the radius	*rr*	=	18,44	
70	*q* 70	—	*qq*	=	39.75	
66½	A. 66½	—	A. *Arctic*	=	48,19	
60	*p* 60	—	*pp*	=	65.3	
50	*o* 50	—	*oo*	=	97,71	
40	*n* 40	—	*nn*	=	143	
30	*m* 30	—	*mm*	=	210	
23½	T. 23½	—	T. *Tropic*	=	281,4	
20	*l* 20	—	*ll*	=	337,5	
10	*k* 10	—	*kk*	=	703,5	

Of the equal parts of which the radius contains 90.

(2) *The Stereographic Projection of the Sphere on the Plane of a Meridian.*

Draw a circle NESW, fig. 4, and the two diameters of it at right angles with each other.

Divide the arc of each quadrant into nine equal parts.

From the point E, draw dotted lines to each point of division on the arc WN.

The intersections made by this means on the semidiameter CN, mark a line of semitangents, which must also be set off on the other three semidiameters, CS, CW and CE.

Draw likewise two dotted lines from E to 23½° and 66½° for the tropic and polar arcs, which must also be set off on the semi-diameter CS.

Each point of intersection on CN, and the corresponding divisions on the arcs WN and EN, are the three points through which the arcs of latitude must pass; and their centres will be in the line NS produced.

Take the radius of the same circle for a scale; divide it into nine equal parts, and each of those parts into ten other parts, as before

The following table exhibits the length in those parts of the radius, which must be taken to describe eaeh respective arc.

For the arc

80	*r* 80	the radius	*rr*	=	15,87
70	*s* 70	—	*ss*	=	32,75
66½	A. 66½	—	A. *Arctic*	=	39,19
60	*t* 60	—	*tt*	=	51,96
50	*v* 50	—	*vv*	=	75,52
40	*w* 40	—	*ww*	=	107,3
30	*x* 30	—	*xx*	=	155,9
23½	T. 23½	—	T. *Tropic*	=	207
20	*y* 20	—	*yy*	=	247,3
10	*z* 10	—	*zz*	=	510,4

Of the equal parts of which the radius contains 90.

The two polar points N, S, and the semitangents on CE, mark the three given points through which each meridian line must pass.

The following table exhibits the length of each radius to describe the meridian arcs.

For the arc		the radius		
NaS.	the radius	*aa*	=	91,4
— NbS.	—	*bb*	=	95,78
— NcS.	—	*cc*	=	104
— NdS.	—	*dd*	=	117,5
— NeS.	—	*ee*	=	140
— NfS.	—	*ff*	=	180
— NgS.	—	*gg*	=	263
— NhS.	—	*hh*	=	513,3

Of the = parts of which the radius contains 90.

(3) *The Globular Projection of the Sphere on the Plane of the Equator.*

On the eentre P, fig. 5, draw the circle WNES, to represent the equator.

Draw the two diameters, WE and NS, at right angles with each other.

Divide the arcs of the four quadrants into nine equal parts; each of the parts will be equal to ten degrees.

Number them from N towards P, 10, 20, 30, 40, 50, &c.

On the centre P draw circles passing through those points of division, which will be the circles of latitude.

For the arctic circle, set off 23½° from P towards N; do the same at N towards P, for the tropic eircle.

Through each of those points draw an obscure circle.

Draw diameters from the divisions on one half of the eircumference to the corresponding divisions on the opposite one, to represent the meridians, and this will complete the projection.

(4) *The Stereographic Projection of the Sphere on the Plane of the Equator.*

Draw the circle N, W, S, E, fig. 6, and the two diameters at right angles with each other.

Divide the arcs of each of the four quadrants into nine equal parts; subdivide each of those parts into 10 degrees; number those degrees 10, 20, 30, &c.

Draw diameters from the divisions on one side of the circumference to the corresponding divisions on the other, which will represent the meridians.

For the parallels of latitude, project a line of semitangents as directed in the 2d ease.

On the centre P describe circles passing through the semitangents, which will complete the diagram.

Note. The foregoing methods of projecting the sphere are the best. There is another method sometimes used, viz. the projection on the plane of the horizon when any assumed place is considered as the centre; but as this method is rarely used, it need not be elucidated.

The orthographic projection is in fact so erroneous, that it ought to be entirely rejected for that purpose, and applied only to dialling.

The gnomonical projection is only applicable to dialling.

We shall now point out the advantage and disadvantage of Mercator's projection.

A method has been found to obviate some of the difficulties attending all the circular projections by one, which, from the person who first used it (though not the inventor), is called Mercator's projection. In this there are none but right lines: all the meridians are equidistant, and continue so through the whole extent; but, on the other hand, in order to obtain the true bearing, so that the compass may be applied to the map (or chart) for the purpose of navigation, the spaces between the parallels of latitudes (which in truth are equal, or nearly so) are made to increase as they recede from the equator in a proportion which, in the high latitudes, becomes prodigiously great.

The great advantages peculiar to this projection are, that every place drawn upon it retains its true bearing with respect to all other places; the distances may be measured with the nicest exactness by proper scales, and all the lines drawn upon it are right lines: for these reasons it is the only projection in drawing maps or charts for the use of navigators. We shall shew the method of this kind of projection.

Mercator's or Wright's projection of maps.—Draw the line AB, fig. 7, and divide it into as many degrees as your map is to contain in longitude, suppose 90°. At the extremities A and B raise perpendiculars, to which draw parallel lines at every single, fifth, or tenth degree of the equator, for the meridians; as in the figure, where they are drawn at every tenth degree. This done, put one foot of the compasses in the point A, and extending the other to the point in the first meridian in the equator G; or, for greater exactness, to some more distant point, as B 90; describe the quadrant FB, when divide into nine equal parts, and drawn lines from A to each point of the division; or, to avoid scoring the paper, only mark where a ruler cuts the first meridian GH, at every tenth degree's distance. Lastly, because the distances of the parallels from one another are marked, by this means, in the line GH, you must transfer them from that line to the side lines AC, BD, after the following manner: 1. Set one foot of the compasses in A, and extending the other to the first point above G, marked 1, transfer this distance, viz. A 1, to the lines AC, BD, and draw a line parallel to the equator AB, for the tenth parallel. 2. Next transfer the distance A 2 into the lines AC, BD, from the 10th parallel to the 20th, which is to be drawn. 3. In the same manner the distances A 3, A 4, A 5, &c. laid off upon the lines AC, BD, from the immediately preceding parallels, viz. 20, 30, 40, &c. will successively point out where the parallels 30, 40, 50, &c. are to be drawn.

This is the geometrical projection, which may also be laid down by means of a scale or table of meridional parts, by the line of secants, &c.

This projection supposes the earth, instead of a globular, to have a cylindrical figure; in consequence of which, the degrees of longitude become of an equal length throughout the whole surface, and are marked out on the map by parallel lines. The circles of latitude also are represented by lines crossing the former at right angles, but at unequal distances. The further we remove from the equator, the longer the degrees of latitude become in proportion to those of longitude, and that in no less a degree than as the secant of an arch to the radius of the circle; that is, if we make one degree of longitude at the equator the radius of a circle; at one degree distant from the equator, a degree of latitude will be expressed by the secant of one degree; at ten degrees distance, by the secant of ten degrees, and so on. A map of the world, therefore, cannot be delineated upon this projection, without distorting the shape of the countries in an extraordinary manner. The projection itself is, however, as we have already observed, very useful in navigation, as it shows the different bearings with perfect accuracy, which cannot be done upon any other map.

We shall now add a more exact method of projecting particular maps, wherein the squares are so projected as to form equal diagonals throughout.

Of the projection of maps of particular parts of the world.—There are several methods of projecting particular parts of the world, we shall notice only two. First, when the meridians and parallels of latitude are right lines.

To project a map of England after this method.—England is situated between 2° E. and 6° 20′ W. from Greenwich, and between 50° and 56° N. lat.

Draw a base line AB, fig. 8, in the middle of which erect the perpendicular CD.

Assume a distance for a degree of lat. and set off as many degrees on CD as are wanted, which in this instance are 6; but as a little space beyond the limits of the country is generally left, set off 7.

Through these points draw lines parallel to AB, which will be parallels of latitude.

Respecting the degrees of longitude it must be observed, that on the equator they would be of the same length as they are on a meridian, but must gradually decrease from thence to 0 at the poles.

The following table exhibits the length in geographical miles, of a degree of longitude for every degree of latitude.

Deg. Lat.	Geograp. Miles.	Deg Lat.	Geograp. Miles.	Deg. Lat.	Geograp. Miles.
0	60,00	31	51,43	61	29,09
1	59,99	32	50,88	62	28,17
2	59 96	33	50,32	63	27,24
3	59,92	34	49,74	64	26,30
4	59,85	35	49,15	65	25,36
5	59,77	36	48,54	66	24,41
6	59,67	37	47,92	67	23,44
7	59,56	38	47,28	68	22,48
8	59,42	39	46,63	69	21,50
9	59,26	40	45,96	70	20,52
10	59,09	41	45,28	71	19,53
11	58,90	42	44,59	72	18,54
12	58,69	43	43,88	73	17,54
13	58,46	44	43,16	74	16,53
14	58,22	45	42,43	75	15,53
15	57,95	46	41,68	76	14,52
16	57,67	47	40,92	77	13,50
17	57,38	48	40,15	78	12,47
18	57,06	49	39,36	79	11,45
19	56,73	50	31,57	80	10,42
20	56,38	51	38,76	81	9,38
21	56,02	52	36,91	82	8,34
22	55,63	53	36,11	83	7,31
23	55,23	54	35,27	84	6,27
24	54,81	55	34,41	85	5,23
25	54,38	56	33,55	86	4,18
26	53,93	57	32,68	87	3,14
27	53,46	58	31,79	88	2,09
28	52,97	59	30,90	89	1,04
29	52,47	60	30,00	90	0,00
30	51,96				

To use this table, divide the assumed degree into sixty parts by a diagonal line, fig. 9: look for the number of miles answering to the degree of lat. 49, which is 39, 36, say $39\frac{1}{2}$, which take off the scale, fig. 9, at *a*, and set off four times from C towards A, and the same from C towards B. The top meridian is 56° of lat. opposite which, in the table, is 33, 55, say $33\frac{1}{2}$, which take from the scale, fig. 9, at *b*, and set off four times from D towards E, and the same from D towards F. Draw the meridian lines to the corresponding divisions at top and bottom, of which 0 0 is the meridian of London.

Second. When the meridians and parallels are curved lines.

To project a map of Europe by this method.—Draw a base line GH, fig. 10, in the middle of which erect the perpendicular JP, and assume any distance for 10° of latitude.

Europe extends from 36° to 72° N. lat.

Let the point J be 30°, from which set off six of the assumed distances to P, which will be the N. pole.

Number the distances 40, 50, 60, &c.

On the centre P, describe arcs passing through the points of division on the line JP, which will be parallels of latitude.

Divide the space assumed for 10° of lat. into 60 parts by a diagonal line, fig. 11.

Look into the foregoing table for the number of miles answering to 30°, which is 51,96, say 52, which take from the scale, fig. 11, at *b*.

Set this distance off on the arc 30, 30, from the centre line JP both ways.

Do the same for 40°, 50°, 60°, &c.

Through the corresponding divisions, on all the arcs, draw curve lines; which will represent the meridians.

Number the degrees of lat. and lon., which will complete the diagram.

MARANTA, *Indian arrow-root*, a genus of the monogynia order, in the monandria class of plants, and in the natural method ranking under the eighth order, scitamineæ. The corolla is ringent and quinquefid, with two segments alternately patent. There are five species, all of them herbaceous perennial exotics of the Indies, kept here in hot-houses for curiosity: they have thick, knotty, creeping roots, crowned with long, broad, arundinaceous leaves, ending in points, and upright stalks, half a yard high, terminated by bunches of monopetalous, ringent, five-parted flowers. The root of the galanga is used by the Indians to extract the virus communicated by their poisoned arrows: whence it has derived its name of arrow-root. The arundinacea, or starch plant, rises to two feet, has broad pointed leaves, small white flowers, and one seed. It is cultivated in gardens and in provision grounds in the West Indies; and the starch is obtained from it by the following process: The roots when a year old are dug up, well washed in water, and then beaten in large deep wooden mortars to a pulp. This is thrown into a large tub of clean water. The whole is then well stirred, and the fibrous part wrung out by the hands, and thrown away. The milky liquor being passed through a hair-sieve, or coarse cloth, is suffered to settle, and the clear water is drained off. At the bottom of the vessel is a white mass, which is again mixed with clean water, and drained: lastly, the mass is dried on sheets in the sun, and is pure starch.

MARATTIA, a genus of the cryptogamia filices. The capsules are oval, gaping longitudinally at top, with several cells on each side. There are three foreign species.

MARBLE, in natural history, a genus of fossils, composed chiefly of lime; being bright and beautiful stones, moderately hard, not giving fire with steel, fermenting with, and soluble in, acid menstrua, and calcining in a slight fire. The word comes from the French marbre, and that from the Latin marmor, of the Greek μαρμαιρειν, to shine, or glitter. See LIME.

The colours by which marbles are distinguished are almost innumerable; but the most remarkable are, 1. The black marble of Flanders. 2. Plain yellow. 3. Yellow with some white veins. 4. Yellow with black dendrites. 5. Yellow with brown figures resembling ruins. 6. Black and yellow. 7. Black and white. 8. Pale yellow, with spots of a blackish-grey colour. 9. Yellow, white, and red. 10. Pale yellow. 11. Olive-colour, with deeper-coloured cross lines, and dendrites. 12. Brownish-red. 13. Flesh coloured and yellow. 14. Common red marble. 15. Crimson, white, and grey. 16. Reddish-brown lumps, on a whitish ground. 17. Blueish-grey. 18. Snowy-white.

The finest solid modern marbles are those of Italy, Blankenburg, France, and Flanders. It has also been lately discovered that very fine marble is contained in some of the western islands of Scotland. Those of Germany, Norway and Sweden, are of an inferior kind, being mixed with a kind of scaly limestone; and even several of those above-mentioned are partly mixed with this substance, though in an inferior degree. Cronstedt, however, mentions a new quarry of white marble in Sweden, which, from the specimens he had seen, promised to be excellent.

The specific gravity of marble is from

2700 to 2800; that of Carriera, a very fine Indian marble, is 2717. Black marble owes its colour to a slight mixture of iron. Mr. Bayen found some which contained five per cent. of the metal; notwithstanding which the lime prepared from it was white, but in time it acquired an ochry, or reddish-yellow colour.

MARBLE, *polishing of*, is performed by first rubbing it well with a freestone, or sand, till the strokes of the axe are worn off, then with pumice-stone, and afterwards with emery.

MARBLING, in general, the painting any thing with veins and clouds, so as to represent those of marble.

Marbling of books or paper is performed thus: Dissolve four ounces of gum-arabic into two quarts of fair water; then provide several colours mixed with water in pots or shells, and with pencils peculiar to each colour, sprinkle them by way of intermixture upon the gum-water, which must be put into a trough, or some broad vessel; then with a stick curl them, or draw them out in streaks, to as much variety as may be done. Having done this, hold your book or books close together, and only dip the edges in, on the top of the water and colours, very lightly; which done, take them off, and the plain impression of the colours in mixture will be upon the leaves; doing as well the ends as the front of the book in the like manner.

Marbling books on the covers is performed by forming clouds with aquafortis, or spirit of vitriol mixed with ink, and afterwards glazing the covers.

MARCGRAVIA, a genus of the polyandria monogynia class of plants, the corolla whereof consists of a single petal, of a conico-oval figure; and its fruit is a globose berry, with a single cell, containing a great number of very small seeds. There is one species, a shrub of the West Indies.

MARCHANTIA, a genus of the cryptogamia class of plants, the corolla of which is monopetalous, turbinated, and shorter than the cup; in the lower cavity of which there are contained several naked seeds, of a roundish but compressed figure. There are seven species, five of them British.

MARCIONITES, christians in the second century, thus denominated from their leader Marcion, who maintained that there were two principles or gods, a good and a bad one.

MARCOSIANS, a sect of christians in the second century, so called from their leader Marcus, who represented the supreme God as consisting not of a trinity, but a quaternity, viz. the ineffable, silence, the father, and truth.

MARE. See EQUUS.

MARGARITERIA, a genus of the dioecia octandria class and order. The male calyx is four-toothed; corolla four-petalled. Female calyx and corolla as above; styles four or five. There is one species, a native of Surinam.

MARICA, a genus of the trigynia monogynia class and order. The calyx is six-parted; stigma petal-form, trifid; capsule three-celled, inferior. There is one species, a fleshy bulb of Guiana.

MARILLA, a genus of the class and order polyandria monogynia. The calyx is five-leaved; corolla five-petalled; capsule four-celled, many-seeded; stigma simple. There is one species, a native of the West Indies.

MARK, *knights of St.*, an order of knighthood in the republic of Venice, under the protection of St. Mark the evangelist. The arms of the order are, gules, a lion winged or, with this device, "Pax tibi Marce evangelista." This order is never conferred but on those who have done signal service to the commonwealth.

MARK, or MARC, also denotes a weight used in several states of Europe, and for several commodities, especially gold and silver. In France, the mark is divided into 8 oz. or 64 drachms, or 192 derniers or pennyweights, or 160 esterlines, or 300 mailles, or 640 felins, or 4608 grains. In Holland the mark-weight is also called troy-weight, and is equal to that of France. When gold and silver are sold by the mark, it is divided into 24 caracts.

MARK is also used among us for a money of account, and in some other countries for a coin. The English mark is two-thirds of a pound sterling, or 13*s.* 4*d.* and the Scotch mark is of equal value in Scotch money of account. The mark-lubs, or lubeck-mark, used at Hamburgh, is also a money of account, equal to one-third of the rix-dollar, or to the French livre: each mark is divided into 16 sols-lubs. Mark-lubs is also a Danish coin equal to 16 sols-lubs. Mark is also a copper and silver coin in Sweden.

MARKET. A market is less than a fair, and is commonly held once or twice a week. According to Bracton, one market ought to be distant from all others at least six miles and a half and a third of a half: but no market is to be kept within seven miles of the city of London; but all butchers, victuallers, &c. may hire stalls and standings in the flesh-markets there, and sell meat and other provisions, four days in a week. Every person who has a market is entitled to receive toll for the things sold in it; and, by antient custom, for things standing in the market, though nothing be sold: but by keeping a market in any other manner than it is granted, or extorting of tolls or fees where none are due, they may be forfeited.

In London every shop in which goods are exposed publicly to sale, is market overt for such things only as the owner professes to trade in: though if the sale is in a warehouse, and not publicly in the shop, the property is not altered. But if goods are stolen from one, and sold out of the market overt, the property is not altered, and the owner may take them wherever he finds them. 5 Rep. 83.

If a man buy his own goods in a market, the contract shall not bind him, unless the property had been previously altered by a former sale.

MARLE. A mixture of carbonat of lime and clay, in which the carbonat considerably exceeds the other ingredient, is called marle. Its structure is earthy. Opaque, sometimes in powder. Specific gravity from 1.6 to 2.877. Colour usually grey, often tinged with other colours. Effervesces with acids. Some marles crumble into powder when exposed to the air; others retain their hardness for many years. Marles may be divided into two varieties: 1. Those which contain more silica than alumina. 2. Those which contain more alumina than silica. Mr. Kirwan has called the first of these siliceous, the second argillaceous marles. Attention should be paid to this distinction when marles are used as a manure.

MARLE, *bituminous*, is found in different parts of Germany. Colour greyish or brownish-black. Found massive. Shistose. Plates flat or waved. Opaque. Feels soft. Easily broken. Moderately heavy. Effervesces with acids. Burns before the blowpipe, leaving black scoriæ.

MARLINS, in artillery, are tarred white skains, or long wreaths or lines of untwisted hemp, dipped in pitch or tar, with which cables and other ropes are wrapped round, to prevent their fretting and rubbing in the blocks or pulleys through which they pass. The same serves in artillery upon ropes used for rigging gins, usually put up in small parcels called skains.

MARMOTTE. See MUS.

MARQUE. See LETTERS *of Marque*.

MARQUETRY, or INLAID WORK, is a curious work composed of several fine hard pieces of wood, of various colours, fastened in thin slices on a ground, and sometimes enriched with other matters, as silver, brass, tortoise-shell, and ivory; with these assistances the art is now capable of imitating any thing, whence it is by some called the art of painting in wood.

The ground on which the pieces are to be arranged and glued is usually of well-dried oak or deal; and is composed of several pieces glued together, to prevent its warping. The wood to be used in marquetry is reduced into leaves of the thickness of a line, or the 12th part of an inch, and is either of its natural colour, or stained, or made black to form the shades by other methods: this some perform by putting it in sand heated very hot over the fire; others by steeping it in lime-water and sublimate; and others in oil of sulphur. The wood being of the proper colours, the contours of the pieces are formed according to the parts of the design they are to represent: this is the most difficult part of marquetry, and that which requires the most patience and attention.

The two chief instruments used in this work are a saw and a wooden vice, which has one of its chaps fixed, and the other moveable; which is open and shut by the foot, by means of a cord fastened to a treadle.

MARQUIS, a title of honour, next in dignity to that of duke, first given to those who commanded the marches, that is, the borders and frontiers of countries.

Marquises were not known in England till the reign of king Richard II. and the year 1337.

MARRIAGE, a contract, both civil and religious, between a man and a woman.

Taking marriage in the light of a civil contract, the law treats it as it does all other contracts: allowing it to be good and valid in all cases where the parties, at the time of making it, were, in the first place, willing to contract; secondly, able to contract; and, lastly, actually did contract in the proper forms and solemnities required by law. 1 Black. 433.

By several statutes a penalty of 100*l.* is inflicted for marrying any persons without banns or licence. But by 25 G. II. c. 33, if any person shall solemnize matrimony without banns or licence obtained from some persons having authority to grant the same, or in any other place than a church or chapel where banns have been usually published, unless by special licence from the archbishop of Canterbury, he shall be guilty of felony, and transported for 14 years, and the marriage shall be void.

MARROW. See ANATOMY.

MARRUBIUM, *white horehound*, a genus of the gymnospermia order, in the didynamia class of plants, and in the natural method ranking under the 42d order, verticillatæ. The calyx is salver-shaped, rigid, and ten-striated; the upper lip of the corolla bifid, linear, and straight. There are 11 species, the most remarkable of which is the vulgare, a native of Britain, growing naturally in waste places, and by way-sides near towns and villages, but not common. It has a strong and somewhat musky smell, and bitter taste. It is reputed attenuant and resolvent; an infusion of the leaves in water, sweetened with honey, is recommended in asthmatic and phthisical complaints, and most other diseases of the breast and lungs.

MARS, in astronomy, one of the superior planets, moving round the sun in an orbit between those of the earth and Jupiter. See ASTRONOMY.

MARSHAL, in its primary signification, means an officer who has the command or care of horses; but it is now applied to officers who have very different employments, as earl-marshal, knight-marshal, or marshal of the king's house, &c.

MARSHAL *of the king's bench*, an officer who has the custody of the king's bench prison in Southwark. This officer is obliged to give his attendance, and to take into his custody all persons committed by that court.

MARSHAL *of the exchequer*, an officer to whom that court commits the king's debtors.

MARSHALLEA, a genus of the class and order syngenesia polygamia æqualis, little known.

MARSHALLING a coat, in heraldry, is the disposal of several coats of arms belonging to distinct families, in one and the same escutcheon or shield, together with their ornaments, parts, and appurtenances.

MARSHALSEA-COURT, is a court of record, originally instituted to hear and determine causes between the servants of the king's household and others within the verge of the court, and has jurisdiction of things within the verge of the court, and of pleas of trespass, where either party is of the king's family; and of all other actions personal, wherein both parties are the king's servants; but the court has also power to try all personal actions, as debt, trespass, slander, trover, action on the case, &c. between party and party, the liberty whereof extends 12 miles about Whitehall.

The judges of this court are the steward of the king's household, and high-marshal for the time being; the steward of the court, or his deputy, is generally an eminent counsel.

If a cause of importance is brought in this court, it is generally removed into the court of king's bench or common pleas by a habeas corpus cum causa.

MARSILEA, a genus of the cryptogamia class of plants, without any corolla or cup: the antheræ are four, and placed on an obtusely conic body; the fruit is of a roundish figure, consisting of four cells, in each of which are contained several roundish seeds. There are three species.

Under this genus are comprehended the salvinia of Micheli, and pilularia of Dillenius.

MARTIAL LAW, is the law of war, which entirely depends on the arbitrary power of the prince, or of those to whom he has delegated it. For though the king can make no laws in time of peace without the consent of parliament, yet in time of war he uses an absolute power over the army.

MARTIN. See HIRUNDO, and MUSTELA.

MARTLETS, in heraldry, little birds represented without feet, and used as a difference or mark of distinction for younger brothers.

MARTNETS, in a ship, small lines fastened to the leech of a sail, reeved through a block on the topmast-head, and coming down by the mast to the deck. Their use is to bring the leech of the sail close to the yard to be furled.

MARTYNIA, a genus of the angiospermia order, in the didynamia class of plants, and in the natural method ranking under the 10th order, personatæ. The calyx is quinquefid; the corolla ringent, the capsule ligneous, covered with a bark, with a hooked beak, trilocular, and bivalved. There are 60 species, tender, herbaceous, flowery, plants of South America.

MARYGOLD. See CALENDULE; and for MARSH-MARYGOLD, see CALTHA.

MASON, a person employed under the direction of an architect, in the raising of a stone building. See ARCHITECTURE.

MASSETER. See ANATOMY.

MASSICOT, a name given to the yellow oxide of lead, as minium is applied to the red oxide.

MASSONIA, a genus of the class and order hexandria monogynia. The corolla is inferior, with 6-parted border; filaments on the neck of the tube; capsule 3-winged, 3-celled, many-seeded. There are four species, bulbs of the Cape.

MAST, in naval architecture, a large timber in a ship, for sustaining the yards, sails, &c.

In large vessels there are four masts, viz. the mainmast, foremast, mizenmast, and bowsprit. The mainmast is the principal one, standing in the middle of the ship: its length, according to some, should be $2\frac{1}{2}$ that of the midship-beam. Others give the following rule for finding its length, viz. multiply the breadth of the ship, in feet, by 24; from the product cut off the last figure towards the right hand, and the rest will be the length required. Thus suppose the length of the midship-beam was 30 feet; then $30 \times 24 = 720$, from which cutting off the last figure, there remains 72 feet for the length of the mainmast. And as for the thickness of the mainmast, it is usual to allow an inch to every yard in length. See SHIP-BUILDING.

MASTER AND SERVANT. In London and other places the mode of hiring is by what is commonly called a month's warning or a month's wages: that is, the parties agree to separate on either of them giving to the other a month's notice for that purpose; or, in lieu thereof, the party requiring the separation to pay, or give up, a month's wages. But if the hiring of a servant is general, without any particular time specified, it will be construed to be a hiring for a year certain; and in this case if the servant departs before the year, he forfeits all his wages. Noy, Max. 107. And where a servant is hired for one year certain, and so from year to year as long as both parties shall agree, and the servant enters upon a second year, he must serve out that year, and is not merely a servant at will after the first year. If a woman-servant marries she must nevertheless serve out her term; and her husband cannot take her out of her master's service.

If a servant is disabled in his master's service by an injury received through another's default, the master may recover damages for loss of his service. And also a master may not only maintain an action against any one who entices away his servant, but also against the servant; and if without any enticement a servant leaves his master without just cause, an action will lie against another who retains him with a knowledge of such departure.

A master has a just right to expect and exact fidelity and obedience in all his lawful commands; and to enforce this he may correct his servant in a reasonable manner, but this correction must be to enforce the just and lawful commands of the master. Bul. N. P. 18.

In defence of his master a servant may justify assaulting another; and though death should ensue it is not murder, in case of any unlawful attack upon his master's person or property.

Acts of the servant are, in many instances, deemed acts of the master; for as it is by indulgence of law that he can delegate the power of acting for him to another, it is just he should answer for such substitute, and that his acts being pursuant to the authority given him, should be deemed the acts of his master. 4 Bac. Abr. 583. If a servant commits an act of trespass by command or encouragement of his master, the master will be answerable; but in so doing his servant is not excused, as he is bound to obey the master in such things only as are honest and lawful.

If a servant of an innkeeper robs his master's guest, the master is bound to make good the loss. Also, if a waiter at an inn sells a man bad wine, by which his health is impaired, an action will go against the master: for his permitting him to sell it to any person is deemed an implied general command. 1 Black. 430. In like manner if a servant is frequently permitted to do a thing by the tacit consent of his master, the master will be liable, as such permission is equivalent to a general command.

If a servant is usually sent upon trust with any tradesman, and he takes goods in the name of his master upon his own account, the master must pay for them: and so likewise if he is sent sometimes on trust, and other times with money; for it is not possible for the tradesman to know when he comes by the order of his master, and when by his own authority, or when with and without money. Str. 506. But if a man usually deals with his tradesmen himself, or constantly pays them ready money, he is not answerable for what his servant may take up in his name; for in this case there is not, as in the other, any implied order to trust him. Or if the master never had any personal dealings with the tradesman, but the contracts have always been between the servant and the tradesman, and the master has regularly given his se vant money for payment of every thing had on his account, the master shall not be charged. Esp. N. P. 115. Or if a person forbids his tradesmen to trust his servant on his account, and he continues to purchase upon credit, he is not liable. The act of a servant, though he has quitted his master's service, has been held to be binding upon the master, by reason of the former credit given him on his master's account, and it not being known to the party trusting that he was discharged. 4 Bac. Abr. 586.

The master is also answerable for any injury arising by the fault or neglect of his servant when executing his master's business, 6 T. R. 659: but if there is no neglect or default in the servant the master is not liable. Esp. Rep. 533.

If a smith's servant lames a horse whilst shoeing him, or the servant of a surgeon makes a wound worse, in both these cases an action for damages will lie against the master, and not against the servant. But the damage must be done while the servant is actually employed in his master's service, otherwise he is liable to answer for his own misbehaviour or neglect.

A master is likewise chargeable if his servant casts any dirt, &c. out of the house into the common street; and so for any other nuisance occasioned by his servants, to the damage or annoyance of any individual, or the common nuisance of his majesty's people. Lord Raym. 264.

A servant is not answerable to his master for any loss which may happen without his wilful neglect; but if he is guilty of fraud or gross negligence, an action will lie against him by his master.

A master is not liable in trespass for the wilful act of his servant; as by driving his master's carriage against another, done without the direction or assent of his master, no person being in the carriage when the act was done. But he is liable to answer for any damage arising to another from the negligence or unskilfulness of his servant acting in his employ. M'Manus v. Crickitt, Mich. 41 G. III.

Master of arts, is the first degree taken up in foreign universities, and for the most part in those of Scotland, but the second in Oxford and Cambridge; candidates not being admitted to it till they have studied seven years in the university.

Master in chancery. The masters in chancery are assistants to the lord chancellor and master of the rolls; of these there are some ordinary, and others extraordinary: the masters in ordinary are 12 in number, some of whom sit in court every day during the term, and have referred to them interlocutory orders for stating accounts, and computing damages and the like; and they also administer oaths, take affidavits, and acknowledgments of deeds and recognizances. The masters-extraordinary are appointed to act in the country, in the several counties of England, beyond 10 miles distant from London; by taking affidavits, recognizances, acknowledgments of deeds, &c. for the ease of the suitors of the court.

Master of the faculties, an officer under the archbishop of Canterbury, who grants licences and dispensations.

Master of the horse, a great officer of the crown, who orders all matters relating to the king's stables, races, breed of horses, and commands the equerries and all the other officers and tradesmen employed in the king's stables. His coaches, horses, and attendants, are the king's, and bear the king's arms and livery.

Master of the ordnance, a great officer, who has the chief command of the king's ordnance and artillery.

Master of the rolls, is an assistant to the lord chancellor of England in the high court of chancery; and in his absence hears causes there, and gives orders. His salary is 1200*l.* per annum.

Master of a ship, the same with captain in a merchantman; but in a king's ship he is an officer who inspects the provisions and stores, and acquaints the captain with what is not good, takes particular care of the rigging and of the ballast, and gives directions for stowing the hold; he navigates the ship under the directions of his superior officer; sees that the log and log-book are duly kept; observes the appearance of coasts; and notes down in his journal any new shoals or rocks under water, with their bearing and depth of water, &c.

Master at arms, in a king's ship, an officer who daily, by turns, as the captain appoints, is to exercise the petty officers and ship's company; to place and relieve sentinels; to see the candles and fire put out according to the captain's orders; to take care the small arms are kept in good order, and to observe the directions of the lieutenant at arms.

MASK, in field fortification: it sometimes happens that a ditch or fosse must be dug in an exposed situation; in this case it will be absolutely necessary for the artificers and workmen to get under cover by means of masking themselves in such a manner as to answer the double purpose of executing their immediate object, and of deceiving the enemy with respect to the real spot they occupy.

To effect the latter purpose several masks must be hastily thrown up, whilst the men are employed behind one; by which means the enemy will either mistake the real point, or be induced to pour his fire in several directions, and thus weaken its effect.

A mask is generally six feet high. Bags made of wad or wool are too expensive on these occasions; nor are gabions, stuffed with fascines, seven or eight feet high, to be preferred; for if the fascines are tied together they will leave spaces between them in the gabions: and if they are not bound together, they will be so open at top as to admit shot, &c.

In order to obviate these inconveniences the following method has been proposed: Place two chandeliers, each seven feet high and two broad, between the uprights, after which fill up the vacant spaces with fascines nine feet high, upon six inches diameter. One toise and a half of epaulement will require two chandeliers and 60 fascines to mask it.

The engineer, or artillery officer, places himself behind this mask, and draws his plan.

As you must necessarily have earth, &c. to complete your work, these articles may be brought in shovels, sacks, or baskets; and if the quarter whence you draw them should be exposed to the enemy's fire, cover that line, as well as the line of communication, between the trenches, or the parallels, with a mask.

If you cannot procure earth and fascines, make use of sacks stuffed with wool, &c. and let their diameters be three feet, and their length likewise three; and let the outside be frequently wetted to prevent them from catching fire.

MASTOIDES. See Anatomy.

MATCH, a kind of rope slightly twisted, and prepared to retain fire for the uses of artillery, mines, fireworks, &c. It is made of hempen tow, spun on the wheel like cord, but very slack; and is composed of three twists, which are afterwards again covered with tow, so that the twists do not appear: lastly, it is boiled in the lees of old wines. This, when once lighted at the end, burns on gradually and regularly, without ever going out, till the whole is consumed: the hardest and driest match is generally the best.

Match, *quick*, used in artillery, is made of three cotton strands drawn into lengths, and put into a kettle just covered with white-wine vinegar, and then a quantity of saltpetre and mealed powder is put into it, and boiled till well mixed. Others put only saltpetre into water, and after that take it out hot, and lay it into a trough with some mealed powder, moistened with some spirits of wine, thoroughly wrought into the cotton by rolling it backwards and forwards with the hands; and when this is done they are taken out separately, drawn through mealed powder, and dried upon a line.

MATERIA MEDICA. "The materia medica (says Dr. Darwin) includes all those substances which may contribute to the restoration of health." If, however, medicine be defined the art of *preventing*, as well as of curing, diseases, the science of which we are now to treat ought, by consequence, to comprehend the preservatives of living existence, as well as the restoratives of healthy action. Instead, therefore, of restricting this article to the mere enumeration and discussion of drugs, we shall, in the first place, introduce some general remarks on those substances which are employed as articles of diet or food.

PART I.

DIETETICS.

Organic life appears to be influenced and supported by two leading principles: 1st, fibrous excitation; and, 2dly, the substitution of nutritious particles, in place of those which are constantly dissipated or abraded. The power by which this last object is effected has been denominated by the author of Zoonomia, animal appetency. The principal and prime organs by which it is exerted, or the media through which new matter is originally communicated, are those which are termed the digestive and assimilating: it has, however, recently been conjectured that the organs of digestion are not the sole organs of nutrition, but that both the external surface of the body, and likewise the lungs, are media for the admission into the system of proper nutritive matter. Accordingly we find the class nutrientia, in the materia medica of the author just quoted, to comprehend not merely those substances which are received into the stomach as food, but also the matter which is taken into the lungs in the act of respiration, as likewise air, water, and other substances that may be applied naturally or artificially to the outer skin. To enquire into the grounds upon which this doctrine is established, that the lungs, the stomach, and the surface of the body, each affords instruments in common of actual nutrition, does not fall within the province of the present article. See PHYSIOLOGY. It will be proper here to confine ourselves to the general consideration of what is usually denominated animal and vegetable diet.

OF ANIMAL FOOD.

That man is designed by nature for a mixture of animal and vegetable food, is obvious from the structure of his organs, both of mastication and digestion. That the flesh of animals contains more nutritive matter, and that it stimulates the absorbent and secerning vessels more powerfully, than vegetable aliment, is demonstrated by the superior warmth and strength which in a state of health we experience after a meal of flesh than of vegetables: of the former (animal flesh), that, in general, which is of the darkest colour, contains more nutritive matter, and stimulates our vessels with more energy, than the white kinds: indeed the flesh of those animals which are carnivorous, or which live entirely on animal food, seldom enters into the diet of European, or civilized nations. The greater stimulating virtue of this kind of food has been attributed to the greater quantity which it has been suppo·ed to contain of volatile alkali. Dr. Darwin, however, properly questions whether it is not rather the elements only of this principle that are contained even in the strongest dark-coloured animal flesh.

Next in strength to the flesh of carnivorous animals ought to rank that of those animals when killed after full growth, the young of which afford a softer, whiter, more digestible, but less nutritious, food, such as the sheep, the bullock, the hog, and likewise several of the shell-fish, as lobsters, crabs, muscles, &c. in which class may likewise be enumerated several fish that are destitute of scales or shells, as eel, barbolt, tench, smelt, turtle, turbot. Of the fowl kind the bustard, woodpecker, starling, sparrow, goose, duck, and lapwing, ought to be arranged in this second class. These, with a due mixture of vegetable aliment, constitute the best kinds of food for healthy and athletic individuals, whose digestion is powerful, and who have a firm fibre.

The flesh of young animals, as of lamb, veal, and sucking pigs, afford a less stimulating and nutritious, but more digestible food: these meats are consequently most congenial to persons of less muscular energy, who have more feeble powers of digestion, and who accustom themselves to but little exercise: they are adapted to the hypochondriac, and should be principally used as aliment by individuals who are disposed to those kind of affections which have received the vulgar and indiscriminate appellation of scorbutic.

A still milder, but, in the same proportion, less nutritive food, is furnished by the white meats, such as the domestic fowl, partridge, pheasant, and their eggs, with oysters and young lobsters. These, from their bland and unacrimonious nature, are generally allowed to convalescents from acute diseases: they are peculiarly suitable to very weak stomachs, and ought in general to form the first articles in the diet of females after childbirth. The major part of the river fish which have scales, as pike, perch, and gudgeon, are possessed of very inferior nutritive faculty.

OF MILK AND ITS PRODUCTS.

Milk partakes of the properties of both animal and vegetable aliment: it may be separated by rest or by agitation into cream, buttermilk, whey, and curd. The cream is easier of digestion by the adult stomach, on account of its containing less of the caseous, or cheesy part; it is likewise on this account more nutritive. Butter contains still more nutriment, and is likewise, if not taken to excess, exceedingly easy of digestion, and is by no means calculated to generate unpleasant humours in the body. If given without any separation of its principles by artificial preparation, it might be admitted into the diet of infancy with much greater propriety than other articles which are employed with less apprehension of injury. Buttermilk is agreeable, bland, and gently nutritive. Whey is the least nutritious, and most easy of digestion. It is on this account ordered with the utmost propriety to those invalids whose constitutions have been rendered too irritable to bear the stimulus of more solid and nutritive aliment. Cheese is of various kinds, arising principally from the greater or less quantity of cream that it contains. Those cheeses which are broken to pieces in the mouth with most readiness are, for the most part, most easy of digestion, and most nutritive. Many kinds of cheeses are a considerable time in undergoing chemical change in the stomach; and on this account, although difficult of digestion, do not disagree with weak stomachs. Dr. Darwin observes that he has seen toasted cheese vomited up a whole day after it was eaten, without having become perceptibly altered, or given any uneasiness to the patient.

New cow's-milk is the food of infants, and is by far the best substitute for the milk of the mother, if this last be not afforded in sufficient quantity or quality by the parent, which, however, is seldom the case. The stomachs of children abound with acidity; and milk, which is always curdled before it is assimilated, is consequently digested with more facility in the earlier than in the more advanced periods of life. It is on this account likewise that certain vegetable substances, which have a great tendency to acidity, are exceedingly injurious to the infantile stomach. See the article INFANCY.

OF VEGETABLE FOOD.

The seeds, roots, leaves, and fruits, of plants, particularly the two former, constitute a very material part of the food of mankind. According to the opinion of Dr. Cullen, and other physiologists, the quantity of actual nourishment that these contain, is in proportion to the quantity of sugar that they can be made to produce; it is imagined that the mucilage which the farinaceous seeds contain, is changed in the granary to starch; and that this starch, in the processes to which the seeds are afterwards subjected, or by digestion in the stomach, is at length converted into saccharine principle. See PHYSIOLOGY. The farinaceous seeds are wheat, barley, oats, rye, millet, maize or Indian corn, &c. The roots of this class are the sugar-root, the common carrot, beet, and polypody. Those with less of the saccharine principle, and which afford a tender farina, are the turnip-rooted cabbage, the parsnip, parsley root, asparagus, turnips, potatoes, &c.; all of which, if less nutritive, are better suited to weakly organs of digestion than those in which the sugar is more abundant.

Other vegetables contain oil, sugar, mucilage, or acid, in various proportions, diluted with much water: these are but slightly nutrimental; and are, for the most part, injurious to delicate stomachs especially, unless taken with moderation; these are the apple, pear, plum, apricot, nectarine, peach, strawberry, grape, orange, melon, cucumber, dried figs, raisins, and a great variety of other roots, seeds, leaves, and fruits. Of these it may be observed generally, that those which are cold, watery, and sweet, are most calculated to prove indigestible, and consequently injurious.

DIFFERENT METHODS OF DRESSING VICTUALS.

Various modes of preparing and dressing both animal and vegetable articles of food have been contrived, in order to render them more palatable, and better adapted to the stomach. By boiling, animal flesh is, in some measure, deprived of its nourishing juice, which is with more or less facility given out to, and incorporated with, the broth: this last then contains the most nutritious part of the meat; but unless stronger than is ordinarily used, it is too diluted to admit of an easy digestion. Broths likewise have a remarkable tendency to acidity, particularly when made from the flesh of young animals, as of lamb and veal; and on this account also are much less congenial to weak stomachs than is generally imagined. The various jellies, which contain the gelatinous and nutritive, to the exclusion of the fibrous part of animal flesh, are in general much more suitable to the invalid and the convalescent than either broths or soups. Perhaps the most eligible mode of preparing animal food is by the process called stewing; for by this process its nutritious and substantive parts are concentrated and preserved. It is scarcely necessary to observe that the gravy of boiled meat contains its nutritive parts in a state of concentration; it is digested with facility; and gravy is therefore the best mode of giving animal food to very young infants.

Roasting preserves the nutritive part of flesh from dissipation in a greater degree than boiling: and it has been asserted by an observant author (Dr. Willich) that "one pound of roast meat is, in real nourishment, equal to two or three pounds of boiled meat." It ought however to be noticed, that the fat of meat treated in this way has undergone some degree of chemical decomposition from its exposure to heat, and is in consequence more oppressive to delicate stomachs, and generally less salutary, than that of boiled flesh. Both baking and frying are upon similar principles improper methods of preparing animal food. Smoked meats, as prepared hams, are hard of digestion. They should only be taken in small quantities, and rather as condiment than food.

The art of cookery, as applied to vegetable substances, is principally useful in destroying the native acrimony, and rendering the texture softer of some, and by converting the acerb juices of others into saccharine matter. The boiling of cabbage, of asparagus, &c. are examples of the one, the baking of unripe pears is an instance of the other. The above are all chemical processes; they are too familiar to need description.

Another mode by which the nourishment of mankind is facilitated, is the mechanic art of grinding farinaceous seeds into powder; and, in some instances, exposing them afterwards to a fermenting process, as in the making of bread, and then to the action of fire by baking or boiling. The mill-stones, by which the process of grinding is effected, have been quaintly termed the artificial teeth of society. It has been suggested by Dr. Darwin, that "some soft kinds of wood, especially when they have undergone a kind of fermentation, and become looser, might, by being subjected to the action of the mill-stones, be probably used as food in the times of famine. Nor is it improbable," continues our ingenious speculator, "that hay which has been kept in stacks, so as to undergo the saccharine process, may be so managed by grinding and by fermentation with yeast, like bread, as to serve in part for the sustenance of mankind in times of great scarcity. Dr. Priestley gave to a cow, for some time, a strong infusion of hay in large quantities for drink, and found that she produced during this treatment above double the quantity of milk. Hence if bread cannot be made from ground hay, there is great reason to suspect that a nutritive beverage may be thus prepared, either in its saccharine state, or fermented into a kind of beer. In times of great scarcity there are other vegetables, which, though not in common use, would most probably afford wholesome nourishment, either by boiling them, or drying and grinding them, or by both those processes in succession. Of these perhaps are the tops and barks of all those vegetables which are armed with thorns or prickles, as gooseberry-trees, holly, gorse, and perhaps hawthorn. The inner bark of the elm-tree makes a kind of gruel; and the roots of fern, and probably very many other roots, as of grass and clover taken up in winter, might yield nourishment, either by boiling or baking, and separating the fibres from the pulp by beating them; or by getting only the starch from those which possess an acrid mucilage, as the white betony. And the alburnum of perhaps all trees, and especially of those which bleed in spring, might produce a saccharine and mucilaginous liquor, by boiling it in the winter or spring."

OF DRINK.

"Water," says Dr. Darwin, "must be considered as a part of our nutriment, because so much of it enters the composition of our fluids; and because vegetables are believed to draw almost the whole of their nourishment from this source." It may, however, be questioned whether pure elementary water taken into the stomach acts upon the system as a nutrimental matter in any other mode than by procuring the solution, and thus facilitating the assimilation, of solid aliment.

Water is the natural and proper drink of man. It is the basis of all other liquids; and the larger proportion of water that enters their composition, the more easily, in a state of health, and provided proper food has been taken, are the solution and digestion of such food effected.

This fluid, however, is never or seldom taken in a state of entire purity. Even in nature's laboratory it is invariably impregnated with foreign substances; and it is this admixture of extraneous matter which constitutes its varieties. Thus we have snow water, rain water, spring water, river water, and water from lakes, wells, and swamps, each possessing their individual characteristics.

Spring water is, in general, most free from impurities; it is, however, less suited for drink than the water of rivers, as it almost constantly contains calcareous, or saline ingredients. The calcareous earth dissolved in the water of many springs, has been supposed indeed by Dr. Darwin to contribute to our nourishment in the manner that lime proves useful in agriculture. This principle, however is not perhaps fully established; and we believe that too much stress has by theorists in general been laid on the specific qualities of water, as modifying both the bodily and intellectual character of individuals and nations. The cretinism and fatuity of the Alpine valleys were formerly attributed to the waters of these countries, but are now more commonly, and we believe more justly, referred to constitutional propensity, innutritious food, and a humid unhealthy atmosphere.

That water however possesses great varieties, according to the nature of the soil and situation of the place in which it is produced or contained, is undeniable; and we shall here extract part of what is observed on these varieties by an attentive and judicious observer.

"*Spring water*," says Dr. Willich, "originates partly from that of the sea, which has been changed into vapours by subterraneous heat, and partly from the atmosphere. As it is dissolved and purified in a variety of ways before it becomes visible to us, it is lighter and purer than other waters.

"*Well water.* Wells opened in a sandy soil are the purest. The more frequently a well is used, the better; for the longer water stands unmoved, the sooner it turns putrid.

"*River water* is more pure and wholesome if it flows over a sandy and stony soil, than if it passes over muddy beds, or through towns, villages, and forests: water is rendered foul by fish, amphibious animals, and plants.

"*Lake water* much resembles river water, but being less agitated it is more impure. The water which, in cases of necessity, is obtained from swamps and ditches, is the worst of all; because a great variety of impurities are there collected, which, in a stagnant and soft soil, readily putrify.

"*Rain water* is also impure, as it contains many saline and oily particles, soon putrefies, and principally consists of the joint exhalations of animals, vegetables, and minerals, of an immense number and variety of small insects and their eggs, seeds of plants, and the like. Rain water is particularly impure in places filled with many noxious vapours; such as marshy countries, and large manufacturing towns, where the fumes of metallic and other substances are mixed with rain. In high and elevated situations, at a distance from impure exhalations, if no strong winds blow, and after a gentle shower, rain water is then purest. In summer, however, on account of the copious exhalations, rain water is most objectionable.

"*Snow water* possesses the same properties as rain water, but is purer; both are soft, that is, without so many mineral and earthy particles as spring, well, and river waters. *Hail water*, being produced in the higher regions of the atmosphere, is still purer from its congelations. Lastly, *dew*, as it arises from the evaporation of various bodies of the vegetable and animal kingdoms, is more or less impure, according to the different regions and seasons."

On the different kinds and qualities of fermented and spirituous liquors, it does not fall within the compass of the present article to treat. They all consist of water as their base or vehicle, of more or less alcohol or ardent spirit according to their different degrees of strength, of sugar, and of the particular ingredient by which their nature is determined; such as the grape in wine, the apple and pear in cyder and perry, the malt and hop in beer, &c. &c. (See the respective articles in their alphabetical order.) It is only necessary here to observe, that, with few exceptions, fermented liquors, when immoderately taken, are more detrimental than elementary fluids, in proportion to the quantity that they contain of alcohol, or ardent spirit.

With respect to the China tea and the coffee-berry, which have lately come into such general use in this country, we believe them to be much less injurious to the animal economy than some theorists have been disposed to conjecture. In excess, however, and when indulged in as substitutes for, and, as is sometimes the case, almost to the exclusion of, nourishing diet, they are highly deleterious, as they tend to the induction of a morbidly irritable condition of the nervous system. It deserves to be remarked, that these stimuli do not, like alcohol, produce those formidable, and often irremediable, disorders, affections of the liver, dropsy, and apoplexy.

An enumeration of spices (which, like spirituous liquors, are used as articles of diet with too great freedom) will be found under the head Aromatics, in a subsequent section of this article.

PART II.

MEDICINALS.

We now proceed to the second division of our subject, or to the consideration of the materia medica in its more ordinary and limited signification.

Various divisions and modes of classification of those articles which are used in medicine, have been proposed and adopted by different authors. Some systematic writers arrange the articles of the materia medica according to their alphabetical order: others have taken for the basis of their arrangement the more sensible properties of drugs, as detected by the taste; thus reducing medicines to the different heads of bitterness, sweetness, astringency, acidity, &c.: while some have been regulated in their classification of medicinal articles, by their characters as objects in natural history. "As, however, the study of the materia medica is merely the study of the medicinal properties of certain substances, it is evident that the method of arranging them as they agree in producing effects on the living system is the one best calculated to fulfil all its objects." Murray.

Among the different plans of arrangement which have been framed on this principle, that adopted by Mr. Murray, in his late work on the materia medica, appears liable to the fewest objections. It is founded on the principle of Dr. Brown, "that medicines operate by stimulating the living fibre, or exciting it into motion." See the article Brunonian System. This proposition, however, was received and applied by its author in too unlimited a sense. In the first place, stimulation differs not merely in *degree*, but also in *kind*; or, in other words, one given medicine cannot by any regulation of its quantity be made to produce the same effects which result from the agency of another; some are more diffusible and transient, others more slow and permanent in their action; some affect the universal system in almost an equal degree, while the operation of others is more especially, and in some instances almost exclusively, directed to a certain part. They have all likewise properties peculiar to themselves.

But besides this general and very important modification of the Brunonian materia medica, it is necessary further to take into view, that medicines sometimes appear to display their agency even on the living body almost entirely upon chemical or mechanical principles: these last modes of operation, although less common and extensive than were supposed in the antient systems of medicine, must still be admitted as interfering with the universality, and opposing the unqualified assumption, of Dr. Brown, to which we have just alluded.

Guided by these views, Mr. Murray has adopted the general division of medicines under the four heads of *universal stimulants, local stimulants, chemical remedies*, and *mechanical remedies*, which are subdivided in the following manner:

TABLE OF CLASSIFICATION.

A. General stimulants.		
	a. Diffusible.	Narcotics.
		Antispasmodics.
	b. Permanent.	Tonics.
		Astringents.
B. Local stimulants.		Emetics.
		Cathartics.
		Emmenagogues.
		Diuretics.
		Diaphoretics.
		Expectorants.
		Sialagogues.
		Errhines.
		Epispastics.
C. Chemical remedies.		Refrigerants.
		Antacids.
		Lithontriptics.
		Escharotics.
D. Mechanical remedies.		Anthelmintics.
		Demulcents.
		Diluents.
		Emollients.

The objections which still lie against this, which we have chosen as the most perspicuous and comprehensive arrangement of medicines, will be urged, as we proceed to make some observations on their subdivisions, in the order of the above table.

The following, then, may be regarded, with some few exceptions, as an abridgment, or condensation, of the materia medica department of Mr. Murray's treatise. The names of the articles are adopted from the last edition, recently published, of the Parmacopœia collegii regii Medicorum Edinburgensis. In this edition the simples are principally indicated by the Linnæan names. We have added, however, the more customary titles, in order to obviate confusion.

OF NARCOTICS.

Medicines of this class had, previous to the time of Dr. Brown, been almost universally regarded as sedative, or depressing, even in their primary operation. By a bold, and, in some measure, legitimate generalization, our author proved that this kind of agency is, in the greater number of cases, merely of a secondary nature; and that the symptoms of depressed, or, more properly speaking, exhausted power, resulting from their administration, are consequent upon the faculty they possess of exciting, in a prompt and very extraordinary manner, the actions of the system. Thus opium, which is one of the most powerful of the narcotics, Dr. Brown maintained is, in the first instance, invariably stimulant; and the same virtue he attributes to the whole range of narcotic, or, as they were formerly characterized, sedative powers.

Although this conclusion is deduced from principles in the main correct, and in its application has been of abundant service in developing the laws of organic existence, it cannot, as we have above remarked, be admitted as universal, as the fact must be obvious to all who are not biassed by system, that "the sedative effects of narcotics are often disproportioned to their previous exciting operation, allowing even in such cases for its rapidity and little permanence." Murray. This fact then, in some measure, interferes with the correctness of our author's (Mr. Murray's) classification.

Narcotics are employed medicinally with different and opposite intentions. As stimulants they are given in various disorders of debility; in intermittent and continued fever, in gout, hysteria, epilepsy, dropsy, &c. As sedatives they are administered to allay pain and irritation, and are consequently largely administered in spasmodic and painful affections.

Alcohol, ardent spirit; spirit of wine. For the origin and preparation of this consult the article Alcohol. The stimulant effect of alcohol is generally known to be very powerful and diffusible; its exciting power is perhaps, in proportion to its sedative quality, greater than any of the other narcotics. Moderate excitement, with proportionate subsequent languor, results from a moderate dose of spirits. In larger quantities it occasions intoxication, delirium, stupor, coma, death.

Alcohol is used externally as a stimulant in muscular pains: it has lately been discovered to be an useful application in the cure of burns. Internally it is seldom employed in medicine without dilution; and then is rather administered as an auxiliary, or solvent of other ingredients.

Ether. Ethers bear some resemblance in their medicinal powers to alcohol: they are more diffusible, and less permanent in their operation. They are employed principally in asthma, hysteria, and other spasmodic affections. Their dose is from half a drachm to one or two drachms. Externally applied, sulphuric ether has been found to relieve spasmodic contraction of the muscles, and is often useful when applied to the temples in headache.

Camphora, laurus camphora (Lin.): habitat, Japan, India. Camphor is a proximate principle of vegetables; it is principally obtained from the laurus camphora of Japan.

In a moderate dose camphor is stimulant; in a larger quantity it invariably diminishes the force of the circulation, and induces sleep.

Camphor has been used as a stimulant in typhus, cynanche maligna, and other affections attended with debility and irritation; as a sedative in pneuomonia, rheumatism, &c. In mania it has been given as an anodyne. As an antispasmodic it is employed in asthma, St. Vitus's dance, and epilepsy. Its dose is from five to twenty grains. Externally, in combination with oil or liquid opium, camphor has been advantageously used in rheumatism, bruises, and other inflammatory affections.

Papaver somniferum, poppy. Europe, Asia. The concrete juice of the capsule of this plant is opium, which is chiefly imported from Egypt, Turkey, and the East Indies.

The effects of opium, as above stated, are stimulating: it often occasions, when given in somewhat large doses, intoxication, and even actual delirium. If a larger dose be given, the symptoms of diminished action appear without any previous excitement, and are succeeded by delirium, stupor, stertorous breathing, convulsions, and death.

Where opium is given as a stimulus it ought to be administered in small and frequently repeated doses. Where the intention is to mitigate pain or irritation, it ought, on the contrary, to be given in a large dose, and at distant intervals. It is of importance to observe, that where evacuations have been previously procured, or when a state of diaphoresis is present, opium is much more genial and salutary than while the skin is dry, or the bowels torpid.

In continued, as well as intermittent, fevers, opium is given as a stimulus. In the profluviæ of Dr. Cullen, opium is employed to diminish the discharge. In gout it is highly serviceable. In convulsive and spasmodic affections it is often administered to a very great extent, as in the tetanus of warm climates. In lues venerea it is thought to accelerate the action of mercury. It is often given to promote suppuration, and is extremely efficacious in arresting gangrene. In the form of enema opium is often administered in violent affections of the bowels.

Its usual dose is one grain to an adult.

Hyoscyamus niger, indigenous, herba, semen, black henbane. This plant, in its action on the system, bears a considerable resemblance to opium; for which it is often employed as a substitute, where the latter, from idiosyncracy, occasions unpleasant symptoms. It is free from the constipating effects of opium.

Atropa belladonna, indigenous, deadly

nightshade. Both the leaves and berries of this plant, and also its root, are narcotic. It is seldom used in medicine.

Aconitum napellus, aconite, monk's-hood, herba. Europe, America.

Aconite has been employed in obstinate chronic rheumatism, in schirrus, &c. Its dose is from one to two grains of the powdered leaves; of the inspissated juice half a grain.

Conium maculatum, cicuta, hemlock, folia, semen, indigenous. This is a powerful narcotic. Like the aconite, it has been used in schirrous and scrophulous affections,as well as in rheumatisms. Dose two or three grains of the powdered leaves; one or two of the inspissated juice.

Digitalis purpurea, foxglove, folia, indigenous. Of all the narcotics, digitalis most speedily and certainly diminishes the actions of the system, especially of the arteries. It acts at the same time as a stimulant on the absorbent system; hence its abundant utility in dropsy. Lately it has been extensively employed in phthisis, and in the early stages of this disorder with remarkable success. Dose one grain of the powdered leaves, and ten drops of the tincture of the Edinburgh pharmacopœia, gradually increased.

Nicotiana tabacum, tobacco, folia. America. This is a powerful narcotic. Its extreme activity prevents it from being much used in medicine.

Lactuca verosa, strong-scented lettuce, folia, indigenous.

From five to ten grains of the inspissated juice, gradually increased, have been given as a narcotic, diuretic, and antispasmodic.

Datura stramonium, thorn-apple, herba, indigenous.

This has been used in mania, epilepsy, and convulsive diseases. Dose from one to three grains of the inspissated juice.

Arnica montana, leopard's-bane, flores, radix. Germany.

The flowers have been used in the dose of five grains in palsy, convulsions, &c. Its root has been employed as a substitute for Peruvian bark.

Rhododendrum chrysanthum, yellow-flowered rhodadendron, folia, Siberia.

This has been given in chronic rheumatism and gout.

Rhus toxicondendron, poison-oak, folia. N. America. The dried leaves have been used in palsy. Dose half a grain twice or thrice a day.

Strychnos nux vomica, vomica nut. East Indies. It has been employed in mania, hysteria, &c. Dose five grains twice a day.

Prunus lauro-cerasus, cherry-tree laurel, folia, Europe.

This has scarcely been employed in medicine.

OF ANTISPASMODICS.

Antispasmodics form a kind of intermediate class between narcotics and tonics. Spasm sometimes arises from local irritation in states of general irritability, and is sometimes occasioned by pure debility. Both narcotics therefore and tonics are used as antispasmodics; but there are certain substances which in some measure appear to possess a specific antispasmodic power; these we are now to enumerate.

Moschus, musk, moschus moschiferus. South of Asia. Musk is a peculiar substance found in a small sac, situated in the umbilicus in the male of the above animal. Its antispasmodic powers are considerable. Dose from six to twenty grains in the form of bolus: it is useful in much smaller quantities in the convulsions of infants from dentition.

Castoreum, castor, castor fiber. This is a deposition collected in cells near the extremity of the rectum in the beaver. It is much used in hysteria. Dose from ten to twenty grains.

Oleum animale empyreumaticum, empyreumatic animal oil. This is nearly discarded from practice.

Petroleum, a bitumen of a red colour. This was formerly, but is not now, much employed.

Ammonia. This, when employed alone as an antispasmodic, is given in the form of carbonate.

Ferula assafœtida, assafœtida, Persia. This is a concrete juice, obtained by incision from the roots of certain plants. Its dose, as an antispasmodic, is from five to twenty grains.

Sagapenum, gummi-resina, Persia; virtues the same as assafœtida, but inferior in power.

Bubon galbanum, gummi-resina, Africa. Dose ten grains.

Valeriana officinalis, wild valerian: radix, indigenous. This is one of the principal antispasmodics. Dose from one scruple to one drachm, three or four times a day.

Crocus sativus, saffron, indigenous. This substance is composed of the stigmata which crown the pistil of the flower. It has scarcely any virtue.

Melaleucha leucadendron, cajeput oil, India. This is scarcely in use, except as a local application in tooth-ache.

OF TONICS.

This term ought not perhaps to be retained. The agency of tonics is not that of increasing tension or tone, but they are permanent stimulants to the living fibre. Tonics, then, are properly regarded as slow and durable, in opposition to the more diffusible and transient stimuli. They are chosen from the mineral and vegetable kingdom; the former are less speedy and sensible in their action than the latter.

From the mineral Kingdom.

Hydrargyrus, argentum vivum, mercury. *Ferrum*, iron. *Zincum*, zinc. *Cuprum*, copper. *Arsenicum*, arsenic. For the various preparations and medicinal virtues of the above important minerals, consult the articles PHARMACY and MEDICINE.

Barytes, terra ponderosa, heavy earth. This has only been used in medicine combined with muriatic acid. Dr. Crawford introduced the saturated solution into practice as a remedy for scrophula. Dose from five to twenty or more drops.

Calx, lime. This earth exists in nature as a carbonate: like barytes, it has been used as a tonic in combination with muriatic acid.

Acidum nitricum, nitric acid. This acid has been used as a tonic to support the system under a mercurial course. It has likewise been tried, but not with decided and invariable success, as a specific in the cure of lues venerea.

Oxymurias potassæ, oxymuriate of potash. This may be classed as a remedy with the former article. Its dose is, ten grains increased to twenty or twenty-five.

Tonics from the vegetable Kingdom.

The tonic faculty in vegetables is intimately united with certain sensible qualities, with bitterness, astringency, and aroma. The aromatic principle is more active, but less permanent in its stimulating operation. The purest bitters independantly possess a tonic power. Astringency, when it exists exclusively, or as the most predominant principle in vegetables, constitutes a distinct class; the remaining tonics may be arranged according as bitterness or aroma is predominant.

Cinchona officinalis, cortex Peruvianus, Peruvian bark, Peru. Three kinds of this bark are in use, the pale, red, and yellow. The last is now principally employed, as it gives out more bitterness and astringency to water, alcohol, and other media. Peruvian bark was first employed in intermittent fever. In this disease it is given in the dose of a scruple or half a drachm every third hour, during the interval of the paroxysm. In continued fever it is principally employed during the latter stages, when debility is urgent. In rheumatism, erysipelas, gangrene, hæmorrhage, and almost all asthenic disorders, it has been administered as a tonic.

Cinchona Caribæa, Caribeean bark, Caribee islands. *Angustura*, Spanish West Indies. These barks have both been used as substitutes for the Peruvian.

Aristolochia serpentaria, Virginian snakeroot. This is a stimulating aromatic tonic. It is generally given in the form of tincture.

Dorstenia contrayerva, contrayerva, Peru, West Indies. This is scarcely possessed of any virtue.

Croton eleutheria, cascarilla cortex, N. America. This is another substitute for Peruvian bark. Dose a scruple or half a drachm.

Colomba, radix, Ceylon, a very useful tonic bitter. Dose half a drachm.

Quassia excelsa, lignum, West Indies. This is likewise an excellent tonic. Dose, in substance, from ten to thirty grains.

Quassia simarouba, simarouba, cortex, South America. This has been extolled as a remedy in dysentery, and chronic diarrhœa. Dose a scruple.

Swietenia febrifuga, Swietenia, cortex, East Indies. *Swietenia mahagani*, mahogany. Two other proposed substitutes for the Peruvian bark.

Gentiana lutea, gentian, Switzerland, Germany. This is a common and useful remedy in dyspepsia; its virtues are extracted both by water and spirit. Dose in substance half a drachm.

Anthemis nobilis, chamomile, flores, indigenous; a powerful and well-known bitter. N. B. The following plants are now not used in medicine: *artemisia absinthium*, wormwood; *chironia centaurum*, centaury; *marrubium vulgare*, horehound; *menyanthes trifoliata*, trefoil; *centaurea benedicta*, blessed thistle.

AROMATICS.

Citrus aurantium, orange, cortex flavus. The rind of the orange is principally employed as an addition to combinations of bitters used in dyspepsia. It is given in the form of tincture, conserve, and syrup.

Citrus medica, lemon, cortex fructûs,

Asia; similar in flavour and virtue, but rather less bitter than the orange.

Laurus cinnamomum, cinnamon, cortex, Ceylon. This is the most grateful of the aromatics.

Laurus cassia, cassia, cortex, E. Indies. This nearly resembles the cinnamon in appearance, taste, and virtue. It is therefore used with the same intention as this last. Its flavour, however, is less grateful.

Canella alba, cortex, West Indies. This is a moderately strong aromatic: it is not much used except in combination with other substances in the form of tincture.

Acorus calamus, sweet-scented flag, radix, indigenous. This is scarcely at all employed in medicine.

Ammomum zingiber, ginger, radix, East Indies. The dose of ginger is about ten grains.

Kæmpferia rotunda, zedoaria, radix, East Indies. This is seldom employed in medicine.

Santalum album, yellow sanders, lignum, E. Indies. This wood is now nearly banished from practice.

Pterocarpus santalinus, santalum rubrum, red sanders, lignum, India. This, although slightly aromatic, is at present merely used in pharmacy as a colouring ingredient.

Myristica moschata, India. Under the officinal name myristica, both nutmeg and mace are included: the former is the seed, or kernel of the fruit; the latter its capsule. Nutmeg is given as an aromatic in doses of from five to fifteen grains. In larger doses it is narcotic. Mace is employed for the same purposes as nutmeg.

Carophyllus aromaticus, clove, flores, India. Cloves are the unexpanded flowers of the plant. Dose from five to ten grains.

Capsicum annuum, capsicum, Guinea pepper, fructus, E. and W. Indies. This fruit is a very powerful stimulant. It is not in much use as a medicine. Dose from five to ten grains.

Piper nigrum, black pepper, fruit, India. Black pepper is the unripe fruit of the plant. White pepper is the ripe berry of the same vegetable, freed from its outer covering. It is milder than the black. Dose ten or fifteen grains.

Piper longum, long pepper. This is the berry of the plant, gathered before it is fully ripened. It is similar to the black pepper in its qualities.

Piper Cubeba, cubebs, the dried fruit of the tree. It has similar virtues to the other peppers.

Myrtus pimenta, Jamaica pepper, baccæ, W. Indies. This is usually called pimento; it is used in medicine principally on account of its flavour.

Amomum repens, lesser cardamom, semen. Cardamoms form an ingredient in many of the bitter tinctures.

Carum carui, caraway, semen, indigenous. These are in common use, in culinary as well as medicinal preparations.

Coriandum sativum, coriander, semen, South of Europe. These are used with the same intention as caraway.

Pimpinella anisum, anise, semen, Egypt. Anise is used chiefly in the flatulence of children. The four following seeds have similar virtues to the anise and caraway: *Anethum fœniculum*, sweet fennel, semen, indigenous. *Anethum graveolens*, dill, semen, Spain and Portugal. *Cuminum cyminum*, cumin, semen. South of Europe.

Angelica archangelica, garden angelica, semen, folia, radix. North of Europe.

Mentha piperita, peppermint, herba, indigenous. *Mentha viridis*, spear mint, herba, indigenous. *Mentha pulegium*, pennyroyal, herba, indigenous. Of these three mints the first is the most pungent and carminative.

Hyssopus officinalis, hyssop, herba, Asia, South and East of Europe. This plant is nearly similar in virtues to the mints just enumerated.

OF ASTRINGENTS.

Astringents are those substances that restrain morbid evacuations. Their mode of operation has been erroneously supposed similar to that by which dead animal matter is constringed and condensed. Increased evacuations do not depend merely upon mechanical laxity of the solids; the process, therefore, by which they are arrested, cannot entirely be ascribed to chemical principles; although in some cases medicines which are employed to arrest profuse discharges, confessedly possess a power of constringing dead animal fibre. This faculty in vegetables is denominated astringency, and results from the union of gallic acid and tanning principle combined; the former, when separated, is distinguished by its property of striking a deep-black colour with the salts of iron; the other by its great attraction to animal gelatin. Vegetable astringents then may be considered as moderate permanent stimuli, modified in their action, even on living matter, by the principle above alluded to. Inordinate evacuations are, however, often restrained by mineral as well as vegetable substances, and in this case the former deserve to be arranged in the class of astringents, according to the definition above given of these powers. Dr. Darwin refers astringency to the promotion of absorption. Many agents, however, which have the greatest efficacy in exciting the absorbent vessels, are not capable of stopping hæmorrhages, or other morbid discharges.

Vegetable Astringents.

Quercus robur, oak, cortex, indigenous. This has been employed in hæmorrhage, diarrhœa, and intermittent fever. Its dose in powder is from fifteen to thirty grains.

Quercus cerris, galls, south of Europe. These are tubercles found on the branch of the tree which produces them. They are employed in medicine for the same purposes, and are used under the same forms, as oak-bark.

Tormentilla erecta, tormentil, radix, indigenous. This has been used in diarrhœa in decoction. Its dose, in substance, is from half a drachm to a drachm.

Polygonum bistorta, bistort, radix, indigenous. This is a strong astringent. Dose a scruple to a drachm.

Anchusa tinctoria, alkanet, radix, South of Europe. This is at present merely employed as a colouring matter.

Hæmatoxylon Campechianum, logwood. It is used as an astringent under the form of decoction, or watery extract.

Rosa gallica, red rose, South of Europe. The principle use of this astringent is in the form of gargle.

Arbutus uva ursi, bear's whortle-berry, folia, Europe, America. This has been principally given in disorders of the urinary organs. Recently it has been proposed in phthisis pulmonalis.

Mimosa catechu, catechu, or Japan earth, East Indies. This is a powerful and useful astringent in diarrhœa. Its dose is from fifteen to thirty grains. *Kino* is employed with the same intention as catechu. Its dose is from twenty to thirty grains.

Pterocarpus draco, dragon's blood, resina, South America. This is scarcely employed in medicine.

Lacca, lac, ficus indica, resina, East Indies. Lac is very little employed as a medicinal.

Pistacea lentiscus, mastiche, resina, South of Europe. This is likewise discarded from practice.

Mineral Astringents.

The chief of these are the mineral acids, especially the sulphuric, and the compounds this acid affords with metals and earths.

Acidum sulphuricum, vitriolic acid. This is used in hæmoptysis, menorrhagia, diabetes, hectic, &c. It is given in general in the form of diluted acid. Dose from ten to thirty drops.

Argilla, argil, argillaceous earth with oxyd of iron, forming the boles of which the chief is the armenian bole, were formerly employed in, but are now rejected from, practice as nearly inert.

Supersulphas argillæ et potassæ, alum, is given in hæmorrhage, and serous evacuations. Its dose is from five to fifteen grains.

Calx, lime; calx viva, quicklime. Lime has been employed as an astringent in the form of lime-water; it is now not much used.

Carbonas calcis, carbonate of lime. The carbonates of lime are chalk (creta alba), crab's-claws (chelæ cancrorum), oyster-shells (testæ astreorum); they are rather antacids than strictly astringents.

Plumbum, lead. This, in the form of oxyd, or salts, is evidently and powerfully astringent. Its preparations that a e employed are the white oxyd (cerusa, white lead), and the acetate (acetis plumbi, sugar of lead).

Zincum, zinc. The sulphate of zinc (sulphas zinci), and the acetate (acetis zinci), are both powerful astringents. The former is in principal use. It is given sometimes in dysentery, in the dose of two or three grains twice a day. In injections and collyria, it is employed in the proportion of two or three grains to an ounce of water.

Ferrum, iron. The sulphate is the most astringent preparation of iron: it is, however, oftener used as a tonic than astringent.

Cuprum, copper. The saline preparations of this metal are considerably astringent. The sulphas cupri is the most powerful. It has been employed externally as a styptic. The acetite of copper (verdigris) is used as a collyrium from its astringent styptic property.

OF EMETICS.

Emetics are very properly defined by Mr. Murray, "Substances capable of exciting vomiting, independant of any effect arising from the mere quantity of matter introduced into the stomach, or of any nauseous taste or flavour." The phenomenon of vomiting, as to its remote cause, is of difficult explanation. It cannot be owing simply to debilitated, and consequently inverted action of the stomach from previous excitement, as a greater quantity of stimulus may be thrown into this organ without being succeeded by an inversion of its peristaltic motion. Dr. Darwin attributes the effect to a suspension of the exciting power of pleasurable sensation, in consequence of which the fibres of the stomach are arrested for a time, and at length, from the undue accumulation of irritability, their action becomes inverted. The sensation of nausea does not, however, invariably precede the act of vomiting; and even allowing this feeling to be a necessary prelude, the cause of the sensation itself is left unexplained by the sensorial theory of Dr. Darwin.

The utility of emetics under some circumstances of the system is very extensive. Their salutary effects are not solely referable to the discharge which they occasion; but they also produce other changes on the living body, both general and partial, which will be noticed in the article MEDICINE.

Emetics are derived from the vegetable and mineral kingdoms.

Emetics from the vegetable Kingdom.

Ipecacuanha, ipecacuan, radix, South America.

This root is the one in most general use as an emetic: it is both mild and certain in its operation. It is given in a dose from fifteen to thirty grains. Ipecacuan is employed in conjunction with opium, as a diaphoretic. In this case its dose is from three or four to ten grains.

Scilla maritima, squill, radix, South of Europe. This bulbous root of a plant growing on the sandy shores of Spain and Italy, is not at present in much use as an emetic: it is principally employed as an expectorant and diuretic.

Sinapis alba, mustard, semen, indigenous. This perhaps might have been classed among the aromatics. When employed as an emetic, its administration has been principally confined to paralytic affections. It is given in the dose of a tea-spoonful mixed with water.

Asarum Europæum, asarabacca, folia, indigenous. The introduction of ipecacuan into practice, has almost superseded the use of this powerful drug. Dose twenty grains of the dried leaves; of the dried root ten grains.

Nicotiana tabacum, tobacco.

This is a violent emetic, as well as narcotic. It is scarce ever employed in practice.

From the mineral Kingdom.

Antimonium, stibium, antimony.

Than antimony, scarcely any mineral is in more general use: it is, however, seldom used but in a state of combination with oxygen or acid. Its preparations, doses, and virtues, will be treated of under the articles PHARMACY and MEDICINE.

Sulphas zinci, sulphate of zinc.

This salt is sudden in its operation: it is in principal use in cases of poisons having been received into the stomach. Its dose is from ten grains to a scruple.

Sulphas cupri, sulphate of copper.

Neither this nor the acetite of copper is in much use; they are violent in their operation, and in no respect preferable to milder emetics.

OF CATHARTICS.

A discharge of the intestinal contents appears to be occasioned by medicines upon a twofold principle. Cathartics either immediately excite the fibres of the intestines, thus accelerating their peristaltic motion, and consequent fæcal evacuations, or they produce this effect more immediately by stimulating the exhalant and secerning vessels; whose fluids (the bile, pancreatic juice, and intestinal mucus) act as solvents to, and promote the discharge of, the fæces. These latter are milder in their operation than the former: they are classed by Darwin among the secernentia. There are, however, many drugs which act at the same time in each of the above modes.

Cathartics, still more than emetics, are extensively employed in medicine, as capable of operating important changes throughout the system. Their use has recently been brought more systematically into notice.

Upon the grounds just stated, cathartics may with some propriety be divided into purgative and laxative.

Purgatives.

Cassia senna, senna, folia, Egypt, Arabia. This is frequently employed: it is given in the form of infusion. Dose a drachm or more.

Rheum palmatum, rhubarb, radix, Tartary.

The best rhubarb is imported from Turkey. The China rhubarb has less of the aromatic flavour. British rhubarb is much inferior to either. The dose of rhubarb, as a cathartic, is from fifteen grains to two scruples. It is given with advantage in diarrhœa and dysentery, as it contains an astringent principle. In small doses it is stomachic and tonic.

Convolvulus jalapa, jalap, radix, Mexico. This is often administered both alone and more especially with calomel (submurias hydrargyri). Its dose is from fifteen grains to two scruples.

Helleborus niger, black hellebore, radix, Austria, Italy.

This, in a dose from ten to twenty grains, is a violent cathartic. It is seldom employed in modern practice. Dr. Mead attributed a powerful emmenagogue property to to it, which however has scarcely been realized by others. The antient physicians gave it freely in maniacal disorders.

Bryonia alba, bryony, radix, indigenous. This root is not much used. Dose from twenty to thirty grains. It is slightly diuretic.

Cucumis colocynthis, colocynth, fructûs pulpa, Syria.

A drastic purgative in a dose from three to six grains. It is seldom given by itself. It has been chiefly had recourse to in obstinate constipation.

Momordica elaterium, wild cucumber, fructus, south of Europe.

This is the most violent of all purgatives. Its dose is half a grain to two grains.

Rhamnus catharticus, buckthorn, baccarum succus, indigenous. This is seldom used.

Aloe perfoliata, socotrine, Barbadoes, or hepatic and cabbaline aloes; succus spissatus, Africa, Asia, America.

The socotrine aloes is the purest. The Barbadoes and hepatic rank next. The cabbaline is the most impure, and is the weakest. Dose from fifteen grains to a scruple. Its action is principally upon the larger intestines, and on account of the vicinity to, and sympathy of these with, the uterus, it is often useful in amenorrhœa.

Convolvulus scammonia, scammony, gummi-resina, Syria.

This is a very drastic cathartic. Dose from five to ten grains.

Gambogia gutta, gamboge, gummi-resina, East Indies.

Another violent cathartic. Dose from one to four or five grains. In conjunction with the last and following article gamboge is often administered in dropsy.

Submurias hydrargyri, mild muriate of mercury, calomel.

Dose from five to eight or ten grains.

LAXATIVES.

Manna, manna, fraxinus ornus, succus concretus, South of Europe.

This is a mild and pleasant laxative. It is frequently given to children in conjunction with senna. Dose to an adult from one to two ounces.

Cassia fistula, purging cassia, or cassia in the pod; pulpa fructûs, Egypt, East and West Indies.

Dose from four to six drachms.

Tamarindus Indica, tamarind, fructus conditus, E. and W. Indies, America, Arabia.

The tamarinds of the shops is the pulp of the tree mixed with seeds and small fibres, with a quantity of coarse sugar.

It may be taken to the extent of two ounces, or more.

Ricinus communis, palma Christi, oleum, semen, W. Indies.

The oil from the nuts of palma Christi is the castor oil of the shops. This is a mild and very useful purgative.

Sulphur, a simple inflammable substance, and *magnesia*, either pure or carbonated, are all the laxatives that are afforded by the mineral kingdom. The operation of either is exceedingly mild.

For the different neutral salts that are employed as purgatives in medicine, see PHARMACY.

The purgatives that are administered only in the form of enema, are the

Murias sodæ, common salt. An ounce of this dissolved in a pint of tepid water with an ounce of expressed oil, forms the common domestic enema.

Terebinthina veneta, turpentine, pinus larix, gummi-resina. This is sometimes employed as an enema triturated with the yolk of an egg. Dr. Cullen recommends this as a very certain cathartic. It is indicated in obstinate costiveness.

Nicotiana. The introduction per-ano of tobacco smoke has sometimes been effectual in procuring alvine evacuation, after other cathartics have failed. The infusion of from one to two drachms in a pint of water is a more convenient mode of administering this medicine. Much caution is requisite in either case to obviate its injurious effects.

OF EMMENAGOGUES.

These are medicines which promote the menstrual discharge. Obstruction or retention of the menses, unless consequent upon defective conformation, or uterine impregnation, is usually owing to weakness or want of due excitation in the vessels of the uterus.

This debility is best overcome by general stimulating and tonic agents, which thus acting, become emmenagogues, ; sometimes, however, it is necessary more immediately and directly to excite the parts in the vicinity of the uterus, by such purgatives whose action is principally directed to the inferior portion of the intestinal canal. In this case these cathartics prove emmenagogues, but not, as was formerly conjectured, by virtue of any specific power.

Emmenagogues from the class of tonics.

Ferrum, the carbonate of iron, rubigo ferri præparata; is given in a dose of ten or fifteen grains in amenorrhœa; the sulphate of iron in three or four grains. This last is the ferrum vitriolatum of the London pharmacopœia.

Hydrargyrus, the mild muriate of mercury, as already noticed.

Cinchona. This is frequently given in amenorrhœa, in conjunction with some of the preparations of iron.

From the class of antispasmodics.

Castoreum. This is a medicine of very trifling efficacy when used as an emmenagogue. Dose from ten to twenty grains.

Ferula assafœtida, and the other fœtid gums, (galbanum, sagapenum, and ammoniacum) are employed sometimes as emmenagogues. Dose from ten grains to fifteen.

From the class of cathartics.

Aloes. This substance is generally connected with others when given to promote the menses, as in the pilula aloes cum myrrhâ, &c.

Helleborus niger. This is not at present in much repute. Dose of the extract from three to ten grains.

Sinapis alba, semen, mustard-seed in the dose of about half an ounce is sometimes taken as an emmenagogue.

Rosmarinus officinalis, rosemary, summitales florentis. This is now nearly banished from practice.

Rubia tinctorum, madder, radix, south of Europe. Dose from a scruple to half a drachm. Its virtues are not much confided in by modern physicians.

Rutea graveolens, ruta, rue, herba, south of Europe. The herb in the form of infusion, and likewise its essential oil, are the preparations of rue that are given. It is perhaps of inferior efficacy.

Juniperus sabina, savin, folia, south of Europe. Savin is not much used internally, although supposed by some to be a powerful emmenagogue.

OF DIURETICS.

Diuretics are those medicines which augment the urinary discharge. This effect is either produced by a direct stimulus communicated to the kidneys, by a sympathetic excitement of these organs from a previous action excited in the stomach, or, lastly, by the promotion of absorption, by which more than their usual quantity is directed to the secretory vessels of the urine. The saline diaphoretics seem principally to exert their agency in the first of these ways. Squill and others appear to produce a primary action of the stomach, and digitalis from its extraordinary power over the absorbent system is an example of the last-mentioned mode of procuring diuresis.

Saline diuretics.

Supertartris potassæ, cream of tartar. Dose four or six drachms twice a day in a considerable quantity of water. This has been much employed in dropsy.

Nitras potassæ, nitre. Dose from five to twenty grains. Nitre was formerly much used in gonorrhœa, in order to abate the ardor urinæ.

Murias ammoniæ, crude sal ammoniac. This is not much employed. Dose from eight grains to a scruple.

Acetis potassæ, sal diureticus. This has now likewise fallen into disuse.

Potassa, kali. The dose of carbonated kali is from twenty to thirty grains.

Vegetable diuretics.

Scilla maritima. Dose as a diuretic from one to three or four grains.

Digitalis purpurea. Dose from one grain to two or more, of the powdered leaves: from ten to thirty drops of the saturated tincture. The dose requires to be regulated and encreased with much caution.

Nicotiana tabacum. An ounce of the dried leaves infused in a pint of water, has been given as a diuretic in the dose of from sixty to a hundred drops.

Solanum dulcamara, woody nightshade, bitter, sweet, indigenous. This is scarcely ever prescribed.

Lactuca verosa. Dose from ten grains to three drachms. It is not much used.

Colchium autumnale, meadow saffron, indigenous. This has not been in much use in this country. It was first prescribed in dropsy by Storck of Vienna.

Gratiola officinalis, hedge hyssop, south of Europe. The leaves of this plant have likewise been given in dropsy, but they have not come into general use.

Spartium scoparium, broom, summitales, indigenous.

The broom tops infused in water have proved advantageous in dropsy.

Juniperus communis, juniper, baccæ indigenous. Juniper berries given in infusion have a pretty considerable diuretic power.

Copaifera officinalis, copaiva balsam, South America. Dose from twenty to thirty drops twice a day. It is principally employed in gleet.

Pinus larix, Venice turpentine, balsamum. Dose from five to twelve drops of the essential oil. This has likewise been given in gleet, and in ischias.

Pistachia terebinthinus, Cyprus turpentine. This is more fragrant than the balsam from the pinus; as is likewise Strasburgh turpentine, the produce of the pinus picea. The common turpentine (pinus sylvestris balsam) is on the other hand the most offensive.

Diuretics from the animal Kingdom.

Meloe vesicatorius, cantharides, Spanish fly. This is an insect collected from the leaves of plants growing in the South of Europe. It has principally been given internally for gleet and retention of urine. Dose one grain gradually increased.

OF DIAPHORETICS.

If the natural and constant exhalation from the skin be condensed on the surface from its augmented discharge, it constitutes sweat. This effect when produced only to a certain extent, is called diaphoresis. Diaphoretic and sudorific powers differ then only in degree. Diaphoretics are classed by Darwin under the head of secernentia. They necessarily operate by directly or indirectly exciting the cutaneous exhalants. The saline and cooling diaphoretics appear to act in the latter, the heating medicinals which are given to procure sweat in the former manner. Diaphoretics with respect to their influence on the system, are often abundantly powerful and salutary.

Ammonia. All saline preparations are more or less diaphoretic under proper regulation. The ammoniacal salts have been imagined to be so in a greater degree than others. See PHARMACY.

Hydrargyrus. The mild muriate (calomel) in conjunction with opium in very small doses, is sometimes usefully employed as a diaphoretic.

Antimonium. All the preparations of antimony may be made to prove sudorific.

Ipecacuanha. In a dose of two or three grains with or without an opiate.

Opium. This when employed as a diaphoretic is generally combined with one or other of the three former medicines.

Camphor likewise must be united with mercury, antimony, or opium, when it is intended as a diaphoretic.

Guaiacum officinale, guaiac lignum, et gummi-resina, South America, and the West Indies. Guaiac wood is given in the form of decoction, a quart of which is given in the course of the day. The gum-resin is commonly administered in spirit of ammonia, from which it derives a considerable part of its virtues. Dose from one drachm to two of the tincture.

Daphne mezereum mezereon, cortex radicis indigenous. This is a stimulating diaphoretic: it is generally given in lues venerea, with sarsaparilla and guaiac, forming the Lisbon diet-drink.

Smilax sarsaparilla, radix, South America. This has scarcely any power exclusively employed.

Laurus sassafras, sassafras, lignum, America. This is slightly stimulant and diaphoretic. It is probably less efficacious than has generally been imagined.

Cachlearia armoracia, horse-radish, radix, indigenous. This is a stimulant capable of promoting perspiration. About a drachm of the root cut in small pieces and swallowed whole, has been recommended in paralysis, rheumatism, asthma, and dropsy.

Salvia officinalis, sage, folia, south of Europe. Its aqueous infusion drunk warm is slightly stimulant and diaphoretic.

EXPECTORANTS

Are those medicines which facilitate the rejection of mucus or other fluids from the lungs. This object is accomplished by increasing pulmonary exhalation where deficient, or diminishing it when too copious. In the one instance expectorants are secernent, in the other absorbent powers: their operation, like that of emetics, is in both cases either direct or indirect.

Antimonium. The most common preparation of antimony for an expectorant is the emetic tartar of the shops. This is given in pneumonia, catarrh, hooping cough, and asthma, in the dose of one eighth of a grain.

Ipecacuanha. It is given with the same intention in a dose of two or three grains.

Digitalis, in the dose of half a grain, has been used as an expectorant, as likewise

Nicotiana, in the dose of one, two, or three grains.

Scilla. This is one of the most effectual of the expectorantia. Dose one grain of the dried root.

Allium sativum, garlic, radix, south of Europe. Garlic is given in humoral asthma, dropsy, &c. in the dose of half a drachm or two scruples.

Polygala senega, seneka, radix, North America. Dose from ten grains to a scruple. It is chiefly employed in the secondary stage of pneumonia.

Ammoniacum, ammoniac, East Indies, gummi-resina. Dose from ten to thirty grains. This is frequently used as an expectorant.

Assafœtida. Dose from ten to twenty grains.

Myrrha, myrrh, gummi-resina, Abyssinia and Arabia. Dose from ten to twenty grains.

N. B. The plants producing the above two gum-resins are unknown.

Styrax benzoin, benzoin or Benjamin, balsamum, East Indies. Dose ten or fifteen grains. It is perhaps possessed of little power.

Styrax officinale, storax, bals. south of Europe, Asia. Storax is like benzoin in its virtues.

Toluifera balsamum, balsam of tolu, South America. The powers of this balsam are very inconsiderable.

Myroxolon peruiferum, Peruvian balsam, South America. Dose in asthma, leucorrhœa, &c. from five to fifteen grains.

Amyris gileadensis, balm of Gilead, Arabia. The qualities of this nearly resemble the balsam of tolu.

OF SIALAGOGUES.

These are substances which increase the secretion of saliva. This is in general effected by mastication of acrid substances, but in some few instances is occasioned by medicines taken into the stomach. Mercury, perhaps, is the only medicine which uniformly displays a sialagogue power.

Hydrargyrus. All the preparations of mercury have more or less influence over the salivary glands.

Anthemis pyretrum, pellitory of Spain, radix, south of Europe. This is sometimes chewed in order to relieve the tooth-ache.

Arum maculatum, wake-Robin, radix, indigenous. This resembles pellitory, and may be employed with the same intention.

Ginger, mezereum, and tobacco especially, are sometimes used as sialagogues.

ERRHINES

Are medicines which occasion a more than ordinary secretion from the mucous membrane of the nostrils. They all operate by direct application.

Iris florentina, Florentine orris, radix, south of Europe. This is a mild sternutatory and forms one of the ingredients of some cephalic snuffs.

Æsculus hippocastinum, horse chesnut, semen. This acts as a moderate sternutatory.

Origanum majorana, sweet marjorum, herba, south of Europe. This has a slight errhine power.

Lavandula spica, lavender, spicæ florentes, south of Europe. The dried leaves in powder.

Nicotiana, tobacco. The powder of the dried leaves is the basis of snuffs.

Asarum Europœum, asarabaca, folia, indigenous. The leaves of this plant in powder form the basis of officinal sternutatory powders.

Veratrum album, white hellebore, radix, south of Europe. This is a very violent errhine.

Euphorbia officinalis, gummi-resina, Africa. This is the most powerful of all the errhines. It is seldom or never employed.

Subsulphas hydrargyri. This preparation of mercury has been recommended to be snuffed up the nostrils in some kinds of chronic ophthalmia.

EPISPASTICS AND RUBEFACIANTS.

Epispastics are those substances which applied to the skin produce either serous or purulent discharge through the medium of inflammation. Rubefaciants occasion inflammation, but not so violent as to be followed by such discharges.

Meloe vesicatorius, cantharis, Spanish fly. This is the principal substance employed for blistering. After a blister has been raised the discharge is often converted from serum into pus by the continued application of any stimulating acrid ointment. This practice is often pursued in asthma, paralysis, &c.

Cantharides in the form of tincture may be employed simply as a rubefaciant.

Ammonia with oil, forms a liniment for this purpose.

Pinus albus, Burgundy pitch, resina. This is used in the form of plaster, in chronic affections of the lungs and chest.

Sinapis, mustard. The flour of mustard-seed mixed with crumbs of bread, and made into a paste with vinegar, forms a sinapism, a powerful rubefaciant. It is applied to the soles of the feet in cases of pressing debility, as in the last stages of typhoid fever, and in comatose affections.

Allium, garlick. The bruised root of this plant is used for similar purposes with the mustard sinapism.

OF REFRIGERANTS.

Mr. Murray considers those medicines which directly lower the temperature of the body, to be principally chemical in their operation. They are acids, or substances containing a superabundant proportion of oxygen, which being received into the stomach, occasions a less demand for this principle (oxygen) by the lungs, and consequently a less generation or evolution of heat. This doctrine, however, does not appear satisfactory. See PHYSIOLOGY, Sections *Digestion* and *Respiration*; and MEDICINE, Section *Fever*, &c.

Of refrigerants, the vegetable acids are the most efficacious.

Citrus aurantium, orange, succus fructûs. The acidity of China orange is connected with sweetness, of the orange from Seville with bitterness. The former is used as a refrigerant in fever.

Citrus medica, lemon, succus fructûs. The juice of the lemon is composed of citric acid, and saccharine and mucilaginous matter. It is the most powerful and agreeable of the refrigerants. With carbonate of potass, (kali prep.) it forms the saline draught, the virtues of which are perhaps owing to the carbonic acid that is evolved by the mixture of the acid and alkali.

Tamarindus indica. Tamarind is a very pleasant refrigerant: a solution of it in water constitutes a pleasant beverage in fever.

Acidum acetosum, vinegar. The use of this in medicine is principally as a substitute for the lemon-juice.

Supertartris potassæ, cream of tartar.

Nitras potassæ. This is given as a refrigerant, in a dose of from five grains to a scruple.

ANTACIDS.

These perhaps are more strictly chemical in their primary operation than the last class of medicines. They immediately neutralise the prevailing morbid acidity of the stomach.

Alkalies. Pure potass in solution is employed to correct acidity, in doses of fifteen drops in water. The carbonates of potass and soda are, however, in more general use for this purpose.

Aqua ammoniæ is given likewise with this intent. Dose from twenty to forty drops.

Aqua calcis. Lime-water is also used to correct acidity; six or eight ounces being taken occasionally.

Carbonas calcis. Of this there are two varieties, creta alba, (prepared chalk) and chelæ cancrorum (crab's claws). These, especially the former, are principally used in the diarrhœa of infants.

Magnesia (carbonas magnesiæ). This in some cases preferable to chalk as an antacid, as the neutral compound formed by its union with the acid of the stomach proves slightly purgative.

OF LITHONTRIPTICS,

Medicines supposed to have a power of dissolving stone in the bladder. Calculus is principally formed by a peculiar acid, called the lithic, or uric, with which alkalies unite out of the body, and thus become solvents of the stone. These medicines, however, cannot in any way be conveyed to the urinary organs in sufficient quantity to effect this purpose, without material injury to the parts and the general system. It has indeed been ascertained, from experiment, that by the exhibition of alkaline substances, for a length of time, the constitutional disposition to secrete fresh calculus is in a great measure obviated. These substances then are rather preventives than curatives of calculary disorders. That they do not, when taken into the stomach, operate as solvents, is sufficiently evident, from the circumstance of their being more useful when administered saturated with carbonic acid; for these alkaline carbonates do not exert any action on the urinary calculi out of the body, as the lithic acid of the concretion is not of sufficient attractive power to disengage the carbonic acid from its union with the salt. The only power then that is possessed by the medicines termed lithontriptics, is that of neutralizing acidity in the first passages, and thus preventing the deposition of lithic acid in the urinary organs.

Potassa, potass. The dose of the solution of pure potass is 15 or 20 drops gradually increased. The form in which it is generally employed as a lithontriptic, is in the supersaturated solution. Dose, one or two pounds daily.

Soda. This is likewise used in the form of saturated solution, under the name of soda water. Dose, one or two pounds.

Sapo albus. Soap is a combination of expressed oil with potass or soda. Dose, one or two ounces in the course of the day.

Calx. Lime-water is sometimes employed as a lithontriptic.

ESCHAROTICS

Are substances which destroy the texture of both living and dead animal matter. They are employed to consume excrescences, or to open ulcer. Their action on the living system is principally, but not entirely, chemical.

The mineral acids have been employed as escharotics, but are not convenient, in consequence of their fluidity.

Potassa, in its solid state, is a powerful escharotic: mixed with lime it is somewhat milder.

Nitras argenti. Lunar caustic. This is in common use.

Murias antimonii. A powerful caustic, but inconvenient from its being in a fluid form.

Sulphas cupri is often employed.

Acetis cupri. (Verdigris.) This is milder than the sulphate.

Murias hydrargyri. Principally used in venereal ulcers.

Subnitras hydrargyri. Employed with the same intention as the muriate.

Oxydum arsenici albi. A solution of white arsenic is sometimes made use of as an external application to cancer.

Juniperus sabina. Savine is principally applied in the form of ointment to obstinate ulcers. It is used in powder to consume warts.

ANTHELMINTICS

Are those medicines employed to expel worms from the intestinal canal. Their operation is supposed to be mechanical; it may how ver be questioned, whether this class should not be a subdivision of the local stimulants, as the greater number of them seem to discharge worms by a stimulant rather than by a mechanically destructive power.

Dolichos pruriens, cowhage, East and West Indies. This substance is the down growing on the pods of the plant. The action of this medicine may perhaps be principally mechanical.

Ferrum, iron. The filings and rust.

Stannum, tin. This is used in the form of powder. Tin may perhaps operate by a mechanical power. Dose, one or two drachms.

Olea Europæa, olive oil, oleum expressum, South of Europe. Dose half a pound.

Artemisia santonica, worm seed, Persia. Dose half a drachm.

Spigelia marilandica, Indian pink, radix, North America. Dose half a drachm.

Polypodium filix (, male fern, radix, indigenous. Dose two or three drachms.

Tanacetum vulgare, tansy, folia et flores, indigenous. Dose from a scruple to a drachm.

Geoffula inermis, cabbage bark-tree, cortex, Jamaica. Dose thirty grains.

Gambogia. Dose from five to twenty grains.

Submurias hydrargyri. Calomel is perhaps the most efficacious of all the anthelmintics. Dose ten or twelve grains to an adult.

DEMULCENTS

Are substances employed in medicine to shield from acrimony; they can only act on the parts to which they are directly applied. From some circumstances, however, attending their internal administration, it is supposed that they are capable of being absorbed and again separated by particular secretory organs. This supposition does not appear to be entirely satisfactory.

Mimosa nilotica, gum arabic, Africa. This is used to allay the irritation of the fauces in catarrh. It is likewise given in tenesmus, strangury, &c.

Astragalus tragacantha, tragacanth, South of Europe, Asia. This has virtues similar to gum arabic. It is more viscid.

Linum usitatissimum, flax, semen, indigenous. This is sometimes used in gonorrhœa, and catarrh.

Althæa officinalis, marsh mallow, radix, indigenous.

Malva sylvestris, common mallow, folia, indigenous.

Glycyrrhiza glabra, liquorice, radix, South of Europe. These three last are all pleasant demulcents.

Cycas circinalis, sago, East Indies. This is a fæcula from the pith of the plant; it is often given in dysentery, &c. as demulcent and at the same time nutritive.

Orchis mascula, salop, indigenous. Similar in virtue to sago.

Maranta arundinacea, South America. Arrow-root is demulcent, and slightly nutritive.

Tryticum hybernum, wheat, amylum. Starch is useful as an enema with opium in dysentery, &c.

Cornu cervi rasura, hartshorn shavings.

Icthyocolla, isinglass is obtained from the skin of the fish. Isinglass is a demulcent in frequent use.

Olea olivæ. The expressed oil principally used as a demulcent is obtained from the fruit of the olive.

Amygdalus communis, almond oil. Ol. express. South of Europe.

Sævum ceti. Spermaceti is obtained from the head of a certain species of whale. Like the almond oil, it is given as a demulcent in catarrh, &c.

Cera, wax. This is collected from the antheræ of vegetables by bees. This is principally employed in the composition of ointments and plasters.

Of diluents and emollients the two remaining classes scarcely any thing remains to be said. Water, strictly speaking, is the only diluent, and emollients are chiefly formed of heat combined with moisture, as in fomentations and cataplasms, or of unctuous substances, as lard (axungia porcina) and the varieties of expressed oils.

MATHEMATICAL INSTRUMENTS. See INSTRUMENTS.

MATHEMATICS, from μαθησις, originally signified any discipline or learning; but at present denotes that science which teaches or contemplates whatever is capable of being numbered or measured, in so far as computable or measurable, and accordingly is subdivided into arithmetic, which has number for its object, and geometry, which treats of magnitude. See ARITHMETIC, and GEOMETRY.

Mathematics are commonly distinguished into pure and speculative, which consider quantity abstractedly; and mixed, which treat of magnitude as subsisting in material bodies, and consequently are interwoven every where with physical considerations.

Mixed mathematics are very comprehensive; since to them may be referred astronomy, optics, geography, hydrography, hydrostatics, mechanics, fortification, navigation, &c. See ASTRONOMY, OPTICS, &c.

Pure mathematics have one peculiar advantage, that they occasion no disputes among wrangling disputants, as in other branches of knowledge; and the reason is, because the definitions of the terms are premised, and every body that reads a proposition has the same idea of every part of it. Hence it is easy to put an end to all mathematical controversies, by shewing either that our adversary has not stuck to his definitions, or has not laid down true premises; or else that he has drawn false conclusions from true principles; and in case we are able to do neither of these, we must acknowledge the truth of what he has proved.

It is true, that in mixed mathematics, where we reason mathematically upon physical subjects, we cannot give such just definitions as the geometricians; we must therefore rest content with descriptions, and they will be of the same use as definitions, provided we are consistent with ourselves, and always mean the same thing by those terms we have once explained.

MATHIOLA, a genus of the pentandria monogynia class and order. The calyx is entire; corolla tubular, superior, undivided, drupe with a globular nucleus. There is one species, American.

MATRICARIA, *feverfew,* a genus of the polygamia superflua order, in the syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The receptacle is naked; there is no pappus; the calyx hemispherical and imbricated, with the marginal leaflets solid, and something sharp. There are eight species, but the only remarkable one is the parthenium or common feverfew, of which there are varieties with double flowers, with semi-double flowers, with double fistular flowers, with a fistular disk and plain radius, with short-rayed flowers, with rayless flowers, with rayless sulphur-coloured heads, and with finely curled leaves. All these varieties flower abundantly in June, each flower being composed of numerous hermaphrodite and female florets; the former compose the disk, the latter the radius or border, and which, in the double and fistulous kinds, are very ornamental in gardens, but of a disagreeable odour; and are all succeeded by plenty of seed in autumn. This plant has received a most extraordinary character in hysteric and other affections of the nerves, as well as for being a carminative or warm stimulating bitter. Dr. Lewis, however, thinks it inferior to camomile; with which he says it agrees in all its sensible qualities, only being somewhat weaker.

MATRICE, or MATRIX, in dyeing, is applied to the five simple colours, whence all the rest are derived or composed. These are, the black, white, blue, red, and yellow, or root-colour. See Dyeing.

Matrice, or *matrices*, used by the letter-founders. See Type.

MATRICES. See Coining.

MATRIX, or Mother Earth, the stone in which metallic ores are found enveloped.

MATROSSES, are soldiers in the train of artillery, who are next to the gunners, and assist them in loading, firing, and spunging the great guns. They carry firelocks, and march along with the store-waggons both as a guard, and to give their assistance in case a waggon should break down.

MATT, in a ship, rope-yarn, junk, &c. beaten flat and interwoven; used in order to preserve the yards from galling or rubbing in hoisting or lowering them.

MATTER. The word matter (materia, which some lexicographers have derived from mater, a mother) denotes, in its primitive sense, that unexplained something from which all those things which are objects of our senses are formed.

The term body is sometimes confounded with that of matter; but they are essentially different. Body is of Saxon origin. It is explained by the Latin words statura, pectus, truncus; and signified the person or form of a man, or other creature; whence it is plain that it ought to be confined to express a substance possessing form or figure.

Substance, both in its etymology and application, approaches nearer to the meaning of the former of these terms. It is well known to be compounded from the Latin preposition sub (under) and the verb stare (to stand). It consequently implies that which supports or stands under the different forms and appearances which are presented to our senses. It is still, however, used in a distinct and more limited sense than matter. It is generally indeed used with the article, to signify a distinct or definite portion of matter; whereas matter in the abstract implies a more confused and general idea of solidity and extension, with little or no regard to figure, proportion, or quantity.

That the whole matter of which this universe of things is composed, is essentially the same, and that the apparent differences which subsist in different bodies depend altogether on the particular distribution or disposition of the component particles, is an opinion which has been entertained by some philosophers of the highest reputation. The wonderful apparent transmutations which take place in the different processes and operations of nature do, it must be confessed, at first sight countenance this hypothesis. A plant will vegetate, and become a solid substance, in the purest water. The generation of stones in the earth, the various phenomena of petrifactions, and a multitude of other facts, contribute greatly, on a fair consideration, to diminish the absurdity of the alchemists (who seem chiefly to have rested on this hypothesis, viz. that all matter was intrinsically the same) and their hopes of converting the basest materials by the efforts of art into the most splendid and valuable of substances.

Mr. Boyle distilled the same water about two hundred times, and at the end of each distillation found a fresh deposit of earth. Margraff repeated the experiment with still greater caution. By means of two glass globes, which communicated with each other, he preserved the water while in the state of vapour from all contact with the air; and on repeated distillation, a quantity of earth of the calcareous kind was deposited at the conclusion of each process.

The extreme rarity and minuteness of the particles into which different substances may be resolved, imparts a still greater degree of probability to this hypothesis; and in general the more any body can be divided, the simpler it appears in its component parts.

We must, however, be cautious of admitting opinions which are not sanctioned by the direct test of experiment; and however plausible the opinion, the accurate observations of modern philosophy have suggested some objections to the homogeneity of matter, which, without further discoveries, it will not be easy to silence.

Whatever phenomena may appear to indicate a transmutation of bodies, or a change of one substance into another, we have the utmost reason, by the latest and best experiments, to believe them merely the effect of different combinations. Thus the conversion of water and air into a solid substance, such as the body of a plant, is merely an apparent conversion; for that solid substance may, by an artificial process, be resolved again into water and air, without any real change in the principles or elementary particles of which those fluids are composed; and the formation of stones, and the phenomena of petrifactions, are accounted for upon much easier principles than that of transmutation. On the other hand, the utmost efforts of chemistry have never been able to proceed farther in the analysis of bodies than to reduce them to a few principles, which appear essentially different from each other, and which have never yet been brought to a more simple form. Thus the matter of fire, or light, appears totally different from that of all other bodies; thus the acid and alkaline principles can never be brought to exhibit the same properties; nor can even the different species of earths be converted into the substance of each other.

If hypothetical reasoning was to be admitted on this occasion, it would probably appear more agreeable to the analogy of nature, to suppose that different substances are formed from the different combinations of a few simple principles in different proportions, than that the very opposite qualities of some of the rarest and most subtile fluids should depend wholly on the different form or modification of the extremely minute particles which enter into their composition.

It is proper, however, to observe, that on this subject there has hitherto appeared no decisive experimental proof on either side. The imperfection of all human efforts, and perhaps of the human faculties themselves, has hitherto confined our investigations to the properties of a few substances, the simplest which chemical analysis has been able to obtain, and which for that reason are denominated elements. See Elements.

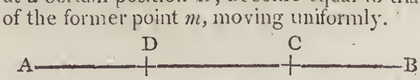
MATTUSCHKÆA, a genus of the tetrandria monogynia class and order. The calyx is four-parted; corolla one-petalled; germ superior, four-cleft. There is one species, a herb of Guiana.

MAURITIA, the *ginkgo*, or *maiden-hair*, a genus of plants belonging to the natural order of palmæ. The calyx of the male is monophyllous; the corolla monopetalous, with six stamina. It is a native of Japan, where it is also known by the names of ginan and itsio. It rises with a long, erect, thick, and branched stem, to the size of a walnut-tree. The bark is ash-coloured, the wood brittle or smooth, the pith soft and fungous. The leaves are large, expanded from a narrow bottom into the figure of a maiden-hair leaf, unequally parted, streaked, without fibres or nerves. From the uppermost shoots hang the flowers in long catkins that are filled with the fertilizing power; and to which succeeds the fruit, adhering to a thick fleshy pedicle, which proceeds from the bosom of the leaves. This fruit is either exactly or nearly round, and of the appearance and size of a damask plum. The substance surrounding the fruit is fleshy juice, white, very harsh, and adheres so firmly to the inclosed nut, as not to be separated from it except by putrefaction. The nut, properly termed gineau, resembles the pistachia nut, especially a Persian species named bergjes pistoia; but is almost double in size, and of the figure of an apricot-stone. The shell is somewhat white, woody, and brittle, and incloses a white loose kernel, having the sweetness of an almond, along with a degree of harshness. These kernels taken after dinner are said to promote digestion, whence they make part of the dessert in great entertainments.

MAXILLA. See Anatomy.

MAXIMUM, in mathematics, denotes the greatest quantity attainable in any given case. If a quantity conceived to be generated by motion, increases, or decreases, till it arrives at a certain magnitude or position, and then, on the contrary, grows less or greater, and it be required to determine the said magnitude or position, the question is called a problem de maximis et minimis.

Thus, let a point m move uniformly in a right line, from A towards B, and let another point n move after it, with a velocity either increasing or decreasing, but so that it may, at a certain position D, become equal to that of the former point m, moving uniformly.



This being premised, let the motion of n be first considered as an increasing one; in which case the distance of n behind m will continually increase, till the two points arrive at the contemporary positions C and D; but afterwards it will again decrease; for the motion of n till then being slower than at D, it is also slower than that of the preceding point m (by the hypothesis), but becoming quicker afterwards than that of m, the distance $m\,n$ (as has been already said) will again decrease; and therefore is a maximum, or the greatest of all, when the celerities of the two points are equal to each other.

But if n arrives at D with a decreasing celerity, then its motion being first swifter, and afterwards slower, than that of m, the distance $m\,n$ will first decrease and then increase, and therefore is a minimum, or the least of all, in the forementioned circumstance. Since then the distance $m\,n$ is a maximum, or a minimum, when the velocities of m and n are equal, or when that distance increases as fast through the motion of m as it decreases by that of n, its fluxion at that instant is evidently equal to nothing. Therefore, as the motion of the points m and n may be conceived such that their distance mn may express the measure of any variable quantity whatever, it follows, that the fluxion of any variable quantity whatever, when a maximum or a minimum, is equal to nothing.

The rule therefore to determine any flowing quantity in an equation proposed, to an extreme value, is: having put the equation into fluxions, let the fluxion of that quantity whose extreme value is sought be supposed equal to nothing; by which means all those members of the equation in which it is found will vanish, and the remaining ones will give the determination of the maximum or minimum required.

Prob. I. To divide a given right line into two such parts, that their product, or rectangle, may be the greatest possible. This is the case when the line is bisected or divided into equal parts. See Fluxions.

In any mechanical engine the proportion of the power to the weight, when they balance each other, is found by supposing the engine to move, and reducing their velocities to the respective directions in which they act; for the inverse ratio of those velocities is that of the power to the weight according to the general principle of mechanics. But it is of use to determine likewise the proportion they ought to bear to each other, that when the power prevails, and the engine is in motion, it may produce the greatest effect in a given time. When the power prevails, the weight moves at first with an accelerated motion; and when the velocity of the power is invariable, its action upon the weight decreases, while the velocity of the weight increases. Thus the action of a stream of water or air upon a wheel, is to be estimated from the excess of the velocity of the fluid above the velocity of the part of the engine which it strikes, or from their relative velocity only. The motion of the engine ceases to be accelerated when this relative velocity is so far diminished, that the action of the power becomes equal to the resistance of the engine arising from the gravity of the matter that is elevated by it, and from friction; for when these balance each other, the engine proceeds with the uniform motion it has acquired.

Prob. II. Let a denote the velocity of the stream, u the velocity of the part of the engine which it strikes when the motion of the machine is uniform, and $a - u$ will represent their relative velocity. Let A represent the weight which would balance the force of the stream when its velocity is a, and p the weight which would balance the force of the same stream if its velocity was only $a - u$; then $p : A :: \overline{a-u}^2 : a^2$, or $p = A \times \frac{\overline{a-u}^2}{aa}$, and p shall represent the action of the stream upon the wheel. If we abstract the friction, and have regard to the quantity of the weight only, let it be equal to qA, (or be to A as q to 1); and because the motion of the machine is supposed uniform, $p = q \times A = \frac{A \times \overline{a-u}^2}{aa}$, or $q = \frac{\overline{a-u}^2}{aa}$. The momentum of this weight is $qAu = \frac{Au \times \overline{a-u}^2}{aa}$; which is a maximum when the fluxion of $\frac{u \times \overline{a-u}^2}{aa}$ vanishes, that is, when $u \times \overline{a-u}^2 - 2uu \times a - u = 0$, or $a - 3u = 0$. Therefore, in this case, the machine will have the greatest effect if $u = \frac{a}{3}$, or the weight $qA = \frac{A \times \overline{a-u}^2}{aa} = \frac{4A}{9}$; that is, if the weight that is raised by the engine be less than the weight which would balance the power in the proportion of 4 to 9: and the momentum of the weight is $\frac{4Aa}{27}$.

Prob. III. Suppose that the given weight P (plate Miscel. fig. 156.) descending by its gravity in the vertical line, raises a given weight W by the cord PMW (that passes over the pulley M) along the inclined plane BD, the height of which BA is given; and let the position of the plane BD be required, along which W will be raised in the least time from the horizontal line AD to B.

Let $AB = a$, $BD = x$, $t =$ time in which W describes DB; then the force which accelerates the motion of W is $P - \frac{aW}{x}$, tt is as $\frac{xx}{Px - aW}$, and if we suppose the fluxion of this quantity to vanish, we shall find $x = \frac{2aW}{P}$, or $P = \frac{2aW}{x}$; consequently the plane BD required is that upon which a weight equal to 2W would be sustained by P; or if BC be the plane upon which W would sustain P, then $BD = 2BC$. But if the position of the plane BD be given, and W being supposed variable, it be required to find the ratio of W to P, when the greatest momentum is produced in W along the given plane BD; in this case, W ought to be to P as BD to $BA + \sqrt{BD + BA} + \sqrt{BA}$.

Questions of this kind may be likewise demonstrated from the common elementary geometry, of which the following may serve as an example.

Prob. IV. Let a fluid, moving with the velocity and direction AC (plate Miscel. fig. 157), strike the plane CE; and suppose that this plane moves parallel to itself in the direction CB, perpendicular to CA, or that it cannot move in any other direction; then let it be required to find the most advantageous position of the plane CE, that it may receive the greatest impulse from the action of the fluid. Let AP be perpendicular to CE in P, draw AK parallel to CB, and let PK be perpendicular upon it in K; and AK will measure the force with which any particle of the fluid impels the plane EC in the direction CB. For the force of any such particle being represented by AC, let this force be resolved into AQ parallel to EC and AP perpendicular to it; and it is manifest, that the latter AP only has any effect upon the plane CE. Let this force AP be resolved into the force AL perpendicular to CB, and the force AK parallel to it; then it is manifest, that the former, AL, has no effect in promoting the motion of the plane in the direction CB; so that the latter, AK, only, measures the effort by which the particle promotes the motion of the plane CE, in the direction CB. Let EM and EN be perpendicular to CA and CB, in M and N; and the number of particles moving with directions parallel to AC, incident upon the plane CE, will be as EM. Therefore the effort of the fluid upon CE, being as the force of each particle, and the number of particles together, it will be as $AK \times EM$; or, because AK is to AP ($=$ EM) as EN to CE, as $\frac{EM^2 EM \times EN}{CE}$; so that CE being given, the problem is reduced to this, to find when $EM^2 \times EN$ is the greatest possible, or a maximum. But because the sum of EM^2 and of EN^2 ($= CM^2$) is given, being always equal to CE^2, it follows that $EN^2 \times EM^4$ is greatest when $EN^2 = \frac{1}{3}CE^2$; for when the sum of two quantities AC and CB (fig. 158.) was given, $AC \times BC^2$ is greatest when $AC = \frac{1}{3}AB$, as will be very evident if a semicircle is described upon AD. But when $EN^2 \times EM^4$ is greatest, its square root $EN \times EM^2$ is of necessity at the same time greatest. Therefore the action of the fluid upon the plane CE, in the direction CB, is greatest when $EN^2 = \frac{1}{3}CE^2$, and consequently $EM^2 = \frac{2}{3}CE^2$; that is, when EM, the sine of the angle ACE, in which the stream strikes the plane, is to the radius, as $\sqrt{2}$ to $\sqrt{3}$; in which case it easily appears from the trigonometrical tables, that this angle is of 54° 44′.

Several useful problems in mechanics may be resolved by what we have just now shewn. If we represent the velocity of the wind by AC, a section of the sail of a windmill perpendicular to its length by CE, as it follows from the nature of the engine, that its axis ought to be turned directly to the wind, and the sail can only move in a direction perpendicular to the axis, it appears, that, when the motion begins, the wind will have the greatest effect to produce this motion, when the angle ACE, in which the wind strikes the sail, is of 54° 44′. In the same manner, if CB represent the direction of the motion of a ship, or the position of her keel, abstracting from her lee-way, and AC be the direction of the wind perpendicular to her way, then the most advantageous position of the sail CE, to promote her motion in the direction CB, is when the angle ACE, in which the wind strikes the sail, is of 54° 44′. The best position of the rudder, where it may have the greatest effect in turning round the ship, is determined in like manner.

Prob. V. To find the internal dimensions of a cylindrical cup, whose capacity is equal to a, when the cup is made with the least possible quantity of silver of a given thickness.

Put the diameter $= x$; and .7854 (the area of a circle whose diameter is 1) $= c$: then, by El. xii. 2, $cx^2 =$ the area of the bottom, and therefore $\frac{a}{cx^2} =$ the altitude; but $4cx =$ the circumference of the bottom, and therefore $4cx \times \frac{a}{cx^2} = \frac{4a}{x} =$ the inside curve superficies. Hence $cx^2 + \frac{4a}{x} =$ the whole inside superficies, which is a minimum; and therefore its fluxion is $= 0$: that is, $2cx\dot{x} - \frac{4a\dot{x}}{x^2} = 0$, or $2cx^3\dot{x} - 4a\dot{x} = 0$, or $cx^3 - 2a = 0$, therefore $cx^3 = 2a$, and $x = \sqrt[3]{\frac{2a}{c}} =$ diameter. By substituting this quantity for x in $\frac{a}{cx^2}$, we have

$$\frac{a}{c \times \overline{\frac{2a}{c}}^{\frac{2}{3}}} = \frac{a \times \overline{\frac{2a}{c}}^{\frac{1}{3}}}{c \times \frac{2a}{c}} = \frac{a}{c} \times \frac{\overline{\frac{2a}{c}}^{\frac{1}{3}}}{\frac{2a}{c}} = \frac{ac}{2ac} \times \overline{\frac{2a}{c}}^{\frac{1}{3}} = \frac{1}{2} \times \overline{\frac{2a}{c}}^{\frac{1}{3}} = \text{altitude}.$$

Since then the diameter is $\overline{\frac{2a}{c}}^{\frac{1}{3}}$ and the altitude is half that quantity, they will be to one another as 2 to 1, to answer the conditions of the problem.

Prob. VI. To find the greatest cone that can be inscribed in a given sphere.

Let AD (plate Miscel. fig. 159) the diameter of the sphere $= a$; .7854 (the area of a circle whose diameter is 1) $= c$; and AC, the altitude of the cone, $= x$; then CD $= a - x$. By El. iii. 35, AC $\times$ CD $=$ CB^2, that is, $x \times \overline{a - x} = ax - x^2 =$ CB^2; but the square of the diameter is four times the square of the radius; therefore, by El. xii. 2, $4acx - 4cx^2 =$ the area of the cone's base, which, by El. xii. 10, drawn into $\frac{1}{3}x$, is $\frac{4}{3}acx^2 - \frac{4}{3}cx^3 =$ the cone's solidity, which is a maximum; therefore, by taking away what is common, we get $ax^2 - x^3$ a maximum, the fluxion of which is $= 0$, that is, $2ax\dot{x} - 3x^2\dot{x} = 0$, or $2a = 3x$, and $x = \frac{2a}{3}$. So that the cone will be a maximum, when its altitude is equal to two-thirds of the sphere's diameter.

MEAD, an agreeable liquor made of honey and water. See HONEY.

There are many receipts for making mead, of which the following is one of the best. Take four gallons of water, and as much honey as will make it bear an egg; add to this the rind of three lemons, boil it, and scum it well as it rises. Then take it off the fire, and add the three lemons cut in pieces; pour it into a clean tub or open vessel, and let it work for three days, then scum it well, and pour off the clear part into a cask, and let it stand open till it ceases to make a hissing noise; then stop it up close, and in three months time it will be fine and fit for bottling. If you would give it a finer flavour, take cloves, mace, and nutmeg, of each four drams; beat them small, tie the powder in a piece of cloth, and put it into the cask.

MEADOW. See HUSBANDRY.

MEAN, a middle state between two extremes; as a mean motion, mean distance, arithmetical mean, geometrical mean, &c.

Arithmetical MEAN, is half the sum of the extremes. So, 4 is an arithmetical mean between 2 and 6, or between 3 and 5. or between 1 and 7; also an arithmetical mean between a and b is $\frac{a+b}{2}$, or $\frac{1}{2}a + \frac{1}{2}b$.

Geometrical MEAN, commonly called a mean proportional, is the square root of the product of the two extremes; so that, to find a mean proportional between two given extremes, multiply these together, and extract the square root of the product. Thus, a mean proportional between 1 and 9, is $\sqrt{1 \times 9} = \sqrt{9} = 3$; a mean between 2 and $4\frac{1}{2}$ is $\sqrt{2 \times 4\frac{1}{2}} = \sqrt{9} = 3$ also; the mean between 4 and 6 is $\sqrt{4 \times 6} = \sqrt{24}$; and the mean between a and b is $\sqrt{ab}$.

The geometrical mean is always less than the arithmetical mean between the same two extremes. So the arithmetical mean between 2 and $4\frac{1}{2}$ is $3\frac{1}{4}$, but the geometrical mean is only 3. To prove this generally, let a and b be any two terms, a the greater, and b the less; then, universally, the arithmetical mean $\frac{a+b}{2}$ shall be greater than the geometrical mean $\sqrt{ab}$, or $a + b$ greater than $2\sqrt{ab}$. For, by squaring both, they are $a^2 + 2ab + b^2 > 4ab$; subtr. $4ab$ from each, then $a^2 - 2ab + b^2 > 0$, that is, - - - - $(a - b)^2 > 0$.

To find a Mean Proportional geometrically, between two given lines M and N. Join the two given lines together at C, in one continued line AB; upon the diameter AB describe a semicircle, and erect the perpendicular CD; which will be the mean proportional between AC and CB, or M and N.

To find two Mean Proportionals between two given extremes. Multiply each extreme by the square of the other, viz. the greater extreme by the square of the less, and the less extreme by the square of the greater; then extract the cube root out of each product, and the two roots will be the two mean proportionals sought. That is, $\sqrt[3]{a^2b}$ and $\sqrt[3]{ab^2}$ are the two means between a and b. So, between 2 and 16, the two mean proportionals are 4 and 8; for $\sqrt[3]{2^2 \times 16} = \sqrt[3]{64} = 4$, and $\sqrt[3]{2 \times 16^2} = \sqrt[3]{512} = 8$.

In a similar manner we proceed for three means, or four means, or five means, &c.; from all which it appears, that the series of the several numbers of mean proportionals between a and b will be as follows: viz.

1 mean, $\sqrt{ab}$;
2 means, $\sqrt[3]{a^2b}, \sqrt[3]{ab^2}$;
3 means, $\sqrt[4]{a^3b}, \sqrt[4]{a^2b^2}, \sqrt[4]{ab^3}$;
4 means, $\sqrt[5]{a^4b}, \sqrt[5]{a^3b^2}, \sqrt[5]{a^2b^3}, \sqrt[5]{ab^4}$;
5 means, $\sqrt[6]{a^5b}, \sqrt[6]{a^4b^2}, \sqrt[6]{a^3b^3}, \sqrt[6]{a^2b^4}, \sqrt[6]{ab^5}$:
&c. &c.

Harmonical MEAN, is double a fourth proportional to the sum of the extremes, and the two extremes themselves a and b: thus, as $a + b : a :: 2b : \frac{2ab}{a+b} = m$, the harmonical mean between a and b. Or it is the reciprocal of the arithmetical mean between the reciprocals of the given extremes; that is, take the reciprocals of the extremes a and b, which will be $\frac{1}{a}$ and $\frac{1}{b}$; then take the arithmetical mean between these reciprocals, or half their sum, which will be $\frac{1}{2a} + \frac{1}{2b}$, or $\frac{a+b}{2ab}$; lastly, the reciprocal of this is $\frac{2ab}{a+b} = m$, the harmonical mean: for arithmeticals and harmonicals are mutually reciprocals of each other;

so that if a, m, b, &c. be arithmeticals,

then shall $\frac{1}{a}$, $\frac{1}{m}$, $\frac{1}{b}$, &c. be harmonicals;

or if the former be harmonicals, the latter will be arithmeticals.

For example, to find a harmonical mean between 2 and 6: here $a = 2$, and $b = 6$; therefore $\frac{2ab}{a+b} = \frac{2 \times 2 \times 6}{2 + 6} = \frac{24}{8} = 3 = m$, the harmonical mean sought between 2 and 6.

Pappus has shewn a curious similarity that subsists between the three different sorts of means: a, m, b, being three continued terms, either arithmeticals, geometricals, or harmonicals, then in the

Arithmeticals $a : a :: a - m : m - b$
Geometricals $a : m :: a - m : m - b$
Harmonicals $a : b :: a - m : m - b$.

MEASLES. See MEDICINE.

MEASURE *of an angle*, is an arch described from the vertex in any place between its legs. Hence angles are distinguished by the ratio of the arches, described from the vertex between the legs to the peripheries. Angles then are distinguished by those arches; and the arches are distinguished by their ratio to the periphery: thus an angle is said to be so many degrees as there are in the said arch. See ANGLE.

MEASURE *of a figure*, or plane surface, is a square whose side is one inch, one foot, one yard, or some other determinate length. Among geometricians, it is usually a rod called a square rod, divided into 10 square feet, and the square feet into 10 square digits.

MEASURE *of a solid*, is a cube whose side is one inch, foot, yard, or any other determinate length. In geometry it is a cubic perch, divided into cubic feet, digits, &c. Hence cubic measures, or measures of capacity. See SPHERE, CUBE, &c.

MEASURE *of velocity*, in mechanics, the space passed over by a moving body in a given time. To measure a velocity therefore, the space must be divided into as many equal parts as the time is conceived to be divided into; the quantity of space answering to such a part of time is the measure of the velocity.

MEASURE, in geometry, denotes any quantity assumed as one, or unity, to which the ratio of the other homogeneous or similar quantities is expressed.

Measures in a legal and commercial sense are various, according to the various kinds and dimensions of the things measured. Hence arise lineal or longitudinal measures, for lines or lengths; square measures, for areas or superficies; and solid or cubic measures, for bodies and their capacities; all which again are very different in different countries and in different ages, and even many of them for different commodities. Whence arise other divisions of antient and modern measures, domestic and foreign ones, dry measures, liquid measures, &c.

I. *Long measures, or measures of application.*

1. The English and Scotch standards.

The English lineal standard is the yard, containing 3 English feet, equal to 3 Paris feet 1 inch and $\frac{3}{12}$ of an inch, or $\frac{7}{9}$ of a Paris ell. The use of this measure was established by Henry I. of England, and the standard taken from the length of his own arm. It is divided into 36 inches, and each inch is supposed equal to 3 barley-corns. When used for measuring cloth, it is divided into 4 quarters, and each quarter subdivided into 4 nails. The English ell is equal to a yard and a quarter, or 45 inches, and is used in measuring linens imported from Germany and the Low-countries.

The Scots elwand was established by king David I. and divided into 37 inches. The standard is kept in the council-chamber of Edinburgh, and being compared with the English yard, is found to measure $37\frac{1}{5}$ inches; and therefore the Scots inch and foot are larger than the English, in the proportion of 180 to 185; but this difference being so inconsiderable, is seldom attended to in practice. The Scots ell, though forbidden by law, is still used for measuring some coarse commodities, and is the foundation of the land-measure of Scotland.

Itinerary measure is the same both in England and Scotland. The length of the chain is 4 poles, or 22 yards; 80 chains make a mile. The old Scots computed miles were generally about a mile and a half each.

The reel for yarn is $2\frac{1}{2}$ yards, or 10 quarters, in circuit; 120 threads make a cut, 12 cuts make a hasp or hank, and 4 hanks make a spindle.

2. The French standard was formerly the aune or ell, containing 3 Paris feet, 7 inches, 8 lines, or 1 yard $\frac{2}{7}$ English; the Paris foot royal exceeding the English by $\frac{682}{1000}$ parts, as in one of the following tables. This ell is divided two ways, viz. into halves, thirds, sixths, and twelfths; and into quarters, half-quarters, and sixteenths.

The French, however, have also formed an entirely new system of weights and measures, according to the following table:

Proportions of the measures of each species to its principal measure or unity.	First part of the name which indicates the proportion to the principal measure or unity.	PRINCIPAL MEASURES OR UNITIES.				
		Length.	Capacity.	Weight.	Agrarian.	For firewood.
10,000 1,000 100 10 0 0.1 0.01 0.001	Myria Kilo Hecto Deca —— Deci Centi Milli	Metre.	Litre.	Gramme.	Are.	Stere.
Proportion of the principal measures between themselves, and the length of the meridian.		10,000,000th part of the dist. from the pole to the equator.	A decimetre cube.	Weight of a centimetre cube of distilled water.	100 square metres.	One cubic metre.
Value of the principal measures in the antient French measures.		3 feet 11 lines and $\frac{1}{2}$ nearly.	1 pint and $\frac{1}{20}$, or 1 litron and $\frac{1}{4}$ nearly.	18 grains and 841,000 parts.	Two square perches des eaux et forêt.	1 demi-voie, or $\frac{1}{4}$ of a cord des eaux et forêt.
Value in English measures.		Inches 39.383	61.083 inches, which is more than the wine and less than the beer quart.	22.966 grains.	11.968 square yards.	

3. The English avoirdupois pound weighs 7004 troy grains; whence the avoirdupois ounce, whereof 16 make a pound, is found equal to 437.75 troy grains. And it follows, that the troy pound is to the avoirdupois pound as 88 to 107 nearly; for as 88 to 107, so is 5760 to 7003.636: that the troy ounce is to the avoirdupois ounce, as 80 to 73 nearly; for as 80 to 73, so is 480 to 438: and, lastly, that the avoirdupois pound and ounce are to the Paris two-marc weight and ounce, as 63 to 68 nearly; for as 63 to 68, so is 7004 to 7559.873. See WEIGHT. 4. The Paris foot expressed in decimals is equal to 1.0654 of the English foot, or contains 12.785 English inches.

3. The standard in Holland, Flanders, Sweden, a good part of Germany, many of the Hanse-towns, as Dantzick and Hamburgh, and at Geneva, Franckfort, &c. is likewise the ell; but the ell in all these places differs from the Paris ell. In Holland it contains one Paris foot 11 lines, or 4-sevenths of the Paris ell. The Flanders ell contains 2 feet 1 inch 5 lines and half a line, or 7-twelfths of the Paris ell. The ell of Germany, Brabant, &c. is equal to that of Flanders.

4. The Italian measure is the bracchio, brace, or fathom. This obtains in the states of Modena, Venice, Florence, Lucca, Milan, Mantua, Bologna, &c. but is of different lengths. At Venice it contains 1 Paris foot, 11 inches, 3 lines, or 8-fifteenths of the Paris ell. At Bologna, Modena, and Mantua, the brace is the same as at Venice. At Lucca it contains 1 Paris foot, 9 inches, 10 lines, or half a Paris ell. At Florence it contains 1 foot, 9 inches, four lines, or 49-hundredths of a Paris ell. At Milan, the brace for measuring of silks is 1 Paris foot, 7 inches, 4 lines, or 4 ninths of a Paris ell; that for woollen cloths is the same with the ell of Holland. Lastly, at Bergama, the brace is 1 foot 7 inches, 6 lines, or 5-ninths of a Paris ell. The usual measure at Naples, however, is the canna, containing 6 feet, 10 inches, and 2 lines, or one Paris ell and 15-seventeenths.

5. The Spanish measure is the vara or yard, in some places called the barra; containing 17 twenty-fourths of the Paris ell. But the measure in Castile and Valencia is the pan, span, or palmi; which is used, together with the canna, at Genoa. In Arragon, the vara is equal to a Paris ell and a half, or 5 feet, 5 inches, 6 lines.

6. The Portuguese measure is the cavedos, containing 2 feet, 11 lines, or four-sevenths of a Paris ell; and the vara, 106 whereof make a 100 Paris ell.

7. The Piedmontese measure is the ras, containing 1 Paris foot, 9 inches 10 lines, or half a Paris ell. In Sicily, their measure is the canna, the same with that of Naples.

8. The Muscovite measures are the cubit, equal to 1 Paris foot, 4 inches, 2 lines; and the arcin, two whereof are equal to 3 cubits.

9. The Turkish and Levant measures are the picq, containing 2 feet, 2 inches, and 2 lines, or three-fifths of the Paris ell. The Chinese measure is the cobre, ten whereof are equal to three Paris ells. In Persia, and some parts of the Indies, the gueze, of which there are two kinds; the royal gueze, called also the gueze monkelser, containing 2 Paris feet, 10 inches, 11 lines, or four-fifths of the Paris ell; and the shorter gueze, called simply gueze, only two-thirds of the former. At Goa and Ormuz, the measure is the vara, the same with that of the Portuguese, having been introduced by them. In Pegu, and some other parts of the Indies, the cando or candi, equal to the ell of Venice. At Goa, and other parts, they use a larger cando, equal to 17 Dutch ells, exceeding that of Babel and Balsora by $\frac{7}{8}$ per centum, and the vara by $6\frac{1}{2}$. In Siam, they use the ken, short of three Paris feet by one inch. The ken contains two soks, the sok two keubs, the keub 12 nious or inches, the niou to be equal to eight grains of rice, *i. e.* to about nine lines. At Camboia they use the haster; in Japan the tatam; and the span on some of the coasts of Guinea.

English MEASURES of Length.

Barley-corns											
3	Inch										
9	3	Palm									
27	9	3	Span								
36	12	4	$1\frac{1}{3}$	Foot							
54	18	6	2	$1\frac{1}{2}$	Cubit						
108	36	12	4	3	2	Yard					
180	60	20	$6\frac{2}{3}$	5	$3\frac{1}{3}$	$1\frac{2}{3}$	Pace				
216	72	24	8	6	4	2	$1\frac{1}{5}$	Fathom			
594	198	66	22	$16\frac{1}{2}$	11	$5\frac{1}{2}$	$3\frac{3}{10}$	$2\frac{1}{4}$	Pole		
23760	7920	2640	880	660	440	220	132	110	40	Furlong	
190080	63360	21120	7040	5280	3520	1760	1056	880	320	8	Mile.

Scripture Measures of Length, reduced to English.

								Eng. feet.	inch. Dec.
Digit								0	0.912
4	Palm							0	3.648
12	3	Span						0	10.944
24	6	2	Cubit					1	9.888
96	24	8	4	Fathom				7	3.552
144	36	12	6	$1\frac{1}{2}$	Ezechiel's reed			10	11.328
192	48	16	8	2	$1\frac{1}{3}$	Arabian pole		14	7.104
1920	480	160	80	20	$13\frac{1}{3}$	10	Schœnus, or measuring line	145	11.04

The Longer Scripture-Measures.

						English miles.	paces.	feet.
Cubit						0	0	1.824
400	Stadium					0	145	4.6
2000	5	Sab. day's journey				0	729	3.000
4000	10	2	Eastern mile			1	403	1.000
12000	30	6	3	Parasang		4	153	3.000
96000	240	48	24	8	A day's journey	33	172	4.000

Grecian Measures of Length, reduced to English.

												English Paces.	feet.	dec.
Dactylus, digit												0	0	0.7554$\frac{11}{16}$
4	Doron, dochme											0	0	3.0218 $\frac{3}{4}$
10	$2\frac{1}{2}$	Lichas										0	0	7.5546 $\frac{7}{8}$
11	$2\frac{3}{4}$	$1\frac{1}{10}$	Orthodoron									0	0	8.3101$\frac{9}{16}$
12	3	$1\frac{1}{5}$	$1\frac{1}{11}$	Spithame								0	0	9.0656 $\frac{1}{4}$
16	4	$1\frac{6}{10}$	$1\frac{5}{11}$	$1\frac{1}{3}$	Foot							0	1	0.0875
18	$4\frac{1}{2}$	$1\frac{4}{5}$	$1\frac{7}{11}$	$1\frac{1}{2}$	$1\frac{1}{8}$	Cubit						0	1	1.5984 $\frac{3}{8}$
20	5	2	$1\frac{9}{11}$	$1\frac{2}{3}$	$1\frac{1}{4}$	$1\frac{1}{9}$	Pygon					0	1	3.109 $\frac{3}{8}$
24	6	$2\frac{2}{5}$	$2\frac{2}{11}$	2	$1\frac{1}{2}$	$1\frac{1}{3}$	$1\frac{1}{5}$	Cubit larger				0	1	6.13125
96	24	$9\frac{3}{5}$	$8\frac{8}{11}$	8	6	$5\frac{1}{3}$	$4\frac{4}{5}$	4	Pace			0	6	0.525
9600	2400	960	$872\frac{8}{11}$	800	600	$533\frac{1}{3}$	480	400	100	Furlong		100	4	4.5
76800	19200	7680	$6981\frac{9}{11}$	6400	4800	$4266\frac{2}{3}$	3840	3200	800	8	Mile	805	5	0

Roman Measures of Length, reduced to English.

										English Paces.	feet.	dec.
Digitus transversus										0	0	0.725$\frac{1}{4}$
$1\frac{1}{3}$	Uncia									0	0	0.967
4	3	Palmus minor								0	0	2.901
16	12	4	Pes							0	0	11.604
20	15	5	$1\frac{1}{4}$	Palmipes						0	1	2.505
24	18	6	$1\frac{1}{2}$	$1\frac{1}{5}$	Cubitus					0	1	5.406
40	30	10	$2\frac{1}{2}$	2	$1\frac{2}{3}$	Gradus				0	2	5.01
80	60	20	5	4	$3\frac{1}{3}$	2	Passus			0	4	10.02
10000	7500	2500	625	500	$416\frac{2}{3}$	250	125	Stadium		120	4	4.5
80000	60000	20000	5000	4000	$3333\frac{1}{3}$	2000	1000	8	Milliare	967	0	0

A TABLE

Of the Measures of Length of the principal Places in Europe, compared with the English Yard.

		Eng. yard.
100 Aunes, or ells of England, equal to		125
100	of Holland or Amsterdam	75
100	of Brabant or Antwerp	76
100	of France	$128\frac{1}{4}$
100	of Hamburgh, Francfort, &c.	$62\frac{1}{2}$
100 Aunes	of Breslau	60
100	of Dantzick	$66\frac{3}{4}$
100	of Bergen and Drontheim	$68\frac{1}{4}$
100	of Sweden or Stockholm	$65\frac{3}{4}$
100	of St. Gall, for linens	$87\frac{1}{2}$
100	of ditto, cloths	67
100	of Geneva	$124\frac{3}{4}$
100 Canes	of Marseilles and Montpelier	$214\frac{1}{2}$
100	of Toulouse & High Languedoc	200
100	of Genoa, of 9 palms	$245\frac{1}{4}$
100 Canes	of Rome	$227\frac{1}{4}$
100 Varas	of Spain	$93\frac{3}{4}$
100	of Portugal	123
100 Cavidos	of Portugal	75
102 Brasses	of Venice	$73\frac{1}{2}$
100	of Bergamo, &c.	$71\frac{1}{4}$
100	of Florence and Leghorn	64
100	of Milan	$58\frac{1}{2}$

N. B. The aunes or ells of Amsterdam, Haerlem, Leyden, the Hague, Rotterdam, and other cities of Holland, as also that of Nuremberg, being all equal, are comprehended under that of Amsterdam; as those of Osnaburg are under those of France; and those of Bern and Basil are equal to those of Hamburg, Francfort, and Leipsic.

For the subdivisions and multiples of each of these measures of length, see the article Aune.

For the proportion of the feet of the principal nations in Europe, compared with the English foot, see the article Foot.

Square, or *Superficial* Measures. English square or superficial measures are raised from the yard of 36 inches multiplied into itself, and thus producing 1296 square inches in the square yard: the divisions of this are square feet and inches; and the multiples, poles, roods, and acres, as in the following table:

English Square-Measures.

Inches						
144	Foot					
1296	9	Yard				
3600	25	$2\frac{7}{9}$	Pace			
39204	$272\frac{1}{4}$	$30\frac{1}{4}$	10.89	Pole		
1568160	10890	1210	435.6	40	Rood	
6272640	43560	4840	1743.6	160	4	Acre.

Roman Square-Measure reduced to English.

The integer was the jugerum or acre, which the Romans divided like the libra or as: thus, the jugerum contained

	Square feet.	Scruples.	English roods.	Square poles.	Square feet.
As	28800	288	2	18	250.05
Deunx	26400	264	2	10	183.85
Dextans	24000	240	2	2	117.64
Dodrans	21600	216	1	34	51.42
Bes	19200	192	1	25	257.46
Septunx	16800	168	1	17	191.25
Semis	14400	144	1	9	125.03
Quincunx	12000	120	1	1	58.82
Triens	9600	96	0	32	264.85
Quadrans	7200	72	0	24	198.64
Sextans	4800	48	0	16	132.43
Uncia	2400	24	0	8	66.21

Note. Actus major was 14400 square feet, equal to a semis; clima, 3600 square feet, equal to sescuncia; and actus minimus equal to a sextans.

Cubical Measures, *or Measures of capacity for liquids.* The English measures were originally raised from troy-weight; it being enacted by several statutes that eight pounds troy of wheat, gathered from the middle of the ear, and well dried, should weigh a gallon of wine-measure, the divisions and multiples whereof were to form the other measures; at the same time it was also ordered, that there should be but one liquid measure in the kingdom: yet custom has prevailed, and there having been introduced a new weight, viz. the avoirdupois, we have now a second standard gallon adjusted thereto, and therefore exceeding the former in the proportion of the avoirdupois weight to troy weight.

From this latter standard are raised two several measures, the one for ale, the other for beer.

The sealed gallon at Guildhall, which is the standard for wines, spirits, oils, &c. is supposed to contain 231 cubic inches and on this supposition the other measures raised therefrom, will contain as in the table underneath; yet, by actual experiment, made in 1688, before the lord-mayor and the commissioners of excise, this gallon was found to contain only 224 cubic inches: it was however agreed to continue the common supposed contents of 231 cubic inches; so that all computations stand on their old footing. Hence, as 12 is to 231, so is $14\frac{12}{20}$ to $281\frac{1}{2}$ the cubic inches in the ale gallon: but in effect the ale quart contains $70\frac{1}{2}$ cubic inches, on which principle the ale and beer gallon will be 282 cubic inches. The several divisions and multiples of these measures, and their proportions, are exhibited in the following tables:

English Measure of Capacity for Liquids.
Wine-Measure.

Solid inches	Pint	Gallon	Runlet	Barrel	Tierce	Hogshead	Puncheon	Butt	
$28\frac{7}{8}$	Pint								
231	8	Gallon							
4158	144	18	Runlet						
$7276\frac{1}{2}$	252	$31\frac{1}{2}$	$1\frac{3}{4}$	Barrel					
9702	336	42	$2\frac{1}{3}$	$1\frac{1}{3}$	Tierce				
14553	504	63	$3\frac{1}{2}$	2	$1\frac{1}{2}$	Hogshead			
19279	672	84	$4\frac{2}{3}$	$2\frac{2}{3}$	2	$1\frac{1}{3}$	Puncheon		
29106	1008	126	7	4	3	2	$1\frac{1}{2}$	Butt	
58212	2016	252	14	8	6	4	3	2	Tun.

Jewish Measures of Capacity for Liquids, reduced to English Wine-measure.

							Gall.	pints.	Solid inches.
Caph							0	$0\frac{5}{8}$	0.177
$1\frac{1}{3}$	Log						0	$0\frac{5}{6}$	0.211
$5\frac{1}{3}$	4	Cab					0	$3\frac{1}{3}$	0.844
16	12	3	Hin				1	2	2.533
32	24	6	2	Seah			2	4	5.067
96	72	18	6	3	Bath, or Epha		7	4	15.2
960	720	180	60	30	10	Coron, or Chomer	75	5	7.625

Attic Measures of Capacity for Liquids, reduced to English Wine-measure.

										Gall.	Pints.	Solid inch. Dec.
Cochliarion										0	$\frac{1}{120}$	$0.0356\frac{5}{12}$
2	Cheme									0	$\frac{1}{60}$	$0.0712\frac{5}{6}$
$2\frac{1}{2}$	$1\frac{1}{4}$	Mystron								0	$\frac{1}{48}$	$0.089\frac{11}{48}$
5	$2\frac{1}{2}$	2	Conche							0	$\frac{1}{24}$	$0.178\frac{11}{24}$
10	5	4	2	Cyathos						0	$\frac{1}{12}$	$0.356\frac{11}{12}$
15	$7\frac{1}{2}$	6	3	$1\frac{1}{2}$	Oxybaphon					0	$\frac{1}{8}$	$0.535\frac{3}{8}$
60	30	24	12	6	4	Cotyle				0	$\frac{1}{2}$	$2.141\frac{1}{2}$
120	60	48	24	12	8	2	Xestes			0	1	4.283
720	360	288	144	72	48	12	6	Chous		0	6	25.698
8640	4320	3416	1728	864	576	144	72	12	Metretes	10	2	19.629

Roman Measures of Capacity for Liquids, reduced to English Wine-measure.

										Gall.	Pints.	Solid inch. Dec.
Ligula										0	$0\frac{1}{48}$	$0.117\frac{5}{12}$
4	Cyathus									0	$0\frac{1}{12}$	$0.469\frac{2}{3}$
6	$1\frac{1}{2}$	Acetabulum								0	$0\frac{1}{8}$	$0.704\frac{1}{2}$
12	3	2	Quartarius							0	$0\frac{1}{4}$	1.409
24	6	4	2	Hemina						0	$0\frac{1}{2}$	2.818
48	12	8	4	2	Sextarius					0	1	5.636
288	72	48	24	12	6	Congius				0	7	4.942
1152	288	192	96	48	24	4	Urna			3	$4\frac{1}{2}$	5.33
2304	576	384	192	96	48	8	2	Amphora		7	1	10.66
46080	11520	7680	3840	1920	960	160	40	20	Culeus	143	3	11.095

Beer and Ale Measure.

Pints					
8	Gallon				
72	9	Firkin			
144	18	2	Kilderkin		
288	36	4	2	Barrel	
576	72	8	4	2	Hogshead.

English Dry or Corn Measure.

Solid inches					
33.6	Pint				
268.8	8	Gallon			
537.6	16	2	Peck		
2150.4	64	8	4	Bushel	
17203.2	512	64	32	8	Quarter.

Scripture Measures of Capacity for things dry, reduced to English Corn measure.

							Peck.	Gall.	Pint.	Solid inch. Dec.
Gachal							0	0	$0\frac{17}{120}$	0.031
20	Cab						0	0	$2\frac{5}{6}$	0.073
36	$1\frac{4}{5}$	Gomor					0	0	$5\frac{1}{10}$	1.211
120	6	$3\frac{1}{3}$	Seah				1	0	1	4.036
360	18	10	3	Epha			3	0	3	12.107
1800	90	50	15	5	Leteeh		16	0	0	26.500
3600	180	100	30	10	2	Chomer, or Coron	32	0	1	18.969

Attic Measures of Capacity for things dry, reduced to English Corn-measure.

							Peck.	Gal.	Pint.	Solid inch. Dec.
Cochliarion							0	0	0	$0.276\frac{7}{20}$
10	Cyathos						0	0	0	$2.763\frac{1}{2}$
15	$1\frac{1}{2}$	Oxybaphon					0	0	0	$4.144\frac{3}{4}$
60	6	4	Cotyle				0	0	0	16.579
120	12	8	2	Xestes			0	0	0	33.158
180	18	12	3	$1\frac{1}{2}$	Choenix		0	0	1	$15.705\frac{3}{4}$
8640	864	576	144	72	48	Medimnos	4	0	6	3.501

Roman Measures of Capacity for things dry, reduced to English Corn-measure.

							Peck.	Gal.	Pint.	Solid inch. Dec.
Ligula							0	0	$0\frac{1}{48}$	0.01
4	Cyathus						0	0	$0\frac{1}{12}$	0:04
6	$1\frac{1}{2}$	Acetabulum					0	0	$0\frac{1}{8}$	0.06
24	6	4	Hemina				0	0	$0\frac{1}{2}$	0.24
48	12	8	2	Sextarius			0	0	1	0.48
384	96	64	16	8	Semimodius		0	1	0	3.84
763	192	128	32	16	2	Modius	1	0	0	7.68

Measure *for horses*, is the hand, which by statute contains four inches.

MEATUS AUDITORIUS. See Anatomy.

MECHANICS, that branch of practical mathematics which considers motion and moving powers, their nature and laws, with their effects in machines.

The term mechanics is equally applied to the doctrine of the equilibrium of powers, more properly called statics; and to that science which treats of the generation and communication of motion, which constitutes mechanics strictly so called. See Statics, Power, Motion, &c.

The knowledge of mechanics is one of those things, says Mr. Mac Laurin, that serve to distinguish civilized nations from barbarians. It is by this science that the utmost improvement is made of every power and force in nature; and the motions of the elements, water, air, and fire, are made subservient to the various purposes of life; for however weak the force of man appears to be, when unassisted by this art; yet, with its aid, there is hardly any thing above his reach. It is distinguished by sir Isaac Newton into practical and rational mechanics; the former of which treats of the mechanical powers, viz. the lever, balance, axis and wheel, pulley, wedge, screw, and inclined plane.

Rational mechanics comprehends the whole theory of motion, shews when the powers or forces are given how to determine the motions that are produced by them; and conversely when the phænomena of the motions are given, how to trace the powers or forces from which they arise.

Mechanical powers are simple engines that enable men to raise weights, to move heavy bodies, and overcome resistances, which they could not do with their natural strength alone. Their importance to society is incalculable. Every machine whatever is composed of one or more of them, sometimes of several combined together.

In considering this science, it will be necessary at first to take some things for granted that are not strictly true; and after the theory is established, to make the proper allowances for them.

1. That a small portion of the earth's surface, which is spherical, may be considered as a plane. 2. That all bodies be supposed to descend in lines parallel to each other; for though all bodies really tend to the centre of the earth, yet the distance from which they fall is comparatively so small, that their inclination towards each other is inconsiderable. 3. That all planes be considered as perfectly smooth; levers to be inflexible, and without thickness or weight; cords perfectly pliable; and machines without friction and inertia.

Three things are always to be considered in treating of mechanical engines; the weight to be raised, the power by which it is to be raised, and the instrument or engine by which this is to be effected.

The mechanical powers are generally reckoned six; the lever, the pulley, the wheel and axis, the inclined plane, the wedge, and the screw.

These perhaps may be reduced to two; for the pulley and wheel are only assemblages of levers, and the wedge and screw are inclined planes.

To calculate the power of a machine, it is usually considered in a state of equilibrium; that is, in the state when the power which is to overcome the resistance just balances it. Having discovered what quantity of power will be requisite for this purpose, it will then be necessary to add so much more as to overcome the friction and weight of the machine itself, and to give the necessary velocity.

The *lever* is the simplest of all machines; and is only a straight bar of iron, wood, or other material, supported on, and moveable round, a prop called the fulcrum.

In the lever there are three circumstances to be principally attended to: 1. The fulcrum, or prop, by which it is supported, or on which it turns as an axis, or centre of motion: 2. The power to raise and support the weight: 3. The resistance or weight to be raised or sustained.

The points of suspension are those points where the weights really are, or from which they hang freely. The power and the weight are always supposed to act at right angles to the lever, except it is otherwise expressed.

The lever is distinguished into three sorts, according to the different situations of the fulcrum or prop, and the power, with respect to each other. 1. When the prop is placed between the power and the weight. 2. When the prop is at one end of the lever, the power at the other, and the weight between them. 3. When the prop is at one end, the weight at the other, and the power applied between them.

A poker, in stirring the fire, is a lever of the first sort: the bar of the grate upon which it rests is the fulcrum; the fuel, the weight to be overcome; and the hand is the power. The lever of the first kind is principally used for loosening large stones; or to raise great weights to small heights, in order to get ropes under them, or other means of raising them to still greater heights; it is the most common species of lever.

ABC, Plate Mechanics, fig. 1. is this lever, in which B is the fulcrum, A the end at which the power is applied, and C the end where the weight acts.

To find when an equilibrium will take place between the power and the weight, in this as well as in every other species of lever, it is necessary to recollect, that when the momenta, or quantities of force, in two bodies are equal, they will balance each other. Now let us consider when this will take place in the lever. Suppose the lever AB (fig. 2) to be turned on its axis, or fulcrum, so as to come into the situation DC; as the end D is farthest from the centre of motion, and as it has moved through the arch AD in the same time as the end B moved through the arch BC, it is evident that the velocity of AB must have been greater than that of B. But the momenta being the products of the quantities of matter multiplied into the velocities, the greater the velocity, the less the quantity of matter need be to get the same product. Therefore, as the velocity of A is the greatest, it will require less matter to produce an equilibrium than B.

Let us next see how much more weight B will require than A to balance it. As the radii of circles are in proportion to their circumferences, they are also proportionate to similar parts of them; therefore, as the arches AD, CB, are similar, the radius or arm DE bears the same proportion to EC that the arch AD bears to CB. But the arches AD and CB represent the velocities of the ends of the lever, because they are the spaces which they moved over in the same time; therefore the arms DE and EC may also represent these velocities.

It is evident then, that an equilibrium will take place when the length of the arm AE multiplied into the power A, shall equal EB multiplied into the weight B; and consequently, that the shorter EB is, the greater must be the weight B; that is, the power and the weight must be to each other inversely, as their distances from the fulcrum. Thus, suppose AE, the distance of the power from the prop, to be 20 inches, and EB, the distance of the weight from the prop, to be eight inches, also the weight to be raised at B to be five pounds, then the power to be applied at A must be two pounds; because the distance of the weight from the fulcrum eight, multiplied into the weight five, makes 40; therefore 20, the distance of the power from the prop, must be multiplied by two, to get an equal product, which will produce an equilibrium.

It is obvious, that while the distance of the power from the prop exceeds that of the weight from the prop, a power less than the weight will raise it, so that then the lever affords a mechanical advantage: when the distance of the power is less than that of the weight from the prop, the power must be greater than the weight to raise it; when both the arms are equal, the power and the weight must be equal, to be in equilibrio.

The second kind of lever, when the weight is between the fulcrum and the power, is represented by fig. 3. in which A is the fulcrum, B the weight, and C the power. The advantage gained by this lever, as in the first, is as great as the distance of the power from the prop exceeds the distance of the weight from it. Thus if the point *a*, on which the power acts, is seven times as far from A as the point b, on which the weight acts, then one pound applied at C will raise seven pounds at B.

This lever shews the reason why two men carrying a burden upon a stick between them, bear shares of the burden which are to one another in the inverse proportion of their distances from it. For it is well known, that the nearer either of them is to the burden, the greater share he bears of it; and if he goes directly under it, he bears the whole. So if one man is at A, and the other at a, having the pole or stick resting on their shoulders; if the burden or weight B is placed five times as near the man at A, as it is to the man a, the former will bear five times as much weight as the latter.

This is likewise applicable to the case of two horses of unequal strength to be so yoked, that each horse may draw a part proportionable to his strength; which is done by so dividing the beam they pull, that the point of traction may be as much nearer to the stronger horse than to the weaker, as the strength of the former exceeds that of the latter.

To this kind of lever may be reduced oars, rudders of ships, doors turning upon hinges, cutting-knives which are fixed at the point, &c.

If in this lever we suppose the power and weight to change places, so that the power may be between the weight and the prop, it will become a lever of the third kind; in which, that there may be a balance between the power and the weight, the intensity of the power must exceed the intensity of the weight just as much as the distance of the weight from the prop exceeds the distance of the power. Thus, let E (fig. 4.) be the prop of the lever EF, and W a weight of one pound, placed three times as far from the prop as the power P acts at F, by the cord going over the fixed pulley D: in this case the power must be equal to three pounds, in order to support the weight of one pound.

To this sort of lever are generally referred the bones of a man's arm; for when he lifts a weight by the hand, the muscle that exerts its force to raise that weight is fixed to the bone about one-tenth part as far below the elbow as the hand is. And the elbow being the centre round which the lower part of the arm turns, the muscle must therefore exert a force ten times as great as the weight that is raised.

As this kind of lever is a disadvantage to the moving power, it is used as little as possible; but in some cases it cannot be avoided, such as that of a ladder, which being fixed at one end, is by the strength of a man's arms reared against a wall.

What is called the hammer-lever differs in nothing but its form, from a lever of the first kind. Its name is derived from its use, that of drawing a nail out of wood by a hammer.

Suppose the shaft of a hammer to be five times as long as the iron part which draws the nail, the lower part resting on the board as a fulcrum; then by pulling backwards the end of the shaft, a man will draw a nail with one-fifth part of the power that he must use to pull it out with a pair of pincers, in which case the nail would move as fast as his hand; but with the hammer the hand moves five times as much as the nail, by the time that the nail is drawn out.

Let ACB (fig. 5.) represent a lever of this sort, bent at C, which is its prop, or centre of motion. P is a power acting upon the longer arm AC, at A, by the means of the cord DA going over the pulley D; and W is a weight or resistance acting upon the end B of the shorter arm CB. If the power is to the weight as CB is to CA, they are in equilibrio: thus, suppose W to be five pounds, acting at the distance of one foot from the centre of motion C, and P to be one pound, acting at A, five feet from the centre C; the power and weight will just balance each other.

Thus we see, that in every species of lever there will be an equilibrium, when the power is to the weight, as the distance of the weight from the fulcrum is to the distance of the power from the fulcrum.

In making experiments on the mechanic powers, some difficulties arise from the weight of the materials; but as it is impossible to find any that are without weight, we take care that they are perfectly balanced themselves, before the weights and powers are applied. The bar, therefore, used in making experiments on levers, has the short end so much thicker than the long arm, as will be sufficient to balance it on the prop.

Hitherto we have supposed that the power and weight acted perpendicularly upon the lever; but if they do not, they act with less force upon it; the power should, therefore, if possible, be always made to act at right angles to the lever.

If several levers are combined together in such a manner, as that a weight being appended to the first lever, may be supported by a power applied to the last, as in fig. 6. (which consists of three levers of the first kind, and is so contrived, that a power applied at the point L of the lever C, may sustain a weight at the point S of the lever A), the power must here be to the weight, in a ratio, or proportion, compounded of the several ratios, which those powers that can sustain the weight by the help of each lever, when used singly and apart from the rest, have to the weight. For instance: if the power which can sustain the weight P by the help of the lever A, is to the weight as 1 to 5; and if the power which can sustain the same weight by the lever B alone, is to the weight as 1 to 4; and if the power which could sustain the same weight by the lever C, is to the weight as 1 to 5; then the power which will sustain the weight by the help of the three levers joined together, will be to the weight in a proportion consisting of the several proportions multiplied together, of 1 to 5, 1 to 4, and 1 to 5; that is, of 1 to 100.

For since, in the lever A, a power equal to one-fifth of the weight P pressing down the lever at L, is sufficient to balance the weight; and since it is the same thing whether that power is applied to the lever A at L, or the lever B at S, the point S bearing on the point L; a power equal to one-fifth of the weight P, being applied to the point S of the lever B, will support the weight; but one-fourth of the same power being applied to the point L of the lever B, and pushing the same upward, will as effectually depress the point S of the same lever, as if the whole power was applied at S; consequently a power equal to one-fourth of one-fifth, that is, one-twentieth of the weight P, being applied to the point L of the lever B, and pushing up the same, will support the weight; in like manner, it matters not whether that force is applied to the point L of the lever B, or to the point S of the lever C, since, if S be raised, L, which rests on it, must be raised also; but one-fifth of the power applied at the point L of the lever C, and pressing it downwards, will as effectually raise the point S of the same lever, as if the whole power was applied at S, and pushed up the same; consequently a power equal to one-fifth of one-twentieth, that is, one-hundredth part of the weight P, being applied to the point L of the lever C, will balance the weight at the point S of the lever A.

The balance, an instrument of very extensive use in comparing the weights of bodies, is a lever of the first kind, whose arms are of equal length. The points from which the weights are suspended being equally distant from the centre of motion, will move with equal velocity; consequently, if equal weights are applied, their momenta will be equal, and the balance will remain in equilibrio.

In order to have a balance as perfect as possible, it is necessary to attend to the following circumstances: 1. The arms of the beam ought to be exactly equal, both as to weight and length. 2. The points from which the scales are suspended should be in a right line, passing through the centre of gravity of the beam; for by this the weights will act directly against each other, and no part of either will be lost on account of any oblique direction. 3. If the fulcrum, or point upon which the beam turns, is placed in the centre of gravity of the beam, and if the fulcrum and the points of suspension are in the same right line, the balance will have no tendency to one position more than another, but will rest in any position it may be placed in, whether the scales are on or off, empty or loaded.

If the centre of gravity of the beam, when level, is immediately above the fulcrum, it will overset by the smallest action; that is, the end which is lowest will descend; and it will do this with more swiftness, the higher the centre of gravity is, and the less the points of suspension are loaded.

But if the centre of gravity of the beam is immediately below the fulcrum, the beam will not rest in any position but when level; and if disturbed from that position, and then left at liberty, it will vibrate, and at last come to rest on the level. In a balance, therefore, the fulcrum ought always to be placed a little above the centre of gravity. Its vibrations will be quicker, and its horizontal tendency stronger, the lower the centre of gravity, and the less the weight upon the points of suspension.

4. The friction of the beam upon the axis ought to be as little as possible; because, should the friction be great, it will require a considerable force to overcome it; upon which account, though one weight should a little exceed the other, it will not preponderate, the excess not being sufficient to overcome the friction, and bear down the beam. The axis of motion should be formed with an edge like a knife, and made very hard; these edges are at first made sharp, and then rounded with a fine hone, or piece of buff leather, which causes a sufficient bluntness, or rolling edge. On the regular form and excellence

of this axis, depends chiefly the perfection of the instrument.

5. The pivots which form the axis or fulcrum, should be in a straight line, and at right angles to the beam. 6. The arms should be as long as possible, relatively to their thickness, and the purposes for which they are intended; as the longer they are, the more sensible is the balance.

They should also be made as stiff and inflexible as possible; for if the beam is too weak, it will bend, and become untrne. 7. The rings, or the piece on which the axis bears, should be hard and well polished, parallel to each other, and of an oval form, that the axis may always keep its proper bearing, or remain always at the lowest point.

Very delicate balances are not only useful in nice experiments, but are likewise much more expeditious than others in common weighing. If a pair of scales with a certain load is barely sensible to one-tenth of a grain, it will require a considerable time to ascertain the weight to that degree of accuracy, because the turn must be observed several times over, and is very small. But if no greater accuracy was required, and scales were used which would turn with one-hundredth of a grain, a tenth of a grain more or less would make so great a difference in the turn, that it would be seen immediately.

The statera, or Roman steel-yard, is a lever of the first kind, and is used for finding the weights of different bodies, by one single weight placed at different distances from the prop or centre of motion D (fig. 7.). For the shorter arm DG is of such a weight as exactly to counterpoise the longer arm DX. If this arm is divided into as many equal parts as it will contain, each equal to GD, the single weight P (which we may suppose to be one pound) will serve for weighing any thing as heavy as itself, or as many times heavier as there are divisions in the arm DX, or any quantity between its own weight and that quantity. As for example, if P is one pound, and placed at the first division 1 in the arm DX, it will balance one pound in the scale at W; if it is removed to the second division at 2, it will balance two pounds in the scale; if to the third three pounds; and so on to the end of the arm DX. If any of these integral divisions is subdivided into as many equal parts as a pound contains ounces, and the weight P is placed at any of these subdivisions, so as to counterpoise what is in the scale, the pounds and odd ounces therein will by that means be ascertained.

The wheel and axle is a machine much used, and is made in a variety of forms. It consists of a wheel with an axle fixed to it, so as to turn round with it; the power being applied at the circumference of the wheel, and the weight to be raised is fastened to a rope which coils round the axle.

AB (fig. 9.) is a wheel and CD an axle fixed to it, and which moves round with it. If the rope which goes round the wheel is pulled, and the wheel turned once round, it is evident that as much rope will be drawn off as the circumference of the wheel; but while the wheel turns once round, the axle turns once round; and consequently the rope by which the weight is suspended, will wind once round the axis, and the weight will be raised through a space equal to the circumference of the axis.

The velocity of the power, therefore, will be to that of the weight, as the circumference of the wheel to that of the axis.

That the power and the weight may be in equilibrio, therefore, the power must be to the weight as the circumference of the wheel to that of the axis.

It is proved by geometry that the circumferences of different circles bear the same proportion to each other as their respective diameters do; consequently the power is to the weight, as the diameter also of the axis to that of the wheel.

Thus, suppose the diameter of the wheel to be eight inches, and the diameter of the axis to be one inch; then one ounce acting as the power P, will balance eight ounces as a weight W; and a small additional force will cause the wheel to turn with its axis, and raise the weight; and for every inch which the weight rises, the power will fall eight inches.

The wheel and axis may be considered as a kind of perpetual lever, of which the fulcrum is the centre of the axis, and the long and short arms are the diameter of the wheel and the diameter of the axis. See fig. 10.

From this it is evident, that the larger the wheel, and the smaller the axis, the stronger is the power of this machine; but then the weight must rise slower in proportion.

A capstan is a cylinder of wood, with holes in it, into which are put bars, or levers, to turn it round; these are like the spokes of a wheel without the rim. Sometimes the axis is turned by a winch fastened to it, which in this respect serves for a wheel; and is more powerful in proportion to the largeness of the circle it describes, compared with the diameter of the axle.

When the parts of the axis differ in thickness, and weights are suspended at the different parts, they may be sustained by one and the same power applied to the circumference of the wheel; provided the product arising from the multiplication of the power into the diameter of the wheel, is equal to the sum of the products arising from the multiplication of the several weights into the diameters of those parts of the axis from which they are suspended.

In considering the theory of the wheel and axle, we have supposed the rope that goes round the axle to have no sensible thickness; but as in practice this cannot be the case, if it is a thick rope, or if there are several folds of it round the axis, you must measure to the middle of the outside rope, to obtain the diameter of the axis, for the distance of the weight from the centre is increased by the coiling up of the rope.

If teeth are cut in the circumference of a wheel, and if they work in the teeth of another wheel of the same size, as fig. 11, it is evident that both the wheels will revolve in the same time; and the weight appended to the axle of the wheel B, will be raised in the same time as if the axle had been fixed to the wheel A. But if the teeth of the second wheel are made to work in teeth made in the axle of the first, as at fig. 12, as every part of the circumference of the second wheel is applied successively to the circumference of the axle of the first, and as the former is much greater than the latter, it is evident that the first wheel must go round as many times more than the second, as the circumference of the second wheel exceeds that of the first axle.

In order to a balance here, the power must be to the weight, as the product of the circumferences, or diameters of the two axles multiplied together, is to the circumferences or diameters of the two wheels.

This will become sufficiently clear, if it is considered as a compound lever, which was explained above. Instead of a combination of two wheels, three or four wheels may work in each other, or any number; and by thus increasing the number of wheels, or by proportioning the wheels to the axis, any degree of power may be acquired.

To this sort of engine belong all cranes for raising great weights; and in this case the wheel may have cogs all round it, instead of handles; and a small lanthorn, or trundle, may be made to work in the cogs, and be turned by a winch, which will make the power of the engine to exceed the power of the man who works it, as much as the number of revolutions of the winch exceeds those of the axle CD, fig. 9, when multiplied by the excess of the length of the winch above the length of the semidiameter of the axle, added to the semidiameter or half-thickness of the rope K, by which the weight is drawn up. Thus, suppose the diameter of the rope and axle taken together to be 13 inches, and consequently half their diameter to be $6\frac{1}{2}$ inches, so that the weight W will hang at $6\frac{1}{2}$ inches perpendicular distance from below the centre of the axle. Now, let us suppose the wheel AB, which is fixed on the axle, to have 80 cogs, and to be turned by means of a winch $6\frac{1}{2}$ inches long, fixed on the axle of a trundle of eight staves, or rounds, working in the cogs of the wheel; here it is plain, that the winch and trundle would make ten revolutions for one of the wheel AB, and its axis CD, on which the rope K winds in raising the weight W; and the winch being no longer than the sum of the semidiameters of the great axle and rope, the trundle could have no more power on the wheel than a man could have by pulling it round by the edge, because the winch would have no greater velocity than the edge of the wheel has, which we here suppose to be ten times as great as the velocity of the rising weight; so that, in this case, the power gained would be as 10 is to 1. But if the length of the winch is 13 inches, the power gained will be as 20 to 1; if $19\frac{1}{2}$ inches (which is long enough for any man to work by), the power gained will be as 30 to 1; that is, a man could raise 30 times as much by such an engine, as he could do by his natural strength without it, because the velocity of the handle of the winch would be 30 times as great as the velocity of the rising weight; the absolute force of any engine being in the proportion of the velocity of the power, to the velocity of the weight raised by it. But then, just as much power or advantage as is gained by the engine, so much time is lost in working it, which is common in all mechanical cases whatever.

In this sort of machines it is requisite to have a ratchet wheel on the end of the axle C, with a catch to fall into its teeth; which will at any time support the weight, and keep it from descending, if the person who turns the handle should, through inadvertence or carelessness, quit his hold while the weight is rising. By this means, the danger is prevented which might otherwise happen by the running down of the weight when left at liberty.

The *pulley* is a small wheel turning on an axis, with a drawing-rope passing over it: the small wheel is usually called a sheeve, and is so fixed in a box, or block, as to be moveable round a pin passing through its centre.

Pulleys are of two kinds:—1. Fixed, which do not move out of their places; 2. Moveable, which rise and fall with the weight.

When a pulley is fixed, as fig. 13, two equal weights suspended to the ends of a rope passing over it, will balance each other; for they stretch the rope equally, and if either of them is pulled down through any given space, the other will rise through an equal space in the same time; and consequently, as the velocities of both are equal, they must balance each other. This kind of pulley, therefore, gives no mechanical advantage; so that you can raise no greater weight by it than you could do by your natural strength. Its use consists in changing the direction of the power, and sometimes enabling it to be applied with more convenience. By it, a man may raise a weight to any point, without moving from the place he is in; whereas, otherwise, he would have been obliged to ascend with the weight: it also enables several men together to apply their strength to the weight by means of the rope.

The moveable pulley represented at A (fig. 14), is fixed to the weight W, and rises and falls with it. In comparing this to a lever, the fulcrum must be considered as at A; the weight acts upon the centre, and the power is applied at the extremity of the lever D. The power, therefore, being twice as far from the fulcrum as the weight is, the proportion between the power and weight, in order to balance each other, must be as 1 to 2. Whence it appears, that the use of this pulley doubles the power, and that a man may raise twice as much by it as by his strength alone. Or it may be considered in this way: Every moveable pulley hangs by two ropes equally stretched, and which must, consequently, bear equal parts of the weight; but the rope A B being made fast at B, half the weight is sustained by it; and the other part of the rope, to which the power is applied, has but half the weight to support; consequently the advantage gained by this pulley is as 2 to 1.

When the upper and fixed block contains two pulleys, which only turn upon their axes, and the lower moveable block contains also two, which not only turn on their axis, but rise with the weight F (fig. 15), the advantage gained is as 4 to 1. For each lower pulley will be acted upon by an equal part of the weight; and because in each pulley that moves with the weight, a double increase of power is gained, the force by which F may be sustained, will be equal to half the weight divided by the number of lower pulleys; that is, as twice the number of lower pulleys is to 1, so is the weight suspended to the power.

But if the extremity C (fig. 16) is fixed to the lower block, it will sustain half as much as a pulley; consequently here the rule will be, as twice the number of pulleys adding unity is to 1, so is the weight to the power.

These rules hold good, whatever may be the number of pulleys in the blocks.

If, instead of one rope going round all the pulleys, the rope belonging to each pulley is made fast at top, as in fig. 17, a different proportion between the power and the weight will take place. Here it is evident, that each pulley doubles the power: thus, if there are two pulleys, the power will sustain four times the weight.

Fig. 8, is the concentric pulley, invented by Mr. James White. O, R, are two brass blocks, in which grooves are cut; and round these a cord is passed, by which means they answer the purpose of so many distinct pulleys. The advantage gained is found by doubling the number of grooves in the lower block.

It is common to place all the pulleys in each block on the same pin, by the side of each other, as in fig. 18; but the advantage, and rule for the power, are the same here as in figs. 15 and 16.

A pair of blocks with the rope fastened round it, is commonly called a tackle.

The *inclined plane*. This mechanical power is of very great use in rolling up heavy bodies, such as casks, wheelbarrows, &c. It is formed by placing boards, or earth, in a sloping direction.

The force wherewith a body descends upon an inclined plane, is to the force of its absolute gravity, by which it would descend perpendicularly in free space, as the height of the plane is to its length. For suppose the plane A B (fig. 19) to be parallel to the horizon, the cylinder C will keep at rest on any part of the plane where it is laid. If the plane is placed perpendicularly, as A B, fig. 20, the cylinder C will descend with its whole force of gravity, because the plane contributes nothing to its support or hindrance; and therefore it would require a power equal to its whole weight to keep it from descending.

Let A B (fig. 21) be a plane parallel to the horizon, and A D a plane inclined to it; and suppose the whole length A D to be three times as great as the perpendicular D B. In this case, the cylinder E will be supported upon the plane D A, and kept from rolling, by a power equal to a third part of the weight of the cylinder; therefore a weight may be rolled up this inclined plane, by a third part of the power which would be sufficient to draw it up by the side of an upright wall.

It must also be evident, that the less the angle of elevation, or the gentler the ascent is, the greater will be the weight which a given power can draw up; for the steeper the inclined plane is, the less does it support of the weight; and the greater the tendency which the weight has to roll, consequently the more difficult for the power to support it: the advantage gained by this mechanical power, therefore, is as great as its length exceeds its perpendicular height.

To the inclined plane may be reduced all hatchets, chisels, and other edge-tools.

The *wedge* is the fifth mechanical power or machine: it may be considered as two equally inclined planes, joined together at their bases; then D G (fig. 22) is the whole thickness of the wedge at its back A B G D, where the power is applied; E F is the depth or height of the wedge; B F the length of one of its sides; and O F is its sharp edge, which is entered into the wood intended to be split, by the force of a hammer or mallet striking perpendicularly on its back. Thus, A B (fig. 23) is a wedge driven into the cleft C E D of the wood F G.

When the wood does not cleave at any distance before the wedge, there will be an equilibrium between the power impelling the wedge downward, and the resistance of the wood acting against the two sides of the wedge, when the power is to the resistance as half the thickness of the wedge at its back is to the length of either of its sides; because the resistance then acts perpendicular to the sides of the wedge. But when the resistance on each side acts parallel to the back, the power that balances the resistances on both sides will be, as the length of the whole back of the wedge is to double its perpendicular height.

When the wood cleaves at any distance before the wedge (as it generally does), the power impelling the wedge will not be to the resistance of the wood as the length on the back of the wedge is to the length of both its sides, but as half the length of the back is to the length of either side of the cleft, estimated from the top or acting part of the wedge. For, if we suppose the wedge to be lengthened down from the top C E, to the bottom of the cleft at D, the same proportion will hold; namely, that the power will be to the resistance as half the length of the back of the wedge is to the length of either of its sides: or, which amounts to the same thing, as the whole length of the back is to the length of both the sides.

The wedge is a very great mechanical power, since not only wood, but even rocks, can be split by it; which it would be impossible to effect by the lever, wheel and axle, or pulley; for the force of the blow, or stroke, shakes the cohering parts, and thereby makes them separate more easily.

The *screw* (fig. 24.) is the sixth and last mechanical power, but cannot properly be called a simple machine, because it is never used without the application of a lever or winch to assist in turning it; and then it becomes a compound engine of a very great force, either in pressing the parts of bodies closer together, or in raising great weights. It may be conceived to be made by cutting a piece of paper, A B C (fig. 25), into the form of an inclined plane, or half-wedge; and then wrapping it round a cylinder (fig. 26), the edge of the paper A C will form a spiral line round the cylinder, which will give the thread of the screw. It being evident that the winch must turn the cylinder once round, before the weight of resistance can be moved from one spiral winding to another; therefore, as much as the circumference of a circle described by the handle of the winch is greater than the interval or distance between the spirals, so much is the force of the screw. Thus, supposing the distance of the spirals to be half an inch, and the length of the winch twelve inches, the circle described by the handle of the winch where the power acts will be 76 inches nearly, or about 152 half-inches, and consequently 152 times as great as the distance between the spirals: and therefore a power at the handle, whose intensity is equal to no more than a single pound, will balance 152 pounds acting against the screw; and as much additional force as is sufficient to overcome the friction, will raise the 152 pounds; and the velocity of the power will be to the velocity of the weight, as 152 to 1. Hence it appears, that the longer the winch is, and the nearer the spirals are to one another, so much the greater is the force of the screw.

A machine for shewing the force or power of the screw may be contrived in the following manner:—Let the wheel C have a screw (fig. 24) on its axis, working in the teeth of the wheel D, which suppose to be 48 in number. It is plain, that for every time the wheel C and screw are turned round by the winch A, the wheel D will be moved one tooth by the screw; and therefore, in 48 revolutions of the winch, the wheel D will be turned once round. Then, if the circumference of a circle, described by the handle of the winch A, is equal to the circumference of a groove round the wheel D, the velocity of the handle will be 48 times as great as the velocity of any given point in the groove. Consequently, if a line G goes round the groove, and has a weight of 48 pounds hung to it, a power equal to 1 pound at the handle will balance and support the weight. To prove this by experiment, let the circumferences of the grooves of the wheels C and D be equal to one another; and then if a weight H, of 1 pound, is suspended by a line going round the groove of the wheel C, it will balance a weight of 48 pounds hanging by the line G; and a small addition to the weight H will cause it to descend, and so raise up the other weight.

If a line G, instead of going round the groove of the wheel D, goes round its axle I, the power of the machine will be as much increased as the circumference of the groove exceeds the circumference of the axle; which supposing to be six times, then one pound at H will balance six times 48, or 288 pounds, hung to the line on the axle: and hence the power or advantage of this machine will be as 288 to 1. That is, a man who by his natural strength could lift a hundredweight, will be able to raise 288 cwts. by this engine. If a system of pulleys was applied to the cord H, the power would be increased to an amazing degree.

When a screw acts in a wheel in this manner, it is called an endless screw.

When it is not employed in turning a wheel, it consists of two parts: the first is called the male or outside screw; being cut in such a manner, as to have a prominent part going round the cylinder in a spiral manner, which prominent part is called the thread of the screw; the other part, which is called the female, or inside screw, is a solid body, containing a hollow cylinder, whose concave surface is cut in the same manner as the convex surface of the male screw, so that the prominent parts of the one may fit the concave parts of the other.

A very considerable degree of friction always acts against the power in a screw; but this is fully compensated by other advantages; for on this account the screw continues to sustain a weight, even after the power is removed, or ceases to act, and presses upon the body against which it is driven. Hence the screw will sustain very great weights; insomuch that several screws properly applied, would support a large building, whilst the foundation was mending, or renewed.

OF COMPOUND MACHINES.

Though it is evident from the principles delivered above, that any one of the mechanical powers is capable of overcoming the greatest possible resistance, in theory; yet, in practice, if used singly for producing very great effects, they would be frequently so unwieldy and unmanageable, as to render it impossible to apply them. For this reason, it is generally found more advantageous to combine them together; by which means the power is more easily applied, and many other advantages are obtained. In all machines, simple as well as compound, what is gained in power is lost in time. Suppose that a man, by a fixed pulley, raises a beam to the top of a house in two minutes, it is clear that he will be able to raise six beams in twelve minutes; but by means of a tackle, with three lower pulleys, he will raise the six beams at once, with the same ease as he before raised one; but then he will be six times as long about it, that is, twelve minutes: thus the work is performed in the same time, whether the mechanical power is used or not. But the convenience gained by the power is very great; for if the six beams are joined in one, they may be raised by the tackle, though it would be impossible to move them by the unassisted strength of one man.

Consequently, if by any power you are able to raise a pound with a given velocity, it will be impossible, by the help of any machine, to raise two pounds with the same velocity; yet, by the assistance of a machine, you may raise two pounds with half that velocity, or even one thousand with the thousandth part of that velocity; but still there is no greater quantity of motion produced, when a thousand pounds are moved, than when one pound is moved; the thousand pounds moving proportionally slower.

No real gain of force is, therefore, obtained by mechanical contrivances; on the contrary, from friction, and other causes, force is always lost; but by machines we are able to give a more convenient direction to the moving power, and to apply its action at some distance from the body to be moved, which is a circumstance of infinite importance. By machines also, we can so modify the energy of the moving power, as to obtain effects which it could not produce without this modification.

In machines composed of several of the mechanical powers, the power will be to the weight, when they are in equilibrio, in a proportion formed by the multiplication of the several proportions which the power bears to the weight in every separate mechanical power of which the machine consists.

Suppose a machine, for instance, composed of the axle in the wheel, and a pulley; let the axle and wheel be such, that a power consisting of one-sixth of the weight will balance it; and let the pulleys be such, that by means of them alone, a power equal to one-fourth of the weight would support it: then, by means of the axle in the wheel, and the pulleys combined, a power equal to one-fourth of one-sixth, that is, $\frac{1}{24}$ of the weight, will be in equilibrio with it.

In contriving machines, simplicity ought particularly to be attended to; for a complicated machine is not only more expensive, and more apt to be out of order, but there is also a greater degree of friction, in proportion to the number of rubbing parts.

Whatever may be the construction of a machine, its power will always be in proportion to the velocity of the power to the weight; and so that this is obtained in the greatest degree that circumstances will admit, or that are necessary, then the fewer parts the better.

It is evident, from the principles already laid down, that the velocity of a wheel is to that of a pinion, or smaller wheel which is driven by it, in proportion to the diameter, circumference, or number of teeth in the pinion to that of the wheel. Thus, if the number of teeth in a wheel are 60, and those of the pinion 5, then the pinion will go 12 times round for once of the wheel, because 60, divided by 5, gives 12 for a quotient.

Hence, if you have any number of wheels acting on so many pinions, you must divide the product of the teeth in the wheels by those in the pinions; and the quotient will give the number of turns of the last pinion in one turn of the first wheel. Thus, if a wheel A (fig. 27) of 48, acts on a pinion B of 8, on whose axis there is a wheel C of 40, driving a pinion D of 6, carrying a wheel E of 36, which moves a pinion F of 6, carrying an index; then the number of turns made by the index, will be found in this manner: $\frac{48}{8} \times \frac{40}{6} \times \frac{36}{6} = \frac{69120}{288} = 240$, the number of turns which the index will make while the wheel A goes once round.

Any number of teeth on the wheels and pinions having the same ratio, will give the same number of revolutions to an axis: thus, $\frac{64}{10} \times \frac{50}{8} \times \frac{36}{6} = \frac{115200}{480} = 240$, as before. It therefore depends upon the skill of the engineer, or mechanic, to determine what numbers will best suit his design.

It is evident, that the same motion may be performed, either by one wheel and pinion, or by many wheels and pinions, provided the number of turns of all the wheels bear the same proportion to all the pinions which that one wheel bears to its pinion.

When a wheel is moved immediately by the power, it is called a leader; and if there is another wheel on the same axis, it is called the follower. Thus A, being moved immediately by the power, is to be considered as a leader, and B as a follower; the wheel C being driven by B, becomes a leader, and D a follower; E (fig. 28) is a leader, and the cylinder F may be considered as a follower.

Sometimes the same wheel acts both as a leader and a follower; as in fig. 29, where B is moved by A, and consequently is a follower, while, as it drives C, it is also a leader. Therefore, as to multiply both the divisors and dividend by the same number does not alter the quotient; in mechanical calculations, every wheel that is both a leader and a follower, may be entirely omitted.

The power of a machine is not at all altered by the size of the wheels, provided the proportions to each other are the same.

On the application of men and horses, as moving powers in machinery, &c. A horse draws with the greatest advantage, when the line of draught is not level with his breast, but inclines upwards, making a small angle with the horizontal plane.

A horse drawing a weight over a single pulley, can draw 200lb. for eight hours a day, and walking at the rate of 2½ miles in an hour, which is about 3⅔ feet in a second; and if the same horse be made to draw 240lb., he can work but six hours a day, and cannot go quite so fast. To this may be referred the working of horses in all sorts of mills and water-works; where we ought to know as near as we can, how much we make every horse draw, that we may judge of what the effect will be, when proper allowance shall have been made for all the frictions and hindrances, before we cause any machine to be erected.

When a horse draws in a mill, or gin of any kind, great care should be taken that the horse-walk, or circle in which he moves, be large enough in diameter, otherwise the horse cannot exert all his strength; for, in a small circle, the tangent (in which the horse draws) deviates more from the circle in which the horse is obliged to go, than in a larger circle. The horse-walk should not be less than 40 feet in diameter, when there is room for it. In a walk of 19 feet diameter, it has been calculated that a horse loses two-fifths of his strength.

The worst way of applying the force of a horse, is to make him carry or draw up hill; for, if the hill is steep, three men will do more than a horse; each man loaded with 100lb. will move up faster than a horse that is loaded with 300lb. This is owing to the position of the parts of a man's body, which are better adapted for climbing than those of a horse.

As a horse, from the structure of his body, can exert most strength in drawing almost horizontally in a straight line, a man exerts the least strength that way; as for example: if a man weighing 140lb., walking by a river or canal side, draws along a boat, or barge, by means of a rope coming over his shoulders, or otherwise fastened to his body, he cannot draw above 27lb., or about $\frac{1}{27}$ of what a horse can draw in that case. Five men are about equal in strength to one horse, and can with the same ease push round the horizontal beam in a 40-foot walk; but three of the same men will push round a beam in a 19-foot walk, which a horse (otherwise equal to five men) can but draw round.

A man turning a horizontal windlass by a handle, or winch, should not have above 30lb. weight acting against him, if he is to work ten hours a day, and raise the weight at the rate of three feet and a half in a second. This supposes, however, that the semidiameter of the windlass is equal to the distance from the centre to the elbow of the handle; for if there is a mechanical advantage, as there usually is, by having the diameter of the axle, on which the rope winds, four or five times less than the diameter of the circle described by the hand, then may the weight (taking in also the resistance, on account of the friction and stiffness of the rope) be four or five times greater than 30lb.; that is, so much as it rises slower than the hand moves.

MECONIUM, in pharmacy, the extract of English poppies. Meconium has all the virtues of the foreign opium, but in a somewhat lower degree.

MEDAL denotes a piece of metal in the form of coin, such as was either current money among the antients, or struck on any particular occasion to preserve the portrait of some great person, or the memory of some illustrious action, to posterity. Its etymology is probably of little consequence, though the best authorities give it from "metallum."

To enlarge on the utility of medals in the sciences, were needless. As historical documents, they form the principal evidence we can have of the veracity of old historians. In some few instances they correct the names of sovereigns; and in a great many, illustrate the chronology of reigns. By their assistance the geographer has sometimes been enabled to determine the situation of a town whose name alone has reached us. To the naturalist they afford the only proofs of the knowledge which the ancients had of certain plants and animals; and they sometimes preserve delineations of buildings for the architect, of which not even a ruin is, at this day, standing. The connection of medals and poetry has been treated at considerable length by Mr. Addison. To the connoisseur they are absolutely necessary, as they enable him to appropriate the busts and portraits of antiquity. And the scholar need hardly be reminded that they have contributed in no small degree to the elucidation of obscure passages in antient authors. The alto-relievo of the Greek coins is one of the best schools of study for the sculptor.

The study of medals, perhaps, is not of very antient date. The preservation of the Greek coins among their choicest treasure, is said to have been one of those marks of due respect which the Romans shewed the Greeks: but the knowledge of medals in series does not seem to have formed a distinct branch, either of study or entertainment, till the revival of literature in Europe. Petrarch is related to have been one of the first who began to study the medallic science. Alphonso, king of Arragon, formed another collection. And a third was placed by Cosmo de Medici among the curiosities in the Museum at Florence.

In this country, though we know of the existence of no cabinet before the time of Camden, it may be fair to suppose that the knowledge of coins and medals was introduced from Italy. The "Britannia" was the first work in which engravings of them were produced: and Speed's Chronicle, which soon followed it, was illustrated with coins from the collection of sir Robert Cotton. Henry prince of Wales was one of the first who had a *rich* cabinet; and he bequeathed it at his death to Charles. The most considerable of our other early collectors were, archbishop Laud, lord Arundel, and Mr. Selden. Oliver Cromwell, we are told, had a small collection; and the cabinet of Charles the Second is mentioned by Vaillant.

In the article here presented to the reader's notice, we shall give first a brief account of the coins of the most antient nations which are still extant; reserving only the Greek and Roman, which are the most interesting of all coins, for a more extended view; adding, at the close, a particular though condensed history of the coins and coinage of England. For the first part, as well as for the Greek and Roman coins, we have relied principally on the authority of Mr. Pinkerton. For the last, all the best writers have been consulted.

In what country coinage originated is uncertain, though the Greeks have the fairest claim to the invention. Homer, indeed, makes no mention of money; and even in Scripture we find weight alone used in the estimation of metals. The Hebrew shekels, and the brass coins with Samaritan characters, are thought to be, most of them, later than the Christian æra, and generally the fabrication of modern Jews. A sprig on one side, and a vase upon the other, is their general impression.

The Assyrians, the Medes, and the early inhabitants of Egypt, appear to have been totally ignorant of coined money. Nor was it used by the Phœnicians till after the Greeks had set the example. "Upon the whole," says Mr. Pinkerton, "the Lydian coins seem the most antient of Asia: they are without legends, but have all the rude appearance of antiquity." The next are the Persian, which are well known from the archer on them; and from Mithras the Persian deity, the dress of the princes, and other marks. One of the Darics, coined about five hundred years before the Christian æra, is engraved in the first plate of the Numismata Pembrochiana. "All the real Darics," says Mr. Pinkerton, "are gold; the silver coins with the archer are later, and never were called Darics." Of the latter, a great many are preserved in the cabinet of Dr. Hunter. A second series of Persian coins begins with Artaxares, or Artaxerxes, who overthrew the Parthian monarchy about the year 210, and ends with the year 636, when Persia was conquered by the Saracens. These are large and thin, with the king's bust on one side, and usually the altar of Mithras on the other; the former accompanied by Persian letters. Four of them are engraved in the Numismata Pembrochiana, and six others on a separate plate from the cabinet of the late Mr. Duane. The Phœnician and Punic, with the Palmyrene and the Etruscan coins, and perhaps the early Spanish, make up the list of the more antient. The early Gaulish coins are too rude and indistinct for explanation.

The description of the Greek coins it is probable will be best prefaced by a few remarks on their original value. A knowledge of this subject is not more necessary to the collector than the classical scholar. The first shape, says Mr. Pinkerton, in which money appeared, it is well known, was that of pieces of metal without stated form or impression, but merely regulated to a certain weight. For weight was the grand standard of antient coinage. In Greece large sums were referred to so many mnæ or minæ; and the yet larger denomination of so many talents. The mina is thought to have contained 100 drachmæ, and the talent 60 minæ. Such at least was the measure of Athens. A list of the value of the other antient talents has been given by Dr. Arbuthnot: its authority, however, has been questioned, and the difficulty of applying it to antient coinage seems extremely great.

The leading denomination of the Greek silver money was the drachma, or eighth part of an ounce, of which Mr. Pinkerton describes the medial value to be ninepence sterling: the didrachm, tridrachm, and tetradrachm, explain themselves, except the tetradrachm of the Ægineau standard, which was valued at five shillings. This last was the largest form of the Greek silver coins. The silver divisions of the drachma were the tetrobolion, the hemidrachm or tribolion, the diobolion, the obolus, the hemiobolion, the tetrabolion, and dichalcos; the first of the value of sixpence, the last of a farthing and a half. Of the distinct names by which many of these coins were called among the different states, our intelligence is partial; nor are such names of consequence.

The next Greek coinage, in point of antiquity, is that of copper, which is said not to have been introduced till four hundred and four years before the Christian æra. The first copper coin of Greece was the chalcos, of which two went to the quarter of the silver obolus. In days of poverty, however, even this was divided by different states into different portions, which were called Λεπτα, or little coins. The lepton, dilepton, and tetralepton, were the divisions of the chalcos, the smaller of which, from their perishable size, are very rare. Such were the brass coins of Greece previous to the subjection of that country to the Roman empire.

The earliest of the gold coins of Greece are those of Philip of Macedon, although they were struck in Sicily considerably earlier. Philip, having conquered the city Crenides, on the confines of Thrace, found gold-mines in its neighbourhood, formerly ill explored, and of small produce. From this gold he first struck the coins called Philippi, because of his portrait which appears on them. The Philippi it should seem were didrachms, the form most universal in the antient coinages of gold; and at their first appearance went for 20 silver drachmæ, but in latter times for 25 Greek drachmæ or Roman denarii. The Philippus was also called Χρυσος. There were likewise the ημιχρυσος and the τεταρτοχρυσος, with gold coins of Cyrene, which could not have gone for more than two drachmas of silver. There were also the Δι χρυσος and the Τετραςηρ, or quadruple Χρυσος; the former worth about two, and the latter worth about four pounds of our money.

The original value of the Roman coins is a subject still more intricate and extensive. As in Greece, the first estimation of their money was by weight; though copper, not silver, was the first medium of coinage. The first Roman coinage, according to Mr. Pinkerton, was in the reign of Servius Tullus, about the year 460 before the common æra, and was confined to the as or æs libralis, or piece of brass only, which was stamped with the two-faced head of Janus on the one side, and the prow of a ship on the other; though Mr. Pinkerton afterward thinks it probable that the very first Roman ases of Tullus had the figure of a bull, ram, or other species of cattle. However this may be, parts of the as were very early given in proportion of weight and value: such were the semis or half, the triens, the quadrans, the sextans, and the uncia. After a certain period, the as, though still called libra, fell to two ounces; and as it fell in weight, larger denominations were coined. Such were the bissus or dupondius, the tressis, the quadrussis, and even the decussis, or piece of ten ases in copper.

When the Romans began, by intercourse with Greece, to imbibe the arts of elegance, a variety of types appeared upon the parts of the as, and at length upon the as itself; though these, it is believed, are not seen till near the time of Sylla. Dupondii, or double ases, were also coined in the later period of the commonwealth, as in the former; together with the sestercii ærei, which came in place of the quadrusses. It must also be observed that the Romans, in some instances, accommodated their coins to the country in which their army was stationed; so that it is from the coins struck at Rome only that the coinage can be adjusted.

The largest of the imperial brass coins, according to our author, was the sestercius, worth about twopence English; no sensible diminution of which from its first weight of an ounce took place till the reign of Alexander Severus, when it lost upwards of a sixth. In the time of the Philippi, it was still more reduced; and under Trajanus Decius it had lost near a half. He was the first prince who seems to have coined double sestercii, or quinarii of brass, for such are the common medallions inscribed FELICITAS SAECVLI, or VICTORIA AVG., which just weigh double his sestercii, and little more than the sestercii of the early emperors. From Trebonianus Gallus down to Gallienus, when what is called the first brass ceases, the sestercius does not weigh above one-third of an ounce: any larger are double sestercii, or medallions struck upon uncommon occasions. After Gallienus, the sestercius totally vanishes. Under Valerian and Gallienus, a new coinage appears of what were called denarii æris, or Philippei æria of copper washed with silver. In the reign of Diocletian, the follis supplied the place of the sestercius; and soon after we find the denarius æreus dropped for ever. Such was the progress of the largest form of the imperial brass coin of Rome.

The dupondius, being half the sestercius, was the next in value. Prior to Augustus, it seems to have been commonly struck in copper; though after his time it was struck in yellow brass. It kept pace with the sestercius in all its stages.

The imperial as or assarium is the next coin. It began to be called assarium as soon as its size was reduced to half an ounce, and, like the dupondius, diminished gradually in its form, till at the end of Gallienus's reign it became what is called small brass. The parts of the as, says Mr. Pinkerton, in the imperial times, are, generally speaking, very rare. However, of Nero, there are the semis, triens, quadrans, sextans, and uncia, being all the parts; and of Domitian there are the same.

From Pertinax down to Gallienus, there is no small brass save of Trajanus Decius. With Gallienus it becomes extremely common. Toward the end of his reign the assaria were diminishing to a still less size. Farther we shall not trace this branch of the coinage.

The silver coinage of Rome is supposed first to have taken place about 266 years before the christian æra. The most antient denarii are those on which no inscription, save the word ROMA, appears: and at that time the denarius seems to have gone for ten ases; though it was afterward raised to sixteen, till the time of Gallienus. Under Caracalla, when the silver coinage was debased, denarii were struck of two sizes; the larger bearing an increase of value by a third. Both, however, lessened by degrees till after Gordian III. when the smaller totally vanished, and the larger alone remained. The latter, in the time of Gallienus, was the sole denarius of silver, and probably gave rise to the denarii æreì, which have been already mentioned. Such was the silver coinage till the time of Constantine the First, when the milliarensis was introduced, weighing about 70 grains, and answering in worth to our shilling. The denarii or argentei were, however, still coined, and were the money most common in currency.

Of the smaller silver coins of Rome, two only remain to be mentioned, the quinarii or pieces of five ases, and the sestercii of silver, which seem to have been coined down to Augustus.

Gold, we are informed by Pliny, was first coined at Rome in the 204th year before the present æra; and his account of the diminution in weight which marked the progress of its coinage, is singularly corroborated by such coins as have come down to us. The scruple, he says, went for 20 sesterces. "It was afterward thought proper to coin 40 pieces out of the pound of gold. And our princes have by degrees diminished their weight to 45 in the pound." Till Sylla's time, the aureus continued at 30 denarii; it afterwards fell to 20; though both under Claudius and Severus we find it at 25. Constantine the First, instead of the aureus, gave the solidus, of six in the ounce of gold, one of which answered to 14 of the milliarenses. The solidus continued of the very same standard to the close of the Byzantine empire.

Of the portraits which are to be found on coins, those of the kings of Macedon have the first rank, as their coins have the greatest antiquity of any yet discovered on which portraits are found. Alexander I. begins the series, who reigned 501 years before the christian æra. Then follow the kings and queens of Sicily, Caria, Cyprus, Pontus, Egypt, Syria, Thrace, Bithynia, &c. extending in series from the time of Alexander the Great to the birth of Christ, comprising a period of about 330 years. In this class are placed the beautiful coins of the Seleucidæ. The last series of antient kings goes down to the fourth century, including those of Mauritania and Judea; and finishing the series of the portraits of kings found on medals struck with Grecian characters.

The Roman emperors present a most distinct series from Julius to a later period than the destruction of Rome by the Goths.

The kings, upon Greek coins, have generally the diadem, without any other ornament, usually with a side face, and almost always in very high relief; though several, particularly the beautiful gold coin of Ptolemy Philadelphus, others of Antony and Cleopatra, &c. have more portraits than one upon them. The chief ornament of the portraits is the diadem or vitta. The radiated crown, a mark of deification, on the posthumous coins of Augustus, was, in a little more than a century after, put upon most of the emperors' heads in their several medals. The crown of laurel is continually seen: and Agrippa appears not only with the rostral but the mural crown. The successors of Alexander assumed, by way of distinction, different symbols of deity on the busts of their medals. A few instances also occur, among the Roman coins, of the helmet.

The reverses of medals, both among the Greeks and Romans, were of infinite variety. They contain figures of deities at whole length with their attributes and symbols; public buildings and diversons; allegorical representations; ceremonies; historical and private events; figures of antient statues; subjects of natural history; magistracies, &c. The reverses of the Roman coins have more of art and design than the Greek, though the latter have more exquisite relief. In the very antient coins no reverse is found, and of the antient Greek reverses some are in intaglio. The figures of deities and personifications on the Roman coins, are commonly attended with the names: as, the figure of Virtue with VIRTVS AVGVSTI: but on the reverse of the Greek coins the figure is only accompanied by some certain symbol; as Ceres with her wheaten garland, Mars with his armour, or Mercury with his caduceus. The anchor on Seleucian coins is the mark of Antioch; the owl, of Athens; the labyrinth, of Crete; the horse, of Thessaly; and so on.

Of the legends, the early Greek coins usually contain the name or the initials of the city they belong to; or the name, the first character of it, or the monogram, of the prince. The earliest coins of Athens have only ΑΘΕ, money of Athens: ΣΥ, of Sybasis; ΜΑΣ, of Massilia. ΣΥΡΑΚΟΥΣΙΩΝ occurs at full length, as well as ΦΙΛΙΠΠΟΣ for Philip of Macedon. And though in aftertimes the names of princes were accompanied by modest adjuncts, there were others that were not a little proud. Of the former were ΔΙΚΑΙΟΥ, ΕΥΣΕΒΟΥΣ, ΦΙΛΕΛΛΗΝΟΣ of the latter, ΘΕΟΠΑΤΟΡΟΣ, ΒΑΣΙΛΕΩΣ ΒΑΣΙΛΕΩΝ, &c.

After the Roman empire had swallowed up the Grecian, the legends on Greek coins became as remarkable for length as they had before been for brevity. The Greek imperial coins have a great variety in their legends. Nor are many of the reverses wanting in adulation. The legends of the Roman imperial coins are still more deservedly celebrated for their beautiful simplicity. IVDEA CAPTA and ASIA SUBACTA are sufficient instances.

Of the pieces produced by the antient mints, there were some of a size which shewed them evidently to have been intended for something else than circulation. Medallions were occasionally presented by the emperor to his friends; and sometimes by the mintmaster to the emperor as specimens of workmanship. These are usually known by their weight, which is far greater than that of the acknowledged money. Both the Greek and Roman medallions appear to have been principally struck in the imperial periods. Till the time of Hadrian they are rare. For a more full account of them, we refer to the work of Mr. Pinkerton.

To dwell longer on the various types either of the Grecian or the Roman coins, would be superfluous. Their curiosity and elegance are infinite. The regal coins of Greece are interesting from their portraits; the coins of cities, from their importance to geography. On the consular coins of Rome, the names and titles of the consuls do not appear till toward the close of the series: the brass consular coins are uninteresting. The imperial brass is of three sizes, large, middle, and small; the first forming a series of the greatest beauty. The imperial silver coins are numerous; the gold, of wonderful perfection. For the different abbreviations which occur both upon the Greek and Roman coins, we shall refer to the Tables selected by Mr. Pinkerton, as it would be impossible, in so concise a work as this, to give every information which the collector might require. The best works upon the Greek and Roman coins are probably these: Froelich's Notitia Elementaris; Neuman's Populi & Reges inediti; the Works of Pellerin; the Nummi populorum et urbium Magnæ Græciæ, by Dr. Combe; Havercamp on the Consular Coins; and the Roman Imperial, by Vaillant, edition 1745, by Valdini, with the Supplement by Kehl.

Of the early British coins, previous to the arrival of the Romans, we know but little. They were probably like the antient Gaulish, rudely ornamented, and without inscriptions. Those which we usually call British, were evidently the work of Roman moneyers. Those with CVNO on one side, and CAMV on the other, are usually ascribed to Cunobelin, the king of the Trinobantes. There is also one which has a bull on the obverse, with V.E.R.V.L.A.M.I.O. for the legend, apparently struck at Verulam. The meaning of *tascia*, which is common both to the Gallic and the British coins, wants explanation.

Of the coins of the Saxon heptarchy, there are but two descriptions: the sceatta, or penny, and the styca; the latter of which seems to have been principally confined to the kingdom of Northumbria. Of the coins of the heptarchic princes, the series is very far from regular; and of one or two princes unique specimens only are known. Of the chief monarchs, Ethelbald and Edmund Ironside are the only two who break the series. Of their coinage we have no specimens. The obverses of all these bear merely the resemblance of a human bust; though the reverses are occasionally interesting. The inscriptions also are sometimes peculiar; and we have a few specimens in the ninth century of archiepiscopal coinage. The best guide to the collector of Anglo-Saxon coins will be found in the plates of Dr. Hickes's "Thesaurus;" their rarity and value may be learnt from the Essay we have so often quoted.

The two first kings after the Conquest coined only pennies, the types of which are different, though in point of weight and goodness they agree with the pennies of the Saxons: their weight was usually 22 grains and a half. The obverse represents sometimes the full, and sometimes the side face of the sovereign, with the name of the mint-master and town of mintage on the reverse. To pennies, Henry the First added halfpennies, though none of them have reached us. King Stephen's pennies were of the same value as those of his predecessors. There are also some extant, which have the name of Eustace on them, Stephen's son; and one occurs with the head and title of Henry bishop of Winchester, the king's base brother. Those of Stephen which have the banner, are the rarest. The pennies of Henry the Second are also scarce; of Richard the First we have only the French penny; and of John no money but what was coined in Ireland; though of the last there are not only pennies but halfpennies and farthings. The first coinage of Henry the Third had only on the obverse HENRICVS REX, and his pennies till within these 30 years were usually ascribed to Henry the Second. After his 32d year, we find III or TERCI added to the title. The pennies, halfpennies, and farthings of Edward the First are all common. Such pennies as have EDW. R.ANGL. DNS.HYB upon the obverse, are usually ascribed to Edward the First; those with EDWA. or EDWAR. to Edward the Second; and those with EDWARD or EDWARDVS to Edward the Third. This, however, is but conjecture. In the 18th of Edward the Third, the penny was brought down to 20 grains; and in his 27th year, we find groats and half-groats coined, in which the king's head was surrounded by a sort of double tressure. In the reign of Edward the Fourth, having previously sunk to 15, the penny fell to 12 grains. In Edward the Sixth's time, it was reduced to eight, and in Elizabeth's to little more than seven. Of the groats, Richard the Third is very rare. In 1503, Henry the Seventh coined the shilling or testoon: it resembled the groat, but was larger, and weighed no less than 144 troy-grains. The crown of silver was first struck by Henry VIII. and the half-crown, sixpence, and threepence, by Edward the Sixth. Elizabeth, in 1558, coined three-halfpenny, and in 1561, three-farthing pieces; but they were disused in 1582. Henry the Eighth was the first of our princes who debased the coinage; and in the earlier part of Edward the Sixth's reign, the practice was continued: but from the 43d of Elizabeth, 1601, the denomination, weight, and fineness of English silver, have remained the same. From 1561 to 1568, the money of Elizabeth was coined in a better taste, by means of a mill and screw; but the artist of this money being hanged for counterfeiting coins, the hammering system was again recurred to. Till the time of Charles the Second, we have little more of the milled money.

The design of a gold coinage appears to have been first formed by Henry the Third, the most particular account of which is to be found in lord Liverpool's Letter to the King. The piece ordered to be current was called a gold penny; but being of too great value for general circulation, it was in two or three years called in, and now but three specimens remain. In itself, the gold penny is a beautiful specimen of the coinage of the time. The obverse is much in the manner of the king's great seal, and the inscription Henricus Rex III.; on the reverse, the mint-master's name and place. The three known are all of different types: one reads LVND, another LVNDE, and the third LVNDEN. But it is from Edward the Third that the series of our gold coins commences. In 1344, he struck the florin, half, and quarter florin. The florin was current for six shillings, but was the same year succeeded by the noble, the value of which was half a mark. Henry the Fifth diminished the value of the noble; Henry the Sixth restored it to its size, and gave it the name of ryal; while Edward the Fourth, in 1465, supplanted it with the angel. Henry the Eighth, in 1523, added the gold crown and half crown at their present value: the sovereign of 22*s.* 6*d.*; the ryal at 11*s.* 3*d.*; the angel at 7*s.* 6*d.*; and the noble at its old value. In 1546, he coined sovereigns and half-sovereigns, the former to go at 20*s.* and the latter in proportion. Charles the Second, however, instead of the sovereign, introduced the guinea and half-guinea. George the First added the quarter-guinea. But though it was continued in the early part of the reign of his present majesty, the seven-shilling piece has been preferred.

The history of our copper coinage, the last in order of chronology, will be shorter. From the reign of Henry the Eighth till the close of queen Elizabeth's reign, the scarcity of silver farthings and halfpence gave rise to the introduction of tokens or pledges for money among tradesmen, many of which are undoubtedly alluded to in what has been said by Erasmus and other writers about leaden money. Elizabeth, it appears, would never hear of a copper coinage for the country: and though farthing tokens of copper were issued both by James and Charles the First, they were considered rather as pledges of government than legitimate money. The death of Charles the First put an effectual stop to their farther currency: and till 1672, the country again swarmed with town pieces and tradesmen's pledges; when, in the latter year, halfpence and farthings of copper were made public money, and the circulation of tokens forbidden. His present majesty has added two-penny pieces.

MEDEOLA, *climbing African asparagus*, a genus of the hexandria order, in the trigynia class of plants, and in the natural method ranking under the 11th order, sarmentaceæ. There is no calyx; the corolla is sexpartite and revoluted; the berry trispermous. Its characters are these: the flower has no empalement; it has six oblong oval petals, and six awl-shaped stamina terminated by incumbent summits; and three horned germina terminating the style; the germina afterward turn to a roundish trifid berry with three cells, each containing one heart-shaped seed. There are three species.

MEDICAGO, *snail-trefoil*, a genus of the decandria order, in the diadelphia class of plants, and in the natural method ranking under the 32d order, papilionaceæ. The legumen is compressed and screwed; the carina of the corolla luring down from the vexillum. There are 11 species, though only five are commonly cultivated in this country. They are low trailing plants, adorned with small yellow flowers, succeeded by small round snail-shaped fruit, which are downy, and armed with a few short spines. They are all easily propagated by seeds. The M. sativa or lucern, has been latterly much recommended as a green fodder for cattle, and has been cultivated by some farmers with success.

MEDICINE, is the art of preserving health, and of curing or alleviating disease. It is the same science in its application to animal, as agriculture to vegetable, life.

Origin and progress of medicine. "Medicina nusquam non est." This art arises out of the natural, as others more gradually and indirectly origiuate from the artificial and adventitious, wants of mankind. The exact period, however, in which medicine began to be formally practised as an art, or separately cultivated as a profession, has by no means been accurately ascertained. All the accounts which have been transmitted on this subject from a date prior to the time of Hippocrates, are either conjectural or fabulous. Hippocrates first effected a separation of medicine from philosophy and religion, and gave it the form of a distinct science: he has therefore been generally regarded by the moderns as the father of physic; and from his time the history of this science may be made with propriety to commence.

Hippocrates was a native of Greece. He was born in the island of Cos, and flourished about 400 years prior to the christian æra. Of his character as a physician, an estimate cannot, confessedly with much accuracy, be formed from his writings, or from those works which have been attributed to him, but which are generally regarded as in a great measure the inventions of his disciples and successors. "Hippocrates," says a modern author, "lived at too early a period to be acquainted with the collateral branches of science. He studied life and disease in the book of nature, and had the merit of an original observer." We do not, however, feel disposed with this author fully to acquit the "Coan sage of the many idle theories which have been imputed to him." It may well be conceived that he was influenced in his opinions on the cause of disease and on the nature of healing, if not by the splendid fictions of the Greek philosophy, by preconceived theory and vague conjecture. Indeed, the hypotheses contained in the reputed writings at least of Hippocrates, have been, with trivial modifications, the hypotheses of modern times; for in this author's pervading and presiding principle of nature, and in his attraction, depuration, decoction, and crisis of disease, may be traced the same mode of theorizing which has been adopted by later systematics.

The humoral pathology, and even the *vis naturæ medicatrix* of modern times, appear to be modifications or relics of Hippocratic reasoning.

The immediate successors of Hippocrates began to direct their researches into the auxiliary departments of medicine; and among these, Praxagoras, Chrysippus, Hirophilus, and Erasistratus, particularly the two last, made no inconsiderable discoveries (when we consider the scantiness of their materials) respecting the structure and functions of the human frame. It was about this period, according to Celsus, that the science was divided into the three distinct branches of dietetical, pharmaceutical, and chirurgical medicine—"una quæ victu, altera quæ medicamentis, tertia quæ manu mederetur." Shortly after the time of Herophilus, the medical world became divided into the two sects of empirics and dogmatists: the one, rejecting the reasoning and deriding the practice of their predecessors, affected to disregard all authority but that of experience; the other, retaining their faith in the scholastic philosophy of the times, and their conviction of the utility of physiological knowledge in detecting the causes and regulating the treatment of disease. The empiric sect was founded by Serapion of Alexandria, about 287 years before Christ.

The next revolution of importance in the medical art was occasioned by the introduction of the Epicurean philosophy into the schools of medicine. This was effected by Asclepiades, who was succeeded by Themison, the founder of the methodic sect, the members of which were equally hostile to the dogmatists and empirics. They discarded what they considered the occult reasoning of the former, and substituted in the room of the laborious observations of the latter, indications of treatments deduced from the analogy of diseases, or the mutual resemblance they bear to each other, "nullius causæ notitiam quicquam ad curationes pertinere; satisque esse quædam communæ morborum intueri methodici contendunt." *Celsus.* The most celebrated of Themison's followers were Thessalus, who flourished under the emperor Nero, and Soranus, a native of Ephesus, who lived during the time of the emperors Trajan and Adrian.

We have now arrived at a very conspicuous æra in the science of medicine. About the 131st year after Christ, in the reign of Adrian, lived the celebrated Galen, who was born at Pergamus. At this time the dogmatic, empiric, and methodic sects of physicians had each their advocates. The methodics, however, were held in greatest estimation. Galen undertook the reformation of medicine, and affected to restore the Hippocratic philosophy and practice. Instead, however, of abiding by the doctrines of his master, his systems were almost entirely of his own invention. "Philosophy and science had now made some advances; and from those sources Galen introduced many corruptions into medicine." Like Hippocrates, he supposed the existence of four humours, from the predominancy or deficiency of one or other of which the varieties of constitutions, and likewise the complexion and nature of disease, were conjectured to originate. These humours are, in the Galenic system, the blood, the phlegm, the yellow bile, and the black bile. He likewise establishes three distinct kinds of spirits—the natural, the vital, and the animal; the first of which he supposes to be a subtile vapour arising from the blood; this, conveyed to the heart, becomes, when conjoined to the air taken into the lungs, the vital spirits, which are changed into the animal kind in the brain. These three species of spirits our author imagined to serve as instruments to distinct faculties: the natural faculty, which he supposed to reside in the liver, and to preside over the nutrition, growth, and generation of the animal body; the vital faculty, which he lodged in the heart, and imagined that through the intervention of the arteries it communicated warmth and preserved life; while the animal faculty, according to Galen, has its seat in the brain, is the cause of motion and sensation, and presides over all the other faculties. The origin or principle of motion in these respective faculties, Galen, as well as Hippocrates, calls *nature.*

The authority of Galen, notwithstanding the tissue of extravagances and idle conjectures of which his systems were formed, continued to prevail until the downfal of the Roman empire. The seat of learning now became the theatre of war, and the arts of peace took refuge in the Eastern nations. The Arabian succeeded to the Greek and Roman physicians, and still further obscured the theories of medicine by the introduction of fresh absurdities. Anatomy was totally neglected, or at least not in any measure advanced, by the Saracens: they made some progress in the science of botany, and introduced several new drugs, principally of the aromatic kind, from the East, which retain still a place in the materia medicá.

The mention of a singular controversy which occurred among the Arabian physicians, may serve to indicate the complexion of the times in relation to the dogmas and practice of physic.

Hippocrates had directed that in pleurisy blood should be drawn from the arm of that side which might be principally affected. Some of the Arabians contended that it should be taken from the side opposite; and such was the medical ignorance and fanaticism of the age, that a decree was issued from the university of Salamanca in Spain, forbidding any one to pursue the practice of Hippocrates. The members of this university even endeavoured to procure an edict from the emperor Charles V. to confirm their authority, alleging, that the practice they opposed was no less pernicious to medicine than Luther's heresy had been to religion!

From the time of the decay of learning to the commencement of the 16th century, the history of medicine furnishes no particulars of interest. This last is the period which gave birth to the celebrated Paracelsus. Now, all the facts and doctrines of medicine came to be explained by, and founded upon, imaginary principles of chemical philosophy. The antient authors fell into disrepute; and the elements, qualities, and temperaments of the Greeks, were melted down and dissipated in the laboratory of the chemist. Fermentation, effervescence, ebullition, and deflagration with salts, sulphur, alkali, and mercury, came now to be familiarly, but without any precise signification, introduced among the terms of the medical art. With several, however, the Galenic philosophy continued to prevail.

In the year 1628, Dr. W. Harvey, of London, first demonstrated and communicated to the world the most important fact of the circulation of the blood. This discovery afforded a new foundation for the whole structure of medical and physiological reasoning. Even this, like all other improvements in science, and bold innovations of established doctrines, met with very cold encouragement by the contemporaries of Harvey. It is said that no physician or teacher of medicine, who had attained his 40th year, would subscribe to the fact; and that in thus conferring an incalculable benefit on the community, Harvey diminished his own contemporary reputation, and nearly lost his practice as a physician.

While some were industriously endeavouring to controvert the fact, others were busied in attempts to wrest the discovery from its author.

Servitus, a native of Spain, had, many years previous to the time of Harvey, published a Treatise on Medicine and Theology. In this work it is asserted, or rather perhaps conjectured, that the blood, by some unknown channel, passes from the pulmonary arteries into the veins. Even allowing that this intimation justly laid claim to the title of a discovery, it is merely a discovery of the passage of the blood through the lungs, and could in no measure interfere with the merit or be regarded as an anticipation of the Harveyian doctrine.

The period, however, had not yet arrived when a rational use was to be made of the important fact in question. As the alchemists had derided the Galenists, so the reasonings of the latter were now to give way to the mathematical sect of physicians, who by axioms, postulata, theorems, problems, experiments, and corollaries, ("a capite ad calcem armatos, et necem undique minitantes,") attempted to explain, in the most futile manner, the functions of life, and to regulate the remedial process.

The learned and industrious Boerhaave, of Leyden, whose name stands conspicuous in the annals of medicine, at length attempted to restore the authority of the antient writings; and by uniting the doctrines of Hippocrates with the philosophy of the times, he framed a theory of medicine upon the supposition of acrimony, lentor, and other changes in the circulating fluids. From these changes he inferred the origin of all disease; and the process of cure is, according to Boerhaave, either the process of correcting or expelling acrimony from the body, or the correction of morbid viscidity or tenuity in the humours. Boerhaave has, therefore, been considered the founder of the humoral pathology; a pathology which even to this day retains a material influence on the opinions, the phraseology, and the practice at least of the vulgar.

Contemporary with Boerhaave was the illustrious Hoffman, a German professor, and founder of a medical system. Dr. Staahl having first suggested, or rather borrowed from the antients, the idea of the rational soul of man governing and directing the whole economy of his body, and obviating the adverse tendency of noxious agents by exciting such actions in the system as are calculated to effect their expulsion, or destroy their malignity; Hoffman endeavoured to demonstrate, that the first operation of the causes creating disease was the production of universal atony or spasm in the primary moving powers of the system, and did not consist of changes produced either in the quantity or quality of the humours or fluids of the body, as taught by the celebrated Boerhaave.

The humoral, however, continued to prevail over the pathology of Hoffman; and Dr. Cullen informs us, that "when he came to take a professor's chair in the university of Edinburgh, he found the Boerhaavian system then in its full force." In framing a system of his own, Dr. Cullen reverted to the theory of Hoffman; and indeed the whole of his pathology, as far as it relates to leading systematic doctrines, is scarcely any thing more than an attempt to unite the hypothesis of Hoffman with the Stahlian principle of an intelligent, presiding, and preservative power.

We have thus rapidly conducted our readers over the ground of medical history, and have presented a faint outline of the prevailing systems of medical philosophy, from the time of the Grecian to the time of the "English Hippocrates;" to the period when the fanaticism and prejudice of system were shortly to give way before the precepts of genuine philosophy and temperate induction; when the medical science was to be established upon a new foundation; when chemistry was to undergo a reformation equally radical and important; when by consequence a new alliance was to be formed between these two sciences; when the language of metaphor and hypothesis was to be discarded from either; and when enquirers after truth were to be influenced and directed by the independant and invaluable maxim, "Nihil in intellectu quod non prius in sensu."

On nosology, or the classification of diseases. Dr. Sydenham was the first who proposed to adopt a division of diseases into class, order, and genus, upon similar principles with those of botanical arrangement. The idea has been followed out by several of Sydenham's successors, but by no means with that success which had been anticipated. The reason why nosologists have in some measure failed, is sufficiently obvious. While the objects of natural history possess a certain degree of uniformity, enabling the systematic to identify in a manner certain individuals, and thus to refer them to one class, scarcely any thing of this order is observed, or at least not sufficient to justify arrangement of the infinitely diversified phenomena of disease. For example: a certain series of symptoms shall present themselves during the life of an individual, which shall prove to have depended upon, or at least have been connected with, disordered condition of some particular organ. A careful register of such symptoms might be supposed to furnish the same guide to the pathologist and physician, as a recollection of the prominent character of a plant to the botanist or agriculturist. This, however, is by no means the case. Similar symptoms are not invariably characteristic of similar disorders. A cough may originate at one time from circumstances which would at another time suppress it. A catarrh of the nostrils will now be produced by a deficient, now by an excessive, action of precisely the same membrane. The generic terms then which are introduced into medicine, are extremely fallacious: they in fact convey no idea of the precise nature of that affection which they have been employed to indicate; and the difficulty is still greatly augmented when we recollect the endless diversities that must arise from the varied external circumstances, as affecting and modifying the constitutional character of the same individual.

A disease, then, as indicated by name, and described by signs, is in some measure an imaginary existence. Dr. Brown, the outline of whose doctrines is elsewhere exhibited (see the article BRUNONIAN SYSTEM), aware of the errors attached to nosology founded on symptoms, proposed to comprehend all morbid affections under the two leading divisions of diseases of increased and diminished excitement. Our author, however, in his opposition to particulars, went over to the other extreme of too indiscriminate and hasty generalization. The human frame is too complicated to admit of the simplification which Brown aimed at. His division is a guide to principle but not to practice.

A recent attempt has been made to include in one scheme both general principles and particular facts. This plan, however, notwithstanding the boldness of conception by which it was formed, and extraordinary ingenuity by which it has been executed, is defective. It rests upon a hypothetical, and therefore upon a sandy, foundation. Our readers who are acquainted at all with modern medicine, will be at no loss to conclude that we refer to the system of the late Dr. Darwin. By this author, excitability, which was left as an ultimate fact in the Brunonian theory, is attempted to be traced to its origin. The sensorial power, excitability, or spirit of animation, is conceived to be "a subtle fluid, residing in the brain and nerves, and liable to general or partial accumulation." The vital changes effected by the medium of this imaginary fluid, are, 1st, "Irritation, which is an exertion or change of some extreme part of the sensorium residing in the muscles or organs of sense, in consequence of the appulses of external bodies. 2. Sensation, an exertion or change of the central parts of the sensorium, or of the whole of it, beginning at some extreme parts of it, which reside in the muscles or organs of sense. 3. Volition is an exertion or change of the central parts of the sensorium, or of the whole of it, terminating in some extreme parts of it, which reside in the muscles or organs of sense. 4th. Association is an exertion or change of some extreme part of the sensorium, residing in the muscles or organs of sense, in consequence of some antecedent or attendant fibrous contractions."

With these assumptions as his guide, Dr. Darwin endeavours to penetrate deeper into the cause of disease than is allowed by a mere knowledge of the condition of the fibre. The powers of the sensorium are the proximate cause; the fibrous action, the excitement of Dr. Brown, the proximate effect; and hence, from an ingenious, but by no means satisfactory, statement of the mode in which excitations are produced, he treats of diseases as occasioned by the comparative redundancy or deficiency of the sensorial power of irritation, sensation, volition, or association.

It would carry us far away beyond our limits to pursue this theory through the minutiæ of its ramifications. Some opportunities will be afforded in the course of the present article to acknowledge the obligations which medicine is under to its ingenious framer. We shall here confine ourselves to the statement of what we consider fundamental objections to the doctrines, and, by implication, the nosology or arrangement of Zoonomia.

In the first place, it does not distinguish between cause and effect, between fibrous motion and its source. Secondly, it substitutes, like the antient systems, mere statements of phenomena for explication of their origin. Thirdly, and what is more immediately applicable to our present enquiry, it divides that which in its nature is indivisible.

Dr. Brown had defined excitement to be a certain state of fibrous action produced by the exciting powers acting upon the excitability. Dr. Darwin after him considers irritation or excitement as an exertion of the spirit of animation, exciting the fibres to contraction. Here we observe the want of precision alluded to, and the confusion originates from forsaking induction to embrace hypothesis. "On Dr. Darwin's principles the identical fibrous motion exists before the faculty of irritation can be exerted." The spirit of animation ought to have been stated as the unknown medium ("quo pacto adficiatur ignoratur") through which the excitement or irritation is produced.

Again, the sentient and fibrous changes which in the Darwinian system of life are thus connected, are not rendered more explicable by the intervention of a subtle fluid. The spirit of animation of Darwin, allowing its existence to be capable of proof, in no measure facilitates the conception of vital causation. As an exemplification of the last of the above objections, it may be urged, that when Dr. Darwin, in framing his classification, referred all morbid affection to the heads of irritation, sensation, volition, and association, he seems to have overlooked his former assumption, founded upon the inseparability and identity of the sensorial power or fluid, and not to have been aware he had already asserted that "propensity to action, whether it be called irritability, sensibility, voluntarity, or associability, is only another mode of expressing the quantity of sensorial power residing in the organ to be excited."

An increase then or diminution of one of these energies necessarily supposes an increase or diminution of all, "and the disorder of decreased irritability, ought also to be the disorder of decreased sensibility, voluntarity, and associability." The classification, then, is even in contradiction to the principles of Zoonomia. It is intricate and erroneous.

Perhaps the most consistent and comprehensive plan of arranging individual diseases would be that which, while it preserved the important fact in view, of the indivisibility of the living system, would take into its account the three leading, and in one sense separate, functions performed by the arterial, the nervous, and the glandular organization.

As approaching nearest to this plan, and likewise because it is in most general use in this country, at least as a text-book for teachers of medicine, we shall make use in the present article of the nosology of Dr. Cullen, requesting the reader to recollect the unavoidable objections which oppose themselves to all systems and all classifications of morbid affections.

The following are the classes, orders, and genera of Cullen, with the exception of the class locales, which relates to those disorders principally that come under the head of surgery.

TABLE OF CLASSIFICATION.

Class I. Pyrexiæ. A frequent pulse, succeeding to shivering or horror; increased heat; disturbed functions; prostration of strength.

Order I. *Febris.* Pyrexia, independant of local affection as its cause; languor, lassitude, and other signs of debility.

Sect. 1. *Intermittentes.* Fevers arising from the miasma of marshy grounds, with an evident remission, the returning fits being almost always ushered in by horror or trembling. One paroxysm only in the day.

Genera. Tertiana; quartana; quotidiana.

Sect. 2. *Continuæ.* Fevers without intermission, not occasioned by marsh miasma, attended with exacerbations and remissions, though not very perceptible.

Genera. Synocha; typhus; synochus.

Order II. *Phlegmasiæ.* Fever, accompanied by local inflammation or topical pain, lesion, or disturbance of the internal functions; sizy blood.

Genera. Phlogasis ophthalmia; phrenitis; cynanche; pneumonia carditis; peritonitis; gastritis; enteritis; hepatitis; splenitis; nephritis; cystitis; hysteritis; rheumatismus; odontalgia podagra; arthropuosis.

Order III. *Exanthemata.* Contagious diseases, which only affect once during life, commencing with fever, and succeeded by phlogosis or inflammatory eruptions on the skin.

Genera. Erysipelas; pestis; variola; varicella; rubeola miliaria; scarlatina; urticaria; pemphygus; apthæ.

Order IV. *Hemorrhagiæ.* Pyrexia; spontaneous discharge of blood; blood when drawn from a vein of a sizy appearance.

Genera. Epistasis; hemaptisis; hæmarrhois menarrhagia.

Order V. *Profluviæ.* Pyrexia; inordinate discharge, but not of blood.

Genera. Catarrh; dysenteria.

Class II. Neuroses. A lesion of sense and motion, without idiopathic pyrexia or local disorder.

Order I. *Comata.* A diminution of voluntary motion with sleep, or a deprivation of sense.

Genera. Apoplexia; paralysis.

Order II. *Adynamiæ.* Diminished voluntary motion, whether vital or natural.

Genera. Syncope; dyspepsia; hypochondriasis; chlorosis.

Order III. *Spasmi.* Irregular action of the muscular fibre.

Sect. 1. In the animal functions.

Genera. Tetanus; trismus; chorea; raphania; epilepsia.

Sect. 2. In the vital functions.

Genera. Palpitatio; asthma; dyspnæ; pertussis.

Sect. 3. In the natural functions.

Genera. Pyrosis; colica; cholera; diarrhœa; diabetes; hysteria; hydrophobia.

Order VI. *Vesaniæ.* Derangement of judgment, independantly of pyrexia or coma.

Genera. Amextia; melancholia; mania; oneirodynia.

Class III. Cachexiæ. A depraved habit of body, without idiopathic pyrexia or neurosis.

Order I. *Macores.* A wasting of the whole body.

Genera. Tabes; atrophia.

Order II. *Intumescentiæ.* A swelling of the whole or of the greatest part of the body.

Sect. 1. *Adiposæ.* Fatty swellings.

Genus. Polysarcia.

Sect. 2. *Flatulosæ.* Windy swellings.

Genera. Pneumatosis; tympanites; physometra.

Sect. 3. *Hydropes.* Watery swellings.

Anasarca; hydrocephalus; hydrorachitis; hydrothorax; ascites; hydrometra; hydrocele; physconia.

Order III. *Impetigines.* Cachexies, chiefly deforming the skin and external parts of the body.

Genera. Scrophula; syphilis; scorbutus; elephantiasis; lepra; frambæsia; trichoma; icterus.

CLASS I. ORDER I.—*Febris.*

What is fever? To this question it appears difficult to give a precise and satisfactory reply. It is observed by the author of Zoonomia, that "the term *fever* is given to a collection of morbid symptoms, which are indeed so many distinct diseases that sometimes appear together, and sometimes separate; hence it has no determinate meaning, except it signifies simply a quick pulse, which continues for some hours;" in which sense Dr. Darwin employs the word throughout his ingenious work.

On this head, however, we differ in opinion with the author just mentioned. An increased action of the sanguiferous system shall be induced sometimes by, and at other times independant of, a diseased irritation, without being accompanied with other peculiar feelings, which, not restricting ourselves to the etymological signification of the term *fever*, we purpose regarding as necessary constituents of this, as a distinct malady.

In every proper fever, there is a feeling of depressed power, which essentially differs from actual debility. "A diminution of strength in the animal functions," which constitutes part of Dr. Cullen's definition of the febrile state, is scarcely characteristic of the condition to which we allude. It is a feeling with which every one is more or less familiar, and appears to indicate rather obstructed than exhausted strength. Dr. Rush endeavours to illustrate this necessary constituent of genuine fever as a distinct expression from simple irritation of the blood-vessels on the one hand, and mere debility on the other, by comparing it with the smothered sound which may be supposed to be emitted from a musical instrument, provided a heavy weight were applied to the chords; which ought to be suffered to vibrate freely and without obstruction, in order to produce a full and harmonious sound. An illustration of a similar nature is likewise employed by Dr. Jackson.

Dr. Brown defines fever, "an asthenic disease that disturbs the pulse." In this, however, there is the same want of distinction which we have just complained of in the definition of Dr. Cullen. Asthenic diseases are diseases of deficient excitement; but in fevers we have an interruption rather than diminution of power. The faculties are locked up, not lost.

Of the phenomena of fever. Dr. Cullen very properly selects the more ordinary circumstances that present themselves in the course of an attack of intermittent fever, as an example of what occurs with more or less regularity in every case of genuine febrile disorder.

"The following," he says, "are to be observed in such a paroxysm. The person is affected with languor or sense of debility, a sluggishness in motion, and some uneasiness in exerting it, with frequent yawning and stretching. At the same time the face and extremities become pale, the features shrink, the bulk of every external part is diminished, and the skin over the whole body appears constricted as if cold had been applied to it. At the coming on of these symptoms, some coldness of the extremities, though little taken notice of by the patient, may be perceived by another person. At length the patient himself feels a sensation of cold, commonly first in his back, but then passing over his whole body; and now his skin feels warm to another person. The patient's sense of cold increasing, produces a tremor in all his limbs, with frequent successions or rigors in the trunk of the body. When this sense of cold and its effects have continued for some time, they become less violent, and are alternated with warm flushings. By degrees the cold goes off entirely; and a heat greater than natural prevails and continues over the whole body. With this heat the colour of the skin returns, and a preternatural redness appears especially in the face. Whilst the heat and redness come on, the skin is relaxed and smooth, but for some time continues dry. The features of the face and other parts of the body, recover their usual size, and become even more turgid. When the heat, redness, and turgescence, have increased and continued for some time, a moisture appears on the forehead, and by degrees becomes a sweat, which gradually extends downwards over the whole body. As this sweat continues to flow, the heat of the body abates; the sweat, after continuing for some time, gradually ceases, the body returns to its usual temperature, and most of the functions are restored to their ordinary state.

Species of fevers. The general division of systematics is into continued and intermittent. The very correct description above given answers, as we have stated, to a single paroxysm or fit of fever. It is not however often that the disorder terminates with the decline of the paroxysm. In the course of a certain time it is renewed; and according to the suddenness or tardiness of the paroxysm's recurrence, the fever is called continued, remittent, or intermittent. Sometimes, indeed, the disordered actions recur with such celerity, that the fever appears to be one continuous series; "the remission is inconsiderable, is perhaps without sweat, and the returning paroxysm is not marked by the usual symptoms of a cold stage, but chiefly by the exacerbation or aggravation of the hot one." The disease in this last case is considered as a continued fever; in which, however, there is, though not the distinct stages of an intermittent, almost invariably, especially in the earlier periods, a diurnal remission and recurrence of paroxysm. Of intermittent fevers, the paroxysms, such as we have just described, are always finished in less than 24 hours, and most frequently are not extended to nearly this time.

We are then furnished with a natural division of fever into intermittent and continued, which however have many circumstances in common, and often pass into each other; thus, what is termed in the schools a quartan intermittent, formed by an interval of 72 hours from the commencement of one to the commencement of another paroxysm, will in its course become a tertian ague, with only 48 hours of interval: this again shall fall into a quotidian, characterized by an interval of only 24 hours. A quotidian shall pass into the state of a remittent, and this last be converted into a true continued fever.

Besides, however, this leading distinction of fever, from the times of the recurrence of the fits, we have many others arising from the nature of the constitution of the individuals attacked, the prevailing condition of the atmosphere, and other extraneous circumstances, and likewise (what is ascertained however with less exactness) the specific difference of the exciting cause; thus, common fever has sometimes the inflammatory, at others the typhoid, character. Thus are presented the bilious remittent fever of damp and warm climates, the yellow fever of the West India islands, the jail fever of crowded prisons, and the plague in Eastern countries.

On Cullen's genera. It will be perceived that under the appellation of fever we confine ourselves to the consideration of what has been by way of distinction termed simple fever, and perhaps with propriety regarded by Mr. Wilson as "the only general disease," other diseases being either local, or general and local. Thus the sensitive irritated fever of Darwin, which forms principally the phlegmasia of Cullen, is a disorder either symptomatic of, or at least supported by, local irritation.

The genera of Dr. Cullen of continued fever, are,

1. *Synocha.* "Great heat, pulse frequent, strong, and hard; high-coloured urine, the functions of the sensorium not much impaired." Such character, however, does not answer to any case of simple fever; it is the definition of what Dr. Brown calls the sthenic, which is opposed to the true febrile state.

2. *Typhus.* "A contagious disease, the heat not much increased, pulse frequent, small, and weak; urine little changed, sense much impaired, and the strength greatly diminished." This definition approaches nearest to the more usual form of fever in this country. That part of the definition, however, is extremely defective which describes the heat as not much increased.

3. *Synochus.* This is made by Cullen a kind of intermediate disease between synocha and typhus.

Exciting causes of fever. On this subject the most opposite opinions prevail. It is imagined by some, that no case of genuine fever, beyond those ephemeral irritations which are of daily occurrence, can possibly originate without the previous application, either through the medium of the lungs, or the surface of the body, of a certain something generated in the system of another individual in the course of the same disease. Others infer, from the daily observation of febrile diseases where no communication with the sick can be traced or suspected, that although the febrifacient matter just spoken of be in many, it is not in all instances the cause of fever; that cold, damp, heat, putrid exhalations whether animal or vegetable, insufficient ventilation, the depressing passions, &c. are all, either singly or in conjunction, capable, under some circumstances, not merely of predisposing to, but of actually engendering, proper fever. Lastly, there are some who consider contagion, or the generation in fever of specific febrifacient matter, as totally imaginary; and conceive in instances where fever has spread by communication, that either certain undetected conditions in the air, or the confined effluvia of animal excretions accumulated by want of cleanliness and ventilation, with other circumstances, are causes sufficiently adequate to produce the affection, without supposing the agency of a specific and occult power. "It is from nastiness," says one of the most celebrated of the anticontagionists, "degenerating into infection by chemical changes, that the bodies, clothes, beds, and apartments, of the poor in Great Britain, derive their poisonous, their pestilential charge. By a common putrefactive process, this *septic venom* is formed, and derives none of its qualities from pulsating arteries or glands. Away then with this preposterous phrase, 'from the poison engendered by septic processes.' Let human contagion for the future mean nothing but small-pox, vaccinia, and the kindred forms of morbid secretions." (Dr. Rush.)

Notwithstanding, however, the circumstances here pointed out and rested upon, we conceive the general facts to be in favour of poison engendered, independant of mere putrefaction or filth; and we shall shortly state the grounds upon which our opinion is established, when upon the subject of preventing the spread of fever. That contagion, however, is absolutely requisite to the production of this disorder, in every instance, does not seem an opinion authorized by facts, although it must be admitted that the negative is incapable of proof; for when we refer to its generation from mere filth and sloth, under the circumstances just mentioned from Dr. Rush, it may be replied, that contagion in such cases might have been in some manner conveyed without suspicion, and that the situation of the recipient constituted merely a predisposition to suffer from its application.

A contest has likewise arisen respecting the production of intermittent as well as continued fever. Intermittent fevers are observed to prevail especially in situations the soil of which is marshy: on this account it has been imagined, that they are invariably consequent upon a certain taint or miasma arising from moist ground. "The similarity of the climate, season, and soil, in the different countries in which intermittents arise, and the similarity of the disease, though arising in different regions, concur in proving that there is one common cause of these diseases, and that this is the marsh miasma." (Cullen.) Dr. Brown and others have contended, that the noxious influence of cold or of heat, "when the common asthenic noxious powers accompany either," are sufficient to occasion genuine intermittent. It however appears an established principle, that intermittent fevers are most frequently the offspring of poison arising from marshes or moist ground. That other causes act in conjunction, and augment the predisposition, is likewise an established fact; for the agues of marshy countries occur most abundantly at cold seasons which have succeeded hot ones, and especially amongst those whose diet has been innutritious and unstimulating. It is also beyond dispute that mere cold or poor living will induce ague after the habit has been once established.

Proximate cause of fever. On this subject the following errors appear to have misled systematics. 1. A want of distinction between final and proximate cause; between enquiries instituted in order to divine the intentions of nature, and a careful examination of the phenomena of nature as they occur in sequence. 2. The indivisibility of the body, and the universal nature of the disorder, have been too much overlooked. Fever has been considered as an affection of parts rather than of the universal system. 3. An error which appears to result from the conjunction of the two former; that shrinking and coldness of the external surface, which is merely a consequence and concomitant effect resulting from a febrile attack, has been viewed as a cause of the other symptoms which present themselves in the course of the affection.

"The remote causes of fever," says Dr. Cullen, "are certain sedative powers applied to the nervous system, which diminishing the energy of the brain, thereby produce a debility in the whole of the functions, and particularly in the action of the extreme vessels; this debility proves an indirect stimulus to the sanguiferous system, whence by the intervention of the cold stage, and spasm connected with it, the action of the heart and larger arteries is increased, and continues till it has had the effect of restoring the energy of the brain, of extending this energy to the extreme vessels, of restoring therefore their action, and thereby especially overcoming the spasm affecting them."

In the historical sketch of the progress of medical theory with which we introduced the present article, it was observed that the spasmodic theory of Hoffman engendered that of Dr. Cullen. In the hands, however, of this last systematist, the doctrine in question appears to have received mutilation rather than amendment: Dr. Cullen added another set of entangled links to the previously entangled chain. The shrinking, coldness, and general inactivity, observed at the commencement of fever fits, and which are the necessary consequences of the sudden quiescence throughout the system, induced by the peculiar action of the noxious powers producing fever, our author considers as one of nature's first steps in obtaining relief and obviating the progress of the disorder.

On this theory we may in the first place remark, that when the progress of a febrile affection is arrested by remedies applied during the first or cold stage, both the torpor of the brain and the shrinking of the surface may be removed without the intervention of the hot fit. Indeed, obviating the recurrence of this constitutes the cure of fever. The succession, then, of the hot fit is not a necessary consequence of the previous cold one, much less is it an agency contrived by nature to remedy this last. The theory is likewise "erroneous, in as far as it enters into the supposed intentions of nature."

Secondly, the action of the heart and larger arteries is not, as is justly observed by Dr. Darwin, occasioned in the mechanical manner of reaction, which the theory we are canvassing supposes. During the continuance of the cold fit, the whole circulation is lessened, or in a manner suspended, the blood is not retreating for safety to the centre, less blood passes through the lungs as well as through the vessels on the surface of the body; the fortress, and not merely the outposts, has received the attack of the enemy.' Now, when the hot fit comes on, the marks of irritation, or as Dr. Brown happily terms it, of "counterfeited vigour," by which it is characterized, are merely consequent upon the natural stimuli acting upon accumulated irritability, of irritability accumulated by the previous quiescence of the cold stage, and are not to be attributed to the blood's reacting and flowing back in order to influence and occupy the parts and cavities which it had deserted. This supposed action and reaction cannot indeed take place in that mode and to that extent which our theorists imagine. The human body is a living and not an hydraulic machine. The blood is not dammed up at one part in order to rush with violence into another. To illustrate: When even a part of the body only, as the hand, is immersed in water, or in any other way abruptly exposed to a diminished temperature for a short period, a lessened fibrous or vital action is the immediate consequence, the sensorial power or excitability accumulates in a corresponding ratio, and when the part is now again subjected to the influence of those powers which were previously operating, an irritative and disturbed, in place of regular and healthy, action succeeds; the blood, however, does not flow into the empty vessels like the waters of a river into lateral channels: not more than the same volume of blood, in cases of much weakness not so much, now circulates through parts, the excitability of which has been changed, and an accelerated, but not, properly speaking, increased motion, with febrile heat, is the consequence.

We have perhaps conceded too much to the spasmodic theory of fever, in likening the state of the surface in the cold fit to that produced in consequence of diminished temperature, for in this last the shrinking is directly produced; whereas, in fever, it is occasioned indirectly, or, as we have previously noticed, is merely one of the effects arising from the general interruption of the functions. Fever does not commence by attacking exclusively "the extreme vessels and the capillaries of the surface."

The spasmodic theory of fever then, is not only a substitution of terms for an explanation of facts, but even the phraseology which it employs in order to trace and connect the leading symptoms of the malady, appears to be deduced from defective knowledge of the laws and qualities of life. It is physically, metaphysically, and practically wrong. "Fever fits are not efforts of nature to relieve herself." Darwin.

Before proceeding further, it may be proper to notice one or two defects, as they appear to us, in the ingenious theory of the author of Zoonomia. In our remarks on nosology, the mistakes which Dr. Darwin had been led into from his untenable division of sensorial power, were hinted at. These mistakes appear to us to be evident in the learned author's attempts to form a sympathetic theory of the disorders under notice: a theory, which, in our opinion, involves the second error which we have above stated, viz. that of overlooking the indivisibility of the body, or the universal distribution of sensorial power, and regarding fever rather as an affection of parts than of the whole frame. It likewise, by consequence, embraces the erroneous doctrine of ascribing the secondary actions in fevers to the cutaneous torpor. The cold fit of simple fever, says Dr. Darwin, consists of a torpor of the cutaneous capillaries, with their mucous and perspirative glands, which is extended by direct sympathy to the heart and arteries. The torpor, however, of the heart and arteries is coexistent with, and not consequent upon, the inaction of the cutaneous vessels; the sensorial power residing in the former at the time of an attack of fever, must be affected in the same manner as the sensorial power of the latter; and the admission of association, is the introduction of an unnecessary link in the chain of cause. That distant parts sympathize with each other, in a manner which physiology has not hitherto been able to unfold, as the stomach with the surface of the body for example, is admitted; in the case of fever, however, we wish particularly to insist upon such sympathy as an explanation of symptoms being superfluous: the heart and arteries, the stomach, the surface of the body, the secretory glands, all receive a diminution or sudden interruption of their functions at the same moment of time, and from the same cause: they are simultaneous and not successive effects. Dr. Darwin seems equally unfortunate in referring the hot skin and remaining quiescence of some internal organs, as of the stomach, in the second stage of fever, to reverse sympathy. Sympathy cannot be direct in one instance, and reverse in another: "The laws of association are invariable, or they do not exist."

What then is the cause of fever? It is an abrupt suspension and consequent disruption of all the connected movements of the animal frame by which the balance of excitement is overthrown, "the laws of excitability are changed, and in consequence of which the same agents no longer produce the same effects. Fever differs from debility inasmuch as the latter is a gradual and regular exhaustion, not an abrupt interruption of the powers of life; it differs from strength, as strength consists in a powerful and equable excitement, while fever, however it may "counterfeit vigour," is never attended by the necessary constituent of vigour, regular and orderly display of power.

The primary cold, or as the Latins term it, "horror," is from the quiescence that has been induced; during this state of quiescence, a new and inordinate condition of the excitability is established, and by consequence both the external and internal stimuli excite perturbed in the place of orderly and usual actions: action without power commences; hence morbid heat is generated, diseased associations are formed, and without being in a state of actual weakness, the whole system sinks, oppressed. The plain indications of

Treatment in fever, are therefore to break the morbid associations on which this oppression is established, or obviate the symptoms by which it is continued; to diminish the cold in the cold stage, the heat in the hot stage, and not to await the sanative process of nature, either of dissolving spasm, or of correcting and expelling morbific matter. The various remedies employed for these purposes are, the external and internal use of cold and warm water; refrigerants, sudorifics, opiates, emetics, purgatives: on each of these, we shall introduce a few separate remarks; in the course of which an opportunity will be afforded, of enquiring more minutely into the pathology of the febrile state.

Of cold and tepid affusion, and ablution.—Cold water internally.—Cold air.—The medical reports of Dr. Currie, on the effects of water cold, and warm, in the treatment of fever, are introduced in the following manner:

Narrative of Dr. Wright:

"In the London Medical Journal for the year 1786, Dr. William Wright, formerly of the island of Jamaica, gave an account of the successful treatment of some cases of fever, by the ablution of the patient with cold water.

"On the 1st of August, 1777," says Dr. Wright, "I embarked in a ship bound to Liverpool, and sailed the same evening from Montego-bay. The master told me he had several sailors on the same day we took our departure, one of whom had been at sick quarters on shore, and was now but in a convalescent state. On the 23d of August, we were in the latitude of Bermudas, and had had a very heavy gale of wind for three days, when the above-mentioned man relapsed, and had a fever with symptoms of the greatest malignity. I attended this person often, but could not prevail on him to be removed from a dark and confined situation to a more airy and convenient part of the ship; and as he refused medicine and even food, he died on the eighth day of his illness.

"By my attention to the sick man, I caught the contagion, and began to be indisposed on the 5th of September; and the following is a narrative of my case, extracted from notes daily marked down: I had been many years in Jamaica, but except being somewhat relaxed by the climate and fatigue of business, I ailed nothing when I embarked. This circumstance, however, might perhaps dispose me more readily to receive the infection.

"Sept. 5th, 6th, 7th: Small rigours now and then; a preternatural heat of the skin; a dull pain in the forehead; the pulse small and quick; a loss of appetite, but no sickness at the stomach; the tongue white and slimy; little or no thirst; the belly regular; the urine pale and rather scanty; in the night restless with starting and delirium.

"Sept. 8th. Every symptom aggravated; with pains in the loins and lower limbs, and stiffness in the thighs and hams.

"I took a gentle vomit on the second day of this illness, and next morning a decoction of tamarinds; at bed-time an opiate joined with antimonial wine; but this did not procure sleep or open the pores of the skin. No inflammatory symptoms being present, a drachm of Peruvian bark was taken every hour for six hours successively, and now and then a glass of port-wine, but with no apparent benefit. When upon deck my pains were greatly mitigated, and the colder the air the better. This circumstance, and the failure of every means I had tried, encouraged me to put in practice on myself, what I had often wished to try on others, in fevers similar to my own.

"Sept. 9th. Having given the necessary directions, about three o'clock in the afternoon I slipt off all my clothes, and threw a sea-cloak loosely about me till I got upon deck, when the cloak also was laid aside: three buckets of salt water were then thrown at once upon me; the shock was great, but I felt immediate relief. The head-ache and other pains instantly abated, and a fine glow and diaphoresis succeeded; towards evening, however, the same febrile symptoms threatened a return, and I had again recourse to the same method as before, with the same good effect. I now took food with an appetite, and for the first time had a sound night's rest.

"Sept. 10. No fever, but a little uneasiness on the hams and thighs; used the cold bath twice.

"Sept. 11. Every symptom vanished; but to prevent a relapse I used the cold bath twice. Mr. Thomas Kirk, a young gentleman, passenger in the same ship, fell sick of a fever on the 9th day of August; his symptoms were nearly similar to mine, and having taken some medicines without experiencing relief, he was desirous of trying the cold bath; with my approbation he did on the 11th and 12th of September, and by this method was happily restored to health. He lives at this time (Jan. 1786) near Liverpool."

We have thus presented our readers with this important narration of Dr. Wright, both as it furnishes a history of fever, as it details the mode in which the cold affusions should be employed, and as it was confessedly the means of introducing this most valuable remedy into general practice. We shall now add from Dr. Currie the more particular rules which ought to govern the use of the affusion or aspersion of cold water in fevers, and then make one or two observations on the nature of its operation.

"The safest and most advantageous time," says Dr. Currie, "for using the cold water is, when the exacerbation is at its height, or immediately after its declination has begun; and this has led me almost always to direct it to be employed from six to nine in the evening; but it may be safely used at any time of the day, *when there is no sense of chilliness present, when the heat of the surface is steadily above what is natural, and when there is no general or profuse perspiration.*—These particulars are of the utmost importance: for, 1st. If the affusion be used during the cold stage, the respiration is nearly suspended; the pulse becomes fluttering, feeble, and of incalculable frequency; the surface and the extremities become doubly cold and shrivelled, and the patient seems to struggle with the pangs of instant dissolution. I have no doubt, from what I have observed, that in such circumstances the repeated affusions of a few buckets of cold water would extinguish life. This remedy should therefore never be used when any considerable sense of chilliness is present, even though the thermometer applied to the trunk of the body, should indicate a degree of heat greater than usual.

"2nd. Neither ought it to be used, when the heat measured by the thermometer is less than, or even only equal to, the natural heat, though the patient should feel no degree of chilliness. This is sometimes the case towards the last stages of fever, when the powers of life are too weak to sustain so powerful a stimulus.

"3d. It is also necessary to abstain from the use of this remedy under profuse sensible perspiration, and this caution is more important in proportion to the continuance of this perspiration."

"Under these restrictions," our author adds, "the cold affusion may be used at any period of fever; but its effects are more salutary in proportion as it is used early. When employed in the advanced stages of fever, where the heat is reduced and the debility great, some cordial should be given immediately after, and the best is warm wine."

Observations. Cold water, as a remedy for fever, may be conceived to operate upon a twofold principle. In the earlier stages, and before the vital power is too much harassed and oppressed to endure a violent shock, the copious and sudden affusion of cold water all over the naked body, appears to effect its beneficial purposes in part by the abruptness of its agency; it in a manner severs the chain of diseased associations, and restores the healthy and orderly movements of the frame. This operation is not, as has been suggested, mechanical: it is in some measure similar to that produced by the operation of an emetic, to which it is in every respect greatly preferable, or to sudden mental agitation. In the language of the schools, it cuts short fever.

When, however, the diseased associations are more firmly established, and the vital power greatly oppressed by the disorder's continuance, although the surface of the body retains its morbid heat, the water is to be applied, not in the way of sudden affusion, but by washing with a spunge, and this under the restrictions enjoined by Dr. Currie, or we may safely say, while it is found genial to the patient's feelings, ought to be resorted to in every case of simple fever. The action of the water at this time is somewhat different from that in the previous period, or under different circumstances of the disorder. It proves a direct stimulus. But how, it has been urged, can the negative of a power prove stimulative? "Darkness might as well be called a stimulus to the eye, or hunger a stimulus to the stomach, as cold to our sense which perceives heat." Darwin. To this it has been replied by Dr. Currie, and before him by Dr. Beddoes, that the objection is founded upon a disregard of the sentient principle: "Cold," says the latter author, "may very often be so applied as, by removing the very disagreeable sense of heat, that attends some diseases, to produce an effect equivalent to stimulation. It is, I believe, exactly in this way, that bathing the body with cold water proves serviceable in low fevers."

From the urgency, however, of the debility, or from the prejudices of the patient or his friends, in some periods of fever, even the application of cold water in the way of ablution may be regarded as too severe. In this case tepid ablution has been made to supply its place, and often with propriety and success; it is, however, particularly deserving of remark, that unless this last be used with precaution, the object of the practitioner in its choice is defeated, as the evaporation from the surface is more copious from the tepid affusion; and this is one of the most powerful, indeed, strictly speaking, the only means of abstracting heat. The term tepid is applied by Dr. Currie to water, from 87° to 97° of Fahrenheit; from 87° to 75° the water is denominated cool. Cold water may be given internally, and with the utmost freedom, in the hot stage of the febrile paroxysm. Its use, however, requires to be carefully regulated by the same restrictions as in the external application; it must never be given unless the heat of the surface be steadily above the natural standard. Draughts of cold water have been known, when properly administered, to procure a sudden solution of the disease.

Cold air. The extraordinary melioration in the modern practice of medicine, as it relates to the treatment of fever and febrile diseases, is not confined to the copious use of affusion and ablution. The terrors of our predecessors, in relation likewise to cold air, are fast departing; and the importance of its free admission in the apartments of the febrile sufferer especially, comes to be generally acknowledged and applied. It has been stated by a physician, above all praise for fidelity of observation and justness of remark, that the corrupted air of sick rooms, from neglect of ventilation, has been much more fatal even among the higher classes of society, than the virulence of the disease itself: "Vereor ne quidam ægroti non tam morbo suo perierint, quam halitibus putribus, quos discuti vetuit præpostera amicorum cura." Heberden.

The utility of cold air in fever is referable to two principles: 1st. That of immediately lowering the heat of the surface, and thus taking off the oppression occasioned by such heat: and 2ndly, from affording a larger quantity of oxygen at each inspiration. The first of these principles is sufficiently evident, and does not require any further illustration: if cold ablution prove beneficial chiefly by virtue of diminishing the temperature of the body, it necessarily follows that coldness in the circumambient atmosphere must be attended with precisely similar effects: but on the purity, as connected with diminished temperature of the atmosphere, it may not be improper to embrace the present opportunity of offering one or two remarks. A given bulk of air at an inferior temperature, contains more of the oxygenous principle than the same quantity at a superior degree of heat; hence the greater refreshment which is experienced from the inhalation of a cold and dense, over that of a warm and rarefied atmosphere; hence, in part, the more vigorous digestion and keen appetite of a healthy individual during the winter, than the summer months; and finally, by the relief a febrile patient experiences from the inspiration of such air, it is rendered evident, both that the heat of fever originates, and is kept up, independently of those organs which modern chemistry and physiology have supposed to be the sole organs for the supply of heat to the living system. From this fact Dr. Reid infers, and we think with justice, that the constant equality of animal temperature in a condition of health, has more dependance upon living actions in general than upon the chemical evolution of caloric in the lungs, according to the ingenious theory first suggested by Dr. Crawford, but since materially modified. See PHYSIOLOGY.

But the frigorific virtue of a more oxygenous atmosphere, when received into the lungs of a febrile invalid, is a further proof, that however violent the reaction, as it has been erroneously called, such reaction is, in every case of genuine fever, far from being an evidence of actual increase of power. Whatever theory we adopt respecting the precise mode in which pure air influences the animal economy, an uniformity of opinion must prevail, that it is, in the strictest sense of the word, an exciting agent. Now as far as it operates beneficially in fever, it reduces the inordinate heat; that power then which actually and properly excites, by this very agency moderates the turbulent action, and by consequence reduces the prevailing morbid heat. The admission of cold air requires likewise to be restricted to the hot stage, and to be limited by the patient's feelings; a current of cold air passing rapidly over the body while in a state of perspiration, may be productive of fatal consequences.

Of refrigerants in fever. Besides, however, the employment of cold water, and the free admission of a cool and pure atmosphere, other agents have been had recourse to, and with considerable effect, in order to abate the inordinate heat of fever. From possessing the faculty of cooling the system, certain medicines have been distinguished by the term refrigerants: refrigerants are principally chosen from the vegetable acids, and the different neutral salts; and so evident is their power in reducing animal temperature, that they have properly been made to constitute a considerable part of regimen in fever. Indeed nitre, and other neutral salts, with the vegetable acids, have been received into some systems of classification, under the distinct head of febrifuge medicines. The modus operandi of refrigerants has not perhaps hitherto received explanation; the substances of which they are composed are for the most part those which contain oxygen in a concentrated, and, at the same time, loose state of combination; from this circumstance, their action has been ingeniously but not perhaps satisfactorily accounted for. "It has been sufficiently established," says a modern writer, "that the consumption of oxygen in the lungs is materially influenced by the nature of the ingesta received into the stomach; that it is increased by animal food and spirituous liquors, and, in general, by whatever substances contain a comparatively small quantity of oxygen in their composition. But the superior temperature of animals is derived from the consumption of oxygen gas by respiration; an increase of that consumption must necessarily, therefore, occasion a greater evolution of caloric in the system, and of course an increase of temperature, while a diminution in the consumption of oxygen must have an opposite effect. If, therefore, when the temperature of the body is morbidly increased, substances be introduced into the stomach, containing a large proportion of oxygen, especially in a state of loose combination, and capable of being assimilated by the digestive powers, the nutritious matter received into the blood must contain a larger proportion of oxygen than usual; less of that principle will be consumed in the lungs, by which means less caloric being evolved, the temperature of the body must be reduced; and this operating as a reduction of stimulus, will diminish the number and force of the contractions of the heart." Murray's Materia Medica.

This reasoning is perhaps more specious than just. In the first place, the remarks which we have above introduced on the actual diminution of febrile heat from inhaling an oxygenous atmosphere, seem to oppose the theory of refrigeration, from " less of the oxygenous principle being consumed in the lungs." Secondly, it may be noticed that the effects of these medicines are too speedy and direct to admit of the supposition of this intermediate kind of agency; and thirdly, although the refrigerantia are for the most part, they are not universally, substances which contain this suberabundance of the oxygenous principle. The saline draught, for example, appears to moderate febrile heat, principally by reason of the carbonic acid gas that it contains.

Chemical reasoning has recently been extensively applied to the developement of the mode in general in which the functions of the stomach and lungs are connected, and as this enquiry is closely related both to the theory of febrile heat, and the dietetical as well as the medicinal management of the febrile invalid, it may not be improper to detain the reader by one or two further reflections on this very interesting point of discussion. It is an axiom of Hippocrates, that animal food should not be given in fever; an axiom which was no doubt founded upon observation of its general irritating and disordering tendency. Modern physiology, however, has not rested content with a knowledge of the fact, but has endeavoured to divine its immediate cause. That digestion of the food is, cæteris paribus, in proportion to the oxygenation of the blood; or to avoid an expression involving theory, to the purity of air and freedom of inspiration, which an individual enjoys, is without question; and it is further evident from daily observation, that the facility of assimilating animal food, in particular, is increased by air, exercise, and whatever promotes an uninterrupted circulation through the pulmonary organs. Hence it is said, we are furnished with an explanation why animal diet is uncongenial to the patient in fever. The pulmonary circulation is impeded by febrile oppression, less oxygen is received from the atmosphere, and the power of assimilating materials which contain the hydrogenous and azotic principles in abundance is consequently weakened, or, as we have heard it expressed still more chemically, less fuel or combustible matter is required, on account of there being less power of consuming such fuel, or of maintaining combustion.

Perhaps the peculiarity or distinct nature of living action, has not been sufficiently attended to by modern physiologists of the chemical school. That hypothesis, the outline of which we have just delineated, appears at first sight perspicuous and unobjectionable, but when pursued more in detail, facts present themselves which are in some measure at variance with its fundamental principles.

Animal food may, perhaps, prove less congenial to the patient in fever, than under circumstances of debility without febrile disturbance, on account of the direct irritation it communicates to the fibre, independantly of its chemical properties; the difference between animal and vegetable diet in this particular, is abundantly obvious. But it may further be urged, that several materials taken into the stomach during the burning heat of fever, appear to be productive of nearly similar effects, in their immediate operation, with a diet of animal food; of this we have an instance in opium. Opium, which when duly administered is congenial and salutary, when given while the skin is dry, and there is no disposition to perspiration, proves irritating and hurtful; it still further impedes the weakened digestive organs, augments the tendency to costiveness, and increases febrile heat. These properties it surely does not possess by virtue of the quantity of hydrogen or azote that it contains.

Of Sudorifics.

We now proceed to consider the agency of sudorifics as febrifuge remedies. Moisture on the surface of the body may be procured by medicines which appear to have a direct power over the cutaneous vessels, or by those whose action seems to be directed primarily to the stomach. These last are principally of the saline class, which are by far the most suitable in the febrile state.

The physiology of perspiration, and the principles by which it operates as a cooling process, are, notwithstanding the recent discoveries in chemistry, and their application to this interesting subject, still involved in much obscurity.

The ancients imagined sweat to be not merely an excrementitious product, but the vehicle of conveying that morbific matter out of the body which had been the occasion of disease. This opinion does not, in the present state of science, require to be confuted. The questions of most interest, respecting the phenomena and causes of perspiration, are, in what relation does it stand to the respiratory function; and is that moisture on the surface of the skin which closes a febrile paroxysm, to be regarded as a cause or consequence of the disorder's declination?

" That an animal," says Dr. Currie, " possesses to a certain extent the faculty of rendering sensible heat latent, or, to speak more philosophically, of reducing caloric from a free to a combined state, in cases in which the stimulus of heat might otherwise overpower the living energy, there is reason to believe, from a variety of experiments and observations; and that this is in part performed by perspiration from the surface can scarcely admit of a doubt. The process of perspiration, which is continually going on from the surface of the body, is in this point of view the converse of respiration; as in respiration a gas is constantly converted into a solid or fluid, and thus heat evolved, so in perspiration a fluid is constantly converted into a vapour, and thus heat is absorbed. A vessel filled with water and exposed to the atmosphere, cannot be raised above 220° of Fahrenheit by any quantity of fuel, because, heat is applied from below, evaporation carries it off from the surface; in like manner we may suppose the heat of the living body to be kept uniform, by the evaporation from its surface increasing or diminishing, according to the quantity of heat extricated from the system, or received from the surrounding medium."

These speculations are beautiful and highly ingenious. It however admits of question, whether Dr. Currie, in applying them to the subject of febrile heat, may not have given too much weight to the analogy of absorption of caloric in inanimate matter, as explanatory of the cooling process in the living body; and whether sensible perspiration, produced by medicine or otherwise, may not be consequent upon, rather than prior to, the diminution of febrile heat? If, for example, a large quantity of water be swallowed in the height of a febrile paroxysm, and be directly succeeded by general diaphoresis, or sweat, with relief from the burning sensations of fever, although it be natural to attribute such relief to the sweat that is produced, this last may be subsequent to that altered condition of the fibre by which the evolution of caloric is diminished. Such an opinion has been ingeniously argued by Dr. Reid; and if the following observations of Dr. Darwin are just, they appear to place the matter beyond dispute. " The perspirable matter," says this last author, " is secreted in as great quantity during the hot fit of fever, as towards the end of it, when the sweat is seen upon the skin. But during the hot fit, the cutaneous absorbents act also with increased energy, and the exhalation is likewise increased by the greater heat of the skin; and hence it does not appear in drops upon the surface; but is in part reabsorbed and in part dissipated in the atmosphere. But as the mouths of the cutaneous absorbents are exposed to the cool air or bed-clothes; while those of the capillary glands, which secrete the perspirable matter, are exposed to the warmth of the circulating blood; the former, as soon as the fever fit begins to decline, lose their increased action first; and hence the absorption of sweat is diminished, whilst the increased secretion of it continues for some hours afterwards, which occasions it to stand in drops upon the skin. As the skin becomes cooler, the evaporation of the perspirable matter becomes less as well as the absorption of it. And hence the dissipation of aqueous fluids from the body, and consequent thirst, are perhaps greater during the hot fit than during the subsequent sweat. For the sweats do not occur, according to Dr. Alexander's experiments, till the skin is cooled from 112 to 108 degrees of heat; that is, till the paroxysm begins to decline. From this it appears that the sweats are not critical to the hot fit, any more than the hot fit can be called critical to the cold one, but simply that they are the natural consequences of the decline of the hot fit. And from hence," continues our author, " it may be concluded, that a fever fit is not an effort of nature to restore health, but a necessary consequence of the previous torpor; and that the causes of fever would be less detrimental, if the fever itself could be prevented from existing, as appears in the cool treatment of the small pox."

Of Purgatives and Emetics.

Nothing, perhaps, is of greater moment in almost every stage and every kind of fever, than to preserve the whole of the alimentary canal free from accumulations of colluvies, &c. From a deficient attention to this principle, the medical practitioner is in many instances foiled in the treatment of this, and indeed in a variety of other diseases. Viscidities and impurities in the stomach and bowels, are often both effect and cause of the persistance of the febrile state; for as the powers of assimilation are weakened by the induction of fever, so the consequent accumulations of foreign matter in the alimentary and intestinal canal, themselves prove direct sources of irritation and disorder. In the primary stages of fever, an emetic has been known abruptly to arrest its progress, and the same purpose is sometimes accomplished, especially in ephemeral affections of the febrile kind, by the employment of a brisk purgative. In the more advanced periods however of the disorder, the object of the physician ought to be rather that of keeping the bowels gently open, and this is best effected by saline in place of drastic purgatives; the former of which principally operate by exciting the exhalants on the internal surface of the intestines to pour out their contents, the latter by stimulating in a forcible manner the intestinal fibre.

It is a fact worthy particular notice in the treatment of fevers especially, that where due attention is given to ensure regular evacuations from the bowels, those stimuli, the copious use of which is often necessary to support the sinking powers in the last stages of the disease, are more freely admissible and abundantly more efficacious: this is indeed an important principle in the treatment of diseases generally; and it is perhaps chiefly by virtue of preserving the excitability in an orderly and due condition for the agency of other stimuli, that purgatives, like sudorifics, form so useful, and indeed the former, almost an indispensable, part of the remedial process in the greater number of aliments. In intermittent fevers it is generally necessary to evacuate the bowels by more stimulant cathartics, more especially when the cure of these fevers is conducted by the Peruvian bark.

Having thus discussed the nature, causes, and treatment of fever, it may be proper to present the reader with a recapitulatory view of the remedies which are required in the different forms of this affection: as a preliminary, however, to such recapitulation, we shall make one or two remarks on the more unfavourable symptoms with which fever is sometimes attended, and on the periods in which the disorder displays a greater or less disposition to terminate.

The unfavourable signs are, in the first place, an abrupt alteration of type. If during fever, indicating in its primary stages no particular severity of disease, a rapid change take place in the feelings and expressions of the invalid; if upon the more ordinary symptoms, suddenly and unexpectedly supervene delirium, prostration of strength, an observable change in the countenance, accompanied by irregular and partial alternations of heat and cold, without the intervention of the perspiring state, the patient's life is in considerable danger. The above changes are often indeed preludes to a speedy death.

Weakness, quickness, and irregularity of pulse, delirium, tendency to fainting when in an erect posture, prostration of strength, partial and irregular sweats, difficult respiration and deglutition, starting of the tendons, unusual fœtor in the excretions, great foulness of the tongue and fauces, are all evidences of a fatal tendency in the complaint; in general likewise it may be observed, that in cases where marks of great nervous irritation attend the onset of a fever, even though the disorder may not assume what has erroneously been termed the putrid type, much danger is to be apprehended. Indeed, the management of fever is not seldom rendered more difficult, and the indications of treatment less decided, from the absence of such type. Genuine nervous fevers are often the most obstinate and malignant.

In fevers of this kind, indeed, the heat is often so partial and irregular as not to admit of the cold affusion. Dr. Currie in his Medical Reports, describes a fever in which this remedy was tried without success. This fever, says Dr. Currie, does not appear to originate in contagion, or to be propagated by contagion.

Calculations respecting critical days have been in some measure forced and systematic. It is worthy however of remark, that continued fevers as well as intermittent, in the successive stages of their course, are disposed to assume progressively the quotidian, tertian, and quartan aspect.

Thus, if the fever has lasted more than a week, the ninth and eleventh days from its first attack are those on which we may anticipate its declination; after the second week the seventeenth and twentieth are the more usual days of termination. These, however, are by no means unexceptionable rules.

RECAPITULATION OF THE TREATMENT OF FEVER.

Treatment of continued fever during the first three or four days. Cold affusion. Water to be impregnated with salt, its application to be confined to the hot stages of the paroxysm. Large draughts of cold water taken under the same limitation. Cold and pure air. Emetics. Purgatives. Antimonial and saline sudorifics.

After the fifth or sixth day. Cold and tepid ablution. Water employed to be impregnated with salt or mixed with vinegar. In the urgency of debility, coldness, or delirium, pediluvium or the warm bath. Bowels to be kept gently but constantly open, by saline or mild purgatives and subacid drinks. While the skin is preserved moist by diaphoretics, give opiates and wine; these last are almost invariably improper when the skin is dry and hot, and the bowels costive. For head-ache and other nervous affections, blisters, æther, camphor. In the last stages, when critical sweats break out, and the powers of life appear to be shrinking from the contest, repeated glasses of port wine with tincture of opium in large quantities. During the whole course of the disease, the apartment to be diligently preserved cool, clean, constantly ventilated, and free from all individuals but those who are necessary attendants on the sick.

Treatment of intermittent fever. Cold affusion immediately upon the full accession of the hot fit. Warm bath, warm spiced wine, during the cold stage of the paroxysm. Tincture of opium, either previous to the accession of the cold, or towards the decline of the hot fit. Emetics, immediately preceding the accession of the paroxysm. Calomel purges before the administration of tonics; arsenic, zinc, Peruvian bark, quassia, and if any enlargement of one of the viscera (ague cake) appear, steel. Hope: upon the excitation of hope the power of charms altogether depends; these sometimes succeed in ague, when other remedies are counteracted by the violence of the complaint.

Although we have judged it expedient to enumerate the different medicines which in the event of fever's protraction may be requisite, it is proper to observe that the progress of the complaint may for the most part be abruptly arrested, and the necessity of other means of cure consequently superseded, by an early and judicious employment of the cold affusion. If the application of the water in the mode described in the narrative of Dr. Wright be objected to, a shower bath may be employed, or, what is an excellent and convenient substitute for the latter, a common gardener's watering-pot; the patient is to be taken out of his bed, if convenient, conducted or carried into an adjoining apartment, and the water poured from this instrument as hastily as it will admit of over his naked body; the skin is then to be quickly and effectually dried with towels, and the invalid reconducted to his bed; this course is to be repeated with the full recurrence of the hot paroxysm, even should this be on the same day, and continued, if requisite, on the following days, until the disorder's decline; or, in the pointed language of a modern writer, until "the fever be washed away." (Reid's Medical Reports, Monthly Magazine.)

Fever Houses, &c.

The rapid and extended diffusion of fever through families and districts might be deemed sufficient evidence in favour of matter engendered by febrile action, having the power to produce a similar disorder in another individual. The fact, however, appears to have been placed beyond doubt by the unfortunate result of several experiments made with sceptical temerity in order to prove the negative of this assumption.

While the writer of the present article was pursuing his studies in the Edinburgh university, several anti-contagionists, as these gentlemen were denominated, freely exposed themselves within what they regarded the imaginary sphere of contagion, in the wards of the infirmary of that city; many in consequence became infected with fever, and in some instances the disorder had a fatal termination. In these instances the production of the disease could not be referred to want of cleanliness, or to any peculiar condition of the atmosphere; for the fever did not extend to those gentlemen attending the hospital, who were fortunate enough to remain satisfied with the previous evidence in favour of contagion.

But with a knowledge of the evil, we have at length acquired a knowledge of its antidote; and it has been demonstrated by experiments upon a most extensive scale, that, whether the matter producing fever be introduced into the system by the lungs, the surface of the body, or the stomach, its power to infect extends but an exceedingly small distance—three feet at furthest—from the patient in whom it is generated, "when he is confined where the air has free entrance and egress." This fact, it has been well observed, "cannot be corroborated by too great a variety of testimony, nor repeated too often, until it shall be familiar not only to the most unlearned of the profession, but well known to the community at large." (Dr. Bateman.)

Its application with that of another fact immediately to be mentioned, has already gone a considerable way towards the actual extermination of febrile contagion.

This second fact is, that although infectious matter be rendered almost immediately inert by exposure to the air, it is capable of being rendered concentrated, and even transported to an unlimited distance, when made to come in contact with any material, even "a rag or a bit of lint," if such material be excluded from the air. From these, one should expect unquestionable premises, separate receptacles, apartments, and houses, have been exclusively devoted to the admission of the sick in fever, and, as we have just observed, with the most evident and extended benefit, particularly to the inferior classes of the community.

The example of fever institutions was set to the metropolis by the very active and laudable exertions of provincial physicians. In Chester, Manchester, Liverpool, Dublin, Cork, and other large towns in the British isles, the plan of thus separating the infectious fevers from other diseases, had already been adopted, and at length an establishment of this kind was founded in Gray's-inn-lane, in London, and with the happiest effects. Among the internal regulations of these houses, the following are the most important;—they have been adopted in the fever wards of common hospitals, and apply in a general manner to private practice.

Every patient when admitted into the house, is to change his infectious for clean linen; the face and hands are to be washed clean with warm water, and the lower extremities fomented. "The effect which this salutary change has upon the patient before any medicine is given, is often more beneficial than those which all the febrifuge drugs in the world could bestow." All discharges are to be speedily removed. The floors of the sick room are to be washed twice a week, and near the beds every day. The clothes which the patient brings with him are to be carefully purified by washing the linen, and exposure for a length of time of the other habiliments to pure air.

Blankets and other bed-clothes are to be exposed to the open and fresh air before they are used by another patient. Several windows of the apartment to be constantly opened in the day, unless the weather is very cold and wet; and some of them should not be shut in the night, if the patients are numerous, and the weather moderate.

By a due enforcement of these regulations, the necessity in general may be obviated of employing the acid fumigations recommended by Morveau, Carmichael Smith, and others, which have been ingeniously, and we think justly, imagined to operate upon the same principles with atmospheric or pure air, viz. by oxidating, and thus destroying the virulence of the contagious effluvia.

By cleanliness then, and procuring a free circulation of air, by guarding against the lodgment of contagious matter, and by keeping as much as possible from actual contact with the sick in fever, every cause is obviated from which infection can be communicated. The individual who resides in the house adjoining to a fever institution is equally out of the sphere of contagious influence with one at fifty miles distance; nay, in the contiguous apartment, and even in the sick room itself, the immunity is precisely the same: such are the preventive as well as the sanative effects of cleanliness and ventilation, which, whether in sickness or in health, cannot be too highly appreciated, or too extensively adopted.

ORDER II.—*Phlegmasiæ*, Inflammations.

When any part of the body has an unusual heat and redness, with pain and swelling, it is said to be inflamed. To constitute this state of a part, an inordinate action and dilatation of vessels have generally been esteemed sufficient. Such opinion, however, has been questioned by the author of Zoonomia. "Inflammation," says Dr. Darwin, "is uniformly attended with the production or secretion of new fibres, constituting new vessels; this, therefore, may be esteemed its essential character, or the criterion of its existence. The extension of the old vessels seems rather a consequence than a cause of the germination or pullulation of these new ones; for the old vessels may be enlarged and excited with unusual energy, without any production of new ones, as in the blush of shame or of anger." On the contrary, however, we are disposed to regard the formation of new vessels, which does not perhaps take place in every case even of genuine inflammation, to be subsequent to, and not the occasion of, capillary dilatation. The case which Dr. Darwin puts in opposition to this theory is not in point. It is permanent and forcible, not transient and slight, extension of blood vessels, which constitutes the inflamed state. The eye may be exposed to a vivid light, its vessels consequently act with more than ordinary excitement, and this to a certain extent without actual inflammation; but if such excitation be extended beyond a certain point, the small vessels of the organ shall be deprived of their proper resistance, and thus shall not merely transmit a more than due quantity of blood, but such blood shall in a manner become congested in their vessels, and shall cause pain, unusual redness, heat, and tumour. This induced weakness of the capillaries, ought then, perhaps, according to the opinion of some modern physiologists, to be regarded as the proximate cause of inflammation; the too great or too little excitement on which it may have depended the remote cause; and the increased action of the larger vessels of the part, the proximate effect. The augmented action, if considerable, is accompanied by an irritation of the whole system; such irritation constitutes the "sensitive irritated fever" of Dr. Darwin, which is distinguished from simple, or what we have considered genuine fever, by its being a sequente of local affection.

Sthenic and asthenic inflammation. The disturbance of the system does not correspond more with the magnitude of the local disorder, than with the constitutional character of the individual affected. Of two persons that are the subjects of inflammation, as of the mucous membrane of the nostrils, constituting inflammatory catarrh, or a cold; of the pulmonary vessels, occasioning inflammation of the lungs; or of the joints, forming rheumatism; one shall previously have possessed much constitutional vigour, the other shall have been languid and feeble—the former will have a sthenic, the latter an asthenic disease. This distinction in practice will be found of immeasurable importance. It was first distinctly pointed out by Dr. Brown. We believe, however, that this author was mistaken in the mode in which the inflammation of a part, and the disorder of the system, are connected; for the purpose of confirming his favourite tenet of sthenic and asthenic disorder, he laboured to prove that the systematic in many cases of inflammation actually preceded the local disease —this is not the case. Even in the most violent forms of pneumonia, the disorder of the lungs precedes that of the system; and indeed sthenic disorder, independantly of local irritation, is in some measure a contradiction in terms. High excitement, to whatever extent it may be carried, while there is no irregularity or want of balance in any of the corporeal or mental functions, and no affection of a part, cannot be properly regarded as a disease, however it may predispose to the diseased state.

Termination of inflammation. Inflammation is said to be resolved when the natural state and action of parts are renewed without disorganization. If, however, the inflammation has existed for any time, or has been violent, an unnatural secretion takes place from the vessels inflamed, which is called pus; this when collected or confined, constitutes abscess, and when the inflammation ends in this manner, it is said to terminate by suppuration. In cases of much weakness, constitutional or induced, the vascular action in the part shall cease altogether, its excitability be irrecoverably exhausted, and what in scholastic language is termed gangrene be the consequence, which extending, shall form sphacelus, or mortification. Resolution, suppuration, gangrene, are therefore the usual modes in which inflammation terminates. There are others, however, which are peculiar to certain parts; thus, an inflammation of the lungs often ends fatally by a copious effusion of a watery matter into the cellular texture of these organs; thus, an inflammation of a gland shall end in schirrus, or hardness of the parts, depending perhaps upon the deposition of matter which remains unabsorbed.

Species of inflammation. This disorder is systematically divided into two leading species—phlegmonous and erythematic. The first is defined by Dr. Cullen, "an inflammation of a bright-red colour, with a circumscribed pointed tumour, and tending towards suppuration." The erythema has a less vivid colour, with scarcely any tumour, spreading irregularly, burning rather than throbbing pain, and terminating in vesicles.

These species are principally established by the difference of part upon which the inflammation may happen to fall. Thus if the disorder be seated superficially, or in any internal part where there is an uninterrupted expansive or cellular texture, it will be erythematic or spreading; if it be more deeply lodged among muscular substance, it will be for the most part phlegmonic.

Indications of the disorder's decline. It scarcely requires to be observed, that a cessation of pain, a reduction of tumor, a loss of redness and heat, a diminution of the systematic disturbance, are all evidences that the inflammation is about to terminate. If, however, it be suffered to run on into the stage of suppuration, the indications of this state are, the pulse becoming fuller and softer, the patient being attacked with shiverings, and a pulsatory feel in the affected part. Again, the tendency to gangrene is denoted by the tumour losing of its redness, and assuming a darker hue; by the sudden cessation of pain; sometimes by blisters arising near or upon the tumour; and, lastly, if the local disorder have been considerable, by a rapid declension of the pulse, and powers of life.

Treatment. The indications of cure are to be deduced from the sthenic or asthenic disposition of the disease, and from the peculiar nature of the part or organ injured.

Before the time of Dr. Brown, action, at least inflammatory action, was too indiscriminately viewed as an evidence of power; the inference from this highly erroneous doctrine was, that inflammation almost invariably required for its cure a debilitating and evacuating plan of treatment. Nothing can be more inconsistent with the laws of the animal economy.

"It had been," says the author of the Elementa Medicinæ, "a prevailing opinion that the fits of the gout could not be constituted by debility, because inflammation accompanies them. This question he subjected to the test of experiment. He invited some friends to dinner; and by taking stimulants in their presence, recovered the most perfect use of that foot with which, before dinner, he could not touch the floor for pain. By this he saw, that not only the gout itself, but the inflammation accompanying it, was asthenic, that is, depending upon debility. Such he found likewise to be the nature of the inflammations in the gangrenous sore throat, in chronic rheumatism, &c. &c." The application of this principle in the practice of medicine has proved of incalculable importance. In conducting the cure, then, of inflammation, the physician is to be guided not so much by the extent and degree of the local injury, as by the nature of what Brown calls the prevailing diathesis; if inflammation be attended by a full, hard, and vigorous pulse, with other expressions of power, a debilitating plan of treatment is to be adopted; blood is to be drawn from the arm, saline purgatives are to be administered; cold, under the limitations immediately to be mentioned, is to be applied, and the exciting powers as much as possible withdrawn. If, on the contrary, an equal degree of local affection shall be accompanied with feeble, although quick, pulse, and the remaining symptoms of debility, an opposite plan, under certain regulations and exceptions, is to be pursued; stimulants are to be thrown in, and the inflammation cured by impelling and supporting the torpid and feeble powers of the frame. But from the peculiar nature of the part or organ affected, the mode of treatment in the same degree and kind of inflammation will likewise be materially modified. Thus an asthenic affection of the liver requires different stimuli from an asthenic affection of the stomach.

Again, although in inflammation, as in fever, we generally recommend the cool treatment, and consequent free admission of air, it is to be recollected that this principle is objectionable in some kinds of inflammations, as of the lungs. For example, in small-pox and in measles, we shall have the same degree of pyrexia, or fever, present; and cold air would be equally indicated in either, were we to infer the proper method of treatment alone from the inflammatory excitement; but in measles the lungs are often the principal seat of the local affection, an oxygenous or pure atmosphere would prove too stimulating to these organs; and thus if we pursued general doctrines without particular exceptions, or overlooked "the peculiar nature of the part or organ injured," the object of our plans would be frustrated and defeated.

As it relates to this important principle in medicinal agency, the system of Dr. Brown is exceedingly deficient. The peculiar susceptibility of the separate organs our author overlooked in the rapid and general survey which he took of the animal economy.

Genus I. *Ophthalmia*, inflammation of the eyes. See SURGERY.

Genus II. *Phrenitis*, inflammation of the brain. This, as a sthenic affection, independently of proper maniacal disorder, or febrile affection, is an extremely rare disease.

Symptoms. Redness of the face and eyes, impatience of light and sound, watchfulness, and furious delirium.

Methodus medendi. Copious evacuations. "Foment the head with cold water for hours together." Blisters. Blood to be drawn from the temporal artery.

N. B. The delirium of fever, which has been supposed to indicate an inflammation of the brain, is for the most part of an asthenic nature, and requires stimuli.

Genus III. *Cynanche*, quinsy.

Species 1st. Cynanche tonsillaris, common inflammatory sore throat.

M. M. Acid gargles. Saline purgatives. Blisters. Antimonial diaphoretics.

Species 2d. Cynanche maligna. An accidental, but very common, symptom of scarlet fever. See SCARLATINA.

Species 3d. Cynanche trachealis, croup. See INFANCY.

Species 4th. Cynanche pharyngæa, a mere extension into the pharynx of the cynanche tonsillaris.

Sp. 5th. Cynanche parotidæa. The mumps is an affection of the parotid and maxillary glands, which appears in the form of a swelling under the jaws: it is more common in some than in other counties of England. It sometimes appears as an epidemic. The mumps is in itself a slight disease; but after its declension, which is in general about the fourth day, the testes in men, and breasts in women, are very apt to be affected with swelling, in consequence of some peculiar sympathy of these parts with the throat.

M. M. If delirium supervene upon the retrocession of the swellings, blisters. "Foment the head with warm water." Darwin.

Genus IV. *Pneumonia*, inflammation of the lungs.

Genus V. *Carditis*, inflammation of the heart or pericardium.

Genus VI. *Peritonitis*, inflammation of the peritoneum.

The disorder which is usually termed inflammation of the lungs varies in some measure its seat. Thus the diseased action shall be directed towards that part of the pleura which is called the pericardium, and then it may be called carditis; or it may pass down the diaphragm, or the peritoneum, and form the peritonitis of Cullen, the diaphragmatis of Darwin.

The general symptoms are, pyrexia, pain in the chest, difficulty of breathing, cough; and, if the disorder happen in the sthenic diathesis, the pulse is hard and frequent. Sometimes the expectoration is tinged with blood.

The particular symptoms are, in carditis, palpitation, with unequal intermitting pulse, pain in the region of the heart, vomiting, fainting: if the inflammation be particularly directed to the diaphragm, the pain is situated towards the lower ribs, the respiration in a recumbent posture is extremely difficult, and the corners of the mouth are sometimes so retracted as to form a disagreeable smile, called risus sardonicus.

M. M. It is of the utmost importance to attend to the prevailing diathesis. If the constitution is sthenic, and the disorder urgent, immediate and copious bleeding. Refrigerant and emollient cathartics. Cool and equal, not cold and irregular, atmosphere. Diluent drinks. Total abstinence from animal food, sometimes during the first five days. Antimonial preparations. After venesection a blister on the pained part. Digitalis. In Dr. Currie's Medical Reports we find the following observations: "I have employed the digitalis to a very considerable extent in inflammations of the brain, of the heart, and the lungs; and have succeeded with it in cases where I otherwise should have despaired." In Dr. Reid's Treatise on Consumption we meet with an acquiescence in this sentiment on the fox-glove. Our experience, however, has taught us to value this remedy principally in other pulmonary affections than the more violent kinds of inflammation, as is mentioned under the head of phthisis. After the excitement has been moderated, opium in small doses. "Do neutral salts increase the tendency to cough?" Pediluvium. Small doses of calomel, to prevent adhesions.

N. B. If pneumonia run on into suppuration pus will be discharged by cough, and thus a species of consumption be formed; or will be detained in the cavity of the chest, and constitute empyema. In either case, digitalis in large doses. Calomel. Opium. Peruvian bark.

Genus VII. *Gastritis*, inflammation of the stomach.

Symptoms. Violent pain in the region of the stomach, with pyrexia; small, frequent, and sometimes contracted, pulse; vomiting; hiccough.

Causes. It may be occasioned by any thing acrid taken into the stomach; by blows on the region of this organ; and a slight species of it is often consequent upon taking cold liquids after exercise.

M. M. In inflammation of the stomach and bowels we have, in some measure, an exception to the general rule of cure, according as the disease appears sthenic or asthenic. The pulse and vital powers are often suddenly reduced, and yet venesection is required. Warm bath. Fomentations. Anodyne and mucilaginous clysters. Blisters on the pained part.

Genus VIII. *Enteritis*, inflammation of the bowels; fixed and distressing pain in the bowels. Pyrexia; pulse always quick, sometimes hard.

Causes. The same as of gastritis. Likewise strangulated hernia, spasmodic colic, intro-susception.

M. M. The same as in gastritis after the urgent symptoms have subsided. Small doses of calomel and opium.

Genus IX. *Hepatitis*, inflammation of the liver.

Symptoms. Pain in the region of the liver, extending to the clavicle and top of the right shoulder; difficulty of lying, on the left side especially. Pyrexia; high-coloured urine; pulse frequent, strong, and often hard. Bilious evacuations, or jaundice. The tendency of the disease is to suppuration.

M. M. Copious and repeated bleeding, before the suppurative process has commenced. Calomel, and cathartics of the refrigerant class. Digitalis in considerable doses. Blisters to the region of the liver.

If suppuration takes place, the matter makes its way through the lungs, or the intestinal canal, into the cavity of the abdomen, or through the peritoneum to the surface. During this process opium and bark.

N. B. The disease above described is principally an affection of warm climates. A species of chronic hepatitis is more usual in Britain, and indeed is one of our most common maladies, especially among dram-drinkers.

Symptoms. Obtuse and weighty kind of sensation in the region of the liver; difficulty of lying on the left side; pain in the right shoulder; the countenance slightly marked by hectic; dejection of spirits. Œdema of the ancles.

M. M. Small doses of calomel, with, or without, opium. Tonic bitters, such as quassia, or gentian. An abstinence from spirituous liquors.

Genus X. *Splenitis*, inflammation of the spleen.

Symptoms. Tension; tumor; heat of the left side; pyrexia; pain increased by pressure.

M. M. Blisters, cathartics, calomel, and digitalis.

Genus XI. *Nephritis*, inflammation of the kidneys.

Symptoms. Pyrexia; pain in the lumbar regions; retraction of the testicle; numbness of the thigh; vomiting; costiveness.

Causes. Alternations of heat and cold; external violence, &c. as in other inflammations, but chiefly calculi.

Distinctions. Nephritis is distinguished from lumbago by the more confined situation, and pungent character of the pain; by the presence of pyrexia; and by there being in the latter no retraction of the testicle, or numbness of the thigh. It is distinguished from incipient psoas abscess, by the pain of this last being principally seated in the vertebral column; by such pain being increased on pressure of this part; and by its taking the course of the psoas muscle. See SURGERY.

M. M. Venæsection. Digitalis, and opium. Nitrous æther. Emollient clysters. Castor oil. Demulcents.

Genus XII. *Cystitis.* Inflammation of the bladder.

Pyrexia. Pain and tumor above the pubes; pain in discharging urine; tenesmus.

M. M. Venæsection. Warm bath. Anodyne clysters. Diluents.

Genus XIII. *Hysteritis.* Inflammation of the womb.

Heat, pain, tension, and swelling in the lower belly; pyrexia; vomiting.

M. M. Venæsection. Mucilaginous clysters, with opiates. Anodyne fomentations.

Genus XIV. *Rheumatismus.*

Pyrexia; pains in the joints, frequently extending along the muscles; heat and tumor on the part.

Peculiarities. Rheumatic inflammations never, like others, terminate in suppuration. Dr. Darwin attributes this circumstance to the secondary and associate nature of the disease; the original cause, like that of the gout, not being in the inflamed part; and therefore not continuing to act after the inflammation commences. Perhaps the peculiarity would be more properly referred to the nature of the parts that rheumatism attacks.

Division. Rheumatism is sthenic, or asthenic: the latter, or chronic rheumatism, often succeeds to the former; which the author just quoted refers to the deposition of mucus, or coagulable lymph, which the inflamed vessels had poured out in the first stages, remaining unabsorbed on the membranes of the joints. It would probably be more correctly attributed to the loss of energy in the parts affected: an opinion which appears to receive support from the circumstance of the asthenic form of the complaint sometimes coming on in a direct way, without the intervention of the acute species.

M. M. Bleeding would appear to be indicated in the sthenic kind of rheumatism: in this disorder, however, the physician is so often unexpectedly foiled by the rapid occurrence of indirect debility, that venesection is almost never advisable; it lays the foundation for obstinate chronic complaint. Leeches to the inflamed joints. Volatile embrocations after the inflammation has in some measure subsided. Calomel, and opium. Sudorifics. Warm bath. "I have found digitalis an excellent remedy in inflammatory rheumatism, one of the most tedious and intractable of all diseases." Dr. Currie.

Peruvian bark in chronic rheumatism. Volatile tincture of gum guaiacum. Flesh-brush. Sea-bathing. Electricity. Bath waters.

Genus XV. *Odontalgia*, tooth-ache. See SURGERY.

Genus XVI. *Podagra*, gout.

Symptoms. Pain in the joints, principally of the great toe, and especially of the hands and feet, returning at intervals. Previously to the accession of the inflammation the functions of the stomach are generally disturbed. The fits generally come on in the morning.

Causes and peculiarities. Gout is invariably a disease of the asthenic diathesis. It is produced in a system predisposed to its influence by the indirectly debilitating powers; such as a too liberal indulgence in fermented and spirituous liquors, high-seasoned meats, &c. and likewise by the directly debilitating powers of vegetable and watery food, depressing passions, &c. The inflammation of this disease often alternates with, and appears in a manner vicarious of, torpor in other parts of the system; as of the brain producing apoplexy, the stomach constituting dyspepsy, and of the liver giving rise to jaundice: all which symptoms indeed may be considered as part of the disease. On this account gout has been divided into the atonic; that is, where a disposition to the inflammation of the foot is observable, but does not actually take place; the retrocedent, where, after the continuance for some time of such inflammation, it shall seem to be transferred to another part, and thus form a gouty inflammation of the stomach, or other organs; and, lastly, the misplaced, in which the gouty tendency, instead of displaying itself in its ordinary course, falls upon some other organs, as the lungs, the stomach, or the brain.

Dr. Darwin supposes "the original seat of the gout to be the liver, which is probably affected with torpor not only previous to the annual paroxysms, but to every change of its situation from one limb to another." For this principle of associate action there does not, however, appear sufficient support; and indeed the sympathy is displayed with more force and frequency between the inflamed foot and the organs we have above-mentioned (the stomach, the lungs, and the brain), than the hepatic viscus. It is indeed the nervous system, and not the glandular, with which the paroxysm of the gout appears to have the most intimate connection; and it would have found a more appropriate place under the head of nervous diseases, than where it now stands in the Nosology. It is, however, very often combined with calculary disorders. The predisposition to gout is evidently hereditary; but the attacks of this malady may, in general, be warded off, even from the most susceptible habit, by a temperate mode of living. This principle is illustrated in an extraordinary manner by the history of Dr. Gregory, the present professor of the practice of medicine in Edinburgh. We have often heard him in his lectures produce his own as an instructive case of the beneficial effects of abstinence from fermented and spirituous liquors. Gout has been imagined, like fever, to be a sanative process of nature for the purpose of expelling something from the constitution. The doctrine, in either instance, is equally erroneous.

M. M. In treating gout it should never be forgotten that it is an asthenic disease: while excitement is kept up in the system the paroxysms are suspended. Dr. Beddoes, in his Hygeia, says, that one of the greatest martyrs to gout he ever met with informed him, "that his freest year was that of a warmly contested election, at which he was candidate for a county. He both drank and exerted himself at this time more than at any period of his life." This evident principle of the asthenic nature, even of the actual inflammation in gout, ought to render the physician extremely careful in his application of the remedy lately introduced into practice, the application of cold water to the inflamed part. In some violent cases this may be proper; but it should never be extended beyond the limit of pleasurable sensation. To bleed is likewise hazardous in the extreme. Dr. Brown's mode of suspending the paroxysms has already been referred to; and every arthritic experiences temporary benefit from his dinner, his glass, and pleasurable company. It is by acting on the imagination that empirics suspend the threatened attacks of gout. In this, as in numberless other instances, faith in, constitutes the virtue of, remedies; both therefore in chronic rheumatism and gout, we might place among the curative agents metallic tractors, whether authorized by Perkins, or formed of old nails, as in the instructive experiments of Dr. Haygarth. Even a piece of sealing-wax, or stick, when supposed by the patient to be the genuine tractors, operated in a most astonishing manner. (Haygarth on Perkins's Tractors.) The influence of the imagination over the body, whether in health or disease, has not been sufficiently acted upon in the professional practice of medicine. The irregular affections in gout must be combated by stimulants carefully adapted to the excitability; for the spasmodic affections of the stomach aromatics and bitters, as ginger and quassia. If the head is affected camphor, musk, ether, opium; these likewise are remedies for the gouty asthma. The Portland powder, which is a composition of bitters and aromatics, may prove for a time highly useful; but the protracted use of medicines of this class is objectionable, as eventually detrimental to the stomach and general fibre. Regular and steady, and not capricious and merely temporary, abstinence from wine, spirits, and spices. The body to be preserved gently open. Pure air, moderate exercise, encouragement of cheerful habits. Warm and cold sea-bathing. Bath waters. Very small doses of digitalis. Hop (humulus lupulus)?

ORDER III.—*Exanthemata*, Eruptions.

The exanthemata are more nearly allied to genuine fever than those disorders of which we have just been treating, as the local affections are consequences rather than causes of the general irritation. They have been called eruptive fevers. They are defined by Cullen contagious diseases, affecting a person only once during the whole of life, commencing with fever, and succeeded by eruption on the skin. The contagious matter upon which these depend may indeed operate upon certain parts more particularly, and thus the disease be entitled to rank among the sensitive, irritative, or symptomatic fevers. This, however, is by no means certain: the primary action of contagion, whether of a specific or general nature, has hitherto escaped the penetration of the pathologist.

Genus I. *Erysipelas*, St. Anthony's fire.

Symptoms. This disease does not correspond with the whole of the above definition; it is not contagious; and it has frequently been found to recur. The face is the more ordinary seat of this affection. After febrile irritation has commenced, and continued for a short time, during which there is often an unusual drowsiness, and sometimes delirium, the face suddenly becomes bloated, the eyelids swell, and the skin is red and blistered. If the disorder is violent, or ill-treated, the inflammation and redness extend down the neck, and spread sometimes on the shoulders; the tumid appearance of the countenance increases, delirium supervenes, and the patient has been known to die apoplectic. The erysipelas is an erythematic inflammation. Its seat is the rete mucosum. Its tendency is to gangrene rather than to suppuration. A fatal termination is said to be principally on the 7th, 9th, or 11th days.

M. M. In no other affection is it of more urgent moment to decide on the treatment by the nature of the prevailing diathesis. It has been observed, that in large and populous cities St. Anthony's fire almost always appears in the form of asthenia; and in this case requires wine, bark, opium: while in the hardy constitution of the rustic it assumes a sthenic character, and demands the vigorous employment of what has been called the antiphlogistic regimen. Venesection. Saline purgatives. Diluent drinks. Might not digitalis be employed with a prospect of singular advantage, as the disease has an evident affinity with certain species of dropsy? With respect to external application, it has been customary to use mealy substances, such as flour. Solutions of lead, zinc, or alum, are improper, "as they stimulate the secerning vessels into too great action." (Darwin.) Cold water.

Genus II. *Pestis*, the plague, is an epidemic typhoid fever.

Genus III. *Variola*, small-pox.

Symptoms. After the pyrexial symptoms have continued for three days eruptions appear on the skin, which on the eighth day contain pus, and at length fall off in crusts.

Species. The small-pox is divided into the distinct, and confluent: the first has more of the sthenic, the latter of the asthenic, character. In the former the eruptions are of a phlegmonic, in the latter of an erythematic or spreading, nature. The eruption of the distinct small-pox makes its appearance in circumscribed red spots on the face; in the course of two days the body and legs receive their portion. The fever now ceases, the face swells, the pustules enlarge, and on the eighth day are mature. The swelling of the face now goes off, and the hands and feet begin to swell, with a slight return of fever, which however soon declines.

In the confluent, or asthenic, species, the fits are not so regular; the eruptions are not circumscribed and prominent, but diffused, and scarcely appearing above the skin; a kind of erysipelas sometimes precedes them, and every symptom denotes debility. The fatal termination is often on the 11th day.

Inoculation. The advantages of inoculation for the small-pox need not be insisted on. The circumstance, however, upon which depends the more favourable character of inoculated over natural small-pox, does not appear to have been satisfactorily accounted for. The only cautions requisite in preparing for inoculation, are to preserve the bowels free from sordes, and to choose a time for the insertion of the matter when teething, or other irritative processes, are not going on in the system. With respect to the time, it has been well said, that inoculation ought to be performed either before the second month, or after the second year.

M. M. Cold air. The bowels to be preserved open. Animal food to be denied. If the fever runs high, antimonials and nitre. In the confluent species, the alimentary and intestinal canal is with the utmost solicitude to be preserved free from congestions by purgatives, and the powers of the system supported by opium, bark, small doses of nitre, wine, pure air; vinegar aspersed about the bed, walls, and floor, of the apartment. Pediluvium.

N. B. For an account of the vaccine disease, or cow-pox, see the article VACCINATION.

Genus IV. *Varicella.* The chicken-pox is a very slight disease; the eruptions sometimes assume nearly the character of the distinct small-pox; but there is not much irritation of the system, and they generally disappear in the course of three or four days from their first breaking out.

Genus V. *Rubeola.* Measles.

Symptoms. Pyrexia, sneezing, inflamed eyes, dry cough, drowsiness; about the fourth day, or later, small red points appear on the skin, which in the course of about three days fall off in branny scales.

"As the contagious material of the small-pox may be supposed to be diffused in the air like a fine dry powder, and mixing with the saliva in the mouth to infect the tonsils in its passage to the stomach, so the contagious material of the measles may be supposed to be more completely dissolved in the air, and thus to impart its poison to the membrane of the nostrils which covers the sense of smell; whence a catarrh with sneezing ushers in the fever." Zoonomia.

M. M. Measles too often lay the foundation of pulmonary consumption, to prevent which the symptoms denoting inflammation of the lungs are to be with much solicitude obviated; and for this purpose small doses of tincture of digitalis are to be preferred to every other medicine. Venæsection cannot with propriety be used in young subjects, however imperiously called for; and digitalis supplies its place without the risk of inducing indirect debility. Steady and cool atmosphere, not cold air in currents. Refrigerant cathartics, with calomel. Animal food not to be given. Digitalis, with a very small quantity of opium, for the cough succeeding to measles.

Genus VI. *Miliaria*, miliary fever, is merely a symptomatic eruption of small red pimples about the neck and face, which in two days become white pustules, and desquamate. They have a peculiar smell. Much anxiety and difficulty of breathing precede the eruption. This disorder appears to be a consequence of an improper heating regimen in fever.

Genus VII. *Scarlatina*, scarlet fever.

Symptoms, &c. After pyrexia has lasted about four days a scarlet eruption appears on the skin, sometimes attended with inflamed tonsils and cervical glands: these last sometimes appear without cutaneous eruption, and the disease has been called cynanche maligna. This disorder is apt to be mistaken for measles; but in scarlet fever there are no catarrhal symptoms as in measles. This disorder is very irregular in its aspect; and often, without much care, fatal in its termination. Sometimes, without any alarming symptoms in the onset of the fever, a change takes place, and in the course of a few hours the patient falls into the arms of death. The unfavourable symptoms are the same as in other fevers. It is a disease principally of children. Whether it depend upon specific contagion, like measles and small-pox, is not perhaps fully ascertained.

M. M. Cold affusion. Cold air. Antimonials, opium, bark, wine, saline purgatives or enemas, nitre, blisters. See the section on Fever in this article.

Genus VIII. *Urticaria*, nettle-rash. After pyrexia for a day, small red spots, like the stinging of nettles, appear on the skin, which almost vanish during the day, but return in the evening. It scarcely requires any medical treatment. The disease does not last more than two or three days.

Genus IX. *Aphtha*, thrush. Spots on the fauces and tongue, by which this disorder is constituted, are almost always symptomatic of other diseased states.

Genus X. *Pemphigus*, "a fever attended by successive eruptions of vesicles about the size of almonds, which are filled with a yellowish serum, and in three or four days subside." The treatment is to be regulated by the nature of the attendant fever.

Order IV.—*Hemorrhagiæ* Discharges of blood.

The definition of this order is, pyrexia, with profusion of blood, without any external violence; blood when drawn from a vein shewing the buffy coat. Discharges of blood, however, are often unattended with pyrexical irritation, and indeed for the most part are evidences, not merely of local, but also of general weakness. Augmented energy in the larger propelling vessels may indeed overcome the resisting power of the smaller branches, and produce what is called active hemorrhage; in this case we have only local debility to contend with in the cure. Dr. Darwin divides hemorrhage into the arterial and venous, the latter of which he attributes to defect of venous absorption; it does not appear, however, that the veins act in the manner of absorbents, according to the opinion of our author. Venous hemorrhage depends upon general weakness, accidentally directed to the vessels from which the blood is poured out by rupture of their coats. It is always a highly asthenic disease.

Rupture of blood-vessels, and consequent hemorrhage, has been ascribed to an immediate and primary change effected in the constituent particles of the vital fluid. This supposition, however, seems to be totally unfounded; even in the most active hemorrhage the blood does not undergo "orgasm, ebullition, turgescence, or expansion," according to the theory of Hoffmann.

Genus I. *Epistaxis*, bleeding from the nose.

Symptoms. Pain or fulness of the head, giddiness, dimness of vision, drowsiness, irritation of the nostrils. It is the disorder principally of young persons, who have a lax and weak fibre; in some few instances it occurs as vicarious of obstructed menses, and sometimes appears in men when the hemorrhoidal discharge has been suddenly arrested.

M. M. Cold applied to the neck and head. Mechanical pressure, or absorbing substances, to the nostrils. Acids and astringents internally. Avoiding irritation of the body or mind. The bowels to be kept gently open. Nourishing but not stimulating aliment. In the epistaxis of old people, and in cases of much weakness, bark, vitriolic acid, opium. If the disorder is violent, and have depended upon the suppression of some other discharge, such discharge to be restored.

Genus II. *Hemoptysis*. Spitting of blood. Symptoms. Redness of the cheeks, a sensation of weight in the breast, difficult respiration. Saltish taste in the mouth, irritation in the trachæa, coughing up of florid blood.

Hemoptysis more usually appears in individuals with a slender make and contracted chest, who are of an irritable habit, and who have been subjected in their earlier years to epistaxis. It generally comes on at the age of puberty.

Causes. Violent irritation of mind or body, sudden vicissitudes of heat and cold, too powerful exertion of the lungs, as in singing, coughing, playing upon wind instruments. Like epistaxis, and indeed more frequently, it immediately originates from obstructed menses. Sometimes it appears vicarious of a gouty paroxysm.

M. M. All irritation and irregularities to be carefully guarded against. Bowels to be kept evacuated by mild purgatives. Manna. Tamarinds. Peruvian or oak-bark, combined with mineral acids, especially the sulphuric. Opium. Digitalis in large doses, so as to occasion nausea. "A table-spoonful of common salt." (Dr. Rush.) "One immersion in cold water, or a sudden sprinkling all over with cold water, would probably stop a pulmonary hæmorrhage." (Darwin.) Procure a return of the obstructed discharge.

Phthisis pulmonalis, consumption of the lungs.

Symptoms. Emaciation, weakness, cough, hectic fever, and for the most part an expectoration of pus.

Dr. Cullen has introduced pulmonary consumption into his nosology, as a sequel of hemoptysis. This common and fatal malady, however, often, and indeed for the most part, originates independantly of hemorrhage from the lungs. Its origin and progress are most usually exceedingly insidious. The persons chiefly obnoxious to phthisis, are those of a scrophulous habit, who have been disposed previously to suffer by lymphatic tumours, who are of a slender make, have long necks and narrow chests, who have been liable in their earlier years to bleeding at the nose, who have had frequent catarrhal affections while children, and in whom cough has remained or been ill-treated after the eruptive diseases of infancy, more especially the measles. These predispositions ordinarily break out into actual disease, at or shortly after the period of puberty. It is at this time that the pulmonary circulation becomes altered; and the seeds of the disease, hitherto latent, are expanded and developed.

In any constitution then at this period, and more especially in those that are characterised by a scrophulous tendency, a short and generally dry cough, succeeding perhaps to a trivial cold, attended with emaciation in the smallest degree, and more especially if the pulse be rapid, and the cheek be marked by hectic redness, alternating with more than usual paleness of countenance, the patient is to be assiduously watched, and the disorder earnestly combated.

Causes. Phthisical ulceration of the lungs, or confirmed consumption, is ordinarily produced through the medium of tubercles, or small bodies, in the cellular texture of these organs, which by repeated and gradual irritation, at length come to ulcerate and destroy the fabric of the lungs, and produce the symptoms of fully-formed phthisis. The origin and actual nature of these bodies are not perhaps very evident; they were formally erroneously imagined to be indurated lymphatic glands.

The more immediately exciting cause of pulmonary consumption is generally an exposure to cold, which operates in the manner described under the section Catarrh. Consumption, however, may be brought on by amenorrhœa, lues venerea, unseasonably repelled eruptive action on the surface, mental affections, &c.

M. M. "The facility," says a modern author, "of repressing the primary symptoms of phthisis pulmonalis, is proportioned to its difficulty of cure when the characters of the disorder are fully confirmed, and the texture of the lungs almost wholly destroyed." (Reid on Consumption.) In no case, perhaps, is neglect or early mismanagement of disease more pregnant with irremediable evils, than in the instance of consumptive affections. Digitalis properly and timely had recourse to is "the anchor of hope." "In families where this fatal disease (phthisis) is hereditary, the use of this remedy as a prophylactic, will, I have no doubt, save many lives that would otherwise have been cut short." (Dr. Currie.) "Digitalis is a remedy in pulmonary consumption in its earlier periods, which under due regulations, and with sufficient attention to other circumstances of regimen and diet, may be employed with a prospect of almost invariable relief." (Dr. Reid.) Other testimonies, equally decided, might be adduced in favour of this valuable remedy. Warm bathing. A regular temperature in the air that the person breathes. Warm clothing. Avoiding currents of air. Assiduously guarding against damp, and especially cold application to the feet, as by sitting with the feet on a stone floor, or an oil-cloth. Milk diet, of which Hoffman elegantly says, "Quà perplures phthisicos, in cymba Charontis quasi hærentes, sanatos, pristinæque redditos valetudini, novi." Avoiding all spirituous liquors, and spiced or high-seasoned meats. Keeping the bowels gently open by manna, castor-oil, senna, &c. Uva ursi has recently been recommended by Dr. Bourne.

These are the remedies of the first stage, or, more properly speaking, the menacing symptoms of consumption. When the lungs have actually become ulcerated after gradual and protracted irritation, very little expectation of recovery can remain. Griffith's mixture, composed of steel, myrrh, and alkali. Digitalis in larger doses, and combined with the above tonic. Uva ursi? opium and vitriolic acid. Digitalis combined with calomel. Change of climate. If a tendency to absorption from the surface of pulmonary ulcer could be induced greater than the deposition of it, we might have some prospect of curing the disease in its advanced stages. In order to produce this absorption, sailing so as to occasion sea-sickness has been had recourse to. Swinging, riding in a carriage, and other modes of occasioning a degree of vertiginous affection, and consequent nausea, have likewise been recommended and practised. Inhalation of a lowered atmosphere, of other modified gases, and even volatile astringent substances, have been also proposed and tried, but not with decided benefit. In the confirmed stages of phthisis, animal diet which is nutritive, without being stimulant, ought to be advised. Bath waters and cold seabathing are improper in every stage of the complaint.

N. B. If consumption be symptomatic of other diseases, while the symptoms are subdued by the above remedies, the attention must necessarily be turned principally towards the original affection.

Caution. All the signs of consumption may be present without the presence of the disease. Debility, emaciation, and cough, may be brought on by nervous, independant of organic disease, as well as by worms and intestinal viscidities. Hectic fever may be occasioned in certain constitutions by mental affections alone; this likewise is sometimes induced by worms. Purulent expectoration, indeed, is decisive; but the nature of the sputa is not with facility, in every case, to be decided upon.

Genus III. *Hæmorrhois*, the piles.

Weight and pain of the head, vertigo, pain in the anus and loins, swellings and flux of blood from the anus.

M. M. If symptoms of arterial activity accompany the hæmorrhoids, vitriolic acid, with moderate astringents, such as infusion of roses. Temperance, exercise, abstinence from spirituous liquors and spices. Tamarinds. Lenitive electuary, sulphur, chrystals of tartar. Castor oil. Warm fomentation, by sitting over the steam of heated water. Leeches. These two last remedies, are especially serviceable in what are called the blind hæmorrhoids, where there is swelling with pain from congestion in the hæmorrhoidal veins, without any discharge of blood from the anus.

When the hæmorrhoidal flux is attended with much debility, while the bowels are kept open by castor-oil and other similar purgatives, the more powerful astringents are to be employed. Steel. Exercise. Generous diet. Cheerful train of thinking. See SURGERY.

Genus IV. *Menorrhagia*, immoderate menstrual flux.

Symptoms. Pain in the back and loins, vertigo, difficulty of breathing, flushes of heat and cold, frequent pulse; in cases where the disease is more directly from debility, loss of appetite, paleness of countenance, coldness of the limbs, œdematous swellings about the ancles.

M. M. In the first species, the menstrual irregularity generally arises from hysteric or nervous affections, libidinous desires, and other violent passions; in this case attention must be paid to counteract the cause. Avoid stimuli of all kinds, mental or physical. Refrigerant cathartics, if costiveness be present. Moderate astringents, such as infusion of roses, and the sulphuric acid. In the menorrhagia of direct debility, astringents, cordials, and stimulants. Peruvian bark and sulphuric acid, opium, alum, port wine. External application of cold water, or vinegar. Steel. See MIDWIFERY.

ORDER V. *Profluvia.*

The profluviæ are distinguished by Dr. Cullen from hemorrhages, by the discharges not being naturally sanguinary. This order contains two genera, catarrhus and dysenteria, both of which might have found more appropriate situations even in Dr. Cullen's own nosology.

Genus I. *Catarrhus*, a cold.

Symptoms. Pyrexia, with increased discharge from the muccus membrane of the nostrils, and in violent cases of the fauces and bronchiæ, with cough.

The term cold, which is made use of, in common language, principally to denote an inflammatory condition of the mucous membrane of the nose, is exceedingly incorrect; it not only confounds the effect with the cause of the disorder, but conveys an erroneous idea of the mode in which such disorder is created.

The operation of cold, unless through the medium of the sensations, is invariably negative; it is merely an abstraction of the stimulant power of heat, and by its application to the living body (from an invariable law of organic existence) renders the frame in a more than ordinary measure susceptible of such, and other stimulant powers. For example: Suppose an animal to exist in a medium temperature of 60°, let 10° be subtracted for a short period, and afterwards precipitately added, the 60° will now act as with a power, perhaps, of 65, on account of the previous abstraction of stimuli producing, as it has been very properly expressed, "an accumulation of excitability." In this manner then is explained the agency of cold, in engendering inflammatory disorders, among which that we are now considering is one of the most frequent; an explanation founded upon a principle for the developement of which we are unquestionably indebted to the genius of Dr. Brown. This author, however, made an improper use of his own discovery; he did not sufficiently take into account the complicated and combined functions of the animal economy; and the very first position which he deduced from the detection of this important, and indeed, characteristic, quality of living existence, is practically incorrect. "Cold applied to the animal system never proves injurious unless succeeded by heat:" frigus nunquam nocet, nisi ubi ejus actionem calor excipit. In endeavouring to support this assumption, Dr. Brown and his disciples have aimed to prove that those symptoms which are usually characterised by the appellation of a cold, as well as rheumatism, and all other diseases arising from exposure to cold, are not occasioned until the same or a superior degree of external heat be restored; forgetting that the "accumulation of excitability" immediately resulting from diminished temperature is acted upon, and thus inflammatory irritation engendered, by the remaining stimuli of the frame, external and internal. Thus an individual, while still exposed to the catarrh-producing temperature, while, for example, his feet remain wet and cold, shall have inflammation in the mucous membrane of the nose and fauces, febrile irritation, and all the usual phenomena of catarrh; the balance of excitement being overturned, and turbulent irritant action being established in its stead.

Further, the existence of a cold does not suppose the presence of a sthenic disease: indeed the exact contrary is the fact, for the malady will be occasioned with most facility when the frame is weak and irritable.

Why the membrane of the nostrils, &c. should be the readiest to suffer more particularly, does not seem to admit of an easy explanation; it is important, however, to recollect what has been pointed out in an explicit manner by Dr. Beddoes, and since by Dr. Reid, that this membrane is a part of the same expansion with that which lines the windpipe and enters the lungs; so that in fact a common inflammatory cold is a degree of the same disease with an inflammation of the lungs.

M. M. Moderate and equal temperature. The bowels to be kept gently open. If the febrile irritation is considerable, sudorifics. Antimonials, nitre. Oleaginous substances may be used to allay the cough; but irritating balsams, such as cough medicines are generally composed of, are in the highest degree detrimental; they too often increase the disposition to, and sometimes actually produce, confirmed consumption. Liquorice, honey, boiled fig, almond emulsion.

If the phthisical tendency is conspicuous, digitalis (see the section on Phthisis pulmonalis).

Genus II. *Dysenteria*, dysentery.

Symptoms. Frequent stools, mixed with mucus, and sometimes with blood, attended with griping and tenesmus, the proper alvine excretions being retained; pyrexia, pulse quick and feeble. The disease is sometimes contagious and epidemic.

Causes. Dysentery depends upon the irritability of weakness, determined by particular circumstances to the alimentary canal; its predisposing and exciting causes are alternations of heat and cold, more especially when accompanied by damp, as when an army is encamped on marshy ground; the putrid miasma arising from the marshes; the contagious effluvia proceeding from the discharge in the disease; and, according to sir John Pringle, from dead bodies left unburied in the field of battle.

The immediate cause of the symptoms seems to be, a spasmodic construction of the larger intestines, retaining the fæces.

M. M. Calomel, opium, and rhubarb, to relieve the spasm, and discharge the contents of the bowels. Mucilaginous clysters, as of starch with tincture of opium. Emetics. Small doses frequently repeated of ipecacuan. Colombo. Peruvian bark. Warm bathing.

CLASS II. *Neuroses*, Nervous diseases.

Man is indebted for all his acquisitions to casual observation, leading to experiment. That the faculty we call the sentient resided in, or was developed through, the instrumentality of a peculiar and distinct organization, we should not, a priori, have conceived; there is nothing in the composition either of brain or nerve to lead to this conjecture. If, however, a portion of the bony defence of the encephalon be accidentally pressed in upon its substance, and an interruption in the faculties of sensation and voluntary motion be the consequence; if such accident be repeated with the same result; finally, if it be found, as it has been, that by voluntarily producing pressure on this organ, similar effects may be occasioned in proportion to the degree and extent of the force employed; the inference will come at length to be indisputable, that the brain is the organ or reservoir of sensation, and the medium through which loco-motion is effected.

Again, if it be found that at pleasure we can deprive any portion of the body both of sense and motion, by dividing the nerve supplying such part, or cutting off its communication with the brain, we are likewise fully justified in inferring, that the chord we have severed was the instrument by which the empire of the will had been exercised over the now inert and useless member.

It is by the aggregation of such observances that we arrive at the pathology of nervous, as a distinct class of morbid affections. When, for example, any particular member of the body suddenly refuses to obey the command of the will, or, in common language, becomes paralytic, although we may not be able to trace the remote cause from which this has originated, we know that it must have immediately depended upon some morbid change, either in the brain itself, or at least in the nerve supplying the organ indisposed.

This mode of inferring the nature of what is not an object of our senses, by comparing it with what we actually observe, will be found equally satisfactory, in relation to partial as total interruptions of sense and motion; thus, by a less degree of injury done to a nerve, as by lacerating or puncturing, instead of dividing it, we shall perceive not an entire deprivation of, but merely an impediment to, the loco-motive faculty; the actions of the member will be in a manner refractory; and convulsive or irregular, instead of orderly and steady, motion, will follow the mandates of the will.

If then, without the interference of an experimenter, and without visible injury to the animal structure, the movements of an organ become improperly accelerated, or cease to be exercised in their usual mode; if, to instance by example, the heart perform two feeble, in place of one full and vigorous contraction; we are authorised to state, that the disorder thus constituted is strictly and properly a nervous affection; and our conclusion, as to the fact, will be precisely the same, whatever theory we incline to, respecting the quo modo in which nervous power is displayed; whether with Hartley we conceive it to depend upon vibrations and vibratiuncles, whether we embrace the doctrine of universally pervading æther, or subscribe to the untenable positions of the author of Zoonomia.

Depraved perception and interrupted motion, are therefore the essences of nervous disease: the percipient, however, is to be distinguished from the motive faculty; for we have a class of living actions, which, although equally under the influence of nervous power with those over which the will presides, are nevertheless, in a state of health, incessantly carried on without perception or consciousness; thus, by impeding the functions of the nerves of the stomach, we may interrupt the function of digestion. Digestion, however, is a process performed without design, and independantly of volition; on the other hand, the intellect may be impaired by a derangement in the nervous system, while the digestive power shall proceed without the smallest hindrance.

Dr. Cullen's definition of a nervous disease, would therefore have been more accurate, had he stated it to be an affection of either sense or motion, without idiopathic pyrexia, or visible disease of parts. The orders of this class (neuroses) are four:

1. Comata. A diminution of voluntary motion, with sleep or impaired senses.

2. Adynamiæ, a diminution of the involuntary motions of either natural or vital functions.

3. Spasmi, morbid motions of muscular fibre.

4. Vesaniæ, disorders of the judgment or intellect without primary pyrexia, or observable affection of any particular part of the body.

Order I. *Comata.*

Genus I. *Apoplexia*, apoplexy.

Symptoms. Abolition of the sentient and loco-motive faculties, the sleep in general attended with snoring. The respiration, motion of the heart, and other involuntary actions, remaining.

Causes. We conclude from the analogy above-stated, that there is some degree of pressure on the brain in almost all cases of apoplectic stupor; but that effusion of blood takes place in the manner described by the generality of authors, is exceedingly problematical; if the appearances on dissection are appealed to in behalf of this theory, it is answered, that such appearances can alone apply to fatal cases of the disease; and in such, an actual rupture of vessels and effusion of blood will readily be admitted.

Epilepsy, palsy, and apoplexy, were contended by Brown to originate from the mere irregularity of nervous power consequent upon debility or deficient excitement; and to be occasioned without either an unusual impetus of circulation to the vessels of the brain, or impeded return of blood from this organ. We believe, however, that although the cause of apoplexy often is in one sense mere deficiency of excitement directed to the sentient organization, the immediate occasion of the apoplectic symptoms is for the most part the state of the vessels of the brain.

Apoplexy, for the sake of illustration, may be divided into sthenic and asthenic. If a vigorous and plethoric man, sitting down to his dinner and his glass, suddenly, during the excitement of conviviality, of mirth, and of alcohol, fall on the floor with deprivation of sense and apoplectic stertor, it must be evident that the fit has been induced by a greater flow of arterial blood into the vessels of the brain, than the veins of this organ could, in due time, convey away. The apoplexy has been induced in the manner of a sthenic disease.

If, on the other hand, a debauched and debilitated individual be the subject of an apoplectic attack, at the time when the excitement of intoxication shall have been succeeded by the condition of indirect debility, the disease will here have been brought about in a different manner; the impetus in the vessels of the brain shall have partaken of the general diminution of power throughout the whole system; sluggish vascular action shall have caused congestion; which congestion, in union with the deficient excitement on which it had depended, shall have induced that sudden suspension of the sentient faculty which constitutes the apoplectic paroxysm.

Apoplexy often immediately succeeds to a full meal: what more natural than, under such circumstances, to attribute the fit to a distended stomach pressing upon the aorta or large descending blood-vessel, and consequent determination of the vital fluid in an inordinate measure to the head? Such conclusion, however, will not bear the scrutiny of strict enquiry. Upon this principle, the apoplectic stertor and insensibility ought to be induced with most readiness, as in oneirodynia or night-mare, while the body is in a recumbent posture, and the stomach is most distended from the extrication of gas which takes place in consequence of the weakened digestive power; in place of this, however, the fall is immediate; the attack is made while the body is in an erect position, and often before the stomach has become in a very great degree distended; the fit then arises, in this last case, from that degree of excitement which the digestive powers have called off to their aid, leaving the brain in a condition of insufficient energy, properly to propel the vital fluid through its own vessels; congestion of blood is the consequence, and this last the proximate or immediate cause of the fit.

M. M. The strictest attention to the manner in which the disorder has been brought on. If the disease is sthenic, and the physicians are called in while the paroxysm still continues, immediate and copious bleeding from the arm, the jugular veins, or the temporal artery. Every ligature about the patient's body, especially about the neck, to be loosened immediately. Press hard with the thumb and fore-finger upon the carotid arteries, taking care to avoid the jugular veins. Place the head of the patient high on his pillow, or seat him erect in a chair. Preserve the apartment cool. Cold water may in some cases be applied vigorously to the forehead and temples. Afterwards saline purges, and subacid drinks. Enemas. Careful preservation from irregular and violent excitations, either of body or mind. In the asthenic, and by far the most usual form, of the complaint, bleeding with much less freedom and only during the paroxysm; in general, it is not at all proper. It is better to open the temporal artery, if convenient, than to bleed from the arm or jugulars. The application of cupping-glasses still preferable; apply blisters to the neck. When the power of deglutition has returned, cordials and stimulants. Opium and wine in very small doses. Volatile alkali. Sprinkle vinegar about the room. To prevent the returns of the fits; tonics, particularly bitters, as colombo, gentian, quassia; exercise and mental amusement, without violent excitation. Journeys to Bath or elsewhere. Preserve the body regularly open, without violent purgations. Avoid sudden exposure to cold, especially cold and wet feet. If the fit has followed the suppression of any accustomed discharge, or cutaneous eruption, let them, if possible, be restored.

Genus II. *Paralysis*, palsy.

Partial interruption of the loco-motive faculty, sometimes with a degree of apoplectic stertor.

This is partial apoplexy, arising from similar causes operating in a less degree. It sometimes succeeds to a full fit of apoplexy, and continues for months, or during life. The palsy often affects the whole of one side, and is confined to that side; hence it has been supposed, that the injury of the brain is likewise partial; and from the decussation that has been imagined traceable of the nerves from the encephalon, Dr. Darwin and others have concluded, that the origin of the disease is on that side of the brain opposite to the affected side.

Palsy, however, certainly originates at times (even if genuine apoplexy does not) from interrupted excitement, without any congestion in the brain, as its more immediate source; as when it results from the poison of lead and other causes.

M. M. Ascertain the exciting cause, and, if possible, counteract it. Emetics, purgatives, preceding stimulants and tonics. Tonics and stimulants the same as in asthenic apoplexy. Volatile embrocations to the paralyzed side or limb. Warm bath. Bath waters. Electricity. Galvanism.

N. B. Fatuity, or second childhood, very often takes place through the medium of paralytic affections; the faculty of memory appears to be overthrown by the associate sentient actions, which constitute this faculty, being dissevered beyond the power of reunion; and existence is reduced, in consequence, to a state of mere vitality from immediate impression. This is not seldom the case when the loco-motive power, and the energy of the muscular fibre, shall have been restored to their former state. In this case the recollection of the past, and anticipation of the future, have both probably been irrecoverably lost.

The mere possibility of his being reduced to this condition of humiliating existence, one would think a motive sufficiently powerful to check the intemperate in his course.

Order II. *Adynamiæ.*

Genus I. *Syncope*, fainting.

Symptoms. A diminution, or even, for a time, a total cessation, in the action of the heart.

Fainting may arise from passions of the mind; from sudden reduction of stimulus, as from bleeding, or drawing off the waters in dropsy; violent pain; the irritation of worms, or other crudities, in the stomach and bowels; much heat, offensive effluvia, &c.: in these cases the disorder has been called syncope cerebralis. When fainting arises from deficiency of oxygen in the circumambient air, as in a crowded assembly, the cessation of the heart is produced nearly upon the same principles as in actual suffocation, drowning, or strangling. It is then termed syncope pulmonea.

M. M. Immediately obviate, if possible, the exciting cause. Endeavour to restore sensation by aspersing cold water on the face and neck; attempt to force down a small quantity of brandy; and in all cases, but more especially when the affection arises from impure air, throw open the windows, and prevent compassionate spectators from crowding round the insensible patient.

N. B. If fainting, or palpitation, recur frequently, and without any manifest cause, either predisposing or exciting, there will be reason to suspect that the disorder is not nervous, but depends upon some malconformation in the heart, or neighbouring blood-vessels. In this last case it is irremediable.

Genus II. *Dyspepsia*, indigestion.

Symptoms. Deficient, or depraved, appetite; nausea; vomiting; inflation from flatulence; heartburn; pain in the stomach, especially when the body is in a bent position; oppressed breathing; costiveness.

This disease evidently arises from deficient action in the muscular fibres of the stomach, which in violent cases amounts to inverted motion and vomiting. It acknowledges the same sources as other affections of weakness: these are, intemperate use of spirituous liquors, and of tea; exposure to damp and cold; irregular hours of repose; intense study; mental depression and anxiety; when originating from this last source the disorder has an equal claim to the appellation of hypochondriasis, or low spirits, with that of dyspepsia.

M. M. Purgatives, with calomel, previously to giving tonics. An emetic. Columbo, gentian, quassia. Magnesia, in order to neutralize the acidity, and ease the consequent pain of heartburn.

Chalk, which is used with the same intention, is improper, on account of that neutral compound which it forms with the acid of the stomach being insoluble, and tending to increase the costive state. "The dyspeptic must be persuaded that a horse is the best physician; and that temperance of every kind, with reasonable dissipation and exercise in a dry healthy air, will do more for him than all the medicines in the world." (Townsend.) Cold, or shower, bath, in very warm, and warm bathing in cold weather. A glass of warm water after dinner and supper.

Genus III. *Hypochondriasis*, low spirits.

Indigestion, with languor, and causeless apprehension of evil, more especially as it relates to the patient's state of health.

This disease and dyspepsia only deserve to be distinguished by separate names, inasmuch as the mental depression in hypochondriasis appears especially to increase the disease by which it is, in part, constituted; and such disease is again magnified beyond measure by the morbid imagination of the invalid. Thus, in some cases of confirmed hypochondriasis, the dyspeptic sensations shall be attributed by the sufferer to the immediate agency of a malevolent power.

M. M. Aim at converting solicitude and apprehension into confidence and hope; not by deriding the feelings of the hypochondriac, and treating them as fanciful, but by breaking the chain of diseased associations. Procure a gradual change of scene and of habits. Journeys to Bath, or elsewhere, according to the previous disposition of the patient. Bath waters. Warm bathing. Preserve carefully the alimentary canal free from colluvies and viscidities by drastic purges and calomel. Maintain a regular moisture of the skin, without copious perspiration. Tonics with aromatics. Dr. Darwin particularly insists, and with justice, on the advantage of uniformity in the hours of meals: this uniformity should even extend to medicinals, the same hour of repetition being invariably observed. "Siesta, or sleep after dinner."

Genus IV. *Chlorosis*, green-sickness.

Dyspepsia; paleness of the skin and of the lips; lassitude; difficult breathing, and palpitation of the heart, after using more exercise than usual, especially in going rapidly up stairs; pulse small, feeble, and sometimes very quick; coldness of the extremities; appetite deficient, and oftentimes depraved; pain in the back and loins; costiveness; œdematous ancles, especially towards evening; and obstructed menstruation. "Chlorosi laborat debilis puella totum corpus, laxo œdemate tumet; pallent et frigent omnia." (Van Swieten.)

Dr. Cullen has, with much impropriety, classed this among the nervous diseases; it ought to have been transferred to the next leading division of disease, or rather regarded as an affection of the lymphatic and absorbent system. In cases of much debility, especially of disposition to torpor, in the absorbent and secerning vessels; if, at the time when nature demands a new secretion and discharge from the system, in place of generous living, due exercise, moderate and pleasurable excitation of the mind, "the ever-springing hope" of youth, &c. be substituted to poverty and unwholesomeness of diet, watery and vegetable food, inactivity; concealed, oppressing, ungratified, and hopeless desires; the effect is the disease now under notice: which, however, from much natural debility, independantly either of mental depression, unwholesome diet, or any other cause, may be, and very often is, occasioned. Chlorosis, indeed, is of exceedingly frequent occurrence.

The immediate cause is evidently an inactive state of the absorbent vessels, more especially of those which supply the chyle: hence deficiency of red blood in the vessels, want of propelling power in the heart and arteries: hence want of menstruation, œdematous swellings of the feet, "pallent et frigent omnia."

M. M. Almost as certainly as some kinds of pain yield to opium, does even obstinate chlorosis fall before the power of steel. "Dum hoc utitur, incipit oriri major calor." To steel, then, must the physician principally trust in every case of genuine green-sickness. It is necessary, however, frequently to commence with an emetic; and in almost all cases it is proper to give a purgative, joined with calomel, before the administration of steel. Tonic bitters. Aromatics. Moderate exercise in a pure atmosphere. Flesh diet. "A bath of about eighty degrees, as Buxton;" not by any means colder. Marriage.

Order III. *Spasmi*, Spasms.

In the introduction to the class Neuroses, we endeavoured to describe briefly the manner in which a knowledge was acquired of the separate functions and distinct diseases of the nervous system. In the case of spasmodic affections this is especially illustrated. If in any animal the nerve supplying a limb be denuded, and a violent stimulus be applied to its surface, the whole member shall be immediately thrown into convulsive agitations: a fact which is perhaps too often demonstrated in galvanic and other experiments. When then such convulsive movements appear, without experiments, and sometimes without apparent cause, a similar change is justly inferred to take place in the nerve or nerves passing to the organ which may be the subject of the disease. There is one circumstance with respect to spasm that, both in theory and practice, ought always to be retained in the memory; this is, that the spasmodic or convulsive state of parts invariably implies debility. To act irregularly, is in all instances to act with deficient vigour; for the sum total of these disorderly movements, performed in a given time, will not amount to the quantum of power displayed in the same time by healthy and steady action. This fact appears to be a sufficient refutation of Dr. Darwin's hypothesis, that convulsions are voluntary exertions of the muscles to relieve pain, even if we concede to this author, that the strict definition of volition ought to be "the active state of the sensorial faculty in producing motion, in consequence of desire or aversion, whether we have the power of restraining that action or not;" for, according to this principle, convulsion should be an actual and positive increase of vigour, which it is not; for while the utmost agitation is carrying on in the convulsed member or organ, if a due quantity of stimulus be thrown in, excitement will immediately follow, and in consequence of this excitement, quiescence and firmness; in the same manner, but upon a different principle, as tightening the sail of a ship arrests its vibratory motions, but increases its actual and integral force.

If it appear difficult to conceive why a stimulant or exciting agent should produce this debilitated action, we must refer to the invariable law of living existence, that excitation carried beyond a certain point, is immediately productive of indirect debility: thus when the galvanist convulses the leg of a frog, he throws in more of stimulus than is adapted to the fibrous excitability of the organ in question; he exhausts the irritability of the part; and the convulsion that follows is the consequence of such exhaustion, exactly upon the same principle that half a pint of wine shall give steadiness to the tongue, and firmness to the step, while a quart of this stimulus, taken in the same time, shall produce a temporary paralysis of the limbs, and render the speech faultering and inarticulate.

We have indiscriminately employed in the above observations, the terms spasm and convulsion. As it relates to the excitement, they are virtually the same states; and thus, whether convulsion or spasm, that is, whether rigid immoveable contraction, or rapid alternations of contraction and relaxation, follow the debilitating causes upon which they depend, in one sense they are scarcely to be distinguished; the difference of physiognomy which they assume appears to have dependance upon the complicated associations of living actions, which are but little understood, and both in theory and practice too much disregarded.

From the above remarks we hope it has been rendered evident, that in attempting to overcome a spasm or convulsion, the leading principle of cure must be stimulative; the disease in question, however originating, invariably implying debility, or more properly, perhaps, deficiency of excitement.

Sect. I. *Spasmodic affections in the animal functions.*

Genus I. *Tetanus.* A spasmodic rigidity of a great part of the body: in some instances it is drawn violently backward, at others forwards, and in both cases the disease is generally followed or attended by trismus or lock-jaw; these symptoms may last with greater or inferior violence from twenty-four hours to a month or more.

The immediately exciting causes of tetanus are, wounds or pricks of tendons; the sudden application of cold after extreme heat; great intemperance, or other vices: the disease may likewise be consequent upon viscid mucus, worms, and other irritating substances, in the alimentary passages.

M. M. As in fevers, it is highly necessary to preserve the alimentary canal free from colluvies, in order that the return of due and orderly excitement may not be prevented by this cause; so is it especially necessary in nervous and spasmodic affections carefully to keep in mind the incalculable importance of this principle. Indeed, among the actually exciting causes of the malady now under notice, these intestinal crudities are perhaps the most frequent. Let the practitioner then, in every spasmodic disorder, pay solicitous attention to the condition of the stomach and bowels: it is in these organs "that the archer may be seated," in whatever directions he may send out his arrows. It is not, let it be as carefully remembered, by the act of evacuation in reducing the system, that either emetics or purgatives operate thus beneficially; but by the disposition that a freedom in the first passages favours to the due susceptibility of the exciting powers, on the agency of which the return of health depends. Indeed, as far as either purging or vomiting are in themselves immediately instrumental in dissolving spasm, as it has been expressed, independantly of the source just referred to, it is by virtue of the agitation and stimulus, not by the discharge of which they are productive. (See Infancy.) Emetics, cathartics with calomel. Pouring large quantities of cold water over the body during the spasm, in order forcibly to sever the catenated motions by which it is constituted. Warm bathing. Very large quantities of opium. More than four hundred drops of the tincture have been given in some violent tetanic affections in the course of twenty-four hours, and without producing any intoxicating effect. Other antispasmodic medicines. Mercury. If the spasm has originated from a lacerated or punctured tendon, divide it freely, and produce pain and inflammation.

Genus II. *Convulsio,* convulsions. On the cause and treatment of these, we need not enlarge, after the remarks we have introduced on the nature, predisposing and exciting causes, of convulsive and spasmodic disorders in general.

Genus III. *Chorea,* St. Vitus's dance.

Symptoms. Convulsive agitations of the limbs, in general almost confined to one side of the body. When the patient attempts to walk, he produces involuntary gesticulations.

M. M. Emetics, cathartics with calomel; anthelmintics; bark, steel, and other tonics; electricity, galvanism, tepid bathing, sea-bathing.

Genus IV. *Raphania,* contractions in the joints.

Symptoms. Spastic contractions of the joints, with excruciating pain, and convulsive motions, returning periodically, and continuing for many days. It appears to be a species of rheumatism.

M. M. Purges, followed by tonics; mercury combined with opium.

Genus V. *Epilepsia,* epilepsy. Violent convulsions of the muscles, attended with sleep.

Epilepsy in its nature and causes appears to hold a kind of intermediate situation between apoplexy and convulsion; it has the sudden fall and the sopor of the one, with the irregular muscular action of the other. Epilepsy, in a greater or less degree, is a disease of extreme frequency: indeed, all the convulsions of children may be called epileptic. In its full and formidable shape, it is not so frequently met with as several other diseases. A physician, however, may denominate, with propriety, all fits epileptic, of which alternate or combined convulsions and sleep constitute the characters, especially if these are connected in any degree with an increased action of the salivary glands.

M. M. Epileptic fits are sometimes congenital, hereditary, and depend upon some occult state of the nervous system. In these cases the disorder is generally irremediable. All that can be done by art is merely to ascertain, and endeavour, if possible, to obviate, the exciting causes of the disease; and during the paroxysm to loosen every bandage about the neck and head, preserve the apartment in which the fall is made as airy as possible, and be careful that the patient do not inflict injury upon himself by the violence of his agitation. In some cases, indeed, the individual can obviate the full formation of the paroxysm by tying a ligature round the limb in which the sensation threatening the attack is perceived, between the point at which such sensation commences and the brain. This sensation constitutes what is called the epileptic aura: its abstract cause is obscure; but no less so than the phenomena of spasm in general.

In treating the complaint, particular attention is to be given to the predisposing and exciting cause or causes, which are extremely numerous; such as youthful intemperance, indulgence in secret vices, mental passions and affections, imitation of other epileptics, lively recollections of previous impressions, repelled eruptions or discharges, sudden alternations of the extremes of temperature, unpleasant odours, and, as by far the most common source of those epileptic fits which scarcely amount to absolute epilepsy, worms. These causes must all necessarily be removed before the physician can have the least prospect of overcoming the disease. Emetics, cathartics, with calomel; anthelmintics: suddenly dissever the chain of associations, by plunging the patient in the cold bath, or dashing with violence cold water over his naked body. Induce a new disease, as the itch; a plan which Dr. Darwin adopted with success in the treatment of St. Vitus's dance, with which the present has a great affinity. Patients have likewise been cured of epilepsy, by the accidental occurrence of a quartan ague. These are instructive cases to the reflecting and speculative. Tonics. Galvanism. By this newly discovered source of nervous excitation, the writer of this article recollects to have witnessed a supposed cure of a very obstinate case of epilepsy. It is not, however, easy to ascertain how far remedies operate in overcoming gradually, chronic affections.

Of Worms, and Anthelmintics. Worms we have just stated to be among the most frequent of the exciting causes of epileptic fits. As the order of our nosology no where leads us to notice them in an especial manner, it may not be improper in this place to introduce one or two remarks respecting their nature and treatment.

Intestinal worms are of three kinds: the ascaridis, or small thread-like worm; the lumbricus teres, or round worm; and the tænia, or tape worm. The first of these are principally confined to the rectum: they are divided by Dr. Darwin into two species, viz. "the common small one, like a thread, which has a very sharp head, as appears in the microscope, and which is so tender that the cold air soon renders it motionless; and a larger kind, above an inch long, and nearly as thick as a very small crow-quill, and which is very hard in respect to its texture, and very tenacious of life." The symptoms by which the presence of these may be suspected, are an uneasiness and itching in the rectum, especially urgent towards evening: this, if violent, disturbs sleep, and occasions febrile irritation, and sometimes tenesmus, with mucous discharge from the anus, indigestion, and itching of the nostrils.

M. M. Clysters of lime-water, injection of tobacco-smoke. Mercurial ointment introduced into the anus. Aloes and steel, both by the mouth and in the form of enema. Saline purgatives. Harrowgate water, so as to induce six or seven stools every morning.

The lumbricus is the most common. Its symptoms are enumerated in the article INFANCY. Lumbrici are of very different lengths and magnitude; they are principally found in the smaller intestines, but are situated occasionally both in the stomach and larger intestines. These worms have been known to pierce through the coats of the alimentary canal, and have thus occasioned most excruciating pains and death.

The tape worms are sometimes voided of an enormous length: they have been stated to be from two to forty feet long. They properly consist of an united chain of separate animals; as, when broken, each portion has the power of reproduction. "The worms of this genus possess a wonderful power of retaining life. Two of them, which were voided by a pointer dog in consequence of violent purgatives, each of which was several feet in length, had boiling water poured on them in a bason, which seemed not much to inconvenience them. When the water was cool, they were taken out, and put into gin or whisky of the strongest kind, in which their life and activity continued unimpaired, and they were at length killed by adding to the spirit a quantity of corrosive sublimate."

The symptoms are much the same with those of the lumbrici, but more urgent.

M. M. See MATERIA MEDICA, section Anthelmintics.

Spasmodic Affections continued.

SECT. II. *In the vital Functions.*

Genus I. *Palpitatio,* palpitation. See Syncope.

Genus II. *Asthma.*

Symptoms. Difficult respiration returning at intervals, with a sense of tightness across the breast. Wheezing at the commencement of the asthmatic fits; scarcely any cough but what is hard: towards the close of the paroxysm it however becomes more free, attended with a discharge of mucus.

These symptoms certainly arise from a spasmodic construction of the bronchial fibres, "which is communicated by consent to the larynx and diaphragm."

The causes of asthma are numerous, while its predisposition is often hereditary, and dependant upon a peculiar conformation and temperament; the actual disease may be excited by intemperance either in eating or drinking, violent exercise, mental agitation, eruptions or discharges abruptly or unseasonably repelled; the fumes of metallic poison, as of lead, &c.

M. M. Spasmodic asthma, when fully established, scarcely admits of a radical cure. The paroxysms to be relieved by opium and æther; coffee; tonics in the intervals, principally of the class of bitters and aromatics. Avoid distending the stomach inordinately. Emetics; enemas previous to the expected accession; gentle horse exercise; pure air; oxygen gas. If eruptions have been repelled, endeavour to restore them.

Genus III. *Dyspnœa,* difficulty of breathing. This is improperly introduced into the nosology as a genus, it being merely a symptom of other diseases, consequent upon defective formation of the chest, or brought on by evident causes, which being removed, the disorder immediately declines.

Genus IV. *Pertussis,* hooping cough.

Symptoms. Convulsive strangulating cough, with noisy inspiration or hooping, and sometimes attended with vomiting. It is contagious.

The precise nature, or, as physicians express themselves, the proximate cause of hooping cough, does not seem to have been accurately ascertained. Dr. Darwin supposes it to be "an inflammation of the membranes which line the air-vessels of the lungs, and that it only differs from peripneunomia superficialis in the circumstance of its being contagious." He on this account enumerates it among the sensitive irritated fevers: we are inclined, however, to think that the infection principally operates upon the stomach; and that the inflammatory disorder of the mucous membrane is merely a consequence of the protraction, or erroneous treatment, of the complaint. It is not attended, in the first instance at least, with the symptoms of inflammatory irritation; and the vomiting, by which the violent fits are often relieved, proves that the stomach, in pertussis, is in a morbidly irritable state.

It deserves however to be remarked, that the membrane in question is very apt to partake of the prevailing irritation, to become inflamed, and thus, like the inflammation after small-pox, and measles more especially, to lay the foundation of consumption of the lungs.

M. M. Antimonial emetics. Very small doses. Warm bathing. Above all, digitalis; in no disease, perhaps, is the power of this valuable medicine displayed more forcibly and evidently than in hooping cough. Its effects are generally almost instantaneous. After the violence of the disease has subsided, and even before, change of air. Cicuta (conium maculatum) has been much employed in this complaint.

SECT. III. *In the animal functions.*

Genus I. *Pyrasis.* Water-brash of Scotland. Water-qualm.

Symptoms. Sudden eructation of watery fluid with or without heartburn; the fluid brought from the stomach sometimes insipid.

M. M. The author of the present article recently had an opportunity of witnessing in this disease the beneficial effects of the inhalation of tobacco-smoke by a person not previously accustomed to smoking; this man had taken tonics, antispasmodics, and antacids, without effect. "A grain of opium twice a day, soap, iron powder, a blister." (Darwin.)

Genus II. *Colica,* colic.

Symptoms. Permanent and excruciating pain in the belly, with a sensation as of twisting about the navel, constipation, and sometimes vomiting.

Causes. These symptoms evidently originate from spasmodic constriction in some part of the intestinal canal, which may be occasioned by various causes; such as indigestible food, the sudden application of cold; acrid substances received into the stomach; poisons, especially lead; hence colic is a kind of epidemic disease among painters, attended with paralysis of the arms, &c. It is likewise common in cyder countries.

M. M. Opium. Cathartics, principally of castor oil. Warm bathing. Anodyne clysters. Fomentations and blisters to the part. In obstinate cases of the painters' colic, Bath waters. Carefully obviate the exciting causes of the disease.

Genus III. *Cholera.*

Symptoms. Vomiting and purging of bilious matter, violent pains in the stomach and bowels, with great anxiety and irritability.

Cholera is one of the diseases of the autumnal months; it is very often produced by the sudden succession of cold to unusually warm weather: it sometimes follows the taking of indigestible substances, as of much cold cucumber, especially at the period of the year above-mentioned, when the directly debilitating power of cold abruptly succeeds to the indirectly debilitating operation of heat, and the biliary secretion is more than ordinarily copious.

M. M. During the violence of the vomiting and purging, give water-gruel, and inject starch clysters, to each of which add tincture of opium. After the disorder has in some measure subsided, restore due excitement by cordial and nourishing diet, with stomachic medicines. If febrile irritation is induced, the saline draught, composed of salt of wormwood and lemon-juice.

Genus IV. *Diarrhœa.*

Symptoms. Frequent stools, without primary pyrexia, and not induced by contagion.

A morbid action in the excretories of the intestines constitutes this disease: sometimes however, and frequently, purging arises from mere loss of excitability in the intestinal fibre, without increase either of bile or any other excretion. It is immediately occasioned by acrid matter in the intestines; by acidities, by mental passions, or by the sudden application of cold, more especially to the feet.

M. M. According to the exciting causes. If there is reason to suspect the lodgment of acrid matter, calomel, with jalap, senna, or rhubarb Afterwards astringents, of which one of the best is good red wine. Opium. Chalk, if acidity prevails. An emetic if the disorder continues obstinate.

Genus V. *Diabetes.*

Symptoms. Superabundant discharge of urine, in some cases amounting to fifty pounds in twenty-four hours, limpid and sweetish to the taste, with urgent and perpetual thirst, dry skin, weakness, emaciation.

This disease often, perhaps, exists to a very considerable extent without being detected. It is not an uncommon complaint among the poor, especially of the north of Britain.

The principal circumstances that have attracted the notice of the pathologist in reference to this complaint, are the saccharine quality of the urine evacuated, and the attendant emaciation. One of the principal ingredients in the nutrition of the body has been supposed to be the saccharine principle; from the inordinate discharge of this principle in the diabetic urine, the disorder has been therefore referred by some to a deficiency of assimilating power in the stomach and digestive organs, while others have imagined it to originate entirely from altered action in the kidneys. Perhaps both of these causes may operate in producing diabetes. Upon dissection, the kidneys are always found flaccid. Dr. Darwin, after Mr. Charles Darwin, attributes the copious flow of urine to the inverted or retrograde action of the urinary lymphatics; but besides that this theory does not account for the superabundance of sugar or of mucilage in the water, it has been proved that such inversion of the absorbents is inconsistent with their structure and general economy.

M. M. Animal diet. Dr. Rollo and others have observed that when the patient lives on animal food, the saccharine quality of diabetic urine abates. Alkaline and astringent medicines, such as nut-galls and lime-water. Bark. Steel. Opium. Alum-whey.

N. B. A copious flow of urine is frequently observed to attend nervous affections, and indeed is one of the characteristics of the disease we are next to notice: in these cases however, the water has not the superabundance of the saccharine principle as in genuine diabetes, which last disorder has been erroneously placed in the class Neuroses.

Genus VI. *Hysteria.* The hysteric disease.

Symptoms. A gurgling of the bowels, followed by globus hystericus, or a sensation of a ball ascending to the throat, and menacing suffocation. Convulsive agitations, alternate laughing and crying, a general fickleness and irritability of mind. A large quantity of straw-coloured or limpid urine. Hysteria, like epilepsy, is in a certain degree extremely common; it generally first occurs in females about the time of puberty. It is, like all other convulsive affections, a symptom of a lax habit, and is consequent upon the irritability of weakness. It may be brought on by mental agitation, or by irritations in the stomach, bowels, uterine organs, &c.

The discharge of urine which attends or precedes hysteric paroxysm, is attributed by Dr. Darwin to the inverted motions of the lymphatics about the mouth of the bladder, as in diabetes; a temporary torpor, or spasm of these vessels, would appear sufficient to account for the superabundant excretion, the watery part of the urine not being taken up.

M. M. Avoid every occasional and exciting cause of the disease. Bark, quassia, and other tonics. To remove the present symptoms, camphor, assafœtida, castor, opium; if this last, from idiosyncracy, disagrees with the patient, the hyoscyamus will generally be found an excellent substitute. This has not the constipating tendency of opium; and in hysteric cases it is of importance, while much evacuation is guarded against, to preserve a freedom both in the alvine and cutaneous discharges. Emetics. N. B. The customary plan of bleeding in hysteric affections is extremely detrimental to the general health, and disposes to a return of the paroxysms. If it is judged necessary in some cases of hysteria to withdraw a small quantity of blood, it should be done not by venesection in the ordinary mode, but by the application of a cupping-glass.

Genus VII. *Hydrophobia.*

A dread of water as exciting painful convulsions of the pharynx, caused for the most part by the bite of a mad dog, violent spasms, furious insanity, death.

M. M. "When the contagion of a putrid fever is taken by the saliva into the stomach and bowels, which is its constant road," (query) "if the patient the moment he finds himself attacked with a sense of chilliness, loss of appetite, and an unpleasant taste in his mouth, has recourse to two emetics at proper intervals, and after the operation of the first emetic takes a cathartic, he has certainly got rid of the infection: in the same manner, even after three days, or perhaps a week, if the part bitten by the dog be cut out with the knife, the danger is escaped." (Townsend.) Dr. Thornton advised the application of hot vinegar, sharpened with vitriolic acid, to the wounds of five men who had been bitten by a rabid animal, and this application was attended with seeming success. Mercury: this by some has been extolled as a specific for hydrophobia.

Order IV. *Vesaniæ.*

Disorders of the intellect, independant of pyrexia or coma.

"Every nervous disease, (says an author whom we have before quoted) is a degree of insanity." If, however, imagination carried to the height of sentient perception, or, as it has been expressed by Dr. Batty, the raising up in the mind of images not distinguishable from impressions on the senses, is the proper definition of the insane state—"the cardinal point on which madness turns"—the above apophthegm of Dr. Reid may be regarded as rather bold and impressive than strictly accurate. It were surely improper to denominate the apoplectic, the paralytic, the hysteric, or the tetanic, insane; yet an individual under these maladies, is as truly affected with a nervous disorder as one who, like the lunatic astronomer in Rasselas, conceiting himself to possess the mastery of the elements, commands rain to shed fertility on the barren soil.

That the disorders of the intellect are disorders of the nerves we readily admit, it is the converse of the proposition we presume to question; and in so doing, we justify Dr. Cullen, in considering the vesaniæ, or mental affections, as a distinct order of nervous diseases.

The pathology of such diseases is peculiarly perplexing. We find by experience, that an increase of vascular action in a tender organ will give rise to the feeling of pain; we have ascertained by the conjunctive and mutually reflective aid of casual observation and direct experiment, that convulsive movements in the muscular fibre are occasioned by an interruption of nervous excitement in whatever that may consist; we see the brain pressed upon, and the apoplectic stupor follow; but in endeavouring to trace deranged consciousness to disordered organization, temporary or permanent, an increase of intricacy appears in a manner to grow out of labour and research.

Dissection does not afford that assistance to the pathologist in this, as in many other departments of his inquiries; for, independantly of the great want of uniformity that has been observed in the brains of the unfortunate victims to mental derangement, it is impossible to judge from an inspection of this organ, how far the altered structures and appearances have been causes, and how far consequences, of the malady.

Dr. Cullen has four genera in his order vesaniæ, viz. amentia, melancholia, mania, and oneirodynia, on each of which we shall introduce a few remarks.

Genus I. *Amentia*, ideocy.

Amentia is defined an imbecility of judgment, preventing the perception or the recollection of the relations of things.

Man is born with merely a susceptibility of knowledge, a capacity of acquisition; he is conducted from observation to comparison, and from comparison to principle. Place an infant in a spacious apartment, give him for the first time the free use of all the senses with which nature has furnished him, and he will stretch out his hand to perhaps the most distant object in the room, with a full persuasion of being able to grasp it. Like the youth couched by Cheselden on Epsom Downs, every thing within the scope of his vision appears in a manner to touch his eye, he has not the smallest conception either of distance or magnitude, and the same total ignorance prevails in respect to objects which have relation to all his other senses. Knowledge then is the result of experience, which is another word for comparison or observation of "the relations of things."

As man, however, essentially differs from the brute, by the more extended compass of his intellectual grasp, the superinduction of the moral sense, and the anticipation of future events, so different individuals have varied susceptibilities of acquiring information; and this variation, which constitutes every shade of difference in intellectual character, must necessarily arise either from difference in the perceptive organs, or combining and retaining faculty. When then, without any apparent deficiency of the external senses, which are the inlets to knowledge, we find an individual not to have arrived at a given standard of intelligence by the constant employment of such senses, not to have obtained a due knowledge of "the relations of things," we place him out of the range of intelligent existences, have an obscure conception of something defective in the interior structure of his sentient organization, and denominate him an ideot.

This is the amentia congenita of Cullen, ideocy from birth.

Ideocy, however, may be produced. Fatuity may succeed to intellectual vigour, and the whole fabric of acquired knowledge be undermined and overthrown. Thus man may be literally reduced to the humiliating condition of second childhood. This state may be engendered abruptly and visibly, or gradually, and almost in an imperceptible manner. It may follow violent agitations of the frame, as desolation succeeds to tempest, or may be brought about by the gradations of natural decay.

The causes of ideocy, when it is not the result of original malconformation, are, all kinds of intemperance, more especially indulgence in the use of spirituous liquors: "it has been traced up to somnolence too much indulged." The media through which it is principally occasioned are mania, apoplexy, and above all epilepsy. When firmly established even in youth, very little hope of recovery can be entertained by the friends of the unfortunate victim to his own imprudence. The condition of ideocy is a condition beyond the reach either of physical or moral influences!

Genus II. *Melancholia.*

Genus III. *Mania.*

We have placed these two genera of Dr. Cullen together, as we deem our author fundamentally erroneous in considering them distinct affections. Melancholia is defined "partial madness without dyspepsia." From this mode of reasoning, mania, instead of being distinguished by the character of universal madness, would have been with as much propriety denominated partial madness without fever.

Insanity is intensity of idea, converting imagination into implicit belief, and thus producing an incongruity of action; incongruity as it respects former, consistency as it relates to present, impressions and associations. It partakes of the character of mania or melancholia, of violent rage or gloomy despondency, according to the previous temperament of the sufferer, and the nature of the prevailing idea. In each the disordered associations are engendered upon precisely the same principles.

Madness differs from ideocy, as the conclusions derived from erroneous principles, in philosophising, differ from the conceptions of ignorance: the one is correct reasoning from erroneous premises, the other is defective judgment from defective information.

How this intensity of idea is produced, we have no means of ascertaining: we do not indeed feel it difficult to comprehend, that an absorbing attachment to one object, or an exclusive attention to one particular pursuit, may come at last to make shipwreck of the understanding; but it is the susceptibility of being carried away by this idea, that constitutes the difficulty in question. Like the developement of intellectual character, the disposition to run into the state of insanity may perhaps depend upon the most minute circumstances of accidental associations: "Il ne faut qu'un leger accident, qu'un atome déplacé, pour te fair périr, pour te dégrader, pour te ravir cette intelligence dont tu parois si fier!" So precarious is the tenure, even of the most exalted possessions of man!

Madness, however, like ideocy, may be produced through the medium of bodily disorders; thus, fever will often occasion delirium, which is a species of temporary insanity. Thus, an obstruction of the menstrual discharge will frequently be the means of developing the latent disposition to maniacal disorder, occasioned by previous disease, resulting from erroneous education, or depending upon hereditary conformation. Indeed, almost the whole range of nervous diseases may, under predisposing circumstances, come to be exciting causes of genuine insanity. When lunacy has been brought on by bodily disorder, the complexion of the derangement shall be formed by the previous temperament, or natural disposition, of the sufferer; thus, the favourite ideas of health shall, in their increase, be the predominant and overwhelming ideas of madness; again, when the insane state has more immediately proceeded from passions of the mind, or moral rather than physical causes, the idea that has vanquished the intellect shall continue to reign. The imaginary monarch shall preserve his dominions and sway, and through the medium of his distempered fancy, shall observe menials and attendants in the persons who surround him; the melancholy lover shall require but a female form to pass before his cell, to be persuaded of the actual presence of the object of his affections; and the religious enthusiast shall read a special embassy from heaven, in the countenance of every compassionate visitor.

Prognosis. "The chances of recovery are against those madmen, who can trace their indisposition to lunatic ancestry. When the causes are accidental, or obviously corporeal, a favourable termination may be expected. "The insanity subsequent to parturition, is generally curable if the curative attempts be rational." (Cox.) "Patients who are in a furious state recover in a larger proportion, than those who are depressed and melancholic. When the furious state is succeeded by melancholy, and after this shall have continued a short time the violent paroxysm returns, the hope of recovery is very slight. Indeed whenever these states of the diseased frequently change, such alteration may be considered as unfavourable. When insanity supervenes on epilepsy, or where the latter disease is induced by insanity, a cure is very seldom effected." (Haslam.) "When a person becomes insane who has a family of small children to solicit his attention, the prognostic is very unfavourable, as it shews the maniacal hallucination to be more powerful than those ideas that generally interest us the most." (Darwin.) "Though individuals of every temperament become insane, it has been observed that those of the sanguine more frequently recover."

M. M. Endeavour to draw off the mind from the prevailing idea, or otherwise to convince the maniac of the errors of his conceptions, and fallacy of his pretensions, by relating the incongruous conceits of other maniacs which have some affinity with his own. M. Pinel states, that in the Bicétre of Paris, a maniac was cured of the hallucination of supposing his head had been taken off by the guillotine, and that another had been placed on his shoulders, by a person judiciously ridiculing in his bearing the miracle of St. Dennis, who was said to carry his head under his arm, and to kiss it. When the maniac was endeavouring to prove the possibility of the fact by an appeal to his own case, the narrator of the story suddenly exclaims, "Why, how, you fool, could he kiss his own head? was it with his heel?" In incipient and equivocal madness, cautiously abstain from expressing suspicions in the hearing of the patient. "Nothing is more calculated to make a person mad than the idea of being thought so." (Reid.) On this account, premature confinement is to be deprecated, not merely as cruel, but as injudicious in the extreme. Those who are placed over the insane as guardians, should unite decision and firmness of character with tenderness of disposition and gentleness of manners.

In strong plethoric habits, venesection. Cathartics. These last, especially in melancholy, often require to be of the drastic kind, and united with calomel. "Diarrhœa very often proves a natural cure of insanity." (Haslam.) Vomits. Camphor. Opium in large doses. Cold bathing during the violence of the paroxysms, and in some cases warm bathing in the intervals. During the urgency of phrenzy, apply cold water to the head. Clay cap. Blisters to the scalp. In some cases the production of a vertiginous state by a rotatory swing, has lately been found effectual in breaking the morbid associations constituting phrenetic and melancholy paroxysms. Digitalis in very large doses, but regulated with care. Introducing a new disease, which is of a trivial nature, and easy of cure. "I should place considerable hopes on inoculation, had the party not previously had the small-pox, taking care, by proper medicines and management, to increase the symptoms that usually attend this last disease to such a degree, that the whole system should be considerably affected without the life being endangered." (Cox.)

In instances where madness has originated from corporeal diseases, it scarcely requires to be observed, that a considerable part of the treatment must be constituted by the administration of those remedies that in common cases of these affections have been found to be effectual.

Genus IV. *Oneirodynia.* This genus is defined by Dr. Cullen "a violent and distressing imagination in time of sleep." It is divided into two species: the active, or that exciting to walking and various other motions; and the gravans, with a sense of weight or pressure on the chest. This last is the incubus of authors, or night-mare, which is doubtless placed erroneously among the disorders of the judgment.

The former of these is generally either congenital, or induced by unknown causes; it is perhaps principally curious, as it evinces the almost unlimited power of one sense, when concentrated as it were, or employed to the exclusion of the rest. Dr. Darwin relates the case of a gentleman who had lost his sight, entering his room, and immediately informing him of the length, breadth, and height of the apartment, by the undivided exercise of his sense of hearing; an accuracy which he could not have arrived at, had he retained the faculty of sight. In like manner the sleep-walker "will unlock his door, wander far from home, avoid opposing obstacles, and pass with safety over narrow bridges," which during his waking hours he would have shunned as unable to accomplish.

The incubus, or night-mare, appears to arise from an interruption of the circulation of blood through the lungs, from defective irritability in these organs, induced by fatigue, mental oppression, "a full supper, and wine;" which last, in some persons, will almost invariably induce the disease.

M. M. Temperance; especially moderate suppers. "To sleep on a hard bed with the head raised." Emetics. Purgatives of aloes and calomel. Tonics. Sleeping in a large airy apartment, and without curtains to the bed.

Class III. *Cachexiæ.* Cachexies.

Previously to an acquaintance with the distinct structure and separate functions of the nervous system, before the important discovery of the circulation of the blood, and the more recent, but hardly less important, developement of the anatomy and physiology of the secerning and absorbent vessels, the notions of pathologists on the mode in which disease, local and general, is occasioned, were indistinct and erroneous.

When, for example, on the surface of the body appeared a peculiar eruption, which after a certain time broke through the outer skin, and discharged an offensive matter, it was natural to infer that such discharge was engendered from a depraved condition of the solids or fluids of the living system, nearly in the same manner as exhalations proceed from dead and putrid animal or vegetable substance, or as wort is formed in the fermenting vat. Hence the use of the terms bad habit of body, foulness of blood, peccancy of humours, cachexies.

These gross and indiscriminate opinions respecting the actual nature and immediate cause of disease, are now retained alone by the vulgar; and as the nomenclature should keep pace with the advances of science, the word cachexy, as descriptive of those affections we are now to notice, ought to be banished from the phraseology of the nosologist, and a generic title substituted, indicative of disordered or deranged action in the secerning, absorbing, and glandular organs.

Order I. *Marcores.*

A wasting of the body or general emaciation.

Genus I. *Tabes.* Asthenia, emaciation, and hectic.

Genus II. *Atrophia.* Asthenia, and emaciation without hectic.

Dr. Cullen has properly distinguished the emaciation connected in its origin with hectic fever, from that independant of this as a primary and essential character. The latter, however, or atrophia, should not appear in the last class of diseases. When, for example, in consequence of mental affection, of sudden and too copious evacuation of any of the fluids, of deficiency in the quantity or depravation in the quality of the articles of diet, a loss of flesh and strength is perceived, the effect shall have been occasioned without any default in the absorbent vessels, and consequently without hectic; for let it be retained in the recollection, as a principle of the utmost importance in practice, that where hectic fever is present, a greater or less degree of derangement in the lymphatic vessels is likewise present. Hectic fever is a disease of the absorbent system.

For the purpose of illustrating this distinction between tabid and atrophic disorders, let two individuals be supposed equally emaciated and equally weak; but this weakness and emaciation in one shall have been induced by an indisposition to take a due quantity of nourishment, in order to supply the requisitions of the frame; in the other perhaps, notwithstanding the loss of bulk and of strength, an equal, or even greater quantity of aliment shall have been received into the stomach. Now, in this latter case, the tabid state has been occasioned by a torpid condition or improper action of those vessels whose office it is to separate the nutritive part of the food, and convey it, properly prepared, to the blood-vessels (see the article Digestion). In the former the mischief has proceeded from a want of those materials upon which these vessels exercise their functions. In the one the hectic flush from the very onset of the malady shall imprint the cheek; in the other, hectic will not be occasioned until the absorbents, from not being properly exercised, come at length to be disordered. The one complaint is the tabes of Dr. Cullen; the other is the atrophia of the same author.

We have been particular in pointing out this distinction, because it is not sufficiently noticed by writers in general, notwithstanding its extreme importance in practice; and because, by keeping it distinctly in view, we shall be enabled to reconcile the apparently contrary operation of those medicines which are employed with varied effect under different circumstances of debility and emaciation.

Steel, for instance, is one of those articles which, on account of their almost magic power over some diseases of debility, have been indiscriminately recommended in all; it has acquired the erroneous appellation of a tonic medicine, but as a tonic it often fails.

Now let us trace its effects in the two species of emaciation just alluded to. In the first stage of atrophy its administration will be often followed by irritative action, in the place of due excitement; the attendant febrile heat (not hectic fever) will be augmented, costiveness and an arid skin will follow, and indeed all the symptoms of the malady be heightened and confirmed.

In tabid diseases, on the other hand, the reverse effects will arise. Here the fever is hectic; and in the same degree that this valuable medicine, when duly employed, had increased the febrile irritation in atrophia, it will assuage the fever of tabes, and from the same cause, the stimulus which it imparts to the absorbent and lacteal vessels.

How hectic fever originates, it is difficult to explain: its symptoms have been attributed by a writer of the present day to that overplus of excitement being expended upon the arterial, which is occasioned by the deficient excitability of the absorbent system. This, however, is rather a statement than an explanation of its essence. The characteristics of hectic are principally the circumscribed redness on the cheek appearing more evidently once or twice in the course of the day, usually after meals, and alternating with a more than ordinary paleness of countenance; the pulse is feeble and quick; like the crimson flush of the cheek, it is accelerated by any thing received into the stomach; the urine is for the most part high-coloured, but deposits a bran-like sediment after standing for some time; the tongue is not furred in the same manner as in fever in general, but is clean; and often, as the disease advances, it increases in redness, the exact contrary to what is observed in genuine fever; the sweats are partial and irregular, and not attended with the same degree of temporary relief as in other cases; and, more especially in the advanced periods of the complaint, principally break out about the neck, breast, and shoulders; as the disease proceeds, debility and emaciation succeed, the legs and feet become œdematous, and (not however till nearly the fatal close of the malady on which the hectic depends) delirium at length supervenes.

M. M. In atrophia, a supply of nourishment, equivalent to the loss that may have been sustained; if emaciation has arisen from mental disturbance, the remedies must chiefly be made to apply to the mind. Tonics from the vegetable class, such as colomba, quassia, and gentian; not steel. Abate the febrile irritation, by keeping the bowels gently open by the milder purgatives, such as manna, senna, and castor oil. Preserve a slight moisture of the skin by small doses of antimonials. Regular and moderate, not violent or agitating, exercise. Shower-bath in very warm, tepid bathing in cold weather. Pure air.

In tabes, or emaciation, accompanied by primary hectic. An emetic, to accomplish the double purpose of forcibly expelling ventricular and intestinal acidities, and exciting the languid absorbents. Drastic purgatives, as jalap or aloes, with calomel, with the same intention. Steel, in conjunction with Peruvian bark or bitters. Horse exercise. Warm bathing.

N. B. Tabes is for the most part symptomatic of other complaints, as of a disease of the lungs or the liver; and in such cases the treatment by which it is to be overcome is the treatment of the original or radical malady.

Order II. *Intumescentiæ, general swellings.*

Sect. I. *Adiposæ,* Fatty swellings.

Genus I. *Polysarcia,* obesity. This arises from the deposition of oil in the adipose membrane becoming disproportionate to the requisitions of the body. It proceeds in general from indolence and intemperance.

M. M. Temperance, exercise, less animal food, early rising.

Sect. II. *Flatuosæ*, windy swellings.

Genus I. *Pneumatosis*, a tense elastic swelling of the body, crepitating under the touch.

Pneumatosis is constituted by a distension of the cellular membrane from air; it may arise without any evident cause, and in this case is denominated by Dr. Cullen the spontaneous pneumatosis; or the distending air may be introduced by means of an external wound, as of the thorax, in compound fracture of the ribs: sometimes elastic swellings of the whole body follow, from the application of poison; and at others, pneumatosis appears as an attendant upon the hysteric disorder.

The pathology of this disease, unless when it arises from wounds, is exceedingly obscure.

M. M. Scarifications, compresses, tonics.

Genus II. *Tympanites*, a windy swelling of the abdomen, tense, elastic, painful, and attended by costiveness.

Tympanitic swellings, both of the intestinal canal and of the cavity of the abdomen, often take place in conjunction with anasarca, or other disorders of debility, and frequently arise from sedentary habits, hypochondriac ailments, and innutritious diet.

M. M. Carminatives, emetics, tonics, and a generous diet, with exercise.

Tympanites is sometimes connected with obstructed menstruation, and in this case is seldom overcome but with the return of the menstrual discharge.

Genus III. *Physometra*, an elastic swelling in the hypogastrium, consequent upon flatulent distension of the womb.

"This frequently deceives the barren female with the hopes of pregnancy, till nature explains the mystery, and her expectations vanish in air."

Sect. III. *Aquosæ*, watery swellings.

Dropsical enlargement is distinguished from pneumatosis by its being inelastic, or pitting from the pressure of the finger, and slowly recovering its former fulness.

While considerable obscurity attends the nature and proxmiate cause of windy swellings, the theory of dropsical affections is sufficiently evident. Dropsy is a collection of serous fluid, either in the cellular membrane, or in the cavities of the body. It is invariably occasioned by exhalation being disproportionate to absorption; this increase of exhalation and diminution of absorption result from debility, which may be either direct or indirect; the latter follows increased action of the vessels, as in the dropsy succeeding to intemperance; the former arises out of deficient excitement in the lymphatic system, as when an individual becomes dropsical from indolence, inactivity, mental depression, and poverty of diet. Partial dropsies, or anasarcous swellings of the cellular membrane, as well as effusions into cavities, may also originate from pressure on the veins; independantly of original debility in the lymphatic vessels, such pressure obstructing the free reflux of blood through the venous system, and by consequence occasioning a more than ordinary determination to the exhalant arteries in the vicinity. Such are the dropsical accumulations which sometimes occur in pregnancy, and which are relieved by delivery. In this manner likewise, that swelling of the abdomen, constituting ascites, partly originates, when it is caused or attended by an obstructed circulation through the liver, the blood in the vena portæ accumulating in an inordinate measure, and by consequence supplying the lymphatic vessels of the part with more than their due proportion of fluid. Lastly, without universal debility in the exhalant and absorbent vessels, dropsical swellings may arise from inflammation, as is illustrated in the anasarcous collections following erysipelas, in the hydrocele succeeding to a blow on the testicle, in the dropsy of the chest resulting from inflammation of the lungs, and in ascites following peritoneal inflammation.

In whatever mode, and to whatever extent, dropsy may be occasioned, the accumulation of serous fluid by which it is constituted, always argues debility in the lymphatic vessels of the part in which this accumulation occurs. This debility, perhaps, is primarily and principally seated in the lymphatic exhalants; for we do not find hectic fever a characteristic of hydropic, as it is of other affections, in which an original torpor of the absorbents is evidently the cause of the morbid symptoms. Hectic only comes on in the last stages of dropsy, when the absorbents are worn out with constant exertion to absorb the effused fluid.

We have hitherto spoken indiscriminately of dropsy of cavities, and of dropsy in the cellular membrane: these, however, although they often exist conjointly, require to be distinguished; for instance, an accumulation of water in the thorax may be confined to the cellular texture of these organs, and form the disease properly distinguished by the denomination of anasarca pulmonum; or it may be diffused in the cavity of the chest, and constitute the true hydrops pectoris, or hydrothorax. The former generally arises from an universal torpor of the lymphatic system, and is almost constantly connected with hydropic swellings of other parts, particularly the ancles and legs; the latter often originates as a local disease, as from an inflammation of the pleura, and is sometimes confined entirely to the chest.

Genus I. *Anasarca*. General dropsy.

Dropsy of the cellular membrane immediately under the skin appears principally in the lower extremities, on account of the depending situation of these members, and the universal connection between the cells of which the membrane is constituted; and party on account of the deficiency in lymphatic excitement, from which it originates, being more conspicuous in those vessels which are the furthest removed from the centre of the circulation. Anasarca, as it arises from exhausted excitability in the lymphatic vessels, is always a disorder indicating much danger.

M. M. Those stimuli which are found to exert their influence on the absorbent vessels, particularly steel, digitalis, calomel. Diuretics, such as squills, juniper, nitrous æther, cantharides, chrystals of tartar, and nitre. Emetics and cathartics are less proper in anasarca than in dropsy of cavities. The physician must be especially careful while evacuating the fluid by means of diuretics, to support the general excitement, in order to prevent its reaccumulation; from want of solicitous attention to this particular, the waters, after an apparent cure of anasarca, often again collect to an increasing extent. Punctures and scarifications of the extremities are seldom advisable, on account of the prevailing debility and tendency to gangrene.

The sparing use of liquids is generally proper in dropsy; instances, however, have been known of copious draughts of water producing a termination of the complaint.

Genus II. *Hydrocephalus*, dropsy of the brain. See Infancy.

Genus III. *Hydrorachitis*, dropsical tumour in the spine. See Surgery.

Genus IV. *Hydrothorax*, dropsy of the chest.

Symptoms. Difficulty of breathing, especially in a horizontal position, paleness of countenance, starting in sleep, palpitation of the heart, numbness of the arms, especially when elevated, and in the advanced stages of the malady an evident fluctuation of water in the cavity of the chest. The hydrothorax, or hydrops pectoris, "is distinguished from the anasarca pulmonum, as the patient in the former cannot lie down half a minute; in the latter, the difficulty of breathing, which occasions him to rise up, comes on more gradually; as the transition of the lymph in the cellular membrane, from one part to another of it, is slower than that of the effused lymph in the cavity of the chest." (Darwin.) We have already said, that in the anasarca pulmonum the disease is often attended with swelled legs. Dr. Darwin suspects that even this species of dropsy of the chest is in the greater number of instances a disease merely of the cellular membrane of the part, not of a general torpor of the lymphatic system, and that the legs do not swell till the patient, from the protraction of the local malady, becomes universally weak. We often, however, meet with ascitic and anasarcous swellings commencing in the extremities, which, in their course towards a fatal termination, rise up into the chest, and in this manner occasion the pulmonic affection. Here the general paralysis of the lymphatics precedes the primary disorder of the thorax.

Causes. Where the universal has preceded the local affection, the malady is most frequently to be traced to intemperance in the use of fermented and spirituous liquors. The most usual source of genuine hydrothorax, or hydrops pectoris, is the sudden application of cold, while the body is in a state of perspiration and debility, from previous heat and exercise. Young people, during perspiration and fatigue from dancing, "if they drink freely of cold lemonade or water are apt to bring on a dropsy of the chest." (Townsend.)

M. M. Digitalis in considerable doses is especially indicated in dropsy of the chest, and its effects are more visible as well as more certain in the anasarca pulmonum than in the hydrops pectoris, because this medicine influences powerfully the whole extent of the absorbent system. Squill, in combination with calomel, for the hydrops pectoris; and if the cellular membrane be anasarcous, connect steel with both the above medicines. Chrystals of tartar, especially in the anasarca pulmonum. Diuretics of other kinds, the same as in general anasarca. Opium. In hydrothorax, or dropsy of the chest, without anasarca, paracentesis, or puncture in the side. "It is sometimes impossible even to relieve the dropsy of intemperance; and the dropsical from this cause can never expect again to enjoy the pleasures of existence in full measure." (Beddoes.)

Genus V. *Ascites.* Dropsy of the abdomen.

The swelling of the abdomen is tense, scarcely elastic, but fluctuating; the fluctuation can sometimes be perceived by spreading one hand on one side of the abdomen, and striking with the other hand on the opposite side. Ascites is attended with scarcity of urine, thirst, and after some time a degree of hectic fever.

Ascites most usually originates through the medium of a diseased liver; and such disease is, in the greater number of instances, itself induced by intemperance in spirituous liquors. Like the disease, however, of the lungs preceding dropsy in the chest, liver complaints productive of ascites, may be brought on by the precipitate application of cold succeeding to the extremes of heat, by indolence, mental affections, and other causes. Ascites sometimes originates from debility in the abdominal lymphatics, without the intervention of any hepatic disease.

M. M. Ascertain by enquiry into previous and present symptoms, whether any degree of liver complaint has preceded the dropsical accumulation; whether there is any disposition to jaundice of the skin; whether the alvine excretions are insufficient, whitish, and slimy; whether there has been any pain in the region of the liver, difficulty of lying on the side, especially on the left side, high colour of the urine, pain in the right shoulder, &c. and adapt the treatment accordingly. If the water is independant of disease in the liver, chrystals of tartar, digitalis, other diuretics, and steel, may be immediately had recourse to, without the intervention of calomel purgatives and of emetics, which last are almost always indicated in the more usual form of ascites, that form a morbid affection of the biliary organs. Emetics in hepatic ascites are often attended with most beneficial effects. "Per vomitus solvuntur cuncta tenacia, concutiuntur obstructa, expelluntur stagnantia, unde mirabiliter in hoc morbo prosunt." (Boerhaave.) In the administration of ascitic purgatives, care must be taken that, from the violence of excitement which they occasion, they do not induce peritoneal inflammation. A combination of gamboge, elaterium, and calomel, is frequently employed as a purgative in ascites. Mercurial ointment to the region of the liver. Tonics, especially steel. The inhalation of vital air, as recommended and employed by Dr. Thornton and others. Tapping. This is to be regarded in general as merely a palliative: if however there has not been any very considerable disease of the liver, or the debility is not extremely urgent, tapping may be advised with a prospect of effecting a radical cure, provided due care is at the same time employed to maintain a proper excitement, or, as it is generally expressed, to restore and preserve the tone of the system.

Genus V. *Hydrometria.* Dropsy of the womb.

This, like the physometra, already mentioned, often assumes a deceitful resemblance to pregnancy. It is characterized by dropsical swelling, confined to the region of the uterus, not being accompanied by other symptoms of dropsy.

It is a disease to which the unmarried and the barren are principally obnoxious; sometimes it follows abortion.

M. M. Stimulant fomentations. Drastic purgatives. Aromatic fœtid gums. Emmenagogues.

Genus VII. *Hydrocele.* Dropsy of the scrotum. See SURGERY.

SECT. IV. *Solidæ.* Swellings of solid parts.

Genus I. *Physconia.* A swelling chiefly occupying a portion of the abdomen, increasing gradually, and neither tense nor sonorous as in pneumatosis, nor fluctuating as in dropsy.

This disease is principally formed by a schirrous state of the several parts, and viscera, which form its seat. These schirrous enlargements are generally incurable.

Genus II. *Rachitis.* Rickets. See INFANCY.

ORDER III. *Impetigines.*

Deformities and discolourations of the external surface from general disease.

Genus I. *Scrophula.* King's evil.

Swellings of the lymphatic glands, terminating in ulcer, are perhaps the only proper characteristics of actual scrophula: the thick upper lip, transparent skin, and other appearances which are considered as symptoms of the disease, are merely marks of peculiar predisposition.

A scrophulous habit is merely a susceptibility of disease, arising from torpor in the lymphatic vessels, and when brought on by the agency of exciting causes, consists in a peculiar action of the lymphatic glands, by which inflammation and at length ulceration, with a discharge of grumous matter, are induced.

Its exciting causes are those which encourage the original debility, and the disease may almost certainly be avoided by attention to diet and regimen; by nutritious food, a pure oxygenous atmosphere, cleanliness, exercise, &c. See INFANCY.

When by neglect, the predisposition has been permitted to break out into disease, calomel purges, steel, small doses of digitalis, warm and sea-bathing, muriates and phosphates of barytes? above all cleanliness; ventilation, stimulating nutritious diet. Let the mind be preserved free from the erroneous idea, that to cure scrophula is to purge away gross humours. See SURGERY.

Genus II. *Syphilis.* Venereal disease.

After impure connection, a disorder of the genitals, ulcers in the mouth and nose. Eruptions on the skin of a copper colour, terminating in ulceration; these are principally situated near the margin of the hair; blotches on the surface of the body, especially on the surface of the face. Nocturnal pains in the centre of the bones.

M. M. Mercurials. Nitric acid. Tonics. N. B. For the local application to venereal ulcers, the more particular treatment of the complaint, and the mode of curing gonorrhea virulenta, see SURGERY.

Genus III. *Scorbutus,* scurvy.

Indolence and lassitude; gloomy and tumid countenance; gums livid, and disposed to bleed spontaneously, or from the slighest irritation; skin dry, and covered with livid spots; œdematous swellings of the ancles. Scurvy appears to originate from want of, or exhausted excitement, both in the venous and absorbent system; it is produced by a protracted course of salt food, and by mental depression.

M. M. Fresh animal and vegetable diet. Juice of lemon. Bark. Steel. Terrene atmosphere. Mental excitement.

The elephantiasis, lepra, frambæsia, and trichoma, forming the fourth, fifth, sixth, and seventh genera of this order, are diseases of such rare occurrence in this country, as not to require any particular description.

For the more common eruptions which require local application, see SURGERY.

Genus III. *Icterus,* jaundice.

Symptoms. Yellowness of the skin and eyes; white and slimy fæces; high-coloured urine, tinging linen yellow; langour, lassitude, and extreme depression of spirits.

The yellow colour of the skin, which constitutes jaundice, arises from the diffusion through the system of that bile, which, in the natural course, would pass through the biliary ducts into the intestinal canal. This impregnation of the system with bile has been supposed to be effected in three ways, viz. through the medium of the lacteal vessels and the thoracic duct, when the obstruction is in the duodenum; and by regurgitation through the hepatic veins, or absorption by the lymphatics of the liver, when the obstruction is in some part of the bile's course previous to its arrival in the duodenum.

This interruption of the biliary secretion may originate from a spasmodic affection near the duct; from chronic inflammations, or other diseases of the liver interfering with the secretion; from certain concretions lodging in some part of the hepatic organs, called gall-stones; and, as pointed out by Mr. Townsend, from viscid mucus stopping up or obstructing the biliary passages. Indeed, whatever hinders the bile from passing into the duodenum may prove a source of jaundice.

The first of the above species of jaundice is generally of a temporary nature; it occurs principally in those who have much irritability of habit, in consequence of violent passions, and other sources of spasmodic affections.

The second species is not of so decided a nature; it follows upon a long course of intemperance in spirituous liquors, and is only to be remedied by removing the disease of the liver itself.

The biliary calculi, which give rise to the third species of jaundice, appear, like urinary concretions, to arise from some defective action in the secretory or absorbing vessels of the parts in which they are formed or lodged; their production, like the stone in the bladder, is evidently favoured by a retention of fluid, from which they are formed. It may therefore be inferred, that gall-stones are never, or seldom, produced without some previous jaundice having taken place. Thus they are both the cause and consequence of the disease. Their presence may be ascertained from jaundice frequently disappearing and returning, from the appearance of biliary concretions among the fæces, and from the disease being attended with shooting pains in the epigastric region, and right hypochondrium. Nausea, difficult respiration, and sickness, often likewise accompany this species of jaundice.

The icterus mucosus of Townsend, which is perhaps the most frequent species of jaundice, is unattended either by pain or spasmodic affections; there are no gall-stones observed in the fæces; but these are generally discharged mixed with much slime and viscidities. It is generally accompanied with, and indeed is most commonly occasioned by, a depression of mind, especially when favoured by sedentary habits, breathing an impure atmosphere, living upon unwholesome innutritious diet, or indulging in the too free use of "spirituous potation."

While it is the most frequent, and oftentimes the most protracted, of any of the species of jaundice, it is at the same time most easy of cure when properly understood and managed.

M.M. Emetics. Calomel purgatives. Bitter. Tonics, especially colombo, with rhubarb. Pure air. Exercise on horse back. Mental excitement.

In icterus spasmodicus, opium, assafœtida, æther, electricity. If the spasm depends upon any irritations in the stomach or bowels, these to be removed by emetics, purgatives, anthelmintics. In icterus calculosus, emetics to facilitate the passage of the gall-stones. Antispasmodics. Warm bathing. Emollient clysters. Vegetable tonics, and steel.

N. B. The average doses of medicines will be found stated in the articles Materia Medica, and Pharmacy.

MEDIETAS LINGUÆ, a jury or inquest impanelled, whereof the one-half consists of natives or denizens, the other strangers; and used in pleas wherein the one party is a stranger, the other a denizen.

MEDIUM, in logic, the mean or middle term of a syllogism, being an argument, reason, or consideration, for which we affirm or deny any thing; or, it is the cause why the greater extreme is affirmed or denied of the less in the conclusion.

Medium, or Mean, *geometrical*. See Mean.

MEDULLA OBLONGATA. See Anatomy.

Medulla spinalis. See Anatomy.

MEDUSA, a genus of vermes of the order mollusca. The generic character is, body gelatinous, or bicular, and generally flat underneath: mouth central beneath. The animals of this genus consist of a tender gelatinous mass of different figures, furnished with arms or tentacular processes, proceeding from the lower surface: the larger species, when touched, cause a slight tingling and redness, and are usually denominated sea-nettles; they are supposed to constitute the chief food of cetaceous fish, and most of them shine with great splendour in the water. There are 44 species. See Plate Nat. Hist. fig. 262.

MEIONITI, a mineral found only among the lava of Vesuvius, always crystallized. Primitive form, a prism whose bases are squares. It occurs usually in eight-sided prisms, and terminated by four-sided pyramids. Sometimes the edges of the prism are truncated. Colour greyish-white; fracture flat; melts before the blowpipe into a white spongy glass.

MELAMPODIUM, a genus of the class and order syngenesia polygamia necessaria. The calyx is five-leaved; recept. chaffy, conical; down one-leaved, involuted, converging. There are three species, herbs of the West Indies.

MELANITE, a mineral found in the neighbourhood of Vesuvius, and formerly called black garnet. Its colour is black or brownish. Crystallized in six-sided prisms, terminated by trihedral summits. It is composed of

40	silica
28.5	alumina
16.5	oxide of iron
10.0	magnesia
3.5	lime
0.25	oxide of manganese.
98.75	

MELALEUCA, a genus of the polyandria order, belonging to the polyadelphia class of plants. The calyx is quinquepartite, superior; the corolla pentapetalous; the filaments are very numerous, and collected in such a manner as to form five pencils: there is one style; the capsule is half-covered with the calyx, formed like a berry, and is trivalved and trilocular. The species are 11, natives of India and the South Sea islands. The most remarkable species is the leucadendron, from a variety of which (the latifolia, or broad-leaved leucadendron) the cajeput oil is obtained; a medicine in very high esteem among the Eastern nations, particularly in India. It is said to be obtained by distillation from the fruit of the tree. When brought into this country it is a liquid of a greenish colour, of a fragrant but at the same time a very peculiar odour, and of a warm pungent taste. Some authors, however, represent this oil as being, when of the best quality, a white or colourless fluid; and it has been said by the authors of the Dispensatorium Brunsvicense, when prepared in Europe from the seeds sent from India, to be entirely of this appearance. Hitherto the oleum cajeput has been but little employed either in Britain or on the continent of Europe; but in India it is used both internally and externally, and is highly extolled for its medical properties. It is applied externally where a warm and peculiar stimulus is requisite; it is employed for restoring vigour after luxations and sprains, and for easing a violent pain in gouty and rheumatic cases, in tooth-ache, and similar affections; but it has been chiefly celebrated as taken internally, and it is particularly said to operate as a very powerful remedy against tympanic affections.

MELAMPYRUM, *cow-wheat*, a genus of the angiospermia order, in the didynamia class of plants, and in the natural method ranking under the 40th order, personatæ. The calyx is quadrifid; the upper lip of the corolla is compressed, with the edges folded back; the capsule is bilocular and oblique, opening at one side; three are two gibbous seeds. There are five species, four of them natives of Britain, and growing spontaneously among corn-fields. They are exellent food for cattle; and Linnæus tells us, that where they abound, the yellowest and best butter is made. Their seeds, when mixed with bread, give it a dusky colour; and, according to some authors, produce a vertigo, and other disorders of the head; but this is denied by Mr. Withering, though he allows that they give it a bitter taste.

MELASTOMA, the *American gooseberry tree*, a genus of the monogynia order, in the decandria class of plants, and in the natural method ranking under the 17th order, calycanthemæ. The calyx is quinquefid and campanulated; the petals are five, inserted into the calyx; the berry is quinquelocular, and wrapped in the calyx. There are 67 spec. most of them shrubs of the warm parts of America, and very beautiful on account of the variegation of their leaves. Most of the leaves are of two different colours on their surfaces; the under side being either white, gold-coloured, or russet, and the upper parts of different shades of green; so that they make a fine appearance in the hot-house all the year round. There are but few of these plants in the European gardens; which may, perhaps, have been occasioned by the difficulty of bringing over growing plants from the West Indies; and the seeds, being small when taken out from the pulp of their fruits, rarely succeed. Some of these species strike very easily from cuttings.

MELCHITES, in church history, the name given to the Syriac, Egyptian, and other christians of the Levant. They celebrate mass in the Arabian language. The religious, among the Melchites, follow the rule of St. Basil, the common rule of all the Greek monks. They have four fine convents, distant about a day's journey from Damas, and never go out of the cloister.

MELCHIZEDECHIANS, in church history, a sect which arose about the beginning of the third century, and affirmed, that Melchisedech was not a man, but a heavenly power, superior to Jesus Christ.

MELEAGRIS, in ornithology, the turkey, a genus of birds belonging to the order of gallinæ. The head is covered with spongy caruncles; and there is likewise a membranaceous longitudinal caruncle on the throat. There are but two species, viz. the gallopavo, or North American turkey of Ray; and the satyra, or horned turkey. The first has a caruncle both on the head and throat; and the breast of the male is bearded or tufted. It lives upon grain and insects; when the cock struts, he blows up his breast, spreads and erects his feathers, relaxes the caruncle on the forehead, and the naked parts of the face and neck become intensely red. Barbot informs us that very few turkeys are to be met with in Guinea, and those only in the hands of the chiefs of the European forts; the negroes declining to breed any on account of their tenderness, which sufficiently proves them not to be natives of that climate. He also remarks, that neither the common poultry nor ducks are natural to Guinea, any more than the turkey. Neither is that bird a native of Asia; the first that were seen in Persia were brought from Venice by some Armenian merchants. They are bred in Ceylon, but not found wild. In fact, the turkey, properly so called, was unknown to the antient naturalists, and even to the old world, before the discovery of America; and with this the Portuguese name peru remarkably coincides. It was a bird peculiar to the new continent, and is now the commonest wild-fowl in the northern parts of that country, where they are frequently met with by hundreds in a flock; in the day-time they frequent the woods, where they feed on acorns, and return at night to the swamps to roost, which they do on the trees. They are frequently taken by means of dogs, though they run faster for a time; but the dogs persisting in the pursuit, the birds soon grow fatigued, and take to the highest trees, where they will suffer themselves to be shot one after another, if within reach of the marksman. This fowl was first seen in France in the reign of Francis I. and in England in that of Henry VIII. By the date of the reign of these monarchs, the first turkeys must have been brought from Mexico, the conquest of wh ch was completed A. D. 1521.

The turkey hen begins to lay early in the spring, and will often produce a great number of eggs, which are white, marked with reddish or yellow spots, or rather freckles. She sits well, and is careful of her young; of which in this climate she will often have from 14 to 17 for one brood: but she scarcely ever sits more than once in a season, except allured thereto by putting fresh eggs under her as soon as the first set are hatched; for, as she is a close sitter, she will willingly remain two months on the nest, though this conduct, as may be supposed, is said greatly to injure the bird. Turkeys are bred in quantities in some of the eastern counties of England, and are driven up to London towards autumn for sale in flocks of several hundreds, which are collected from the several cottages about Norfolk, Suffolk, and neighbouring counties, the inhabitants of which think it well worth their while to attend carefully to them, by making these birds a part of their family during the breeding-season. It is pleasing to see with what facility the drivers manage them by means of a bit of red rag fastened to the end of a stick, which, from their antipathy to it as a colour, acts with the same effect as a scourge to a quadruped.

Of the turkey there are several varieties, which have arisen from domestication. The most common is dark-grey, inclining to black, or barred dusky-white and black. There is also a beautiful variety of a fine deep copper colour, with the greater quills pure white, and the tail of a dirty white; it is when old a most beautiful bird. A variety with a pure white plumage is also now not unfrequent, and appears very beautiful. It was once esteemed as a great rarity, and the breed supposed originally to have arisen in Holland. The sahjou inhabits India, and is sometimes less than the last. See Plate Nat. Hist. fig. 261.

MELES, in zoology. See URSUS.

MELIA, *azaderach*, or the *bead-tree*, a genus of the monogynia order, in the decandria class of plants, and in the natural method ranking under the 23d order, trihilatæ. The calyx is quinquedentated; the petals five; the nectarium cylindrical, as long as the corolla, with its mouth ten-toothed; the fruit is a plum with a quinquelocular kernel. There are three species, all of them exotic trees of the Indies, rising near 20 feet high, adorned with large pinnated or winged leaves, and clusters of pentapetalous flowers. They are all propagated by seeds sown on hotbeds.

MELIANTHUS, *honey-flower*, a genus of the angiospermia order, in the didynamia class of plants, and in the natural method ranking under the 24th order, corydales. The calyx is pentaphyllous, with the lowermost leaf gibbous: there are four petals, with the nectarium under the lowest ones. The capsule is quadrilocular. There are three species: 1. The major has many upright, ligneous, durable stalks, and from the sides and tops of the stalks long spikes of chocolate-coloured flowers. 2. The minor has upright, ligneous, soft, durable stalks; and from the sides and ends of the branches long, loose, pendulous bunches of flowers tinged with green, saffron-colour, and red. Both the species flower about June; but rarely produce seeds in this country. They are very ornamental, both in foliage and flower, and merit admittance in every collection. They are easily propagated by suckers and cuttings. They thrive best in a dry soil, and in a sheltered warm exposure. 3. The commdous, little known.

MELICA, *ropegrass*, a genus of the digynia order, in the triandria class of plants, and in the natural method ranking under the 4th order, gramina. The calyx is bivalved, biflorous, with an embryo of a flower betwixt the two florets. There are three species, of which the most remarkable is the nutans. It is a native of several parts of Britain, and the adjacent islands; and the inhabitants of some of the western islands make ropes of it for fishing-nets, as it will bear the water for a long time without rotting.

MELICOCCA, a genus of the class and order octandria monogynia. The calyx is four-parted; the petals four, bent back; stigma subpeltate, drupe coriaceous. There is one species, a tree of South America.

MELICYTUS, a genus of the class and order dioecia pentandria. There is one species, of New Zealand, little known.

MELISSA, *baum*, a genus of the didynamia gymnospermia class of plants, with a monopetalous ringent flower, the lower lip of which is divided into three segments, whereof the middle one is cordated: the seeds are four in number, and contained in the bottom of the cup. There are six species.

Baum is greatly esteemed among the common people as good in disorders of the head and stomach; but is less regarded in the shops. It is most conveniently taken in infusion by way of tea; the green herb is greatly better than the dry, which is contrary to the general rule in relation to other plants.

MELITTIS, bastard baum, a genus of the didynamia gymnospermia class of plants; the upper lip of whose cup is emarginated; the upper lip of its flower is plane, and the lower one crenated. There are two species.

MELIUS INQUIRENDUM, in law, a writ that lies for a second inquiry to be made of what lands, &c. a man died seized; when partiality is suspected upon the writ diem clausit, &c.

MELLATS. This genus of salts is but imperfectly known, in consequence of the scarcity of mellitic acid. Hitherto they have been examined only by Klaproth and Vauquelin, and even by them too slightly to admit a description of their properties. The following are all the facts hitherto ascertained.

1. When mellitic acid is neutralized by potass, the solution crystallizes in long prisms. The acid appears capable of combining with this salt, and forming a supermellat of potass. For when the mellite (or native mellat of alumina) is decomposed by carbonat of potass, and the alkaline solutions mixed with nitric acid, crystals are obtained consisting of mellitic acid combined with a small portion of potass.

2. When mellitic acid is neutralized by soda, the solution crystallizes in cubes or three-sided tables; sometimes insulated, sometimes in groups.

3. When mellitic acid is saturated by ammonia, the solution yields fine transparent six-sided crystals, which become opaque when exposed to the air, and assume the white colour of silver.

4. When mellitic acid is dropt into barytes water, strontian water, or lime water, a white powder immediately precipitates, which is dissolved by adding a little more of the acid.

5. When the acid is mixed with a solution of sulphat of lime, very small gritty crystals precipitate, which do not destroy the transparency of the water; but the addition of a little ammonia renders the precipitate flaky. The precipitate produced by this acid in lime water is redissolved by the addition of nitric acid.

6. When this acid is dropt into acetat of barytes, a flaky precipitate appears, which is dissolved by adding more acid. With muriat of barytes it produces no precipitate; but in a short time a group of transparent needle-form crystals is deposited, consisting most likely of supermellat of barytes.

7. When this acid is dropt into sulphat of alumina, it throws down an abundant precipitate in the form of a white flaky powder.

MELLITE, *honeystone, mellat of alumina.* This mineral was first observed about 10 years ago in Thuringia, between the layers of wood coal. It is of a honey-yellow colour (whence its name); and is usually crystallized in small octahedrons, whose angles are often truncated. Fracture conchoidal. Specific gravity, according to Abich, 1.666. When heated it whitens, and in the open air burns without being sensibly charred. A white matter remains, which effervesces slightly with acids, and which at first has no taste, but at length leaves an acid impression upon the tongue.

Klaproth analysed the mellite in 1799, and ascertained it to be a compound of alumina and a peculiar acid, to which he gave the name of mellitic. And this analysis was soon after confirmed by M. Vauquelin.

MELLITIC ACID has been found only in the mellite. It may be procured from that mineral by the following process: Reduce the mellite to powder, and boil it in about 72 times its weight of water. The acid combines with the water, and the alumina separates in flakes. By filtring the solution, and evaporating sufficiently, the mellitic acid is obtained in the state of crystals.

These crystals are either very fine needles, sometimes collected into globules, or small short prisms. They have a brownish colour, and a taste at first sweetish-sour, and afterwards bitterish.

This acid is not very soluble in water; but the precise degree of solubility has not been ascertained. When exposed to heat, it is readily decomposed, exhaling an abundant smoke, which however is destitute of smell. A small quantity of insipid ashes remains behind, which do not alter the colour of litmus paper.

All attempts to convert it into oxalic acid by the action of nitric acid have failed. The nitric acid merely caused it to assume a straw-yellow colour.

The effect of the simple bodies on this acid has not been tried. It combines with alkalies, earths, and metallic oxides, and forms with them salts which are distinguished by the name of mellats. The properties of these compounds will be considered afterwards.

From the analysis of M. Klaproth, we learn that the mellite is composed of

46	mellitic acid
16	alumina
38	water
100.	

From other analyses by the same chemist, he infers that mellitic acid is composed of carbon, hydrogen, and oxygen, but the proportions are not yet known.

MELOCHIA, *Jew's mallow*, a genus of the pentandria order, in the monadelphia class of plants, and in the natural method ranking under the 37th order, columniferæ. The capsule is quinquelocular and monospermous. There are 11 species: but the only remarkable one is the olitorius, or common Jew's-mallow, which is a native of the warm parts of Asia and America. It is an annual plant. The flowers sit close on the opposite side of the branches to the leaves, coming out singly; they are composed of five small yellow petals, and a great number of stamina surrounding the oblong germen, which is situated in the centre of the flower, and afterwards turns to a rough swelling capsule two inches long, ending in a point, and having four cells filled with angular greenish seeds. This species is cultivated about the city of Aleppo in Syria, and in the East Indies, as a pot-herb; the Jews boiling the leaves, and eating them with their meat.

MELODINUS, a genus of the class and order pentandria digynia. It is contorted; nect. in the middle of the tube, stellate; berry two-celled, many-seeded. There is one species, a shrub of New Caledonia.

MELODY, in music, the agreeable effect of different sounds, ranged and disposed in succession; so that melody is the effect of a single voice or instrument, by which it is distinguished from harmony.

MELOE, a genus of insects of the order coleoptera; the generic character is; antennæ moniliform, with the last joint ovate; thorax roundish; wing-sheaths soft, flexile; head inflected. Among the principal species of meloe may be numbered the meloe proscarabæus, commonly called the oil-beetle. It is of considerable size, often measuring near an inch and a half in length; its colour is violet-black, especially on the antennæ and limbs; the wing-sheaths are very short, in the female insect especially, scarcely covering more than a third of the body, and are of an oval shape. This species is frequent in the advanced state of spring in fields and pastures, creeping slowly, the body appearing so swoln or distended with eggs as to cause the insect to move with difficulty. On being handled it suddenly exsudes from the joints of its legs, as well as from some parts of the body, several small drops of a clear, deep-yellow oil or fluid, of a very peculiar and penetrating smell. This oil or fluid has been highly celebrated for its supposed efficacy in rheumatic pains, &c. when used as an embrocation on the parts affected; for this purpose also the oil expressed from the whole insect has been used with equal success. The female of this species deposits her eggs, which are very small, and of an orange-colour, in a large heap or mass beneath the surface of the ground; each egg, when viewed by the microscope, appears of a cylindric shape, with rounded ends; from these are hatched the larvæ, which, at their first appearance, scarcely measure a line in length, and are of an ochre-yellow, with black eyes; they are furnished with short antennæ, six legs of moderate length, and a long, jointed, tapering body, terminated by two forked filaments or processes. These larvæ are found to live by attaching themselves to other insects, and absorbing their juices. They are sometimes seen strongly fastened to common flies, &c. a practice so extraordinary as to have caused considerable doubt whether they could possibly have been the real larvæ of the meloe proscarabæus. The accurate observations of Degeer, however, have completely proved that fact.

The meloe scabrosus extremely resembles the preceding, and is found in similar situations, but differs in being of a reddish purple colour, with a cast of deep gilded green.

Meloe vesicatorius, blister-fly or Spanish fly, is an insect of great beauty, being entirely of the richest gilded grass-green, with black antennæ. Its shape is lengthened, and the abdomen, which is pointed, extends somewhat beyond the wing-sheaths; its usual length is about an inch. This celebrated insect, the cantharis of the materia medica, forms, as is well known, the safest and most efficacious epispastic, or blister-plaster; raising, after the space of a few hours, the cuticle, and causing a plentiful serous discharge from the skin. It is supposed however that the cantharis of Dioscorides, or that used by the antients for the same purpose, was a different species, viz. the meloe cichorei of Linnæus, an insect nearly equal in size to the meloe proscarabæus, and of a black colour, with three transverse yellow bands on the wing-shells. The meloe vesicatorius is principally found in the warmer parts of Europe, as Spain, the south of France, &c. It is also observed, though far less plentifully, in some parts of our own country. See Plate Nat. Hist. fig. 263.

MELON. See CUCUMIS.

MELOTHRIA, a genus of the monogynia order, in the triandria class of plants, and in the natural method ranking under the 34th order, cucurbitaceæ. The calyx is quinquefid; the corolla campanulated and monopetalous; the berry trilocular and monospermous. There is only one species, viz. the pendula, a native of Carolina, Virginia, and also many of the American islands. The plants strike out roots at every joint, which fasten themselves into the ground, by which means their stalks extend to a great distance each way. The flowers are very small, in shape like those of the melon, of a pale sulphur-colour. The fruit in the West Indies grows to the size of a pea, is of an oval figure, and changes to black when ripe; these are by the inhabitants sometimes pickled when they are green. In Britain the fruit are much smaller, and are so hidden by the leaves that it is difficult to find them. The plants are too tender to be reared in this country without artificial heat.

MELYRIS, a genus of insects of the order coleoptera: the generic character is, antennæ entirely perfoliate; head inflected under the thorax; thorax margined; lip elevate, emarginate; jaw one-toothed, pointed. There are three species. See Plate Nat. Hist. fig. 264.

MEMBRANE. See ANATOMY.

MEMECYLON, a genus of the octandria monogynia class and order. The calyx is superior; corolla one-petalled; anth. inserted in the side of the apex of the filament; berry crowned with cylindrical calyx. There are three species, trees of the East Indies.

MEMORY, *artificial*, a method of assisting the memory, by forming certain words, the letters of which shall signify the date or æra to be remembered. In order to this, the following series of vowels, diphthongs, and consonants, together with their corresponding numbers, must be exactly learned, so as to be able at pleasure to form a technical word, that shall stand for any number, or to resolve such a word already formed.

a	*e*	*i*	*o*	*u*	*au*	*oi*	*ei*	*ou*	*y*
1	2	3	4	5	6	7	8	9	0
b	*d*	*t*	*f*	*l*	*s*	*p*	*k*	*n*	*z*

The first five vowels, in order, naturally represent 1, 2, 3, 4, 5; the diphthong *au* = 6, as being composed of *a* and *u*, or 1 + 5 = 6; and for the like reason, *oi* = 7, and *ou* = 9. The diphthong *ei* will easily be remembered for 8, as being the initials of the word. In like manner, where the initial consonants could conveniently be retained, they are made use of to signify the number, as *t* for 3, *f* for 4, *s* for 6, and *n* for 9. The rest were assigned without any particular reason, unless that possibly *p* may be more easily remembered for 7 or septem, *k* for 8, or ὀκτω, *d* for 2, or duo; *b* for 1, as being the first consonant; and *l* for 5, being the Roman letter for 50; than any others that could have been put in their places.

It is farther to be observed, that *z* and *y* being made use of to represent the cypher, where many cyphers meet together, as 1000, 1000000, &c. instead of a repetition of *a z y z y z y*, &c. let *g* stand for 100, *th* for a thousand, and *m* for a million. Thus *ag* will be 100, *ig* 300; *oug* 900, &c. *ath* 1000, *am* 1000000, *loum* 59000000, &c.

Fractions may be set down in the following manner: let *r* signify the line separating the numerator and denominator, the first coming before, the other after it; as *iro* $\frac{3}{4}$, *urp* $\frac{5}{7}$, *pourag* $\frac{79}{100}$, &c. When the numerator is 1, or unit, it need not be expressed, but begin the fraction with *r*; as *re* $\frac{1}{2}$, *ri* $\frac{1}{3}$, *ro* $\frac{1}{4}$, &c. So in decimals, *rag* $\frac{1}{100}$, *rath* $\frac{1}{1000}$.

This is the principal part of the method; which consists in expressing numbers by artificial words. The application to history and chronology is also performed by artificial words. The art herein consists in making such a change in the ending of the name of a place, person, planet, coin, &c. without altering the beginning of it, as shall readily suggest the thing sought, at the same time that the beginning of the word being preserved, shall be a leading or prompting syllable to the ending of it, so changed. Thus, in order to remember the years in which Cyrus, Alexander, and Julius Cæsar, founded their respective monarchies, the following words may be formed; for Cyrus, Cyr*uts*; for Alexander, Alex-

ita; for Julius Cæsar, Jul*ios*. *Uts* signifies, according to the powers assigned to the letters before-mentioned 536; *ita* is 331; and *os* is 46. Hence it will be easy to remember, that the empire of Cyrus was founded 536 years before Christ, that of Alexander 331, and that of Julius Cæsar 46. This account is taken from a treatise, entitled, a New Method of Artificial Memory; where the reader will find several examples in chronology, geography, &c. of such artificial words disposed in verses, which must be allowed to contribute much to the assistance of the memory, since being once learned, they are seldom or never forgotten. However, the author advises his reader to form the words and verses himself, in the manner described above, as he will probably remember these better than those formed by another.

We shall, in this place, give his table of the kings of England since the Conquest, where one thousand being added to the Italics in each word, expresses the year when they began their reigns. Thus,

Will con*sau*, Ruf*koi*, Hen*rag*
Steph*bil* & Hensec*buf*, Rich*bein*, J*ann*, Heth*das* & Ed*doid*.
Ed*setyp*, Edter*tep*, Rise*tois*, Hefo*toun*, Hen*sad*que.
Hen*fifed*, Edquar*fauz*, Efi-Ro*kt*, Hensep*feil*, Henoc*lyh*.
Edsex*los*, Mary*lut*, Els*luk*, Jam*syd*, Caroprim*sel*.
Carsee*sok*, Jam*seif*, Wil*seik*, An*pyd*, Geo*bo-doi*.

MENACHANITE. This substance has been found abundantly in the valley of Menachan in Cornwall; and hence was called menachanite by Mr. Gregor, the discoverer of it. It is in small grains like gunpowder, of no determinate shape, and mixed with a fine grey sand. Colour black. Easily pulverised. Powder attracted by the magnet. Specific gravity 4.427. Does not detonate with nitre. With two parts of fixed alkali it melts into an olive-coloured mass, from which nitric acid precipitates a white powder. The mineral acids only extract from it a little iron. Diluted sulphuric acid, mixed with the powder, in such a proportion that the mass is not too liquid, and then evaporated to dryness, produces a blue-coloured mass. Before the blowpipe does not decrepitate nor melt. It tinges microcosmic salt green; but the colour becomes brown on cooling; yet microcosmic salt does not dissolve it. Soluble in borax, and alters its colour in the same manner.

According to the analysis of Mr. Gregor, it is composed of

46 oxide of iron
45 oxide of titanium
———
91, with some silica and manganese.

According to M. Klaproth's analysis, it is composed of 51.00 oxide of iron
45.25 oxide of titanium
3.50 silica
.25 oxide of manganese.
———
100.00

Another variety of this ore from the Uralian mountains, analysed by Lowitz, contained
53 oxide of titanium
47 oxide of iron
———
100.

A mineral, nearly of the same nature with the one just described, has been found in Bavaria. Its specific gravity is only 3.7. According to the analysis of Vauquelin and Hecht, it is composed of

49 oxide of titanium
35 iron
2 manganese
14 oxygen combined with the iron and manganese
———
100.

A specimen of the same ore from Botany Bay has been lately analysed by Mr. Chenevix.

MENAIS, a genus of the pentandria monogynia class and order. The calyx is three-leaved; the corolla salver-shaped; berry four-celled; seeds solitary. There is one species, a herb of South America.

MENDICANTS, or begging friars, several orders of religious in popish countries, who, having no settled revenue, are supported by the charitable contributions they receive from others.

MENISCIUM, a genus of the cryptogamia filices. The capsules are heaped in crescents interposed between the veins of the pod. There is one species, a native of the West Indies.

MENISCUS. See Optics.

MENISPERMUM, a genus of the dioecia dodecandria class and order. The male petals are four outer, eight inner; stamina sixteen; female corolla, as in the male; stam. eight, barren; berries two, one-seeded. There are 13 species, herbs of the East Indies.

MENNONITES, a sect of baptists in Holland, so called from Mennon Simonis of Friezland, who lived in the sixteenth century. This sect believe that the New Testament is the only rule of faith; that the terms person and trinity are not to be used in speaking of the Father, Son, and Holy Ghost; that the first man was not created perfect; that it is unlawful to swear or to wage war upon any occasion; that infants are not the proper subjects of baptism; and that ministers of the gospel ought to receive no salary. They all unite in pleading for toleration in religion, and debar none from their assemblies who lead pious lives, and own the scriptures for the word of God.

MENSES. See Physiology.

MENSTRUUM, in chemistry, the fluid in which a solid body is dissolved. Thus water is a menstruum for salts, and gums; and alcohol for resins.

MENTHA, mint, a genus of the gymnospermia order, in the didynamia class of plants; and in the natural method ranking under the 42d order, verticillatæ. The corolla is nearly equal and quadrifid, with one segment broader than the rest, and emarginated; the stamina are erect, standing asunder. There are 19 species; but not more than three are cultivated for use, namely, the viridis, or common spearmint, the piperita or peppermint, and the pulegium or pennyroyal. All these are so well known as to need no description; and all of them are very easily propagated by cuttings, parting the roots, or by offsets.

For culinary purposes, the spearmint is preferred to the other two; but for medicine, the peppermint and pennyroyal have almost entirely superseded it. A conserve of the leaves is very grateful; and the distilled waters both simple and spirituous, are universally thought pleasant. Dr. Lewis says, that dry mint digested in rectified spirits of wine, gives out a tincture which appears by day-light of a fine dark-green, but by candle-light of a bright red colour. The fact is, that a small quantity of this tincture is green either by day-light or by candle-light, but a large quantity of it seems impervious to common day-light; however, when held betwixt the eye and a candle, or betwixt the eye and the sun, it appears red.

The virtues of mint are those of a warm stomachic, capable of relieving colicky pains, and the gripes, to which children are subject. It likewise proves an useful cordial in languors and faintness. When prepared with rectified spirit, the whole virtues of the mint are extracted. The expressed juice contains only the astringent and bitter parts, together with the mucilaginous substance common to all vegetables. The peppermint is much more pungent than the others.

Pennyroyal has the same general characters with the mint, but is more acrid and less agreeable when taken into the stomach. It was long held in great esteem in hysteric complaints, and suppressions of the menses, but its effects are trifling. It is observable, that both water and rectified spirit extract the virtues of this herb by infusion, and likewise elevate the greatest part of them by distillation.

MENTZELIA, a genus of the polyandria monogynia class and order. The cal. is five-leaved; cor. five-petalled; caps. inferior, cylindric, many-seeded. There is one species, an annual of South America.

MENYANTHUS, buckbean, a genus of the pentandria monogynia class of plants, with a monopetalous funnel-like flower, divided into five deep segments at the limb: the fruit is an oval capsule with one cell, containing a great many small seeds. There are five species.

Buckbean, called by authors trifolium palustre and paludosum, is greatly recommended as a diuretic in dropsical cases; as also in the cure of intermittent fevers, and disorders of the breast arising from tough matter in the lungs: the general way of taking it is in a strong infusion, though many prefer the juice fresh expressed from the leaves.

MERCATOR's *projection of maps*. See Map.

MENSURATION, in general, denotes the act or art of measuring lines, superficies and solids; and it is, next to arithmetic, a subject of the greatest use and importance, both in affairs that are absolutely necessary in human life, and in every branch of mathematics; a subject by which sciences are established, and commerce is conducted; by whose aid we manage our business, and inform ourselves of the wonderful operations in nature; by which we measure the heavens and the earth, estimate the capacities of all vessels and the bulks of all bodies, gauge our liquors, build edifices, measure our lands and the works of artificers, buy and sell an infinite variety of things necessary in life, and are supplied with the means of making the calculations which are necessary for the construction of almost all machines.

It is evident that the close connection of this subject with the affairs of men would very early evince its importance to them; and accordingly the greatest among them have paid the utmost attention to it; and the chief and most essential discoveries in geometry in all ages have been made in consequence of their efforts in this subject. Socrates thought that the prime use of geometry was to measure the ground, and indeed this business gave name to the subject; and most of the antients seem to have had no other end besides mensuration in view in all their geometrical disquisitions. Euclid's Elements are almost entirely devoted to it; and although there are contained in them many properties of geometrical figures, which may be applied to other purposes, and indeed of which the moderns have made the most material uses in various disquisitions of exceedingly different kinds; notwithstanding this, Euclid himself seems to have adapted them entirely to this purpose: for, if it is considered that his Elements contain a continued chain of reasoning, and of truths, of which the former are successively applied to the discovery of the latter, one proposition depending on another, and the succeeding propositions still approximating towards some particular object near the end of each book; and when at the last we find that object to be the quality, proportion, or relation between the magnitudes of figures both plane and solid; it is scarcely possible to avoid allowing this to have been Euclid's grand object: Accordingly he determined the chief properties in the mensuration of rectilineal plane and solid figures; and squared all such planes, and cubed all such solids. The only curve figures which he attempted besides are the circle and sphere; and when he could not accurately determine their measures, he gave an excellent method of approximating to them, by shewing how in a circle to inscribe a regular polygon which should not touch another circle, concentric with the former, although their circumferences should be ever so near together; and, in like manner, between any two concentric spheres to describe a polyhedron which should not any where touch the inner one: and approximations to their measures are all that have hitherto been given. But although he could not square the circle, nor cube the sphere, he determined the proportion of one circle to another, and of one sphere to another, as well as the proportions of all rectilineal similar figures to one another.

Archimedes took up mensuration where Euclid left it, and carried it a great length. He was the first who squared a curvilineal space, unless Hippocrates must be excepted on account of his lunes. In his times the conic sections were admitted in geometry, and he applied himself closely to the measuring of them as well as other figures. Accordingly he determined the relations of spheres, spheroids, and conoids, to cylinders and cones; and the relations of parabolas to rectilineal planes whose quadratures had long before been determined by Euclid. He has left us also his attempts upon the circle: he proved that a circle is equal to a right-angled triangle, whose base is equal to the circumference, and its altitude equal to the radius; and consequently that its area is found by drawing the radius into half the circumference; and so reduced the quadrature of the circle to the determination of the ratio of the diameter to the circumference; but which, however, has not yet been found. Being disappointed of the exact quadrature of the circle, for want of the rectification of its circumference, which all his methods would not effect, he proceeded to assign an useful approximation to it: this he effected by the numerical calculation of the perimeters of the inscribed and circumscribed polygons; from which calculations it appears that the perimeter of the circumscribed regular polygon of 192 sides is to the diameter, in a less ratio than that of $3\frac{1}{7}$ $(3\frac{10}{70})$ to 1, and that the inscribed polygon of 96 sides is to the diameter in a greater ratio than that of $3\frac{10}{71}$ to 1; and consequently much more than the circumference of the circle is to the diameter in a less ratio than that of $3\frac{1}{7}$ to 1, but greater than that of $3\frac{10}{71}$ to 1: the first ratio of $3\frac{1}{7}$ to 1, reduced to whole numbers, gives that of 22 to 7, for $3\frac{1}{7} : 1 :: 22 : 7$, which therefore will be nearly the ratio of the circumference to the diameter. From this ratio of the circumference to the diameter he computed the approximate area of the circle, and found it to be to the square of the diameter as 11 to 14. He likewise determined the relation between the circle and ellipse, with that of their similar parts. The hyperbola too, in all probability, he attempted; but it is not to be hoped, that he met with any success, since approximations to its area are all that can be given by all the methods that have since been invented.

Besides these figures, he has left us a treatise on the spiral described by a point moving uniformly along a right line, which at the same time moves with an uniform angular motion; and determined the proportion of its area to that of its circumscribed circle, as also the proportion of their sectors.

Throughout the whole works of this great man, which are chiefly on mensuration, he every where discovers the deepest design, and finest invention; and seems to have been (with Euclid) exceedingly careful of admitting into his demonstrations nothing but principles perfectly geometrical and unexceptionable: and although his most general method of demonstrating the relations of curved figures to straight ones, is by inscribing polygons in them, yet to determine those relations, he does not increase the number and diminish the magnitude of the sides ad infinitum; but from this plain fundamental principle, allowed in Euclid's Elements, viz. that any quantity may be so often multiplied, or added to itself, as that the result shall exceed any proposed finite quantity of the same kind, he proves that to deny his figures to have the proposed relations, would involve an absurdity.

He demonstrated also many properties, particularly in the parabola, by means of certain numerical progressions, whose terms are similar to the inscribed figures; but without considering such series to be continued ad infinitum, and then summing up the terms of such infinite series.

He had another very curious and singular contrivance for determining the measures of figures, in which he proceeds as it were mechanically by weighing them.

Several other eminent men among the ancients wrote upon this subject, both before and after Euclid and Archimedes; but their attempts were usually upon particular parts of it, and according to methods not essentially different from theirs. Among these are to be reckoned Thales, Anaxagoras, Pythagoras, Bryson, Antiphon, Hippocrates of Chios, Plato, Apollonius, Philo, and Ptolemy; most of whom wrote of the quadrature of the circle: and those after Archimedes, by his method, usually extended the approximation to a greater degree of accuracy.

Many of the moderns have also prosecuted the same problem of the quadrature of the circle, after the same methods, to greater lengths: such are Vieta and Metius, whose proportion between the diameter and circumference is that of 113 to 355, which is within about $\frac{3}{10000000}$ of the true ratio; but above all Ludolph van Ceulen, who, with an amazing degree of industry and patience, by the same ratio to 20 places of figures, making it that of 1 to 3.14159265358979323846 +. See CIRCLE.

Hence it appears, that all or most of the material improvements or inventions in the principles or methods of treating of geometry, have been made especially for the improvement of this chief part of it, mensuration, which abundantly shews the dignity of the subject; a subject which, as Dr. Barrow says, after mentioning some other things, "deserves to be more curiously weighed, because from hence a name is imposed upon that mother and mistress of the rest of the mathematical sciences, which is employed about magnitudes, and which is wont to be called geometry (a word taken from ancient use, because it was first applied only to measuring the earth, and fixing the limits of possessions): though the name seemed very ridiculous to Plato, who substitutes in its place the more extensive name of metrics or mensuration; and others after him give it the title of pantometry, because it teaches the method of measuring all kinds of magnitudes." See HEIGHTS, SURVEYING, LEVELLING, GEOMETRY, and GAUGING.

MERCURIALIS, mercury, a genus of the enneandria order, in the diœcia class of plants, and in the natural method ranking under the 38th order, tricoccæ. The calyx of the male is tripartite; there is no corolla, but 9 or 12 stamina; the antheræ globular and twin. The female calyx is tripartite; there is no corolla, but two styles; the capsule is bicoccous, bilocular, and monospermous. There are six species.

Of these, the perennis, according to Mr. Lightfoot, is of a soporific deleterious nature, noxious both to man and beast. There are instances of those who have eaten it by mistake, instead of the chenopodium bonus Henricus, or English mercury, and have thereby slept their last. Tournefort informs us, that the French make a syrup of the juice of the annua, another species, two ounces of which are given as a purge; and that they use it in pessaries and clysters, mixing one part of honey to one and a half of the juice. Dr. Withering differs greatly from Lightfoot concerning the qualities of the perennis. "This plant, (says he), dressed like spinach, is very good eating early in the spring, and is frequently gathered for that purpose; but it is said to be hurtful to sheep." Mr. Ray relates the case of a man, his wife, and three children, who experienced highly deleterious effects from eating it fried with bacon; but this was probably when the spring was more advanced, and the plant had become acrimonious. When steeped in water, it affords a fine deep-blue colour. Sheep and goats eat it; but cows and horses refuse it.

MERCURY, called also QUICKSILVER, was known in the remotest ages, and seems to have been employed by the antients in gilding and in separating gold from other bodies, just as it is by the moderns.

Its colour is white, and similar to that of silver; hence the names hydrargyrus, argentum vivum, quicksilver, by which it has been known in all ages. It has no taste nor smell. It possesses a good deal of brilliancy; and when its surface is not tarnished, makes a very good mirror. Its specific gravity is 13.568. At the common temperature of the atmosphere, it is always in a state of fluidity. In this respect it differs from all other metals. But it becomes solid when exposed to a sufficient degree of cold. The temperature necessary for freezing this metal is —39°, as was ascertained by the experiments of Mr. Macnab at Hudson's-bay. The congelation of mercury was accidentally discovered by the Petersburgh academicians in 1759. Taking the advantage of a very severe frost, they plunged a thermometer into a mixture of snow and salt, in order to ascertain the degree of cold. Observing the mercury stationary, even after it was removed from the mixture, they broke the bulb of the thermometer, and found the metal frozen into a solid mass. This experiment has been repeated very often since, especially in Britain. Mercury contracts considerably at the instant of freezing; a circumstance which misled the philosophers who first witnessed its congelation. The mercury in their thermometers sunk so much before it froze, that they thought the cold to which it had been exposed, much greater than it really was. It was in consequence of the rules laid down by Mr. Cavendish, that Mr. Macnab was enabled to ascertain the real freezing point of the metal.

Solid mercury may be subjected to the blows of a hammer, and may be extended without breaking. It is therefore malleable; but neither the degree of its malleability, nor its ductility, nor its tenacity, has been ascertained.

Mercury boils when heated to 660°. It may therefore be totally evaporated, or distilled from one vessel into another. It is by distillation that mercury is purified from various metallic bodies, with which it is often contaminated. The vapour of mercury is invisible and elastic like common air; like air, too, its elasticity is indefinitely increased by heat, so that it breaks through the strongest vessel. Geoffroy, at the desire of an alchymist, inclosed a quantity of it in an iron globe, strongly secured by iron hoops, and put the apparatus into a furnace. Soon after the globe became red-hot, it burst with all the violence of a bomb, and the whole of the mercury was dissipated.

Mercury is not altered by being kept under water. When exposed to the air, its surface is gradually tarnished, and covered with a black powder, owing to its combining with the oxygen of the atmosphere. But this change goes on very slowly, unless the mercury is either heated or agitated, by shaking it, for instance, in a large bottle full of air. By either of these processes, the metal is converted into an oxide: by the last, into a black-coloured oxide; and by the first, into a red-coloured oxide. This metal does not seem to be capable of combustion.

The oxides of mercury at present known are four in number:

1. The protoxide was first described with accuracy by Boerhaave. He formed it by putting a little mercury into a bottle, and tying it to the spoke of a mill-wheel. By the constant agitation which it thus underwent, it was converted into a black powder, to which he gave the name of *ethiops per se*. This oxide is readily formed by agitating impure mercury in a phial. It is a black powder without any of the metallic lustre, has no taste, and is insoluble in water. According to the experiments of Fourcroy, it is composed of 96 parts of mercury and 4 of oxygen. When this oxide is exposed to a strong heat, oxygen gas is emitted, and the mercury reduced to the metallic state. In a more moderate heat it combines with an additional dose of oxygen, and assumes a red colour.

2. When mercury is dissolved in nitric acid without the assistance of heat, and the acid is made to take up as much mercury as possible, it has been demonstrated, by the experiments of Mr. Chenevix, that it combines in that case with 10.7 per cent. of oxygen. Of course an oxide is formed, composed of 89.3 mercury and 10.7 oxygen. This is the deutoxide of mercury. This oxide cannot be separated completely from the acid which holds it in solution without undergoing a change in its composition; of course we are at present ignorant of its colour and other properties. Indeed it is very probable that it is the same with the black oxide just described under the name of protoxide; but this has not yet been proved in a satisfactory manner.

3. When mercury, or its protoxide, is exposed to a heat of about 600°, it combines with additional oxygen, assumes a red colour, and is converted into an oxide, which, in the present state of our knowledge, we must consider as a tritoxide. This oxide may be formed two different ways: 1. By putting a little mercury into a flat-bottomed glass bottle or matrass, the neck of which is drawn out into a very narrow tube, putting the mattrass into a sand-bath, and keeping it constantly at the boiling point. The height of the mattrass, and the smallness of its mouth, prevent the mercury from making its escape, while it affords free access to the air. The surface of the mercury becomes gradually black, and then red, by combining with the oxygen of the air: and at the end of several months the whole is converted into a red powder, or rather into small crystals, of a very deep red colour. The oxide, when thus obtained, was formerly called precipitate per se. 2. When mercury is dissolved, in nitric acid, evaporated to dryness, and then exposed to a pretty strong heat in a porcelain cup, it assumes, when triturated, a brilliant red colour. The powder thus obtained was formerly called red precipitate, and possesses exactly the properties of the oxide obtained by the former process.

This oxide has an acrid and disagreeable taste, possessing poisonous qualities, and acts as an escharotic when applied to any part of the skin. It is somewhat soluble in water. When triturated with mercury it gives out part of its oxygen, and the whole mixture is converted into protoxide or black oxide of mercury. When heated along with zinc, or tin filings, it sets these metals on fire. According to Fourcroy, it is composed of 92 parts of mercury and 8 of oxygen. But the analysis of Mr. Chenevix, to be described hereafter, gives, for the proportion of its component parts, 85 parts of mercury and 15 parts of oxygen.

The red oxide of mercury, prepared in the usual way, is not pure, but always contains a portion of nitric acid. If we dissolve it in muriatic acid, and precipitate it again, it falls in the state of a white powder, and retains a portion of muriatic acid. It was in this state that it was examined by Chenevix. The difficulty of procuring this oxide in a state of purity, and the uncertainty respecting the proportion of acid which it retains, may, in some measure, account for the different results obtained by different chemists in their attempts to ascertain its proportions.

4. Fourcroy has observed, that when oxymuriatic acid gas is made to pass through the red oxide of mercury, it combines with an additional dose of oxygen, and is converted into a peroxide; but as this peroxide cannot be procured in a separate state, we are ignorant of its properties.

Mercury does not combine with carbon or hydrogen; but it unites readily with sulphur and with phosphorus.

When two parts of sulphur and one of mercury are triturated together in a mortar, the mercury gradually disappears, and the whole assumes the form of a black powder, formerly called ethiops mineral. It is scarcely possible by any process to combine the sulphur and mercury so completely, that small globules of the metal may not be detected by a microscope. When mercury is added slowly to its own weight of melted sulphur, and the mixture is constantly stirred, the same black compound is formed.

Fourcroy had suggested, that in this compound the mercury is in the state of black oxide, absorbing the necessary portion of oxygen from the atmosphere during its combination with the sulphur. But the late experiments of Proust have shewn that this is not the case. Berthollet has made it probable that ethiops mineral contains sulphureted hydrogen. Hence we must consider it as composed of three ingredients, namely, mercury, sulphur, and sulphureted hydrogen. Such compounds are at present denominated by chemists hydrogenous sulphurets. Ethiops mineral of course is an hydrogenous sulphuret of mercury. When this substance is heated, part of the sulphur is dissipated, and the compound assumes a deep violet colour.

When heated red-hot, it sublimes; and if a proper vessel is placed to receive it, a cake is obtained of a fine red colour. This cake was formerly called cinnabar; and when reduced to a fine powder, is well known in commerce under the name of vermilion. It has been hitherto supposed a compound of the oxide of mercury and sulphur. But the experiments of Proust have demonstrated that the mercury which it contains is in the metallic state. According to that very accurate chemist, it is composed of 85 parts of mercury and 15 of sulphur. It is therefore sulphuret of mercury.

The sulphuret of mercury has a scarlet colour, more or less beautiful, according to the mode of preparing it. Its specific gravity is about 10. It is tasteless, insoluble in water, and in muriatic acid, and not altered by exposure to the air. When heated sufficiently, it takes fire, and burns with a blue flame. When mixed with half its weight of iron filings, and distilled in a stone-ware retort, the sulphur combines with the iron, and the mercury passes into the receiver, which ought to contain water. By this process mercury may be obtained in a state of purity. The use of sulphuret of mercury as a paint is well known.

Mr. Pelletier, after several unsuccessful attempts to combine phosphorus and mercury, at last succeeded by distilling a mixture of red oxide of mercury and phosphorus. Part of the phosphorus combined with the oxygen of the oxide, and was converted into an acid; the rest combined with the mercury. He observed that the mercury was converted into a black powder before it combined with the phosphorus. As Pelletier could not succeed in his attempts to combine phosphorus with mercury in its metallic state, we must conclude that it is not with mercury, but with the black oxide of mercury, that the phosphorus combines. The compound, therefore, is not phosphorus of mercury, but black phosphureted oxide of mercury.

It is of a black colour, of a pretty solid consistence, and capable of being cut with a knife. When exposed to the air, it exhales vapours of phosphorus.

Mercury does not combine with the simple incombustibles.

Mercury combines with the greater number of metals. These combinations are known in chemistry by the name of amalgams.

The amalgam of gold is formed very readily, because there is a very strong affinity between the two metals. If a bit of gold is dipped into mercury, its surface, by combining with mercury, becomes as white as silver. The easiest way of forming this amalgam is to throw small pieces of red-hot gold into mercury. The proportions of the ingredients are not determinable, because the amalgam has an affinity both for the gold and the mercury; in consequence of which they combine in any proportion. This amalgam is white, with a shade of yellow; and when composed of six parts of mercury and one of gold, it may be obtained crystallized in four-sided prisms. It melts at a moderate temperature; and when heated sufficiently, the mercury evaporates, and leaves the gold in a state of purity. It is much used in gilding. The amalgam composed of ten parts of mercury and one of gold, is spread upon the metal which is to be gilt; and then, by the application of a gentle and equal heat, the mercury is driven off, and the gold left adhering to the metallic surface; this surface is then rubbed with a brass-wire brush under water, and afterwards burnished.

Dr. Lewis attempted to form an amalgam of platinum, but hardly succeeded after a labour which lasted for several weeks. Guyton Morveau succeeded by means of heat. He fixed a small cylinder of platinum at the bottom of a tall glass vessel, and covered it with mercury. The vessel was then placed in a sand-bath, and the mercury kept constantly boiling. The mercury gradually combined with the platinum; the weight of the cylinder was doubled, and it became brittle. When heated strongly, the mercury evaporated, and left the platinum partly oxidated. It is remarkable, that the platinum, notwithstanding its superior specific gravity, always swam upon the surface of the mercury, so that Morveau was under the necessity of fixing it down.

The amalgam of silver is made in the same manner as that of gold, and with equal ease. It forms dentritical crystals, which, according to the Dijon academicians, contain eight parts of mercury and one of silver. It is of a white colour, and is always of a soft consistence. Its specific gravity is greater than the mean of the two metals. Gellert has even remarked that, when thrown into pure mercury, it sinks to the bottom of that liquid. When heated sufficiently, the mercury is volatilized, and the silver remains behind pure.

The affinities of mercury as ascertained by Morveau, and of its oxides as exhibited by Bergman, are in the following order:

Mercury.	Oxide of Mercury.
Gold,	Muriatic acid,
Silver,	Oxalic,
Tin,	Succinic,
Lead,	Arsenic,
Bismuth,	Phosphoric,
Platinum,	Sulphuric,
Zinc,	Saclactic,
Copper,	Tartaric,
Antimony,	Citric,
Arsenic,	Sulphurous,
Iron.	Nitric,
	Fluoric,
	Acetic,
	Boracic,
	Prussic,
	Carbonic.

Mercury, in astronomy, the smallest of the planets, and the nearest the sun. See Astronomy.

MERGUS, in ornithology, a genus of birds of the order of anseres; distinguished by having the beak of a cylindrical figure, and hooked at the extremities, and its denticulations of a subulated form.

1. The cucullatus, or crested diver of Catesby, has a globular crest, white on each side; and the body is brown above, and white below. This elegant species inhabits North America. It appears at Hudson's-bay the end of May, and builds close to the lakes. The nest is composed of grass, lined with feathers from the breast; the number of eggs from four to six. The young are yellow, and are fit to fly in July. They all depart from thence in autumn. They appear at New York, and other parts, as low as Virginia and Carolina, in November, where they frequent fresh waters. They return to the north in March, and are called at Hudson's-bay omiska sheep. See Plate Nat. Hist. fig. 265.

2. The merganser, or goosander, weighs four pounds; its length is two feet four inches; the breadth three feet four. The dun-diver, or female, is less than the male; the head and upper part of the neck are ferruginous; the throat white; the feathers on the hind part are long, and form a pendant crest; the back, the coverts of the wings, and the tail, are of a deep ash-colour; the greater quill-feathers are black, the lesser white; the breast and middle of the belly are white, tinged with yellow. The goosander seems to prefer the more northern situations to those of the south, not being seen in the last except in very severe seasons. It continues the whole year in the Orkneys; and has been shot in the Hebrides in summer. It is common on the continent of Europe and Asia, but most so towards the north.

3. The albellus, or smew, weighs about 34 ounces; the length is 18 inches, the breadth 26; the bill is near two inches long, and of a lead-colour; the head is adorned with a long crest, white above and black beneath; the head, neck, and whole under part of the body, are of a pure white; the tail is of a deep ash-colour, the legs a blueish grey. The female, or lough-diver, is less than the male; the back, the scapulars, and the tail, are dusky; the belly is white. The smew is seen in England only in winter, at which season it will sometimes be met with at the southern parts of it; as also in France, in the neighbourhood of Picardy, where it is called la piette: similar to this, we have heard it called in Kent by the name of magpie-diver.

There are three other species.

MERIDIAN. See Astronomy, and Geography.

MERIDIONAL PARTS, MILES, or MINUTES, in navigation, are the parts by which the meridians in Mr. Wright's chart (commonly though falsely called Mercator's) increase as the parallels of latitude decrease: and as the cosine of the latitude of any place is equal to the radius or semi-diameter of that parallel, therefore, in the true sea-chart, or nautical planisphere, this radius being the radius of the equinoctial, or whole sine of 90°, the meridional parts at each degree of latitude must increase, as the secants of the arch, contained between that latitude and the equinoctial, do decrease. The tables therefore of meridional parts, which we have in books of navigation, are made by a continual addition of secants; they are calculated in some books for every degree and minute of latitude; and they will serve either to make or graduate a Mercator's chart, or to work the Mercator's sailing. To use them, you must enter the table with the degree of latitude at the head, and the minute on the first column towards the left hand, and in the angle of meeting you will have the meridional parts. Having the latitudes of two places, to find the meridional miles or minutes between them: Consider whether one of the places lies on the equator, or both on the same side of it; or, lastly, on different sides. 1. If one of the proposed places lies on the equator, then the meridional difference of latitude is the same with the latitude of the other place, taken from the table of meridional parts. 2. If the two proposed places be on the same side of the equator, then the meridional difference of latitude is found by subtracting the meridional parts answering to the least latitude, from those answering to the greatest, and the difference is that required. 3. If the places lie on different sides of the equator, then the meridional difference of latitude is found by adding together the meridional parts answering to each latitude, and the sum is that required.

To find the Meridional Parts *to any Spheroid, with the same exactness as in a Sphere.* Let the semi-diameter of the equator be to the distance of the centre from the focus of the generating ellipse, as m to 1. Let A represent the latitude for which the meridional parts are required, s the sine of the latitude, to the radius 1: find the arc B, whose sine is $\frac{s}{m}$; take the logarithmic tangent of half the complement of B, from the common tables; subtract the log. tangent from 10.0000000, or the log. tangent of 45°: multiply the remainder by the number 7915.7044679, and divide the product by m; then the quotient subtracted from the meridional parts in the sphere, computed in the usual manner for the latitude A, will give the meridional parts, expressed in minutes, for the same latitude in the spheroid, when it is the oblate one.

Example. If mm : 1 :: 1000 : 22, then the greatest difference of the meridional parts in the sphere and spheroid is 76.0929 minutes. In other cases it is found by multiplying the remainder above-mentioned by the number 1174.078.

When the spheroid is oblong, the difference in the meridional parts between the sphere and spheroid, for the same latitude, is then determined by a circular arc.

We shall here add a table of meridional parts, calculated both for the sphere and oblate spheroid, by the reverend Mr. Murdoch, in his new and learned Treatise of Mercator's Sailing applied to the true Figure of the Earth. By this table may be projected a true chart for any part of the earth's surface, and the several problems of sailing may be solved by it. Maps of countries may be delineated and applied to the various purposes of navigation, geography, and astronomy. Nor are the errors of the common spherical projections so very small in many cases, as to be inconsiderable and not dangerous. For instance, if a ship sails from south latitude 25°, to north latitude 30°, and the angle of the course be 43°; then the difference of longitude by the common table would be 3206′, exceeding the true difference 3141′ by 65′, or miles. Also the distance sailed would be 4512, exceeding the true distance, 4423, by 89′, or miles; which differences are too great to be neglected. For other instances of such a correction of the charts, we refer to the author's admirable book above-mentioned.

A TABLE

Of Meridional Parts to the Spheroid and Sphere, with their Differences.

D.	Spheroid.	Sphere.	Diff.
1	58.7	60.0	1. 3
2	117.3	120.0	2. 7
3	176.1	180.1	4. 0
4	234.9	240.2	5. 3
5	293.8	300.4	6. 6
6	352.7	360.6	7. 9
7	411.8	421.0	9. 2
8	471.0	481.5	10. 5
9	530.4	542.2	11. 8
10	589.9	603.0	13. 1
11	649.7	664.1	14. 4
12	709.6	725.3	15. 7
13	769.8	786.8	17. 0
14	830.2	848.5	18. 3
15	890.9	910.5	19. 6
16	951.8	972.7	20. 9
17	1013.1	1035.3	22. 2
18	1074.8	1098.3	23. 5
19	1136.8	1161.6	24. 8
20	1199.2	1225.2	26. 0
21	1262.0	1289.2	27. 2
22	1325.3	1353.7	28. 4
23	1389.0	1418.6	29. 6
24	1453.3	1484.1	30. 8
25	1518.0	1550.0	32. 0
26	1583.3	1616.5	33. 2
27	1649.1	1683.5	34. 4
28	1715.6	1751.2	35. 6
29	1782.7	1819.5	36. 8
30	1850.5	1888.4	37. 9
31	1919.0	1958.0	39. 0
32	1988.2	2028.3	40. 1
33	2058.3	2099.5	41. 2
34	2129.0	2171.4	42. 3
35	2200.8	2244.2	43. 4
36	2273.4	2317.9	44. 5
37	2347.0	2392.6	45. 6
38	2421.6	2468.3	46. 7
39	2497.2	2544.9	47. 7
40	2573.9	2622.6	48. 7
41	2651.8	2701.5	49. 7
42	2730.9	2781.6	50. 7
43	2811.3	2863.0	51. 7
44	2893.1	2945.8	52. 7
45	2976.2	3029.9	53. 7
46	3060.9	3115.5	54. 6
47	3147.2	3202.7	55. 5
48	3235.1	3291.5	56. 4
49	3324.8	3382.1	57. 3
50	3416.3	3474.5	58. 2
51	3509.7	3568.8	59. 1
52	3605.3	3665.2	59. 9
53	3703.1	3763.8	60. 7
54	3803.1	3864.6	61. 5
55	3905.7	3968.0	62. 3
56	4010.9	4073.9	63. 0
57	4118.9	4182.6	63. 7
58	4229.8	4294.2	64. 4
59	4344.0	4409.1	65. 1
60	4461.5	4527.3	65. 8
61	4582.7	4649.2	66. 5
62	4707.8	4775.0	67. 2
63	4837.1	4904.9	67. 8
64	4971.0	5039.4	68. 4
65	5109.8	5178.8	69. 0
66	5254.0	5323.6	69. 6
67	5403.9	5474.0	70. 1
68	5560.2	5630.8	70. 6
69	5723.5	5794.6	71. 1
70	5894.4	5965.9	71. 5
71	6073.7	6145.6	71. 9
72	6262.4	6334.7	72. 3
73	6461.6	6534.3	72. 7
74	6672.6	6745.7	73. 1
75	6896.8	6970.3	73. 5
76	7136.2	7210.0	73. 1
77	7393.0	7467.1	74. 1
78	7670.1	7744.5	74. 4
79	7970.9	8045.6	74. 7
80	8300.2	8375.2	75. 0
81	8663.8	8739.0	75. 2
82	9070.0	9145.4	75. 4
83	9530.2	9605.8	75. 6
84	10061.1	10136.9	75. 8
85	10688.7	10764.6	75. 9
86	11456.5	11532.5	76. 0
87	12446.0	12522.1	76. 1
88	13840.4	13916.4	76. 0
89	16223.8	16299.5	75. 7
90			37.75

MERLIN. See Falcon.

MERLON, in fortification, is that part of a parapet which is terminated by two embrasures of a battery. Its height and thickness are the same with those of the parapet; but its breadth is generally nine feet on the inside, and six on the outside. It serves to cover those on the battery from the enemy; and is better when made of earth well beaten and close, than when built with stones; because they fly about and wound those they should defend.

MEROPS, in ornithology, a genus belonging to the order of picæ. The bill is crooked, flat, and carinated; the tongue is jagged at the point; and the feet are of the walking kind. The principal species are, 1. The apiaster, or bee-eater, which has an iron-coloured back; the belly and tail are of a blueish green; and the throat yellow. This bird inhabits various parts of Europe, on the continent, though not in England; yet is said to have been seen in Sweden, and flocks of them have been met with at Anspach in Germany in the month of June. It takes the name of bee-eater from its being very fond of those insects; but, besides these, it will catch gnats, flies, cicadæ, and other insects, on the wing, like swallows. These birds make their nests in the holes in the banks of rivers, like the sand martin and kingsfisher; at the end of which the female lays from five to seven white eggs, rather less than those of a blackbird. The nest itself is composed of moss. 2. The viridis, or Indian bee-eater, is green, with a black belt on the breast; and the throat and tail are black. It inhabits Bengal. 3. The erythropterus, or red-winged bee-eater, is in length six inches; the bill is one inch, and black; the upper parts of the head, body, wings, and tail-coverts, are green brown, deepest on the head and back, lightest on the rump and tail-coverts; behind the eye is a spot of the same, but of a very deep colour; the quills and tail are red, tipped with black; the last two inches in length; the throat is yellow; the under parts of the body are a dirty white; and the legs black. There are more than 20 other species.

MESEMBRYANTHEMUM, *fig-marigold*, a genus of the pentagynia order, in the icosandria class of plants, and in the natural method ranking under the 13th order, succulentæ. The calyx is quinquefid; the petals are numerous and linear; the capsule is fleshy, inferior, and monospermous. There are seventy-five species, all African plants, from the Cape of Good Hope, near 40 of which are retained in our gardens for variety. Of these only one is annual, and the most remarkable of them all: it is called the crystallinum, diamond, ficoides, or ice-plant. This singular and curious plant, being closely covered with large pellucid pimples, full of moisture, shining brilliantly like diamonds, is in great esteem. It is a very tender plant while young, and is raised annually from seed by means of hotbeds. In June it will endure the open air till October, when it perishes; but if placed in a hot-house in autumn it will often live all winter.

The other species are most durable in stem and foliage. Some are shrubby; others pendulous, with loose straggling stems, and branches inclining to the ground; while others have no stalks at all; their leaves are universally very thick, succulent, fleshy, and of many various shapes, situations, and directions; while some are punctured, or dotted with transparent points; and some have pellucid pimples, as already mentioned. They afford a very agreeable variety at all times of the year, and merit a place in every collection. They are greenhouse plants, and are propagated by cuttings of their stalks and branches.

MESENTERY. See ANATOMY.

MESNE, he who is lord of a manor, and so hastenants holding of him, yet himself holds of a superior lord. 15 Vin. Abr.

MESNE PROCESS, is an intermediate process, which issues pending the suit, upon some collateral interlocutory matter, as to summon juries, witnesses, and the like; sometimes it is put in contradistinction to final process, or process of execution; and then it signifies all such process as intervenes between the beginning and end of a suit. 3 Black. 279.

MESPILUS, the medlar; a genus of the pentagynia order, in the icosandria class of plants; and in the natural method ranking under the 36th order, pomaceæ. The calyx is quinquefid; the petals are five; the berry is inferior and pentaspermous.

There are nine species, the principal of which are, 1. The Germanica, German mespilus, or common medlar, rises with a deformed tree-stem, branching irregularly 15 or 20 feet high; spear-shaped leaves, and brown fruit, the size of middling apples, which ripen in October, but are not eatable till beginning to decay. The varieties are, common great German medlar; smaller Nottingham medlar; spear-shaped Italian medlar. 2. The arbutifolia, arbutus-leaved mespilus, has a small, roundish, purple fruit, like haws. 3. The amelanchier, or shrubby medlar, with black fruit. 4. The chamæmespilus, or dwarf medlar, commonly called bastard quince, has small red fruit. 5. The cotoneaster, commonly called dwarf quince, with small roundish bright-red fruit. 6. The Cadanensis, Canada snowy mespilus, with small, purplish fruit, like haws. 7. The pyracantha, or evergreen thorn, rises with a shrubby, spinous stem, branching diffusely 12 or 14 feet high, all the shoots terminated by numerous clusters of whitish flowers; succeeded by large bunches of beautiful red berries, remaining all winter, and exhibiting a very ornamental appearance.

MESSENGERS, are certain officers chiefly employed under the direction of the secretaries of state, and always in readiness to be sent with all kinds of dispatches foreign and domestic. They also, by virtue of the secretaries' warrants, take up persons for high treason, or other offences against the state. The prisoners they apprehend are usually kept at their own houses, for each of which they are allowed 6s. 8d. per day, by the government: and when they are sent abroad, they have a stated allowance for their journey.

METALS may be considered as the great instruments of all our improvements: without them, many of the arts and sciences could hardly have existed. So sensible were the antients of their great importance, that they raised those persons who first discovered the art of working them to the rank of deities. In chemistry, they have always filled a conspicuous station: at one period the whole science was confined to them; and it may be said to have owed its very existence to a rage for making and transmuting metals.

1. One of the most conspicuous properties of the metals is a particular brilliancy which they possess, and which has been called the metallic lustre. There are other bodies indeed (mica for instance) which apparently possess this peculiar lustre, but in them it is confined to the surface, and accordingly disappears when they are scratched, whereas it pervades every part of the metals. This lustre is occasioned by their reflecting much more light than any other bodies; a property which seems to depend partly on the closeness of their texture. This renders them peculiarly proper for mirrors, of which they always form the basis.

2. They are perfectly opaque, or impervious to light, even after they have been reduced to very thin plates. Silver leaf, for instance, $\frac{1}{160000}$ of an inch thick, does not permit the smallest ray of light to pass through it. Gold, however, when very thin, is not absolutely opaque: for gold leaf, $\frac{1}{280000}$ of an inch thick, when held between the eye and the light, appears of a lively green; and must therefore, as Newton first remarked, transmit the green-coloured rays. It is not improbable that all other metals, as the same philosopher supposed, would also transmit light if they could be reduced to a proper degree of thinness. It is to this opacity that a part of the excellence of the metals, as mirrors, is owing; their brilliancy alone would not qualify them for that purpose.

3. They may be melted by the application of heat, and even then still retain their opacity. This property enables us to cast them in moulds, and then to give them any shape we please. In this manner many elegant iron utensils are formed. Different metals differ exceedingly from each other in fusibility. Mercury is so very fusible, that it is always fluid at the ordinary temperature of the atmosphere; while other metals, as platinum, cannot be melted except by the most violent heat which it is possible to produce.

4. Their specific gravity is much greater than that of any other body at present known. Antimony, one of the lightest of them, is more than six times heavier than water; and the specific gravity of platinum, the heaviest of all the metals, is 23. This great density, no doubt, contributes considerably to the reflection of that great quantity of light which constitutes the metallic lustre.

5. They are the best conductors of electricity of all the bodies hitherto tried.

6. None of the metals are very hard; but some of them may be hardened by art to such a degree as to exceed the hardness of almost all other bodies. Hence the numerous cutting instruments which the moderns make of steel, and which the antients made of a combination of copper and tin.

7. The elasticity of the metals depends upon their hardness; and it may be increased by the same process by which their hardness is increased. Thus the steel of which the balance-springs of watches are made, is almost perfectly elastic, though iron in its natural state possesses but little elasticity.

8. But one of their most important properties is malleability, by which is meant the capacity of being extended and flattened when struck with a hammer. This property, which is peculiar to metals, enables us to give the metallic bodies any form we think proper, and thus renders it easy for us to convert them into the various instruments for which we have occasion. All metals do not possess this property; but it is remarkable that almost all those which were known to the antients have it. Heat increases this property considerably. Metals become harder and denser by being hammered.

9. Another property, which is also wanting in many of the metals, is ductility; by which we mean the capacity of being drawn out into wire, by being forced through holes of various diameters.

10. Ductility depends, in some measure, on another property which metals possess, namely, tenacity; by which is meant the power which a metallic wire of a given diameter has of resisting, without breaking, the action of a weight suspended from its extremity. Metals differ exceedingly from each other in their tenacity. An iron wire, for instance, $\frac{1}{10}$th of an inch in diameter, will support, without breaking, about 500lb. weight; whereas a lead wire, of the same diameter, will not support above 29lb.

11. When exposed to the action of heat and air, most of the metals lose their lustre, and are converted into earthy-like powders of different colours and properties, according to the metal and the degree of heat employed. Several of the metals even take fire when exposed to a strong heat; and after combustion the residuum is found to be the very same earthy-like substance.

12. If any of these calces, as they are called, is mixed with charcoal-powder, and exposed to a strong heat in a proper vessel, it is changed again to the metal from which it was produced. This fact is easily explained on the principles of modern chemistry; the calx is the metal combined with oxygen, or an oxide, in modern language, and by heating it with charcoal, which has a stronger attraction for oxygen, that substance is taken from the metal, and it is brought again to the metallic state. The oxygen in this process, uniting with the charcoal, forms carbonic acid gas.

The words calx and calcination, then, are evidently improper, as they convey false ideas; philosophers therefore now employ, instead of them, the words oxide and oxidizement, which were invented by the French chemists. A metallic oxide signifies a metal united with oxygen; and oxidizement implies the act of that union.

13. Metals, then, are all capable of combining with oxygen; and this combination is sometimes accompanied by combustion, and sometimes not. The new compounds formed are called metallic oxides, and in some cases metallic acids. These were formerly distinguished from each other by their colour. One of the oxides, for instance, was called black oxide, another was termed red oxide; but it is now known that the same oxide is capable of assuming different colours according to circumstances. The mode of naming them from their colour, therefore, wants precision, and is apt to mislead; especially as there occur different examples of two distinct oxides of the same metal having the same colour.

As it is absolutely necessary to be able to distinguish the different oxides of the same metal from each other with perfect precision, and as the present chemical nomenclature is defective in this respect, we may, till some better method is proposed, distinguish them from each other, by prefixing to the word oxide the first syllable of the Greek ordinal numerals. Thus the protoxide of a metal will denote the metal combined with a minimum of oxygen, or the first oxide which the metal is capable of forming; deutoxide will denote the second oxide of a metal, or the metal combined with two doses of oxygen. When a metal has combined with as much oxygen as possible, the compound formed is denoted by the term peroxide; indicating by it, that the metal is thoroughly oxidized.

Thus we have the term oxide to denote the combination of metals with oxygen in general; the terms protoxide and peroxide to denote the minimum and maximum of oxidizement; and the terms deutoxide, tritoxide, &c. to denote all the intermediate states which are capable of being formed.

14. Metals are capable also of combining with the simple combustibles. The compounds thus formed are denoted by the simple combustible which enters into the combination, with the termination uret added to it. Thus the combination of a metal with sulphur, phosphorus, or carbon, is called the sulphuret, phosphuret, or carburet of the metal. Hydrogen has not been proved capable of entering into similar combinations; neither have the simple incombustibles.

15. The metals are capable likewise of combining with each other, and of forming compounds, some of which are extremely useful in the manufacture of instruments and utensils. Thus pewter is a compound of lead and tin; brass, a compound of copper and zinc; bell-metal, a compound of copper and tin. These metallic compounds are called by chemists alloys, except when one of the combining metals is mercury. In that case the compound is called an amalgam. Thus the compound of mercury and gold is called the amalgam of gold.

16. The metals at present amount to 23; only 11 of which were known before the year 1730. They may be very conveniently arranged under three classes; namely, 1. Malleable metals; 2. Brittle and easily fusible metals; 3. Brittle and difficultly fusible metals. The metals belonging to each of these classes will be seen from the following Table:

Malleable (formerly called perfect metals).

1. Gold,	2. Platinum,	3. Silver,
4. Mercury,	5. Copper,	6. Iron,
7. Tin,	8. Lead,	9. Nickel,
10. Zinc.		

Brittle, and easily fused.

1. Bismuth,	2. Tellurium,
3. Antimony,	4. Arsenic.

Brittle, and difficultly fused.

1. Cobalt,	2. Manganese,
3. Tungsten,	4. Molybdenun,
5. Uranium,	6. Titanium,
7. Chromium,	8. Columbium,
9. Tantolium.	

The antients gave to the seven following metals the names of the planets, and denoted each of them by particular marks, which represented both the planet and the metal:

Gold was the	Sun, and represented by	☉
Silver . . .	Moon, ...	☾
Mercury . .	Mercury, ...	☿
Copper . .	Venus, ...	♀
Iron	Mars, ...	♂
Tin	Jupiter, ...	♃
Lead	Saturn, ...	♄

It seems most probable that these names were first given to the planets; and that the seven metals, the only ones then known, were supposed to have some relation to the planets or to the Gods that inhabited them, as the number of both happened to be the same. It appears from a passage in Origen, that these names first arose among the Persians. Why each particular metal was denominated by a particular planet, it is not easy to see. Many conjectures have been made, but scarcely any of them are satisfactory.

As to the characters by which these metals were expressed, astrologers seem to have considered them as the attributes of the deities of the same nature. The circle, in the earliest periods among the Egyptians, was the symbol of divinity and perfection; and seems with great propriety to have been chosen by them as the character of the sun, especially as, when surrounded by small strokes projecting from its circumference, it may form some representation of the emission of rays. The semicircle is, in like manner, the image of the moon; the only one of the heavenly bodies that appears under that form to the naked eye. The character ♄ is supposed to represent the scythe of Saturn; ♃ the thunderbolt of Jupiter; ♂ the lance of Mars, together with his shield; ♀ the looking-glass of Venus; and ☿ the caduceus or wand of Mercury.

Professor Beckmann, however, who has examined this subject with much attention, thinks that these characters are mere abbreviations of the old names of the planets. "The character of Mars (he observes), according to the oldest mode of representing it, is evidently an abbreviation of the word Θουρος, under which the Greek mathematicians understood that deity; or, in other words, the first letter Θ, with the last letter ς placed above it. The character of Jupiter was originally the initial letter of Ζευς; and in the oldest manuscripts of the mathematical and astrological works of Julius Firmicus, the capital Z only is used, to which the last letter ς was afterwards added at the bottom, to render the abbreviation more distinct. The supposed looking-glass of Venus is nothing else than the initial letter distorted a little of the word Φωσφορος, which was the name of that goddess. The imaginary scythe of Saturn has been gradually formed from the two first letters of his name Κρονος, which transcribers, for the sake of dispatch, made always more convenient for use, but at the same time less perceptible. To discover in the pretended caduceus of Mercury the initial letter of his Greek name Στιλβων, one needs only look at the abbreviations in the oldest manuscripts, where he will find that the Σ was once written as C; they will remark also that transcribers, to distinguish this abbreviation from the rest still more, placed the C thus ◡, and added under it the next letter τ. If those to whom this deduction appears improbable will only take the trouble to look at other Greek abbreviations, they will find many that differ still farther from the original letters they express than the present character ☿ from the C and τ united. It is possible also that later transcribers, to whom the origin of this abbreviation was not known, may have endeavoured to give it a greater resemblance to the caduceus of Mercury. In short, it cannot be denied that many other astronomical characters are real symbols, or a kind of proper hieroglyphics, that represent certain attributes or circumstances, like the characters of Aries, Leo, and others, quoted by Saumaise."

METALLURGY. When it is once ascertained that an ore of metal may be worked with advantage, the metallurgist proceeds in his operations: first extracting the ore by all the mechanical methods the art possesses; which consist in digging shafts, opening adits, employing various machines to raise the water, renew the air, bring up the ore, favour the ascent and descent of the miner, prevent the earth from giving way, &c.

In general, after having bored the ground which contains ores, or having ascertained their existence by various indications, a square perpendicular well, or shaft, is dug in the ground, sufficiently wide to place straight ladders in it; over which machinery is fixed, for the purpose of raising and lowering vessels, and in which it is sometimes necessary to fix pumps to draw off the water which is collected. If the ore is too deep for a single shaft to lead from the grass or surface, to the vein at the bottom of the first shaft, a horizontal gallery is opened, at the end of which a second shaft is sunk, and in this manner the workmen proceed until they arrive at the bottom of the mine.

When the rock to be perforated is hard, solid, and capable of supporting itself, the shaft will not require to be guarded within; but if it is soft and friable, if it threatens to fall in during the excavation, it becomes necessary to support the shaft and gallery with pieces of wood-work, covered with planks all round, in order to support the earth and retain the fragments, which from time to time would separate, and might maim the workmen.

One of the most important particulars of the art of exploring mines, is the renovation of the air. When it is practicable to open a gallery which shall lead from the bottom of the shaft to the day or open air, a current is easily established by this simple artifice. When this is not possible, a second shaft is sunk to the extremity of the gallery, opposite to that where the first was sunk. When one of these shafts opens at a different level from the other, the circulation and renewal of the air are easy. If the second shafts are of equal height, the current will not take place spontaneously, but must be determined by causing them to communicate with a lighted furnace.

The danger of waters which overflow the works, and retard the operations, at the same time that they threaten the safety of the workmen, is no less necessary to be provided against. If the water transudes gradually through the earth, it may be let off into the plain or the nearest river by means of a horizontal adit. If it is collected in a greater quantity, or if it is not possible to open such an adit, the water is extracted by pumps, which are moved either by a stream, or by a pond, or by vapour of water introduced, and condensed in cylinders. These last machines, called steam-engines, are at present much more common than formerly. (See STEAM ENGINE.) It is an object of great difficulty sometimes to defend the works against enormous masses of water which rush forth when, in digging, a vast subterranean reservoir is opened. These cases happily are very rare; but they are in some measure provided against by a kind of moveable strong door, or barricado, which the workmen place at the moment when they find by the particular sound of the rock, that the waters are coming in upon them, which barricado, by separating them from the liquid, gives them time to save themselves.

The destructive elastic fluids, which so frequently are disengaged in the cavities of mines, and particularly the carbonic acid gas, and different species of mixed hydrogen gases, more or less pernicious, are also among the most formidable enemies of miners. Galleries, fires, ventilators, inflammations by means of torches held at a great distance in those parts of the mines which are mephitized by the inflammable gases, and particularly the various methods of causing fresh air to enter, are the only remedies which can be opposed to these subterraneous evils.

Few metals are found in a pure state; gold, silver, and sometimes copper, are exceptions. The other metals are generally found in the state of ores, in which they are mixed and blended with other substances, so as not to have the ductility or other qualities of metals: often, indeed, they have not the metallic lustre. Sometimes the ore is only a pure oxide, which requires no more than that the oxygen should be drawn from it by heating it with an inflammable substance. Such are all the ferruginous ochres, which are oxides of iron.

The ores of metals are generally found in the veins of mountains or rocky strata, and are always separated from the rocks on each side by a quantity of spar, quartz, or sometimes softer clay or earth. The spar is generally of the gypseous kind. These form the matrix of the ore; in English, called the rider. In different veins it is of different thicknesses; the quantity of the ore increasing as that of the matter which surrounds it diminishes. Often the ore is in branching masses wandering irregularly through it, and is often rudely mixed with the matrix in veins of different thicknesses. These are called brangled ores.

The veins or fissures of the rocky strata are sometimes only a few inches wide, and sometimes many yards. In rich mines there are immense masses of ore many feet broad. Where the veins happen not to be filled up, we find the ores crystallized round the cavity.

The ore, when separated from the matrix, generally contains some other matter; as sulphur, arsenic, or both: and sometimes an earthy substance, the whole being united into a compound which at first appears homogeneous.

The first operation on metals is to separate the ore from the matrix. When the ore is found in large masses, most of it may be dug up free from the matrix, and those pieces to which it adheres may be freed by a hammer. But as the ore is often intimately mixed with the matrix, it is necessary to try other methods.

Sometimes the whole is reduced to powder and thrown into water; the water is then put in motion, and the earthy matter floats above the ore, on account of their different specific gravity. It is still better to place the powder on a board, over which water may be made to run; being stirred while the water runs over it, the earthy parts float and are carried off, whilst the metallic parts remain behind. This operation is called washing the ore.

When the matrix is not divisible by water, a stamping-mill is employed, which consists of an axis turned by a water-wheel. On the axis there are a number of cogs, which lift up a perpendicular pillar of wood plated at bottom with iron; this falling down bruises the matrix to powder. It often happens that the matrix is harder than the ore, and in this case the ore will be reduced to a much finer powder than it. Here the ore is a much heavier substance; yet its surface may be so much increased, that it may be carried off by the water before the matrix. This may be obviated by subjecting the mass to a brisk heat, and throwing water upon it when red-hot, which renders the matrix more easy to be powdered. There are many ores of this kind which undergo a fusion by heat; hence the small particles of the matrix, which are angular and irregular, contract themselves into little spheres, by which means losing part of their surface, they become specifically heavier, and fall more readily to the bottom of the water: the ore too generally loses part of the sulphur it contains, and on this account becomes specifically heavier: the stone becomes softer, and is sometimes disposed to fall into powder merely by the application of water, especially if composed of gypseous spar. Quartz is not indeed so easily heated in this way, but it becomes softer by these means; cracks and flaws are produced in it, and of consequence it is more easily divided.

After all there will in washing be some loss of the metal: hence it is found more expedient to bring the whole mass into fusion, as is practised in Germany. The fusion is performed in some of the ordinary furnaces, and commonly with the addition of particular stones, or the scoriæ of former fusions, which greatly promote the fusion of the new matter. Thus the metallic matter settles to the bottom still in the state of an ore, whence the process is called crude separation. When the ore is thus freed from its matrix, the next operations are, to separate the sulphur, arsenic, &c. which the metals may contain; and this must be done by a mild heat, because of their strong adhesion to the metals, which the metallurgists call their rapacity. If exposed to a violent heat, the arsenic will hardly separate when forced off intensely, sometimes carrying off part of the metal along with it. This treating the ore in a gentle heat is called roasting it. The workmen commonly build the ore into heaps with fuel, so that the whole may become red-hot, and the air have free passage through it. Some ores, as those of copper, require many repetitions of the process, the sulphur and arsenic adhering so closely.

In consequence of this operation, the metal remains more or less in the form of an oxide; the operation of reduction becomes therefore necessary. It is often necessary to add earths to the ores, as they often contain earths not so easily fusible, but which by mixture with others become so. The fires being kept up for some time the ore melts; and as it passes through the fuel, which is generally charcoal of wood, the oxygen, which the oxide contained, is drawn off by the charcoal forming fixed air, and the metal falls into the bason constructed for that purpose in the furnace.

Thus the metal is obtained free from earthy and stony matter, and generally from arsenic and sulphur, but it contains other metals: thus copper has always with it more or less of iron, silver a quantity of copper, &c.

Some, as lead ores when rich, are treated by immediate fusion, without previous roasting; for though it would give a greater quantity of the metal, it would be too expensive. There are many ores in which the metal exists in the state of an oxide. Here previous roasting would be of no advantage. The ores of silver and gold require certain additions to them to attract the sulphur and arsenic, and to melt the other matter which is mixed with them, so as to dispose them to separate. See ASSAYING, &c.

METAPHOR, in rhetoric, a trope, by which we put a strange word for a proper word. See RHETORIC.

METAPHYSICS. It is remarkable that scarcely any two writers are agreed with respect to the meaning of the word metaphysics. One lexicographer tells us, somewhat obscurely, that it is "the doctrine of the general affections of substances existing." Another that "it is a science which treats of being as such in the abstract." While a third most gravely assures us, it means "that part of philosophy which considers the nature and properties of thinking beings." This last definition must evidently be unfounded, since "the nature and properties of thinking beings" are either a branch of natural philosophy or of logic. See LOGIC.

The word seems to have originated with Aristotle, who has termed a treatise which is placed after his Physics, μετα τα φυσικα. So that it may mean either something "beyond Physics," or merely "an appendix to his physics" or natural history. This treatise chiefly relates to the intellectual world.

The mode in which authors have treated of metaphysics is as various as their definitions of the term. One author, under the form of a treatise of metaphysics, presents us with a discussion on abstract words, their meaning and application; another with an enquiry into the faculties and operations of the human mind; a third with a volume of theology, a dissertation on the being and attributes of God, and the nature of spiritual and celestial intelligences; and a fourth with a treatise of ethics or moral philosophy.

A science so subtle, so indefinite, so evasive, which, under so many Proteus forms, eludes our grasp, is scarcely a proper subject for a practical work like this. What are metaphysics? Every thing! Nothing! Yet there are some subjects which the learned have agreed in calling metaphysical: such were the discussions between Clarke and Leibnitz concerning the free agency of man; such were the disputes concerning identity and diversity which formerly agitated the schools, and those upon the origin of evil; and if we were called upon to point out a most able and rational work, into which metaphysics are introduced with propriety and ability, we should name Cudworth's Intellectual System.

METATARSUS. See Anatomy.

METEOR. This term is by some writers made to comprehend all the visible phenomena of meteorology, but it is more generally confined to luminous bodies appearing suddenly at uncertain times, and with more or less of motion in the atmosphere. These may be reduced under three classes, viz. fire-balls, falling or shooting stars, and ignes fatui.

Those phenomena which are classed together under the general appellation of fire-balls, were divided by the antients into several species, according to the external form or appearance which they assumed. They were also regarded by them in a much more formidable light than by us; as being the certain prognostics of great and awful events in the moral and political world. Even the philosophic Cicero himself speaks of the "ab occidente faces," as the certain harbingers or indications of those bloody scenes which in his time convulsed and desolated the Roman commonwealth.

Under the general name of comets, Pliny enumerates a variety of these phenomena. If the fire commences at one extremity of the meteor, and burns by degrees, he terms it, from its form and appearance, a lamp or torch; if an extended mass of fire passes longitudinally through the atmosphere, he calls it a dart; and if its length and magnitude are considerable, and it maintains its station for any space of time, it is a beam; and if the clouds seem to part, and emit a quantity of fire, he terms it a chasm; but this last appears to be, strictly speaking, an electrical phenomenon, indeed only a strong and vivid flash of lightning.

Several instances of these meteors are recorded by the same author. During the spectacle of gladiators exhibited by Germanicus, one of them passed rapidly by the faces of the spectators at noon-day. A meteor of that species which he calls a beam, he adds, was seen when the Lacedemonians were defeated at sea, in that memorable engagement which lost them the empire at sea. He also mentions a sanguineous kind of meteor, a flame as red as blood, which fell from heaven about the 107th Olympiad, when Philip of Macedon was concerting his wicked plan for enslaving the republics of Greece. He relates, that when he was himself on the watch during the night in the Roman camp, he was a spectator of a similar appearance—a number of resplendent lights fixed upon the palisadoes of the camp, similar, he says, to those which mariners speak of as attaching themselves to the masts and yards of a ship.

In tropical climates these meteors are more common and more stupendous than in these more temperate regions. "As I was riding in Jamaica," says Mr. Barbham, "one morning from my habitation, situated about three miles north-west from St. Jago de la Vega, I saw a ball of fire, appearing to me about the bigness of a bomb, swiftly falling down with a great blaze. At first I thought it fell into the town; but when I came nearer, I saw many people gathered together, a little to the southward, in the savannah, to whom I rode up, to inquire the cause of their meeting: they were admiring, as I found, the ground's being strangely broken up and ploughed by a ball of fire, which, as they said, fell down there. I observed there were many holes in the ground; one in the middle of the bigness of a man's head, and five or six smaller round about it, of the bigness of one's fist, and so deep as not to be fathomed by such implements as were at hand. It was observed also, that all the green-herbage was burnt up near the holes; and there continued a strong smell of sulphur near the place for some time after."

Ulloa gives an account of one of a similar kind at Quito. "About nine at night," says he, "a globe of fire appeared to rise from the side of the mountain Pichinca, and so large, that it spread a light over all the part of the city facing that mountain. The house where I lodged looking that way, I was surprised with an extraordinary light darting through the crevices of the window-shutters. On this appearance, and the bustle of the people in the street, I hastened to the window, and came time enough to see it, in the middle of its career, which continued from west to south, till I lost sight of it, being intercepted by a mountain that lay between me and it. It was round, and its apparent diameter about a foot. I observed it to rise from the sides of Pichinca, although, to judge from its course, it was behind that mountain where this congeries of inflammable matter was kindled. In the first half of its visible course it emitted a prodigious effulgence, then it began gradually to grow dim; so that, upon its disappearing behind the intervening mountain, its light was very faint."

Meteors of this kind are very frequently seen between the tropics; but they sometimes also visit the more temperate regions of Europe. We have the description of a very extraordinary one, given us by Montanari, that serves to shew to what great heights, in our atmosphere, these vapours are found to ascend. In the year 1676, a great globe of fire was seen at Bononia, in Italy, about three quarters of an hour after sunset. It passed westward with a most rapid course, and at the rate of not less than 160 miles in a minute, which is much swifter than the force of a cannon ball, and at last stood over the Adriatic sea. In its course it crossed over all Italy; and, by computation, it could not have been less than 38 miles above the surface of the earth. In the whole line of its course, wherever it approached, the inhabitants below could distinctly hear it, with a hissing noise, resembling that of a firework. Having passed away to sea, towards Corsica, it was heard at last to go off with a most violent explosion, much louder than that of a cannon; and immediately after, another noise was heard like the rattling of a great cart upon a stony pavement, which was probably nothing more than the echo of the former sound. Its magnitude, when at Bononia, appeared twice as long as the moon one way, and as broad the other; so that, considering its height, it could not have been less than a mile long, and half a mile broad. From the height at which this was seen, and there being no volcano in that quarter of the world whence it came, it is more than probable that this terrible globe was kindled on some part of the contrary side of the globe; and thus, rising above the air, and passing in a course opposite to that of the earth's motion, in this manner it acquired its amazing rapidity.

Two of these meteors appeared in this country in the year 1783, of which a most particular and truly philosophical account and ingenious solution, by Dr. Blagden, are published in the Philosophical Transactions of the following year; and as his account will apply to many phenomena of the kind, we cannot take any better method to elucidate this part of the subject, than by presenting our readers with a short abstract of this very curious and learned memoir.

The first of the two meteors in question was seen on the 18th of August, and was, in appearance, a luminous ball, which rose in the N. N. W. nearly round: it, however, soon became elliptical, and gradually assumed a tail as it ascended, and, in a certain part of its course, seemed to undergo a remarkable change, compared to bursting; after which it proceeded no longer as an entire mass, but was apparently divided into a cluster of balls of different magnitudes, and all carrying or leaving a train behind, till, having passed the east, and verging considerably to the south, it gradually descended, and was lost out of sight. The time of its appearance was about sixteen minutes past nine in the evening, and it was visible about half a minute. It was seen in all parts of Great Britain, at Paris, at Nuits in Burgundy, and even at Rome; and is supposed to have described a tract of 1000 miles at least over the surface of the earth. It appears to have burst and re-united several times; and the first bursting of it which was noticed seems to have been somewhere over Lincolnshire, perhaps near the commencement of the fens. This change in the meteor corresponds with the period in which it suffered a deviation from its course. If, indeed, the explosion was any kind of effort, we cannot wonder that the body should be diverted by it from its direct line; and, on the other hand, it seems equally probable, that if it was forced by any cause to change its direction, the consequence would naturally be a separation of its parts.

The illumination of these meteors is often so great as totally to obliterate the stars, to make the moon look dull, and even to affect the spectators like the sun itself. When this meteor was observed at Brussels, the moon appeared quite red, but when it was passed, recovered its natural light. This effect, the doctor remarks, must have depended on the contrast of colour, and shews how large a proportion of the blue rays enters into that light which could even make the *silver* moon appear to have an excess of red. The body of the fire-ball, even before it burst, did not appear of an uniform brightness, but consisted of lucid and dull parts, which were constantly changing their respective positions, so that the whole effect was to some eyes like an internal agitation or boiling of the matter. By the best accounts that could be procured concerning the height of the meteor, it seems to have varied from 55 to 60 miles. In these two last particulars it seems to have wonderfully corresponded with some other phenomena of the same kind.

A report was heard some time after the meteor disappeared, and this report was loudest in Lincolnshire and the adjacent parts, and again in the eastern parts of Kent: the report we may therefore suppose to be the effect of the two explosions of the body, first over Lincolnshire, and afterwards when it entered the continent: a hissing sound was said also to have accompanied the progress of the meteor. Judging from the height of the meteor, its bulk is conjectured to have been not less than half a mile in diameter; and when we consider this bulk, its velocity cannot fail to astonish us, which is supposed to be at the rate of more than 40 miles in a second.

The other meteor, which appeared on the 4th of October, 1783, at 43 minutes past six in the evening, was much smaller than the former, and of a much shorter duration. It was first perceived to the northward, as a stream of fire, like the common shooting stars, but large; but presently burst out into that intensely bright blueish flame, which is peculiar to such meteors. It left behind it a dusky-red streak of fire, and, except this, had no tail, but was nearly globular. After moving not less than 10 degrees in this bright state, it became suddenly extinct without any explosion. The height of the meteor must have been between 40 and 50 miles; and its duration was not more than three seconds.

The doctor is of opinion, that the general cause of these phenomena is electricity, which opinion he grounds upon the following circumstances: 1st, The velocity of these meteors, in which they correspond with no other body in nature but the electrical fluid. 2dly, The electrical phenomena attending meteors, the lambent flames, and the sparks proceeding from them, which have sometimes damaged ships and houses in the manner of lightning; and, added to these, the hissing sound, resembling that of electricity passing from a conductor. As a third argument in favour of this hypothesis, the doctor remarks the connection of meteors with the northern lights. Instances are recorded, where northern lights have been seen to join, and form luminous balls, darting about with great velocity, and even leaving a train like fire-balls. The aurora borealis appears to occupy as high, if not a higher, region above the surface of the earth, as may be concluded from the very distant countries to which it has been visible at the same time. 4thly, The most remarkable analogy, the doctor thinks, is the course of at least all the larger meteors, which seems to be constantly from or towards the north or north-west quarter of the heavens. Of above forty different fire-balls described in the Philosophical Transactions, twenty are so described, that it is certain their course was in that direction: only three or four seem to have moved the contrary way; and with respect to the remainder, it is left doubtful, from the imperfect state of the relations.

Notwithstanding the doctor's ingenious arguments, we cannot subscribe to the opinion, that these phenomena are altogether electrical. The duration of the fire-ball, the unequal consistency of the mass, and several other points in the narration, seem to indicate that its materials were of a less rare and evanescent nature than the electric fire.

The following probably was electrical.

On board the Montague, under the command of admiral Chambers, in lat. 42° 48′, long. 9° 3′, on the 4th of November 1749, about ten minutes before twelve, as the author, Mr. Chambers, was taking an observation, one of the quarter-masters desired he would look to the windward. On directing his eye that way, he observed a large ball of blue fire about three miles distance from them. They immediately lowered the top-sails, but it came so fast upon them, that before they could raise the main-tack, they observed the ball rise almost perpendicularly, and not above 40 or 50 yards from the main-chains, when it went off with an explosion as great as if hundreds of cannon had been discharged at the same time, leaving behind it a strong sulphureous smell. By this explosion, the main-topmast was shattered in pieces, and the main-mast rent quite down to the keel. Five men were knocked down, and one of them was greatly bruised, and some other damage of less importance was done to the ship. Just before the explosion, the ball seemed to be of the size of a large mill-stone.

The shooting or falling star is a common phenomenon; but though so frequently observed, the great distance and transient nature of these meteors have hitherto frustrated every attempt to ascertain their cause. The connection of these with an active state of the atmospheric electricity, is however certain from observation; and we have more reason to consider them as electric scintillæ than as solid or fluid matter in the act of combustion. They precede a change of wind.

Concerning the nature and composition of the *ignis fatuus*, or Will-with-a-wisp, there is less dispute; the generality of philosophers being agreed, that it is caused by some volatile vapour of the phosphoric kind, probably the phosphorized hydrogen gas. The light from putrescent substances, particularly putrid fish, and those sparks emitted from the sea, or sea-water when agitated, in the dark, correspond in appearance with this meteor. Sir Isaac Newton defines the ignis fatuus to be "a vapour shining without heat;" and it is usually visible in damp places, about dunghills, burying-grounds, and other situations which are likely to abound with phosphoric matter.

A remarkable ignis fatuus was observed by Mr. Derham, in some boggy ground, between two rocky hills. He was so fortunate as to be able to approach it within two or three yards. It moved with a brisk and desultory motion about a dead thistle, till a slight agitation of the air, occasioned, as he supposed, by his near approach to it, caused it to jump to another place; and as he approached, it kept flying before him. He was near enough to satisfy himself that it could not be the shining of glow-worms or other insects: it was one uniform body of light.

M. Beccaria mentions two of these luminous appearances, which were frequently observed in the neighbourhood of Bologna, and which emitted a light equal to that of an ordinary faggot. Their motions were unequal, sometimes rising, and sometimes sinking towards the earth; sometimes totally disappearing, though in general they continued hovering about six feet from the ground. They differed in size and figure; and, indeed, the form of each was fluctuating, sometimes floating like waves, and dropping sparks of fire. He was assured there was not a dark night in the whole year in which they did not appear; nor was their appearance at all affected by the weather, whether cold or hot, snow or rain. They have been known to change their colour from red to yellow; and generally grew fainter as any person approached, vanishing entirely when the observer came very near to them, and appearing again at some distance.

Dr. Shaw also describes a singular ignis fatuus, which he saw in the Holy Land. It was sometimes globular, or in the form of the flame of a candle; and immediately afterwards spread itself so much, as to involve the whole company in a pale inoffensive light, and then was observed to contract itself again, and suddenly disappear. In less than a minute, however, it would become visible as before, and run along from one place to another; or would expand itself over more than three acres of the adjacent mountains. The atmosphere at this time, he adds, was thick and hazy.

In a superstitious age we cannot wonder that these phenomena have all been attributed to supernatural agency: it is one of the noblest purposes of philosophy to release the mind from the bondage of imaginary terrors; and by explaining the modes in which the Divine Providence disposes the different powers of nature, to elevate our thoughts to the One First Cause; to teach us to see "God in all, and all in God."

METEORIC STONES. Almost all the larger fire-balls have been observed to disappear with a loud explosion; and it was almost constantly affirmed that heavy stony bodies fell from them. But though several well-authenticated accounts of the fall of such stones had been from time to time published, little credit was given to them; nor did they indeed attract the attention of philosophers, till Dr. Chladni published a dissertation on the subject in 1794. Two years after, Mr. King published a still more complete collection of examples, both antient and modern; many of them supported by such evidence that it was impossible to reject it. These two dissertations excited considerable attention: but the opinion that stones had really fallen from the atmosphere was considered as so extraordinary, and so contrary to what we know of the constitution of the air, that most people hesitated, or refused their assent. Meanwhile Mr. Howard took a different method of investigating the subject. He not only collected all the recent and well-authenticated accounts of the fall of stony bodies, and examined the evidence of their truth, but procured specimens of the stones which were said to have fallen in different places, compared them together, and subjected them to a chemical analysis. The result was, that all these stony bodies differ completely from every other known stone; that they all resemble each other; and that they are all composed of the same ingredients. His dissertation on the subject was published in the Philosophical Transactions for 1802. The proofs which this admirable dissertation contains, that the stony bodies in question really fell from the atmosphere, are quite irresistible. Indeed, their external characters and chemical analysis would alone decide the point: for it is quite inconceivable that in India, England, France, Germany, and Italy, in climates and soils exceedingly different from each other, stones should have been pointed out which differed from every other mineral in the countries where they were found, and which exactly resembled one another, provided these had not had the same origin. The chemical analysis of Howard was soon after repeated, and verified, by Vauquelin and Klaproth.

Most of the stones which have fallen from the atmosphere have been preceded by the appearance of luminous bodies or meteors. These meteors burst with an explosion, and then the shower of stones falls to the earth. Sometimes the stones continue luminous till they sink into the earth; but most commonly their luminousness disappears at the time of the explosion. These meteors move in a direction nearly horizontal, and they seem to approach the earth before they explode. The following table, drawn up by Mr. Izarn, exhibits the collection of the best-authenticated instances of the falling of stones, &c. from the atmosphere hitherto observed, together with the time when they fell, and the persons on whose evidence the fact rests.

Substances.	*Places where they fell.*	*Period of their Fall.*	*Testimony.*
Shower of stones	At Rome	Under Tullus Hostilius	Livy
Shower of stones	At Rome	Consuls C. Martius & M. Torquatus	J. Obsequens
Shower of iron	In Lucania	Year before the defeat of Crassus	Pliny
Shower of mercury	In Italy	- - - -	Dion
A very large stone	Near the river Negos, Thrace	Second year of the 78th Olympiad	Pliny
Three large stones	In Thrace	Year before J. C. 452	Ch. of Count Marcellin
Shower of fire	At Quesnoy	January 4th, 1717	Geoffroy le Cadet
Stone of 72 lbs.	Near Larissa, Macedonia	January 1706	Paul Lucas
About 1200 stones—one of 120 lbs. Another of 60 lbs.	Near Padua in Italy	In 1510	Carden, Varcit
Another of 59 lbs.	On Mount Vaiser, Provence	November 27th, 1627	Gassendi
Shower of sand for 15 hours	In the Atlantic	April 6th, 1719	Père la Feuillée
Shower of sulphur	Sodom and Gomorrah	- - - -	Moses
Sulphureous rain	In the duchy of Mansfeld	In 1658	Spangenberg
The same	Copenhagen	In 1646	Olaus Wormius
Shower of sulphur	Brunswick	October 1721	Siegesber
Ditto of a viscid unknown matter	Ireland	In 1695	Muschenbroeck
Two large stones weighing 20 lbs.	Liponas in Bresse	September 1753	Delalande
A stony mass	Niort, Normandy	In 1750	Delalande
A stone of 7½ lbs.	At Luce in Le Maine	September 13th, 1768	Bachelay
A stone	At Aire in Artois	In 1768	Gurson de Boyaval
A stone	In Le Cotentin	In 1768	Morand
Extensive shower of stones	Environs of Agen	July 24th, 1790	St. Amand, Baudin, &c.
About 12 stones	Sienna, Tuscany	July 1794	Earl of Bristol
A large stone of 56 lbs.	Wold-Cottage, Yorkshire	December 13th, 1795	Captain Topham
A stone of about 20 lbs.	Salé, department of the Rhone	March 17th, 1798	Lelievre and De Drée
A stone of 10 lbs.	In Portugal	February 19th, 1796	Southey
Shower of stones	Benares, East Indies	December 19th, 1798	J. Lloyd Williams, Esq.
Shower of stones	At Plann, near Tabor, Bohemia	July 3d, 1753	B. de Born
Mass of iron, 70 cubic feet	America	April 5th, 1800	Philosophical Magazine
Mass of ditto, 14 quintals	Abakank, Siberia	Very old	Pallas, Chladni, &c.
Shower of stones	Barboutan, near Roquefort	July 1789	Darcet, jun. Lomet, &c.
Large stone, 260 lbs.	Ensisheim, Upper Rhine	November 7th, 1492	Butenschoen
Two stones, 200 and 300 lbs.	Near Verona	In 1762	Acad. de Bourd
A stone of 20 lbs.	Sales, near Ville-Franche	March 12th, 1798	De Drée
Several ditto, from 10 to 17 lbs.	Near L'Aigle, Normandy	April 26th, 1803	Fourcroy.

The stony bodies when found are always hot. They commonly bury themselves some depth under ground. Their size differs from a few ounces to several tons. They are usually roundish, and always covered with a black crust. In many cases they smell strongly of sulphur. The black crust, from the analysis of Howard, consists chiefly of oxide of iron.

The outer surface of these stones is rough. When broken, they appear of an ash-grey colour, and of a granular texture like a coarse sandstone. When examined with a microscope, four different substances may be discovered, of which the stone is composed: 1st, A number of spherical bodies, varying in size from a pin's head to a pea, of a greyish-brown colour, opaque, breaking easily in every direction, of a compact texture, capable of scratching glass, and of giving a few feeble sparks with steel. 2d, Fragments of pyrites of an indeterminate shape, of a reddish-yellow colour, granular, and easily reduced to powder. The powder has a black colour. 3d, Grains of iron in the metallic state, scattered like the pyrites through the stone. 4th, The three substances just mentioned are cemented together by a fourth of an earthy consistence, and so soft that all the other substances may be easily separated by the point of a knife or the nail, and the stone itself crumbled to pieces between the fingers. This cement is of a grey colour. The proportion and size of these different constituents vary considerably in different specimens; but all of them bear a striking resemblance to each other. Their specific gravity varies from 3.352 to 4.281.

From the analysis of Howard, which was conducted with much precision and address, and which has been fully confirmed by Vauquelin and Klaproth, we learn, that the black crust consists of a compound of iron and nickel, partly metallic and partly oxydized. The pyrites consist of iron, nickel, and sulphur. The metallic grains consist of iron, combined with about one-third of its weight of nickel, and the yellow globules are composed of silica, magnesia, iron, and nickel. The count Bournon observes, that these globules resemble the chrysolite of Werner, and that their chemical analysis corresponds exactly with Klaproth's analysis of that mineral. The earthy cement consists of the very same substances, and nearly in the same proportions, as the globular substances. But it will be necessary to exhibit a specimen of some of the analyses, as published by the philosophers to whom we are indebted for them. A stone which fell at Benares in India, was analyzed by Howard. The pyrites consisted of,

2.0 sulphur
10.5 iron
1.0 nickel
2.0 earths and foreign bodies.

15.5

The spherical bodies,

50.0 silica
15.0 magnesia
34.0 oxide of iron
2.5 oxide of nickel.

101.5

The earthy cement,

48.0 silica
18.0 magnesia
34.0 oxide of iron
2.5 oxide of nickel.

102.5

A stone which fell in Yorkshire, deprived as much as possible of its metallic particles, gave Mr. Howard from 150 grains,

75 silica
37 magnesia
48 oxide of iron
2 oxide of nickel

162.

The increase of weight was owing to the oxydizement of the metallic bodies.

Stones which fell at Laigle in France in 1803, yielded by the analysis of Vauquelin and Fourcroy,

54 silica
36 oxide of iron
9 magnesia
3 oxide of nickel
2 sulphur
1 lime

105.

The celebrated stone which fell at Ensisheim, in Alsace, in 1492, yielded to the same philosophers,

56.0 silica
30.0 oxide of iron
12.0 magnesia
2.4 nickel
3.5 sulphur
1.4 lime.

105.3

5. The experiments of Howard, thus confirmed by others, and supported by the most respectable historical evidence, having demonstrated that these stony bodies really do fall from the heavens, it was natural to expect that various attempts would be made to account for their appearance. But such is the obscurity of the subject, so little progress have we made in the science of meteorology, that no opinion in the slightest degree probable has hitherto been advanced. It was first supposed that the bodies in question had been thrown out of volcanoes; but the immense distance from all volcanoes at which they have been found, and the absence of all similar stones from volcanic productions, render this opinion untenable. Chladni endeavoured to prove, that the meteors from which they fell were bodies floating in space, unconnected with any planetary system, attracted by the earth in their progress, and kindled by their rapid motion through the atmosphere. But this opinion is not susceptible of any direct evidence, and can scarcely be believed, one would think, even by Dr. Chladni himself. Laplace suggests the probability of their having been thrown off by the volcanoes of the moon: but the meteors which almost always accompany them, and the swiftness of their horizontal motion, militate too strongly against this opinion. The greater number of philosophers consider them, with Mr. King and sir William Hamilton, as concretions actually formed in the atmosphere. This opinion is undoubtedly the most probable of all; but in the present state of our knowledge, it would be absurd to attempt any explanation of the manner in which they are formed. The masses of native iron found in South America, in Siberia, and near Agnam, contain nickel, as has been ascertained by Proust, Howard, and Klaproth, and resemble exactly the iron found in the stones fallen from the atmosphere. We have every reason, therefore, to ascribe to them the same original; and this accordingly is almost the uniform opinion of philosophers. Klaproth has shewn, that real native iron is distinguished from meteoric iron by the absence of nickel.

Upon the whole, we may consider these stony and metallic masses as fragments of fire-balls which have burst in the atmosphere; but the origin and cause of these fire-balls will perhaps for ages baffle all the attempts of philosophers to explain them.

METEOROLOGY, the doctrine of meteors, or the study of the variable phenomena of the atmosphere, in which also is commonly included the art of deducing probable conjectures on the future state of the weather.

The latter branch of this science was successfully cultivated by the antients; and it subsists at this day among those whom necessity, arising from the nature of their occupations, renders diligent in comparing the present appearances of the atmosphere, and circumstances depending on its present state, with the changes which succeed. The aphorisms of Virgil, in his Georgics, are beautiful examples of this kind of skill, and possess philosophical, in an equal degree with poetical, merit.

The atmosphere may be considered in respect of the direction of its currents or winds; of the variations in its gravity or pressure; of the changes in its temperature; of the state of the electricity which it exhibits; and lastly, as to the visible phenomena which are supposed to depend on the foregoing; and the regular notation of which, together with the other indications, will be found the only successful way of prosecuting this study. Since the invention of philosophical instruments, an attention to these has too much superseded the antient, and, singly considered, the more rational, way of deducing prognostics: it has been accordingly left to the ploughman, the mariner, and the fisherman; whose experience being successful without, would undoubtedly be more so with, the aid of instruments.

Winds, though proverbially uncertain in some climates, are yet not without a striking degree of regularity and system, if we consider the whole atmosphere; and there is a part of the world where the wind is so constantly in one quarter, that *windward*, in common speech, stands for eastern, and *leeward* for western. We want only a more extensive set of observations to render exceedingly probable the following hypothesis: That a large portion of the whole atmosphere moves constantly from east to west round the earth, on and near the equator; that this is supplied and impelled by air from the temperate and cold latitudes on each side toward the poles; which again receive, by a superior current, the overflow of the tropical regions, where the air, rarefied by the heat, is constantly rising and tending to lateral diffusion. This opinion, as will appear hereafter, is supported by many facts; and it is certainly in theory a most beautiful provision for that constant internal movement in the mass of the air, without which it could not probably serve the salutary purposes to animal and vegetable life which it does at present. The exceptions both in regular and irregular winds to such an hypothesis may perhaps be accounted for when the superior currents, which interest philosophers alone, and of which we know very little, shall have been more investigated. See Wind.

Variable winds evidently stamp the nature of every climate, and therefore depend upon causes which act with uniformity, notwithstanding all their apparent irregularity. They are all intimately connected with each other, and probably succeed each other in a certain order, though that order has not hitherto been observed. All that can be done at present is, to offer a few unconnected remarks.

Winds appear usually to begin at that point towards which they blow. They must therefore be owing to a rarefaction or displacing of the air in some particular quarter, either by the action of heat or some other cause. This is more particularly the case when the wind blows with violence. Hurricanes are uniformly preceded by a great fall of the barometer; and the wind often flows in every direction towards the place where the barometer stands so low. One would be tempted in this case to suppose the sudden decomposition of a portion of the atmosphere. Strong north-east winds have been repeatedly observed beginning at the quarter towards which they flow. In 1740, Dr. Franklin was prevented from observing an eclipse of the moon at Philadelphia by a north-east storm, which came on about seven o'clock in the evening. He was surprised to find afterwards that it had not come on at Boston till near 11 o'clock: and upon comparing all the accounts which he received from the several colonies of the beginning of this and other storms of the same kind, he found it to be always an hour later the farther north-east for every 100 miles.

"From thence (says he) I formed an idea of the course of the storm, which I will explain by a familiar instance. I suppose a long canal of water stopped by a gate. The water is at rest till the gate is opened; then it begins to move out through the gate, and the water next the gate is first in motion, and moves on towards the gate; and so on successively, till the water at the head of the canal is in motion, which it is last of all. In this case all the water moves indeed towards the gate; but the successive times of beginning the motion are in the contrary way, viz. from the gate back to the head of the canal. Thus, to produce a north-east storm, I suppose some great rarefraction of the air in or near the Gulf of Mexico; the air rising thence has its place supplied by the next more northern, cooler, and therefore denser and heavier air; a successive current is formed, to which our coast and inland mountains give a north-eastern direction."

A similar storm was observed by Dr. Mitchell in 1802. It began at Charlestown on the 21st February, at two o'clock in the afternoon; at Washington, which lies several hundred miles to the north-east, it was not observed till five o'clock; at New York it began at ten in the evening; and at Albany not till day-break of the 22d. Its motion, from this statement, was 1100 miles in 11 hours, or 100 miles in the hour.

A remarkable storm of the same kind, and accompanied by an easterly wind, was observed in Scotland on the 8th of February 1799. It was attended by a very heavy fall of snow, and the motion of the wind was much slower. At Falkirk it began to snow at six in the evening of the 7th; at Edinburgh, about one o'clock in the morning of the 8th; and at Dunbar, at eight o'clock in the morning. It lasted 11 hours, and did not travel above 100 miles during that time.

The north-east wind blows most frequently with us during the spring months; and from the observations made by captain Cook, it appears, that the same wind prevails during the same period in the northern Pacific. Hence it appears, that at that season the cold air from the north of Europe and America flows into the Atlantic and Pacific. Hence the reason of its uncommon coldness, dryness, and density.

It is very common to observe one current of air blowing at the surface of the earth, while a current flows in a contrary direction in the higher strata of the atmosphere. Three such winds have been observed blowing in contrary directions all at the same time. It is affirmed that changes of weather generally begin in the upper strata of the air, the wind which blows there gradually extending itself to the surface of the earth.

With regard to the pressure of the atmosphere, it is every where variable, as appears by the barometer; which indicates to us the weight of a column of air, extending to the top of the atmosphere, and whose base is equal to that of the mercury. At the level of the sea, where the column of air is longest, the mean height of the barometer is thirty inches. This sir George Shuckburgh found to be the case in the Mediterranean and the Channel, in the temperature of 55° and 60°; Mr. Bouguer, on the coast of Peru, in the temperature of 84°; and lord Mulgrave, in latitude 80°. The mean height of the barometer is less, the higher any place is situated above the level of the sea, because the column of air which supports the mercury is the shorter.

Between the tropics the variations of the barometer are exceedingly small; and it is remarkable, that in that part of the world it does not descend above half as much for every 200 feet of elevation as it does beyond the tropics.

As the latitude advances towards the poles, the range of the barometer gradually increases, till at last it amounts to two or three inches. This gradual increase will appear from the following table:

TABLE

Of the Range of the Barometer.

Latitude.	Places.	Range of the Barometer. Greatest.	Annual.
0° 0′	Peru	0.20	—
22 23	Calcutta	0.77	—
33 55	Cape Town	—	0.89
40 55	Naples	1.00	—
51 8	Dover	2.47	1.80
53 23	Liverpool	2.89	1.96
59 56	Petersburgh	3.45	2.77

In North America, however, the range of the barometer is a great deal less than in the corresponding European latitudes. In Virginia, for instance, it never exceeds 1.1.

The range of the barometer is greater at the level of the sea than on the mountains; and in the same degree of latitude, the extent of the range is in the inverse ratio of the height of the place above the level of the sea.

From a table published by Mr. Cotte, in the Journal de Physique, it seems exceedingly probable that the barometer has always a tendency to rise from the morning to the evening; and that this tendency is greatest between two o'clock in the afternoon and nine at night, at which hour the greatest elevation takes place; that the elevation of nine o'clock differs from that of two by $\frac{4}{12}$ths, while that at two differs from the morning elevation only by $\frac{1}{12}$; and that in certain climates the greatest elevation takes place at two o'clock. The following is a part of the table on which these observations are founded, reduced to the English standard.

Places.	Years of observation.	Mean Height of the Barometer. Morning.	Noon.	Evening.	Year.
Arles - -	6	29.9347	29.9347	29.9413	29.9347
Arras - -	6	29.6683	29.6683	29.6832	29.6758
Bourdeaux -	11	29.7212	29.8385	29.8385	29.8385
Cambray - -	13	29 8756	29.8682	29.8756	29.8756
Chinon - -	12	29.7719	29.7795	29.8001	29.7869
Dunkirk - -	8	29.9199	29.9347	29.9347	29.9273
Hagenau - -	10	29.5648	29.5643	29.5741	29.5648
Laon - - -	7	29.3354	29.3206	29.3429	29.3354
Lisle - - -	6	29.9165	29.9274	29.9347	29.9077
Mayenne - -	7	29.7172	29.7056	29.7127	29.7127
Manheim - -	5	29.6167	29.6018	29.6167	29.6093
Montmorenci -	22	29 6536	29.6536	29.6610	29.6536
Mulhausen - -	7	29.1873	29.1800	29.1873	29.1873
Obernheim - -	12	29.4834	29.4665	29.4764	29.4764
Paris - - -	67	29.8902	29.8607	29.8756	29.8756
Poitiers - -	12	29.7276	29.7276	29.7276	29.7276
Rouen - -	11	29.8607	29.8535	29.8535	29.8535
Rome - - -	3	29.8607	29.8460	29.8756	29.8607
St. Maurice le Gerard	10	29.8016	29.8016	29.8090	29.8016
Troyes - -	10	29.6885	29.6979	29.6885	29.6885

The range of the barometer is greater in winter than in summer. Thus at York the mean range of the barometer, during October, November, December, January, February, March, of the year 1774, was 1.42, and for the six summer months, 1.016.

It is probable that the variations of the barometer, as well as those of the thermometer, are susceptible of what we may term a local character for each tract or country differing in climate. This will be most readily discovered by the following mode of investigation: Prepare a sheet of paper ruled in squares with pale ink; the horizontal lines agreeing with the inches and decimal divisions of the scale of the barometer; the perpendicular, which may be about twice as distant, representing divisions of time. It will be convenient to consider each line as denoting midnight, and to mark the days of the month at the top of the columns thus defined. On this scale let the several notations of any register of the barometer be set down by means of a dot for each, placed in the part of the scale where it may point out the time and the elevation. The desired number of notations thus made, a curve may be drawn through the series of dots, which will represent at one view the course of the barometer for the time. It will be found, on comparing a number of these curves, that they characterize, in a certain degree, not only the latitude and season, but the locality of the observations. So that although the most obvious resemblances may be traced in different years of the same register, yet the general appearance of registers from different climates, will be found to differ in all respects. In this way may be seen at one view both the correspondence between the latitude or elevation above the sea of any place, and the range at that place; and the coincidence between the movements of the barometer, and the other phenomena of the weather. It is obvious that the same mode, and even the same scale, may be made to serve for temperature also, by marking degrees upon the horizontal lines, and changing the appearance of the line representing temperature, so as to make it readily distinguishable from the other curve. There is a correspondence in this climate between the two instruments, which will thus often become conspicuous. It consists in an elevation of temperature after a rise of the barometer, and vice versa: the exceptions to this occur chiefly at the setting in of frost, and when it rains with the wind from the eastward. But the most remarkable circumstance which has been thus brought to light is, an influence which the sun and moon exercise over the atmosphere in respect to its pressure; and which is detailed in a series of observations, accompanied with a chart of this kind, for the year 1798, in the Philosophical Magazine, vol. vii. p. 355.

The effect of this is, a tendency in the atmosphere to gain weight while the moon is passing to either quarter, and vice versa to lose it during the approach of full or new moon. The actual change which on a mean of ten years is found always to take place at London, amounts only to two-tenths of an inch in the barometer, which thus occurs twice in each moon. The apparent influence is often much greater for a considerable time together. The specimen of the register alluded to, which is given Plate Meteorology, will elucidate the whole of the foregoing observations.

There is something in these movements of the atmosphere very much resembling the waves producible in dense fluids. Thus a sudden and great depression in the barometer is followed by an equally sudden rise, which is often carried beyond the point from which the original movement commenced. After a continued gradual rise on the other hand, there usually occurs a similar depression. Except on the eve of great storms, the rising movement is however the more rapid of the two. The undulations which are to be found in the curve corresponding to the intervals between the phases of the moon, often comprehend in their sweep some smaller ones, which appear to be due to occasional and less extensive causes.

It happens also from some principle of the kind above stated, that these movements, which in fair and moderate weather proceed with considerable regularity, on being disturbed by storms, a.e not resumed suddenly but by degrees, and the interruption is perceptible for a considerable space afterwards.

In long periods of wet weather, the barometer usually keeps about the mean altitude, rising and falling through a short space with little regularity.

In serene and settled weather it is generally high; and low in calm weather, when the air is inclined to rain; it sinks on high winds, rises highest on easterly and northerly winds, and sinks when the wind blows from the south. At Calcutta, it is always highest when the wind blows from the north-west and north, and lowest when it blows from the south-east.

Such are the phenomena respecting the variations of the barometer, as far as they can be reduced under general heads. Various attempts have been made to explain them, but hitherto without any great degree of success. The theory of Mr. Kirwan appears by far the most plausible, though it is not sufficient to explain all the facts. The following observations may be considered as a kind of abstract of his theory, except in one or two instances.

It is evident, that the density of the atmosphere is least at the equator, and greatest at the poles; for at the equator, the centrifugal force, the distance from the centre of the earth, and the heat, all of which tend to diminish the density of the air, are at their maximum, while at the pole they are at their minimum. The mean height of the barometer at the level of the sea, all over the globe, is 30 inches; the weight of the atmosphere, therefore, is the same all over the globe. The weight of the atmosphere depends on its density and height: where the density of the atmosphere is greatest, its height must be least; and, on the contrary, where its density is least, its height must be the greatest. The height of the atmosphere, therefore, must be greatest at the equator, and least at the poles; and it must decrease gradually between the equator and the poles: so that its upper surface will resemble two inclined planes, meeting above the equator in their highest part.

During summer, when the sun is in our hemisphere, the mean heat between the equator and the pole does not differ so much as in winter. Indeed, the heat of northern countries at that time equals the heat of the torrid zone: thus in Russia, during July and August, the thermometer rises to 85°. Hence the rarity of the atmosphere at the pole, and consequently its height, will be increased. The upper surface of the atmosphere, therefore, in the northern hemisphere, will be less inclined, while that of the southern hemisphere, from contrary causes, will be much more inclined. The very reverse will take place during our winter.

The density of the atmosphere depends in a great measure on the pressure of the superincumbent column; and therefore decreases, according to the height, as the pressure of the superincumbent column constantly decreases. But the density of the atmosphere in the torrid zone will not decrease so fast as in the temperate and frigid zones; because its column is longer, and because there is a greater proportion of air in the higher part of this column. This accounts for the observation of Mr. Cassan, that the barometer only sinks half as much for every 200 feet of elevation in the torrid as in the temperate zones. The density of the atmosphere at the equator, therefore, though at the surface of the earth it is less, must at a certain height equal, and at a still greater surpass, the density of the atmosphere in the temperate zones and at the poles.

A current of air is constantly ascending at the equator, and part of it at least reaches and continues in the higher parts of the atmosphere. From the fluidity of air, it is evident, that it cannot accumulate above the equator, but must roll down the inclined plane which the upper surface of the atmosphere assumes towards the poles. As the surface of the atmosphere of the northern is more inclined during our winter than that of the southern hemisphere, a greater quantity of the equatorial current of air must flow over upon the northern than upon the southern atmosphere; so that the quantity of our atmosphere will be greater during winter than that of the southern hemisphere: but during summer the very reverse will take place. Hence the greatest mercurial heights take place during winter, and the range of the barometer is less in summer than in winter.

As the heat in the torrid zone never differs much, the density, and consequently the height, of the atmosphere, will not vary much. Hence the range of the barometer within the tropics is comparatively small; and it increases gradually as we approach the poles, because the difference of the temperature, and consequently of the density, of the atmosphere, increases with the latitude.

The diurnal elevation of the barometer in the torrid zone corresponding to the tides, observed by Mr. Cassan and others, must be owing to the influence of the moon on the atmosphere. This influence, notwithstanding the ingenious attempts of D'Alembert and several other philosophers, seems altogether inadequate to account for the various phenomena of the winds. It is not so easy to account for the tendency which the barometer has to rise as the day advances, which seems to be established by Mr. Cotte's table. Perhaps it may be accounted for by the additional quantity of vapour added to the atmosphere, which, by increasing the quantity of the atmosphere, may possibly be adequate to produce the effect.

The falls of the barometer which precede, and the oscillations which accompany, violent storms and hurricanes, shew us, that these phenomena are produced by very great rarefactions, or perhaps destruction of air, in particular parts of the atmosphere. The falls of the barometer, too, that accompany winds, proceed from the same cause.

That the temperature of the air varies considerably, not only in different climates and in different seasons, but even in the same place and in the same season, must be obvious to the most careless observer. This perpetual variation cannot be ascribed to the direct heat of the sun; for the rays of that luminary seem to produce no effect whatever upon air, though ever so much concentrated; but they warm the surface of the earth, which communicates its heat to the surrounding atmosphere. Hence it happens, that the temperature of the air is highest in those places which are so situated as to be most warmed by the sun's rays, and that it varies in every region with the season of the year. Hence too the reason why it diminishes according to the height of the air above the surface of the earth. That portion of the earth which lies at the equator, is exposed to the most perpendicular rays of the sun. Of course it is hottest, and the heat of the earth diminishes gradually from the equator to the poles. The temperature of the air must follow the same order. The air, then, is hottest over the equator; and its temperature gradually diminishes from the equator to the poles, where it is coldest of all. It it hottest at the surface; and it becomes gradually colder, according to its height above that surface. Let us examine the nature of these two diminishing progressions of temperature.

1. Though the temperature of the air is highest at the equator, and gradually sinks as it approaches the pole, yet as in every place the temperature of the air is constantly varying with the season of the year, we cannot form any precise notion of the progression, without taking the temperature in every degree of latitude for every day of the year, and forming from each a mean temperature for the whole year; which is done by adding together the whole observations, and dividing by their number. The quotient gives the mean temperature for the year. The diminution from the pole to the equator takes place in arithmetical progression; or, to speak more properly, the annual temperatures of all the latitudes are arithmetical means between the mean annual temperature of the equator and the pole. This was first discovered by Mr. Mayer; and by means of an equation which he founded on it, but rendered considerably plainer and simpler, Mr. Kirwan has calculated the mean annual temperature of every degree of latitude between the equator and the pole. He proceeded on the following principle: Let the mean annual heat at the equator be m, and at the pole $m - n$; put φ for any other latitude; the mean annual temperature of that latitude will be $m - n \times \sin. \varphi^2$. If therefore the temperature of any two latitudes is known, the value of m and n may be found. Now the temperature of north latitude 40° has been found by the best observations to be 62.1°, and that of latitude 50°, 52.9°. The square of the sine of 40° is nearly 0.419, and the square of the sine of 50° is nearly 0.586. Therefore,

$m - 0.41\ n = 62.1$, and

$m - 0.58\ n = 52.9$; therefore,

$62.1 + 0.41\ n = 52.9 + 0.58\ n$; as each of them, from the two first equations, is equal to m. From this last equation the value of n is found to be 53 nearly; and m is nearly equal to 84. The mean temperature of the equator, therefore, is 84°, and that of the pole 31°. To find the mean temperature for every other latitude, we have only to find 88 arithmetical means between 84 and 31. In this manner Mr. Kirwan calculated the following table:

TABLE

Of the Mean Annual Temperature of the Standard Situation in every Latitude.

Lat.	Temper.	Lat.	Temper.	Lat.	Temper.
90	31.	71	36.6	52	51.1
89	31.04	70	37.2	51	52.4
88	31.10	69	37.8	50	52.9
87	31.14	68	38.4	49	53.8
86	31.2	67	39.1	48	54.7
85	31.4	66	39.7	47	55.6
84	31.5	65	40.4	46	56.4
83	31.7	64	41.2	45	57.5
82	32.	63	41.9	44	58.4
81	32.2	62	42.7	43	59.4
80	32.6	61	43.5	42	60.3
79	32.9	60	44.3	41	61.2
78	33.2	59	45.09	40	62.
77	33.7	58	45.8	39	63.
76	34.1	57	46.7	38	63.9
75	34.5	56	47.5	37	64.8
74	35.	55	48.4	36	65.7
73	35.5	54	49.2	35	66.6
72	36.	53	50.2	34	67.4

Lat.	Temper.	Lat.	Temper.	Lat.	Temper.
33	68.3	23	75.9	13	81.3
32	69.1	22	76.5	12	81.7
31	69.9	21	77.2	11	82.
30	70.7	20	77.8	10	82.3
29	71.5	19	78.3	9	82.7
28	72.3	18	78.9	8	82.9
27	72.8	17	79.4	7	83.2
26	73.8	16	79.9	6	83.4
25	74.5	15	80.4	5	83.6
24	75.4	14	80.8	0	84.

This table, however, only answers for the temperature of the atmosphere of the ocean. It was calculated for that part of the Atlantic Ocean which lies between the 80th degree of northern and the 45th of southern latitude, and extends westward as far as the Gulf-stream, and to within a few leagues of the coast of America; and for all that part of the Pacific Ocean reaching from latitude 45° north to latitude 40° south, from the 20th to the 275th degree of longitude east of London. This part of the ocean Mr. Kirwan calls the standard; the rest of the ocean is subject to anomalies which will be afterwards mentioned.

Mr. Kirwan has also calculated the mean monthly temperature of the standard ocean. The principles on which he went were these: The mean temperature of April seems to approach very nearly to the mean annual temperature; and as far as heat depends on the action of the solar rays, the mean heat of every month is as the mean altitude of the sun, or rather as the sine of the sun's altitude. The mean heat of April, therefore, and the sine of the sun's altitude, being given, the mean heat of May is found in this manner: As the sine of the sun's mean altitude in April, is to the mean heat of April, so is the sine of the sun's mean altitude in May, to the mean heat of May. In the same manner the mean heats of June, July, and August, are found; but the rule would give the temperature of the succeeding months too low, because it does not take in the heat derived from the earth, which possesses a degree of heat nearly equal to the mean annual temperature. The real temperature of these months, therefore, must be looked upon as an arithmetical mean between the astronomical and terrestrial heats. Thus, in latitude 51°, the astronomical heat of the month of September is 44.6°, and the mean annual heat is 52.4°; therefore the real heat of this month should be $\frac{44.6 + 52.4}{2} = 48.5$. Mr. Kirwan, however, after going through a tedious calculation, found the results to agree so ill with observations, that he drew up the following table, partly from principles, and partly by studying a variety of sea journals:

TABLE of the Monthly Mean Temperature of the Standard from Lat. 80° to Lat. 10°.

Lat.	80°	79°	78°	77°	76°	75°	74°	73°	72°	71°	70°	69°	68°	67°	66°	65°	64°	63°
January	22.	22.5	23.	23.5	24.	24.5	25.	25.5	26.	26.5	27.	27.5	27.5	28.	28.	28.	29.	30.
February	23.	23.	23.5	24.	24.5	25.	25.5	26.	26.5	27.	27.5	28.	28.	28.5	29.	30.	31.	32.
March	27.	27.5	28.	28.5	29.	29.5	30.	30.5	31.	31.5	32.	32.5	33.	33.5	34.	35.	36.	37.
April	32.6	32.9	33.2	33.7	34.1	34.5	35.	35.5	36.	36.6	37.2	37.8	38.4	39.1	39.7	40.4	41.2	41.9
May	36.5	36.5	37.	37.5	38.	38.5	39.	39.5	40.	40.5	41.	41.5	42.	42.5	43.	44.	45.	46.
June	51.	51.	51.5	52.	52.	52.	52.5	53.	53.5	54.	54.	54.5	54.5	54.5	55.	55.	55.5	55.5
July	50.	50.	50.5	51.	51.	51.	51.5	52.	52.5	53.	53.5	53.5	53.5	54.	54.5	54.5	55.	55.
August	39.5	40.	41.	41.5	42.	42.5	43.	43.5	44.	44.5	45.	45.5	46.	47.	48.	48.5	49.	50.
September	33.5	34.	34.5	35.	35.5	36.	36.5	37.	38.	38.5	39.	39.5	40.	41.	42.	43.	44.	45.
October	28.5	29.	29.5	30.	30.5	31.	31.5	32.	32.5	33.	33.5	34.	34.	35.	36.	37.	37.5	38.
November	23.	23.5	24.	24.5	25.	25.5	26.	26.5	27.	27.5	28.	28.5	29.	30.	31.	32.	32.5	33.
December	22.5	23.	23.5	24.	24.5	25.	25.5	26.	26.5	27.	27.5	28.	28.	29.	30.	30.5	31.	31.

Lat.	62°	61°	60°	59°	58°	57°	56°	55°	54°	53°	52°	51°	50°	49°	48°	47°	46°	45°
January	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	42.5	43.5	43.	42.5	44.	44.5
February	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.	44.5	44.5	45.	45.5	46.	46.5
March	38.	39.	40.	41.	42.	43.	44.6	45.	46.	48.	49.	50.	50.5	51.	52.5	53.	53.5	54.5
April	42.7	43.5	44.3	45.09	45.8	46.7	47.5	48.4	49.2	50.2	51.1	52.4	52.9	53.8	54.7	55.6	56.4	57.5
May	47.	48.	49.	50.	51.	52.	53.	54.	55.	56.	57.	58.	58.5	59.	60.	61.	62.	63.
June	56.	56.	56.	56.5	57.	57.	57.5	58.	58.5	59.	59.	60.	61.	62.	63.	64.	65.	66.
July	55.5	55.5	56.	56.5	57.	57.5	58.	59.	60.	61.	62.	63.	63.5	64.	65.	66.	67.	68.
August	51.	52.	53.	54.	55.	56.	57.	58.	59.	60.	61.	62.	63.5	64.	65.	66.	67.	68.
September	46.	47.	48.	49.	50.	51.	52.	53.	54.	55.	56.	57.	58.5	59.	60.	61.	62.	63.
October	39.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.	50.5	51.	52.	53.	54.	55.
November	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.5	46.	46.5	47.	48.	49.	50.	51.
December	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	44.	44.5	45.	46.	47.	48.	49.

Lat.	44°	43°	42°	41°	40°	39°	38°	37°	36°	35°	34°	33°	32°	31°	30°	29°	28°	27°
January	45.	45.5	46.	46.5	49.5	51.	52.	53.5	55.	56.5	59.5	63.	63.	63.	63.5	63.5	63.5	64.
February	47.	48.	49.	50.	53.	56.5	58.	60.	61.	62.	63.	64.5	66.	67.	68.5	68.5	69.5	69.5
March	55.5	56.5	58.5	59.5	60.	60.5	61.	62.	63.	64.	65.	66.5	67.5	68.5	69.5	71.	72.	72.5
April	58.4	59.4	60.3	61.2	62.1	63.	63.9	64.8	65.7	66.6	67.4	68.3	69.1	69.9	70.7	71.5	72.3	72.8
May	64.	65.	66.	67.	68.	69.	70.	70.5	71.	71.5	72.	72.5	73.	73.	73.5	74.5	75.5	76.
June	67.	68.	69.	70.	70.5	71.	71.	71.	71.5	71.5	72.	72.5	73.	73.	73.5	74.5	75.5	76.
July	69.	69.5	70.	70.	71.	71.	72.	72.	72.5	72.5	72.5	72.5	73.	73.	73.5	74.5	75.5	76.
August	69.	69.5	70.	70.	71.	71.	72.	72.	72.5	72.5	72.5	72.5	73.	73.	73.5	74.5	75.5	76.
September	64.	66.	68.	69.5	70.5	71.	71.5	72.	72.5	72.5	72.5	72.5	73.	73.	73.5	74.	75.5	76.
October	56.	57.	58.	59.	60.	61.	62.	63.	64.	65.	66.	67.5	68.5	69.5	70.5	71.	72.5	72.5
November	52.	53.	54.	55.	56.	57.	58.	59.	60.	61.	62.	63.	64.5	65.5	66.5	68.	69.	69.5
December	50.	51.	52.	53.	54.	55.	56.	57.	58.	59.	60.	61.	62.5	63.5	64.5	66.	67.	67.5

TABLE of the Monthly Mean Temperature, &c. *continued.*

Lat.	26°	25°	24°	23°	22°	21°	20°	19°	18°	17°	16°	15°	14°	13°	12°	11°	10°
January	64.5	65.5	67.	68.	69.	71.	72.	72.5	73.	73.5	74.	74.5	75.	76.	76.5	77.	77.5
February	70.5	71.	72.	72.	72.5	74.	75.	76.	76.5	77.	77.5	78.	78.5	79.	79.5	79.8	80.
March	73.	73.5	74.5	75.	75.5	76.	77.	77.5	78.	78.5	79.	79.5	80.	80.8	81.	81.5	81.8
April	73.8	74.5	75.4	75.9	76.5	77.2	77.8	78.3	78.9	79.4	79.9	80.4	80.8	81.3	81.7	82.	82.3
May	76.5	77.5	78.	78.5	79.5	80.	80.5	81.	81.5	82.	82.5	83.	83.	83.5	84.	84.	84.3
June	76.5	78.	78.5	79.	79.5	80.	80.5	81.5	82.	82.5	83.	83.5	83.8	84.	84.3	84.6	84.8
July	76.5	78.	78.5	79.	79.5	80.	80.5	81.5	82.	82.5	83.	83.5	83.8	84.	84.3	84.6	84.8
August	76.5	78.	78.5	79.	79.5	80.	80.5	81.5	82.	82.5	83.	83.5	83.8	84.	84.3	84.6	84.8
September	76.5	77.5	78.	78.5	79.	79.5	80.	81.	81.5	82.	82.5	83.	83.	83.5	84.	84.3	84.6
October	73.	73.5	74.5	75.	75.5	77.	78.	79.	80.	81.	81.5	82.	82.5	83.	83.5	83.8	84.
November	71.5	72.	73.5	74.	74.5	75.	75.5	76.	77.	78.	78.5	79.	79.5	80.	80.5	80.8	81.
December	68.5	69.5	70.	71.	71.5	72.	72.5	73.	74.	75.	75.5	76.	76.5	77.	77.5	78.	78.5

From this table it appears, that January is the coldest month in every latitude, and that July is the warmest month in all latitudes above 48°. In lower latitudes, August is generally warmest. The difference between the hottest and coldest months increases in proportion to the distance from the equator. Every habitable latitude enjoys a mean heat of 60° for at least two months; this heat seems necessary for the production of corn. Within ten degrees of the poles, the temperatures differ very little; neither do they differ much within ten degrees of the equator: the temperatures of different years differ very little near the equator; but they differ more and more as the latitudes approach the poles.

2. That the temperature of the atmosphere gradually diminishes, according to its height above the level of the sea, is well known. Thus the late Dr. Hutton, of Edinburgh, found, that a thermometer, kept on the top of Arthur's-seat, usually stood three degrees lower than a thermometer kept at the bottom of it. Hence, then, a height of 800 feet occasioned 3° of diminution of temperature. On the summit of Pinchinca, the thermometer stood at 30°, as observed by Bouguer; while at the level of the sea, in the same latitude, it stood at 84°. Here a height of 15564 feet occasioned a diminution of temperature, amounting to 54°. But though there can be no doubt of the gradual diminution of temperature, according to the height, it is by no means easy to determine the rate of diminution. Euler supposes it to be in a harmonic progression; but this opinion is contradicted by observations. Saussure supposes, that in temperate climates the diminution of temperature amounts to 1° for every 287 feet of elevation. But Mr. Kirwan has shewn that no such rule holds, and that the rate of diminution varies with the temperature at the surface of the earth. We are indebted to this philosopher for a very ingenious method of determining the rate of diminution in every particular case, supposing the temperature at the surface of the earth known.

Since the temperature of the atmosphere is constantly diminishing as we ascend above the level of the sea, it is obvious, that at a certain height we arrive at the region of perpetual congelation. This region varies in height according to the latitude of the place; it is highest at the equator, and descends gradually nearer the earth as we approach the poles. It varies also according to the season, being highest in summer, and lowest in winter. M. Bouguer found the cold on the top of Pinchinca, one of the Andes, to extend from seven to nine degrees below the freezing-point every morning immediately before sunrise. He concluded, therefore, that the mean height of the term of congelation (the place where it freezes during some part of the day all the year round) between the tropics was 15,577 feet above the level of the sea; but in latitude 28° he placed it in summer at the height of 13,440 feet. Now, if we take the difference between the temperature of the equator and the freezing-point, it is evident that it will bear the same proportion to the term of congelation at the equator, that the difference between the mean temperature of any other degree of latitude and the freezing-point bears to the term of congelation in that latitude. Thus the mean heat of the equator being 84°, the difference between it and 32 is 52; the mean heat of latitude 28° is 72.3°; the difference between which and 32 is 40.3: then 52 : 15577 :: 40.3 : 12072. In this manner Mr. Kirwan calculated the following table:

Lat.			Mean height of the term of congelation. *Feet.*
0	-	-	15577
5	-	-	15457
10	-	-	15067
15	-	-	14498
20	-	-	13719
25	-	-	13030
30	-	-	11592
35	-	-	10664
40	-	-	9016
45	-	-	7658
50	-	-	6260
55	-	-	4912
60	-	-	3684
65	-	-	2516
70	-	-	1557
75	-	-	748
80	-	-	120

Beyond this height, which has been called the lower term of congelation, and which must vary with the season and other circumstances, Mr. Bouguer has distinguished another, which he called the upper term of congelation; that is, the point above which no visible vapour ascends. Mr. Kirwan considers this line as much less liable to vary during the summer months than the lower term of congelation, and therefore has made choice of it to determine the rate of the diminution of heat, as we ascend in the atmosphere. Bouguer determined the height of this term in a single case, and Kirwan has calculated the following table of its height for every degree of latitude in the northern hemisphere:

TABLE

Of the Height of the Upper Line of Congelation in the different Latitudes of the Northern Hemisphere.

N. Lat.	Feet.	N. Lat.	Feet.	N. Lat.	Feet.
0	28000	33	19800	62	4989
5°	27784	34	19454	63	4910
6	27644	35	19169	64	4831
7	27504	36	18577	65	4752
8	27364	37	17985	66	4684
9	27224	38	17393	67	4616
10	27084	39	16801	68	4548
11	26880	40	16207	69	4480
12	26676	41	15712	70	4413
13	26472	42	15217	71	4354
14	26268	43	14722	72	4295
15	26061	44	14227	73	4236
16	25781	45	13750	74	4177
17	25501	46	13235	75	4119
18	25221	47	12740	76	4067
19	24941	48	12245	77	4015
20	24661	49	11750	78	3963
21	24404	50	11253	79	3911
22	24147	51	10124	80	3861
23	23890	52	8965	81	3815
24	23633	53	7806	82	3769
25	23423	54	6647	83	3723
26	22906	55	5617	84	3677
27	22389	56	5533	85	3631
28	21872	57	5439	86	3592
29	21355	58	5345	87	3553
30	20838	59	5251	88	3514
31	20492	60	5148	89	3475
32	20146	61	5068	90	3432

The following rule of Mr. Kirwan will enable us to ascertain the temperature at any required height, provided we know the temperature at the surface of the earth.

Let the observed temperature at the surface of the earth be $= m$, the height given $= b$, and the height of the upper term of congelation for the given latitude be $= t$; then $\frac{m - 32}{\frac{t}{100} - 1} =$ the diminution of temperature for every hundred feet of elevation; or it is the common difference of the terms of the progression required. Let this common difference thus found be denoted by c; then $c \times \frac{b}{100}$ gives us the whole diminution of temperature from the surface of the earth to the given height. Let this diminution be denoted by d, then $m - d$ is obviously the temperature required. An example will make this rule sufficiently obvious. In latitude 56°, the heat below being 54°, required the temperature of the air at the height of 803 feet?

Here $m = 54$, $t = 5533$, $\frac{m - 32}{\frac{t}{100} - 1} = \frac{22}{54.33} = 0.404 = c$, and $c \times \frac{b}{100} = 0.404 \times 8.03 = 3.24 = d$, and $m - d = 54 - 3.24 = 50.75$. Here we see that the temperature of the air 808 feet above the surface of the earth is 50°. 75.

From this method of estimating the diminution of temperature, which agrees remarkably well with observation, we see that the heat diminishes in an arithmetical progression. Hence it follows, that the heat of the air at a distance from the earth is not owing to the ascent of hot strata of air from the surface of the earth, but to the conducting power of the air.

3. This rule, however, applies only to the temperature of the air during the summer months of the year. In winter the upper strata of the atmosphere are often warmer than the lower. Thus, on the 31st of January, 1776, the thermometer on the summit of Arthur's-seat stood six degrees higher than a thermometer at Hawkhill, which is 684 feet lower. Mr. Kirwan considers this superior heat, almost uniformly obs rved during winter, as owing to a current of warm air from the equator, which rolls towards the north pole during our winter.

4. Such, then, in general is the method of finding the mean annual temperature over the globe. There are, however, several exceptions to these general rules, which come now to be mentioned.

That part of the Pacific Ocean which lies between north latitudes 52° and 66°, is no broader at its northern extremity than 42 miles, and at its southern extremity than 1300 miles: it is reasonable to suppose, therefore, that its temperature will be considerably influenced by the surrounding land, which consists of ranges of mountains covered a great part of the year with snow; and there are besides a great many high, and consequently cold, islands scattered through it. For these reasons Mr. Kirwan concludes, that its temperature is at least four or five degrees below the standard. But we are not yet furnished with a sufficient number of observations to determine this with accuracy.

It is the general opinion, that the southern hemisphere, beyond the 40th degree of latitude, is considerably colder than the corresponding parts of the northern hemisphere. Mr. Kirwan has shewn that this holds with respect to the summer of the southern hemisphere, but that the winter in the same latitudes is milder than in the northern hemisphere.

Small seas surrounded with land, at least in temperate and cold climates, are generally warmer in summer and colder in winter than the standard ocean, because they are a good deal influenced by the temperature of the land. The gulf of Bothnia, for instance, is for the most part frozen in winter; but in summer it is sometimes heated to 70°, a degree of heat never to be found in the opposite part of the Atlantic. The German Sea is above three degrees colder in winter, and five degrees warmer in summer, than the Atlantic. The Mediterranean Sea is, for the greater part of its extent, warmer both in summer and winter than the Atlantic, which therefore flows into it. The Black Sea is colder than the Mediterranean, and flows into it.

The eastern parts of North America are much colder than the opposite coast of Europe, and fall short of the standard by about 10° or 12°, as appears from American meteorological tables. The causes of this remarkable difference are many. The highest part of North America lies between the 40th and 50th degree of north latitude, and the 100th and 110th degree of longitude west from London; for there the greatest rivers originate. The very height, therefore, makes this spot colder than it otherwise would be. It is covered with immense forests, and abounds with large swamps and morasses, which render it incapable of receiving any great degree of heat; so that the rigour of winter is much less tempered by the heat of the earth than in the old continent. To the east lie a number of very large lakes; and farther north, Hudson's-bay; about 50 miles on the south of which there is a range of mountains, which prevent its receiving any heat from that quarter. This bay is bounded on the east by the mountainous country of Labrador, and by a number of islands. Hence the coldness of the north-west winds, and the lowness of the temperature. But as the cultivated parts of North America are now much warmer than formerly, there is reason to expect that the climate will become still milder when the country is better cleared of woods, though perhaps it will never equal the temperature of the old continent.

Islands are warmer than continents in the same degree of latitude; and countries lying to the windward of extensive mountains or forests are warmer than those lying to the leeward. Stones or sand have a less capacity for heat than earth has, which is always somewhat moist; they heat or cool, therefore, more rapidly and to a greater degree. Hence the violent heat of Arabia and Africa, and the intense cold of Terra del Fuego. Living vegetables alter their temperature very slowly, but their evaporation is great; and if they are tall and close, as in forests, they exclude the sun's rays from the earth, and shelter the winter snow from the wind and the sun. Woody countries, therefore, are much colder than those which are cultivated.

Air is one of those bodies which have received the name of electric, because they are capable of being positively or negatively charged with electric matter. It not only contains that portion of electricity which seems necessary to the constitution of all terrestrial bodies, but it is liable also to be charged negatively or positively when electricity is abstracted or introduced by means of conducting bodies. These different states must occasion a variety of phenomena, and in all probability contribute very considerably to the various combinations and decompositions which are continually going on in air. The electrical state of the atmosphere, then, is a point of considerable importance, and has with great propriety occupied the attention of philosophers ever since Dr. Franklin demonstrated that thunder is occasioned by the agency of electricity.

1. The most complete set of observations on the electricity of the atmosphere were made by professor Beccaria of Turin. He found the air almost always positively electrical, especially in the day-time and in dry weather. When dark or wet weather clears up, the electricity is always negative. Low thick fogs rising into dry air carry up a great deal of electric matter.

2. In the morning, when the hygrometer indicates dryness equal to that of the preceding day, positive electricity obtains even before sunrise. As the sun gets up, this electricity increases more remarkably if the dryness increases. It diminishes in the evening.

3. The mid-day electricity of days equally dry is proportional to the heat.

4. Winds always lessen the electricity of a clear day, especially if damp.

5. For the most part, when there is a clear sky with little wind, a considerable electricity arises after sunset at dew-falling.

6. Considerable light has been thrown upon the sources of atmospherical electricity by the experiments of Saussure and other philosophers. Air is not only electrified by friction, like other electric bodies, but the state of its electricity is changed by various chemical operations which often go on in the atmosphere. Evaporation seems in all cases to convey electric matter into the atmosphere. On the other hand, when steam is condensed into water, the air becomes negatively electric.

Farther, Mr. Canton has ascertained that dry air, when heated, becomes negatively electric, and positive when cooled, even when it is not permitted to expand or contract: and the expansion and contraction of air also occasion changes in its electric state.

Thus there are four sources of atmospheric electricity known: 1. Friction; 2. Evaporation; 3. Heat and cold; 4. Expansion and contraction: not to mention the electricity evolved by the melting, freezing, solution, &c. of various bodies in contact with air.

7. As air is an electric, the matter of electricity, when accumulated in any particular strata, will not immediately make its way to the neighbouring strata, but will induce in them changes similar to what is induced upon plates of glass or similar bodies piled upon each other. Therefore, if a stratum of air is electrified positively, the stratum immediately above it will be negative, the stratum above that positive, and so on. Suppose now that an imperfect conductor was to come into contact with each of these strata: we know from the principles of electricity that the equilibrium would be restored, and that this would be attended with a loud noise, and with a flash of light. Clouds are imperfect conductors: if a cloud, therefore, comes into contact with two such strata, a thunderclap will follow. If a positive stratum is situated near the earth, the intervention of a cloud will, by serving as a stepping-stone, bring the stratum within the striking distance, and a thunderclap will be heard while the electrical fluid is discharging itself into the earth. If the stratum is negative, the contrary effects will take place. It does not appear, however, that thunder is often occasioned by a discharge of electric matter from the earth into the atmosphere. The accidents, most of them at least, which were formerly ascribed to this cause, are now much more satisfactorily accounted for by lord Stanhope's theory of the returning stroke. The discharge from the clouds directly into

the earth is also probably less frequent than from cloud to cloud.

The far greater part of the visible phenomena of the atmosphere are due to the water which, being raised by evaporation, is transported from place to place in vapour, and which, physically speaking, is a proper component part of the air. When by any means a portion of this is deprived of its constituent caloric, it reappears in minute drops, which are at first uniformly diffused, and lessen the transparency of the air in proportion to their abundance. By the report of those who have ascended the highest mountains, or performed aerostatic voyages, there is usually a sufficient quantity of this diffused water, especially towards evening, to become visible from above as a sea of haze. It should seem that this is, in fact, the veil which, being drawn over the sable of the sky, converts it to a blue of various degrees of intensity; or at least that it shares with the transparent air in this effect.

The next stage is dew, or rather haze, for the latter term seems more appropriate to the appearance of dew while it is falling. Here the drops have so far become collected as to form an aggregate faintly defined in the air. To this succeed various definite aggregates, under the general term cloud. Out of the latter are formed rain, snow, and hail, by which the product of evaporation is finally restored to the earth. The excess for any given time, of the falling water over that which is evaporated, passes off by the springs and rivers to that grand reservoir which forms the far greater part of the surface of the globe.

Tracts of forest, especially if mountainous, invite the rain, and protect the springs; while the accumulated heat on cultivated plains often causes the clouds to pass over them, or to be dissipated. Clearing of land and culture, therefore, tend to lessen the rain and the rivers; but it is for the interest of agriculture to leave a certain quantity of timber growing, especially in springy lands, and to repair the waste of it by planting; for it is not impossible, that in a series of ages, the axe and the plough too freely applied might convert a tract of fruitful country into one little better than an African desert.

The mean annual quantity of rain is greatest at the equator, and decreases gradually as we approach the poles. Thus at

Granada, Antilles,	12° N. lat.	it is	126 inches
Cape François, St. Domingo	19° 46′	- -	120
Calcutta - - -	22 23	- -	81
Rome - - - -	41 54	- -	39
England - - -	33	- -	32
Petersburgh - -	59 16	- -	16.

On the contrary, the number of rainy days is smallest at the equator, and increases in proportion to the distance from it. From north latitude 12° to 43°, the mean number of rainy days is 78; from 43° to 46° the mean number is 103; from 46° to 50° it is 134; from 51° to 60°, 161.

The number of rainy days is often greater in winter than in summer; but the quantity of rain is greater in summer than in winter. At Petersburgh the number of rainy or snowy days during winter is 84, and the quantity which falls is only about five inches; during summer the number of rainy days is nearly the same, but the quantity which falls is about 11 inches.

More rain falls in mountainous countries than in plains. Among the Andes it is said to rain almost perpetually; while in Egypt it hardly ever rains at all. If a rain-gauge is placed on the ground, and another at some height perpendicularly above it, more rain will be collected into the lower than into the higher; a proof that the quantity of rain increases as it descends, owing perhaps to the drops attracting vapour during their passage through the lower strata of the atmosphere where the greatest quantity resides. This, however, is not always the case, as Mr. Copland of Dumfries discovered in the course of his experiments. He observed also, that when the quantity of rain collected into the lower gauge was greatest, the rain commonly continued for some time; and that the greatest quantity was collected in the higher gauge only either at the end of great rains, or during rains which did not last long. These observations are important; and may, if followed out, give us new knowledge of the causes of rain. They seem to show, that during rain the atmosphere is somehow or other brought into a state which induces it to part with its moisture; and that the rain continues as long as this state continues. Were a sufficient number of observations made on this subject in different places, and was the atmosphere carefully analysed during dry weather, during rain, and immediately after rain, we might soon perhaps discover the true theory of rain.

Rain falls in all seasons of the year, at all times of the day, and during the night as well as the day; though, according to M. Toaldo, a greater quantity falls during the day than the night. The cause of rain then, whatever it may be, must be something which operates at all times and seasons. Rain falls also during the continuance of every wind, but oftenest when the wind blows from the south. Falls of rain often happen likewise during perfect calms.

It appears from a paper published by M. Cotte in the Journal de Physique for Oct. 1791, containing the mean quantity of rain falling at 147 places situated between north lat. 11° and 60°, deduced from tables kept at these places, that the mean annual quantity of rain falling in all these places is 34.7 inches. Let us suppose then (which cannot be very far from the truth) that the mean annual quantity of rain for the whole globe is thirty-four inches. The superficies of the globe consists of 170,981,012 square miles, or 686,401,498,471,475,200, square inches. The quantity of rain therefore falling annually will amount to 23,337,650,812,030,156,800 cubic inches, or somewhat more than 91,751 cubic miles of water.

The dry land amounts to 52,745,253 square miles; the quantity of rain falling on it annually therefore will amount to 30,960 cubic miles. The quantity of water running annually into the sea is 13,140 cubic miles; a quantity of water equal to which must be supplied by evaporation from the sea, otherwise the land would soon be completely drained of its moisture.

The quantity of rain falling annually in Great Britain may be seen from the following table: which is probably the most extensive of the kind; and as accurate as the use of instruments, not constructed by one person and adjusted to a common standard, will allow. It is mostly compiled from the Transactions of different learned societies.

Counties (maritime).	Places.	Mean ann. depth in inches.
Cumberland. -	Keswick, 7 years -	67. 5
	Carlisle, 1 year -	20. 2
Westmoreland.	Kendal, 11 years -	59. 8
	Fell-foot, 3 years -	55. 7
	Waith Sutton, 5 years	46
Lancashire. -	Lancaster, 10 years -	45
	Liverpool, 18 years -	34. 4
	Manchester, 9 years -	33
	Townley - -	41
	Crawshawbooth, near Haslingden, 2 years -	60
Gloucestershire.	Bristol, 3 years -	29. 2
Somersetshire.	Bridgewater, 3 years	29. 3
Cornwall. -	Ludguan, near Mount's Bay, 5 years -	41
	Another place, 1 year	29. 9
Devonshire. -	Plymouth, 2 years -	46. 5
Hampshire. -	Selbourne, 9 years -	37. 2
	Fyfield, 7 years -	25. 9
Kent. -	Dover, 5 years -	37. 5
Essex. -	Upminster - -	19. 5
Norfolk. -	Norwich, 13 years -	25. 5
Yorkshire. -	Barrowby, near Leeds, 6 y.	27. 5
	Garsdale, near Sedbergh, 3 years - -	52. 3
Northumberland.	Widdrington, 1 year -	21. 2
Counties (inland).	**Places.**	**Means.**
Middlesex. -	London, 7 years -	23.
Surry. -	South Lambeth, 9 years	22. 7
Hertfordshire.	Near Ware, 5 years -	25
Huntingdonsh.	Kimbolton, 7 years -	25
Derbyshire. -	Chatsworth, 15 years	27. 8
Rutlandshire.	Lyndon, 21 years -	24. 3
Northamptonsh.	Near Oundle, 14 years	23
	General mean -	35.2

As the places subject to much rain predominate considerably in this list, it will probably be nearer the truth, if we take the mean annual rain in England and Wales at a quantity not exceeding 32 inches.

In this country it generally rains less in March than in November, in the proportion at a medium of 7 to 12. It generally rains less in April than October in the proportion of 1 to 2 nearly at a medium. It generally rains less in May than September; the chances that it does so are at least 4 to 3: but when it rains plentifully in May (as 1.8 inches or more), it generally rains but little in September; and when it rains one inch or less in May, it rains plentifully in September.

Snow is evidently formed by a process of regular crystallisation among minute frozen particles of water floating in the air. It is remarkable, that previous to, and during, the fall of snow in quantity, the temperature continues about 32°. It should seem that the evolution of the constituent caloric of the water produces the same effect when ice is formed in the atmosphere, as when it is formed in water. The structure of a crystal of snow demonstrates that a drop of rain is also formed by the union of a great number of smaller drops. When these come together in the act of freezing, and suddenly, they form a nucleus of white spongy ice, which, by its extreme coldness, becoming incrusted with clear ice from the water it collects in its descent, constitutes hail as we usually see it. Sometimes, however, the nucleus falls unincrusted, which is a prognostic of sharp frosts. Hail has been likewise observed perfectly transparent, and having the form of an oblate spheroid, showing that it consisted of drops which had been frozen entire in falling with a rotatory motion.

The forms assumed by the suspended water in the interval between the first precipitation and the descent of rain, afford a copious field of observation. These are not, as might be hastily supposed, the sport of winds, changing with every movement of the containing medium. Indeed the atmosphere, at the height where clouds usually appear, is undisturbed by the various obstacles which throw it into contending streams and eddies near the surface of the earth, and flows in a more direct and even current. Accordingly, the particles of water which it contains are allowed to assume a certain arrangement; and constitute a form, which is often equally well defined at a distance with that of solids, although, were we to penetrate it, we should perceive only the grey mist.

These forms have lately been discovered to be subject to certain laws in their production, their action on each other, and their resolution into rain. The visible course of these has been traced and described; and the antient mode of drawing prognostics seems in consequence likely to be restored, with the advantage of a nomenclature, by which the learned may reason on a subject hitherto, for want of terms, in a manner incommunicable, and confined to the adepts of experience. Before the nomenclature, it will be proper to exhibit the general principles on which its author proceeds in his explanation of the facts.

Evaporation is not a process of solution in air, neither is it probable that the water is decomposed by it. It is the same procession in the great scale of nature, as in a small quantity of water placed over the fire. Vapour is formed and diffused in all directions from its source with a force proportioned to the temperature of the water, and subject to the opposing force of the vapour already in the air.

The vapour thus emitted may be decomposed in different ways; as, 1. Immediately on its passing into the atmosphere, producing a fog or mist. 2. After having mounted through the warm air, near the earth, on its arrival in a higher and colder region, in which case dense clouds are there formed. 3. After having been uniformly mixed with the mass of the atmosphere, and perhaps travelled with it to a great distance from its source; in this case it either falls in dew, or is collected into sheets or horizontal beds during a slower subsidence; or lastly, it becomes a conductor to the electricity, if the equilibrium of the latter is disturbed; and indicates by its arrangement in threads, the usual effects of that fluid on light bodies.

In every case, the caloric which constituted the vapour decomposed, appears to pass into the atmosphere, which hence becomes often sensibly warmer just before rain; and on the other hand, the evaporation of the water suspended in the air, robs it of so much as to become sensible to our feelings in its comparative coldness.

The predisposing causes of these changes near the earth are probably to be found in the state of the superior currents, which undoubtedly both impart and carry off great quantities of vapour; but this part of the subject is at present imperfectly provided with such observations as might serve for data to our reasoning.

There are three simple and distinct modifications, in any one of which the aggregate of minute drops, called a cloud, may be formed, increase to its greatest extent, and finally decrease and disappear.

By modification is to be understood simply the structure or manner of aggregation, not the precise form or magnitude, which indeed varies every moment in most clouds. The principal modifications are commonly as distinguishable from each other as a tree from a hill, or the latter from a lake; although clouds in the same modification, considered with respect to each other, have often only the common resemblances which exist among trees, hills, or lakes, taken generally.

The same aggregate, which has been formed in one modification, upon a change in the attendant circumstances may pass into another.

Or it may continue a considerable time in an intermediate state, partaking of the characters of two modifications; and it may also disappear in this stage, or return to the first modification. Lastly, aggregates, separately formed in different modifications, may unite and pass into one, exhibiting different characters in different parts; or a portion of a simple aggregate may pass into another modification, without separating from the remainder of the mass. Hence, together with the simple, it becomes necessary to admit intermediate and compound modifications, and to impose names on such of them as are worthy of notice.

The simple modifications are thus named and defined: (See Plate Meteorology.)

1. *Cirrus.* Def. Nubes cirrata, tenuissima, quæ undique crescat.

Parallel, flexuous, or diverging fibres, extensible in any or in all directions.

2. *Cumulus.* Def. Nubes cumulata, densa, sursum crescens.

Convex or conical heaps, increasing upward from a horizontal base.

3. *Stratus.* Def. Nubes strata, aquæ modo expansa, deorsum crescens.

A widely extended, continuous, horizontal sheet, increasing from below.

The intermediate modifications which require to be noticed are:

4. *Cirro-cumulus.* Def. Nubeculæ densiores, subrotundæ, et quasi in agmine appositæ.

Small, well defined, roundish masses, in close horizontal arrangement.

5. *Cirro-stratus.* Def. Nubes extenuata, subconcava vel undulata. Nubeculæ hujusmodi appositæ.

Horizontal or slightly inclined masses, attenuated towards a part or the whole of their circumference, concave downward; or undulated, separate, or in groups, consisting of small clounds, having these characters.

The compound modifications are:

6. *Cumulo-stratus.* Def. Nubes densa, basim cumuli cum structura patente exhibens.

A dense cloud with the base of the cumulus, but in its upper part extended into a broad flat structure.

7. *Cumulo-cirro-stratus, vel nimbus.* Def. Nubes vel nubium congeries pluviam effundens.

The rain cloud. A cloud, or system of clouds, from which rain is falling. It is a horizontal sheet, above which the cirrus spreads, while the cumulus enters it laterally, and from beneath.

Of the cirrus.

Clouds in this modification have the least density, the greatest elevation, and the greatest variety of extent and direction. They are the earliest appearance after serene weather. They are first indicated by a few threads pencilled, as it were, on the sky. These increase in length, and new ones are in the mean time added laterally. Often the first-formed threads serve as stems to support numerous branches, which in their turn give rise to others. The process may be compared either to vegetation or to crystallisation; but it is clearly analogous to the delicate arrangements which ensue in the particles of coloured powders, such as chalk, vermilion, &c. when these are projected on a cake of wax, after it has been touched with the knob of a charged Leyden phial. We may consider the particles of water as similarly placed upon or beneath a plate of charged air.

Their duration is uncertain, varying from a few minutes after the first appearance to an extent of many hours. It is long when they appear alone, and at great heights, and shorter when they are formed lower, and in the vicinity of other clouds.

This modification, although in appearance almost motionless, is intimately connected with the variable motions of the atmosphere. Considering that clouds of this kind have long been deemed a prognostic of wind, it is extraordinary that the nature of this connection should not have been more studied, as the knowledge of it might have been productive of useful results.

In fair weather, with light variable breezes, the sky is seldom quite clear of small groups of the oblique cirrus, which frequently come on from the leeward, and the direction of their increase is to windward. Continued wet weather is attended with horizontal sheets of this cloud, which subside quickly, and pass to the cirro-stratus. The cirrus pointing upward is a distant indication of rain, and downward a more immediate one of fair weather. Before storms they appear lower and denser, and usually in the quarter opposite to that from which the storm arises. Steady high winds are also preceded and attended by streaks running quite across the sky in the direction they blow in. These, by an optical deception, appear to meet in the horizon.

The relations of this modification with the state of the barometer, thermometer, hygrometer, and electrometer, have not yet been attended to.

Of the cumulus.

Clouds in this modification are commonly of the most dense structure. They are formed in the lower atmosphere, and move along with the current which is next the earth.

A small irregular spot first appears, and is as it were the nucleus on which they increase. The lower surface continues irregularly plane, while the upper rises into conical or hemispherical heaps.

Their appearance, increase, and disappearance, in fair weather, are often periodical, and keep pace with the temperature of the day. Thus they begin to form some hours after sunrise, arrive at their maximum in the hottest part of the afternoon, then go on diminishing, and totally disperse about sunset.

But in changeable weather they partake of the vicissitudes of the atmosphere; sometimes evaporating almost as soon as formed, at others suddenly forming, and as quickly passing to the compound modifications.

The cumulus of fair weather has a moderate elevation and extent, and a well-defined rounded surface. Previous to rain it increases more rapidly, appears lower in the atmosphere, and with its surface full of loose fleeces or protuberances.

The formation of large cumuli to leeward in a strong wind, indicates the approach of a calm with rain. When they do not disappear or subside about sunset, but continue to rise, thunder is to be expected in the night.

Independantly of the beauty and magnificence it adds to the face of nature, the cumulus serves to screen the earth from the direct rays of the sun; by its multiplied reflections to diffuse, and, as it were, economise the light; and also to convey the product of evaporation to a distance from the place of its origin. The relations of the cumulus, with the state of the barometer, &c. have not yet been enough attended to.

It appears that there is a continual evaporation from the base of this cloud, in consequence of its tendency to subside into lower and warmer air. This evaporation is more than compensated during its increase by the deposition from above: while the two effects balance each other, the cloud remains stationary as to bulk; when the supply from above fails, it sinks into the lower air, and totally disappears. This happens usually a little before sunset, because the inequality in the temperatures of the higher and lower air, by virtue of which it subsisted, gives place at that time to the tendency to equal diffusion of the caloric.

Of the stratus.

This modification has a mean degree of density. It is the lowest of clouds, since its inferior surface commonly rests on the earth or water.

Contrary to the last, which may be considered as belonging to the day, this is properly the cloud of night; the time of its first appearance being about sunset. It comprehends all those creeping mists which in calm evenings ascend in spreading sheets, like an inundation of water, from the bottom of valleys, and the surface of lakes, rivers, &c. Its duration is frequently through the night.

On the return of the sun, the level surface of this cloud begins to put on the appearance of cumulus, the whole at the same time separating from the ground. The continuity is next destroyed, and the cloud ascends and evaporates, or passes off with the appearance of the nascent cumulus.

This has been long experienced as a prognostic of fair weather;

> At nebulæ magis ima petunt, campoque recumbunt:—Virgil. Georg. lib. i.

and, indeed, there is none more serene than that which is ushered in by it. The relation of the stratus to the state of the atmosphere as indicated by the barometer, &c. appears, notwithstanding, to have passed hitherto without due attention.

Of the cirro-cumulus.

The cirrus having continued for some time increasing, or stationary, usually passes either to the cirro-cumulus, or the cirro-stratus; at the same time descending to a lower station in the atmosphere.

The cirro-cumulus is formed from a cirrus, or from a number of small separate cirri, by the fibres collapsing, as it were, and passing into small roundish masses, in which the texture of the cirrus is no longer discernible, although they still retain somewhat of the same relative arrangement. This change takes place, either throughout the whole mass at once, or progressively from one extremity to the other. In either case, the same effect is produced on a number of adjacent cirri at the same time, and in the same order. It appears in some instances to be accelerated by the approach of other clouds; and is probably due to the equilibrium of the electric fluid between the cloud and the surrounding atmosphere.

This modification forms a very beautiful sky, sometimes exhibiting numerous distinct beds of these small connected clouds floating at different altitudes.

The cirro-cumulus is frequent in summer, and is attendant on warm and dry weather. It is also occasionally, and more sparingly, seen in the intervals of showers, and in winter. This cloud is a sure prognostic of increased temperature. It may either evaporate, or pass to the cirrus or cirro-stratus.

Of the cirro-stratus.

This cloud appears to result from the subsidence of the fibres of the cirrus to a horizontal position, at the same time that they approach towards each other laterally. The form and relative position, when seen in the distance, frequently give the idea of shoals of fish. Yet in this, as in other instances, the structure must be attended to, rather than the form, which varies much; presenting at other times the appearance of parallel bars, interwoven streaks like the grain of polished wood, &c. It is always thickest in the middle, or at one extremity, and extenuated towards the edge. The distinct appearance of a cirrus does not always precede the production of this and the last modifications.

The cirro-stratus precedes wind and rain, the near or distant approach of which may sometimes be estimated from its greater or less abundance and permanence. It is almost always to be seen in the intervals of storms. Sometimes this and the cirro-cumulus appear together in the sky, and even alternate with each other in the same cloud, when the different evolutions which ensue are a curious spectacle; and a judgment may be formed of the weather likely to ensue, by observing which modification prevails at last. The cirro-stratus is the modification which most frequently and completely exhibits the phenomena of the solar and lunar halo, and (as supposed from a few observations) the parhelion and paraselene also. Hence the reason of the prognostic for foul weather commonly drawn from the appearance of halo. This cloud is among those natural indications which may be trusted in confirmation of the indications of the barometer and hydrometer for rain. It may be reasonably thought to originate from a supervening cold and moist current, occasioning precipitation in the atmosphere below, before it is itself to be perceived. Its appearance often indicates the simple act of subsidence, as in common cases of precipitation in fluids at rest.

Of the cumulo-stratus.

The different modifications which have been just treated of, sometimes give place to each other: at other times two or more appear in the same sky; but in this case the clouds in the same modification lie mostly in the same plane of elevation, those which are more elevated appearing through the intervals of the lower, or the latter shewing dark against the lighter ones above them. When the cumulus increases rapidly, a cirro-stratus is frequently seen to form around its summit, reposing thereon as on a mountain; while the former cloud continues discernible in some degree through it. This state continues but a short time. The cirro-stratus speedily becomes denser, and spreads; while the superior part of the cumulus extends itself, and passes into it, the base continuing as before, and the convex protuberances changing their position till they present themselves laterally and downward. More rarely the cumulus alone performs this evolution, by the movement or mode of increase of its superior part.

In either case, a large lofty dense cloud is formed, which may be compared to a mushroom with a very thick short stem. But when a whole sky is crowded with this modification, the appearances are more indistinct. The cumulus rises through the interstices of the superior clouds; and the whole, seen as it passes off in the distant horizon, presents to the fancy mountains covered with snow, intersected with dark ridges and lakes of water, rocks and towers, &c. The distinct cumulo-stratus is formed in the interval between the first appearance of the fleecy cumulus and the commencement of rain; also during the approach of thunder-storms. The indistinct appearance of it is chiefly in the longer or shorter interval of showers of rain, snow, or hail.

The cumulo-stratus chiefly affects a mean state of the atmosphere, as to pressure and temperature, but is not peculiar to any season; and it may be seen before a fall of snow, as well as before a thunder-storm.

Of the nimbus, or cumulo-cirro-stratus.

Clouds in any one of the preceding modifications, at the same degree of elevation, or two or more of them, at different elevations, may increase so as completely to obscure the sky, and at times put on an appearance of density, which to the inexperienced observer indicates the speedy commencement of rain. It is nevertheless extremely probable, as well from attentive observation, as from a consideration of the several modes of their production, that the clouds, while in any one of these states, do not at any time let fall rain.

Before this effect takes place, they have been uniformly found to undergo a change, attended with appearances sufficiently remarkable to constitute a distinct modification. These appearances, when the rain happens over our heads, are but imperfectly seen. We can then only observe, before the arrival of the denser and lower clouds, or through their interstices, that there exists at a greater altitude a thin light veil, or at least a hazy turbidness. When this has considerably increased, we see the lower clouds spread themselves till they unite in all points, and form one uniform sheet. The rain then commences; and the lower clouds, arriving from the windward, move under this sheet, and are successively lost in it. When the latter cease to arrive, or when the sheet breaks, every one's experience teaches him to expect an abatement or cessation of rain. But there often follows, what seems hitherto to have been unnoticed, an immediate and great addition to the quantity of cloud. For on the cessation of rain, the lower broken clouds which remain rise into cumuli, and the superior sheet puts on the various forms of the cirro-stratus, sometimes passing to the cirro-cumulus.

If the interval is long before the next shower, the cumulo stratus usually makes its appearance, which it also does sometimes very suddenly after the first cessation.

But we see the nature of this process more perfectly, in viewing a distant shower in profile.

If the cumulus be the only cloud present at such a time, we may observe its superior part to become tufted with cirri. Several adjacent clouds also approach, and unite laterally by subsidence.

The cirri increase, extending themselves upward and laterally; after which the shower is seen to commence. At other times the converse takes place of what has been described relative to the cessation of rain. The cirro-stratus is previously formed above the cumulus; and their sudden union is attended with the production of cirri and rain.

In either case the cirri vegetate, as it were, in proportion to the quantity of rain falling; and give the cloud a character by which it is easily known at great distances, and to which, in the language of meteorology, we may appropriate the *nimbus* of the Latins:

> Qualis ubi ad terras abrupto sidere nimbus
> It mare per medium; miseris, heu! prescia longè
> Horrescunt corda agricolis.—Virgil.

When one of these arrives hastily with the wind, it brings but little rain, and frequently some hail or driven snow. In heavy showers the central sheet, once formed, increases to windward, the cirri being propagated above and against the lower current, while the cumuli, arriving with the latter, are successively arrested in their course, and contribute to reinforce the shower.

In continued gentle rains it does not appear necessary, for the resolution of the clouds, that the different modifications should come into actual contact. It is sufficient, that there exist two strata of clouds, one passing beneath the other, and each continually tending to horizontal uniform diffusion. It will rain during this state of the two strata, although they should be separated by an interval of many hundred feet in elevation.

As the masses of cloud are always blended, and their arrangement destroyed, before rain comes on, so the reappearance of those is the signal for its cessation. The thin sheets of cloud which pass over during a wet day, certainly receive from the humid atmosphere a supply proportionate to their consumption; while the latter prevents their increase in bulk Hence a seeming paradox, which yet accords strictly with observation; that for any given hour of a wet day, or any given day of a wet season, the more cloud the less rain. Hence also arise some further reflections on the purpose answered by clouds in the economy of nature. Since rain may be produced by, and continue to fall from, the slightest obscuration of the sky, by the nimbus, that is, by two sheets in different states, while the cumulus, or cumulo-stratus, with the most dark and threatening aspect, passes over without letting fall a drop, until their change of state commences; it should seem that the latter are the reservoirs, in which the water is collected from a large space of atmosphere, for occasional and local irrigation in dry seasons, and by means of which it is also arrested at times in its descent, in the midst of wet ones. In this so evident provision for the sustenance of all animal and vegetable life, as well as for the success of mankind in that pursuit so essential to their welfare, in temperate climates, of cultivating the earth, we may discover the wisdom and goodness of the Creator and Preserver of all things.

The nimbus, although in itself one of the least beautiful clouds, is yet now and then superbly decorated with its attendant, the rainbow, which can only be seen in perfection when backed by the widely extended uniform gloom of this modification.

METHOD, in logic, &c. the arrangement of our ideas in such a regular order, that their mutual connection and dependance may be readily comprehended.

METONYMY, in rhetoric, is a trope in which one name is put for another, on account of the near relation there is between them. By this trope any of the most significant circumstances of a thing are put for the thing itself. See RHETORIC.

METOPE. See ARCHITECTURE.

METRE, in poetry. See HEXAMETER, PENTAMETER, &c.

METROSIDEROS, a genus of the class and order icosandria monogynia. The calyx is five-cleft, half-superior; petals five; stamina very long, standing out; stigma simple; capsule three-celled. There are 13 species, of New Holland, &c.

MEZEREON. See DAPHNE.

MEZZOTINTO. See ENGRAVING.

MIASMA, among physicians, denotes the contagious effluvia of pestilential diseases, whereby they are communicated to people at a distance.

MICA. This stone forms an essential part of many mountains, and has been long known under the names of glacies Mariæ, and Muscovy glass. It consists of a great number of thin laminæ adhering to each other, sometimes of a very large size. Specimens have been found in Siberia nearly $2\frac{1}{2}$ yards square.

It is sometimes crystallized; its primitive form is a rectangular prism, whose bases are rhombs with angles of 120° and 60°: its integrant molecule has the same form. Sometimes it occurs in rectangular prisms, whose bases also are rectangles, and sometimes also in short six-sided prisms; but it is much more frequent in plates or scales of no determinate figure or size.

Its texture is foliated. Its fragments flat. The lamellæ flexible, and somewhat elastic. Very tough. Often absorbs water. Specific gravity from 2.6546 to 2.9342. Feels smooth, but not greasy. Powder feels greasy. Colour, when purest, silver white or grey; but it occurs also yellow, greenish, reddish brown, and black. Mica is fusible by the blowpipe into a white, grey, green, or black enamel; and this last is attracted by the magnet. Spanish wax rubbed by it becomes negatively electric.

A specimen of mica, analysed by Vauquelin, contained

50.00	silica
35.00	alumina
7.00	oxide of iron
1.35	magnesia
1.33	lime.
94.68	

Mica has long been employed as a substitute for glass. A great quantity of it is said to be used in the Russian marine for panes to the cabin-windows of ships; it is preferred, because it is not so liable as glass to be broken by the agitation of the ship. It is also used in our navy for lantherns, for the use of the powder-rooms.

MICHELIA, a genus of the octandria polygynia class of plants, the flower of which consists of eight petals; the fruit consists of a number of globose unilocular berries, disposed in a cluster; in each of which there are four seeds, convex on one side, and angular on the other. There are two species, trees of the East Indies.

MICHAUXIA, a genus of the class and order octandria monogynia. The calyx is 16-parted; corolla wheel-shaped, 8-parted; nect. 8-valved, staminiferous; caps. 8-celled, many-seeded. There is one species, a biennial of Aleppo, resembling the campanula.

MICROMETER, an astronomical machine, which, by means of a screw, serves to measure extremely small distances in the heavens, &c. and that to a great degree of accuracy.

The micrometer consists of a graduated circle (Plate Miscel. fig. 162), of a screw $q\,o$, and its index $q\,r$. The threads of the screw are such, that 50 make the length of one inch exactly. When it is to be used, the point o is set to the side of the part to be measured, and then the index is turned about with the finger, till the eye perceives the point has just passed over the diameter of that part; then the number of turns, and parts of a turn, shewn by the graduated circle, will give the dimensions in parts of an inch, as we shall shew by the following example: Suppose it is required to measure the diameter of a human hair, and I observe the index is turned just once round while the point o passes over it; then it is plain the diameter of the hair in the image is $\frac{1}{50}$th of an inch. Now if the microscope, I D E F, $d\,e\,f$, magnifies 6 times, or makes the image 6 times larger in diameter than the object, then is the diameter of the hair itself but $\frac{1}{6}$th of $\frac{1}{50}$, that is, but $\frac{1}{300}$th, part of an inch.

Also it is to be observed, that as there are ten large divisions, and twenty small ones, on the micrometer plate, so each of those small divisions is the $\frac{1}{20}$th of $\frac{1}{50}$th, or the $\frac{1}{1000}$th part of an inch. Therefore, if, in measuring any part of an object, you observe how many of these smaller divisions are passed over by the index, you will have so many thousandth parts of an inch for the measure required.

ilium. CC, the acetabula. DD, the ossa ischium. E, the coccyx. F, the lower part of the rectum. GG, the vagina. H, the os internum stretched open about a finger breadth, with the membranes and waters in time of labour-pains. II, the inferior part of the uterus, stretched with the waters which are below the head of the child that presents. KK, the two placentas adhering to the posterior part of the uterus, the two fœtuses lying before them, one with its head in a proper position at the inferior part of the uterus, and the other situated preternaturally with the head to the fundus; the bodies of both are here entangled in their proper funis, which frequently happens in the natural as well as preternatural positions. LLL, the membranes belonging to each placenta.

Fig. 6. exhibits, in a lateral view and longitudinal division of the parts, the gravid uterus when labour is somewhat advanced. A, the lowest vertebra of the back; the distance from which to the last-mentioned vertebra is here shewn by dotted lines. CC, the usual thickness and figure of the uterus when extended by the waters at the latter part of pregnancy. D, the same contracted and grown thicker after the waters are evacuated. EE, the figure of the uterus when pendulous. FF, the figure of the uterus when stretched higher than usual, which generally occasions vomitings and difficulty of breathing. G, the os pubis of the left side. HH, the os internum. I, the vagina. K, the left nympha. L, the labium pudendi of the same side. M, the remaining portion of the bladder. N, the anus. OP, the left hip and thigh.

Fig. 7. exhibits the forehead of the fœtus turned backwards to the os sacrum, and the occiput below the pubes; by which means the narrow part of the head is to the narrow part of the pelvis, that is, between the inferior parts of the ossa ischium. A, the uterus contracted closely to the fœtus after the waters are evacuated. BCD, the vertebræ of the loins, os sacrum, and coccyx. E, the anus. F, the left hip. G, the perinæum. H, the os externum beginning to dilate. I, the os pubis of the left side. K, the remaining portion of the bladder. L, the posterior part of the os uteri.

Fig. 8. presents a lateral internal view of a distorted pelvis, divided longitudinally, with the head of a fœtus of the seventh month passing the same. ABC, the os sacrum and coccyx. D, the os pubis of the left side. E, the tuberosity of the os ischium of the same side.

Fig. 9. presents a side view of a distorted pelvis, divided longitudinally, with the head of a full-grown fœtus squeezed into the brim, the parietal bones decussating each other, and compressed into a conical form. ABC, the os sacrum and coccyx. D, the os pubis of the left side. E, the tuberosity of the os ischium. F, the processus acutus. G, the foramen magnum.

Fig. 10. shews in what manner the head of the fœtus is helped along with the forceps, when it is necessary for the safety of either mother or child. A,A,B,C, the vertebræ of the loins, the os sacrum, and coccyx. D, the os pubis of the left side. E, part of the bladder. FF, the intestinum rectum. GGG, the uterus. H, the mons Veneris. I, the clitoris with the left nympha. X, the corpus cavernosum clitoridis. V, the meatus urinarius. K, the left labium pudendi. L, the anus. N, the perinæum. QP, the left hip and thigh. R, the skin and muscular part of the loins.

Fig. 11. shews in a lateral view the face of the child, forced down into the lower part of the pelvis, the chin below the pubes, and the vertex in the cavity of the os sacrum; the waters being all discharged, the uterus appears closely attached to the body of the child.

Fig. 12. shews the head of the child in the same position as the eleventh figure. AB, the vertebræ of the loins, os sacrum, and coccyx. C, the os pubis of the left side. D, the lower part of the rectum. E, the perinæum. F, the left labium pudendi. GGG, the uterus.

Fig. 13. shews the head of the fœtus, by strong labour-pains, squeezed into a longish form, with a tumour on the vertex, from long compression of the head in the pelvis. K, the tumour on the vertex. L, the forceps. M, the urinary bladder much distended with a large quantity of urine, from the long pressure of the head against the urethra. N, the under part of the uterus. OO, the os uteri.

Fig. 14. exhibits a front view of the pelvis, the breech of the fœtus presenting, and dilating the os internum, the membranes having been prematurely ruptured.

Fig. 15. represents in a front view of the pelvis, the fœtus compressed by the contraction of the uterus into a round form, the fore parts of the former being towards the inferior part of the latter, and one foot and hand fallen down into the vagina. In this figure, the anterior part of the pelvis is removed by a longitudinal section, through the middle of the foramen magnum. AA, the superior portion of the ossa ilium. BB, the uterus. C, the mouth of the uterus shooting and appearing in OOOO the vagina. D, the inferior and posterior part of the os externum. EEEE, the remaining parts of the ossa pubis and ischium. FFF, the adipose membrane.

Fig. 16. represents the forceps and blunt hook. *a*, the straight forceps. *b*, the posterior part of a single blade. *c*, the blunt hook; which is employed to assist the extraction of the head after the cranium is opened, by introducing the small end along the ear on the outside of the head, to above the under jaw, where the point is to be fixed; the other extremity of the hook being held with one hand, while two fingers of the other are to be introduced into the opening. The small end is useful in abortions, to draw down the secundines when they are not expelled by labour-pains, or cannot be extracted by the fingers. The large hook at the opposite end is useful to assist the extraction of the body when the breech presents, but should be used with much caution.

Fig. 17. A represents the whole bone fillet, which, when the operator is not provided with forceps, may sometimes be useful in laborious cases. BB, two views of a pessary for the prolapsus uteri. C, a round pessary which is in more general use than the former. DD, two views of a female catheter.

Fig. 18. *a*, represents a pair of curved crotchets, locked in the same manner as the forceps: the dotted lines indicate a sheath, contrived to defend the point till it is introduced sufficiently high. *b*, gives a view of the back part of one of the crotchets. *c*, a front view of the point. *d*, the scissars for perforating the cranium, in very narrow and distorted pelvises.

MIGRATION, *of birds.* It has been generally believed, that many different kinds of birds annually pass from one country to another, and spend the summer or the winter where it is most agreeable to them; and that even the birds of our own island will seek the most distant southern regions of Africa, when directed by a peculiar instinct to leave their own country. It has long been an opinion pretty generally received, that swallows reside during the winter season in the warm southern regions; and Mr. Adanson particularly relates his having seen them at Senegal, when they were obliged to leave this country. But besides the swallow, Mr. Pennant enumerates many other birds which migrate from Britain at different times of the year, and are then to be found in other countries; after which they again leave these countries, and return to Britain.

1. Crows. Of this genus, the hooded crow migrates regularly with the woodcock. It inhabits North Britain the whole year: a few are said annually to breed on Dartmoor, in Devonshire. It breeds also in Sweden and Austria; in some of the Swedish provinces it only shifts its quarters, in others it resides throughout the year. Our author is at a loss for the summer retreat of those birds which visit us in such numbers in winter, and quit our country in the spring; and for the reason why a bird whose food is such that it may be found at all seasons in this country, should leave us.

2. Cuckoo, disappears early in autumn; the retreat of this and the following bird is quite unknown to us.

3. Wryneck, is a bird that leaves us in the winter. If its diet is ants alone, as several assert, the cause of its migration is very evident. This bird disappears before winter, and revisits us in the spring, a little earlier than the cuckoo.

4. Hoopoe. Comes to England but by accident. Mr. Pennant once indeed heard of a pair that attempted to make their nest in a meadow at Selborne, Hampshire, but were frightened away by the curiosity of people. It breeds in Germany.

5. Grouse. The whole tribe, except the quail, live here all the year round; that bird either leaves us, or else retires towards the sea-coasts.

6. Pigeons. Some few of the ring-doves breed here; but the multitude that appear in winter are so disproportioned to what continue here the whole year, as to make it certain that the greatest part quit the country in the spring. It is most probable they go to Sweden to breed, and return thence in autumn: as Mr. Ekmark informs us, they entirely quit that country before winter. Multitudes of the common wild pigeons also make the northern retreat, and visit us in winter; though numbers breed in the high cliffs in all parts of this island. The turtle also probably leaves us in the winter, at least changes its place, removing to the southern counties.

7. Stare, breeds here. Possibly several remove to other countries for that purpose, since the produce of those that continue

here seems unequal to the clouds of them that appear in winter. It is not unlikely that many migrate into Sweden, whither Mr. Berger observes they return in spring.

8. Thrushes. The fieldfare and the redwing breed pass their summers in Norway and other cold countries; their food is berries, which abounding in our kingdoms tempt them hither in the winter. These two, and the Royston crow, are the only land birds that regularly and constantly migrate into England, and do not breed here. The hawfinch and crossbill come hither at such uncertain times as not to deserve the name of birds of passage.

9. Chatterer. The chatterer appears annually about Edinburgh in flocks during winter, and feeds on the berries of the mountain-ash. In South Britain it is an accidental visitant.

10. Grosbeaks. The grosbeak and crossbill come hither but seldom; they breed in Austria. The pine grosbeak probably breeds in the forests of the Highlands of Scotland.

11. Buntings. All the genus inhabit England throughout the year, except the greater brambling, which is forced hither from the north in very severe seasons.

12. Finches. All continue in some part of these kingdoms, except the siskin, which is an irregular visitant, said to come from Russia. The linnets shift their quarters, breeding in one part of this island, and remove with their young to others. All finches feed on the seeds of plants.

13. Larks, fly-catchers, wagtails, and warblers. All these birds feed on insects and worms; yet only part of them quit these kingdoms, though the reason of migration is the same to all. The nightingale, black-cap, fly-catcher, willow-wren, wheatear, and white-throat, leave us before winter, while the small and delicate golden-crested wren braves our severest frosts. The migrants of this genus continue longest in Great Britain in the southern counties, the winter in those parts being later than in those of the north; Mr. Stillingfleet having observed several wheatears in the isle of Purbeck on the 18th of November. As these birds are incapable of very distant flights, Spain, or the south of France, is probably their winter asylum.

14. Swallow and goat-sucker. Every species disappears at the approach of winter.

Water-Fowl, cloven-footed.

15. Herons. The white heron is an uncommon bird, and visits us at uncertain seasons; the common kind and the bittern never leave us.

16. Curlews. The curlew breeds sometimes on our mountains; but, considering the vast flights that appear in winter, it is probable that the greater part retire to other countries; the whimbrel breeds on the Grampian hills, in the neighbourhood of Invercauld.

17. Snipes. The woodcock breeds in the moist woods of Sweden, and other cold countries. Some snipes breed here; but the greatest part retire elsewhere, as do every other species of this genus.

18. Sandpipers. The lapwing continues here the whole year; the ruff breeds here, but retires in winter; the redshank and sandpiper breed in this country, and reside here. All the others absent themselves during summer.

19. Plovers and oyster-catchers. The long-legged plover and the sanderling visit us only in winter: the dottrel appears in spring and in autumn; yet, what is very singular, we do not find it breeds in South Britain. The oyster-catcher lives with us the whole year. The Norfolk plover and the sea-lark breed in England. The green plover breeds on the mountains of the north of England, and on the Grampian hills.

We must here remark, that every species of the genera of curlews, woodcocks, sandpipers, and plovers, that forsake us in the spring, retire to Sweden, Poland, Prussia, Norway, and Lapland, to breed; as soon as the young can fly, they return to us again, because the frosts which set in early in those countries totally deprive them of the means of subsisting; as the dryness and hardness of the ground, in general, during our summer, prevent them from penetrating the earth with their bills, in search of worms, which are the natural food of these birds.

20. Rails and gallinules. Every species of these two genera continue with us the whole year; the land-rail excepted, which is not seen here in winter. It likewise continues in Ireland only during the summer-months, when it is very numerous.

Finned-footed Water-birds.

21. Phalaropes visit us but seldom; their breeding-place is Lapland and other arctic regions.

22. Grebes. The great-crested grebe, the black and white grebe, and little grebe, breed with us, and never migrate; the others visit us accidentally, and breed in Lapland.

Web-footed Birds.

23. Avoset. Breed near Fossdike in Lincolnshire, but quit their quarters in winter. They are then shot in different parts of the kingdom; which they visit not regularly, but accidentally.

24. Auks and guillemots. The great auk or pinguin sometimes breeds in St. Kilda. The auk, the guillemot, and puffin, inhabit most of the maritime cliffs of Great Britain, in amazing numbers, during summer. The black guillemot breeds in the Bass Isle, and in St. Kilda, and sometimes in Llandinno rocks. We are at a loss for the breeding-place of the other species; neither can we be very certain of the winter residence of any of them, except of the lesser guillemot and black-billed auk, which, during winter, visit in vast flocks the frith of Forth.

25. Divers, chiefly breed in the lakes of Sweden and Lapland, and in some countries near the pole; but some of the red-throated divers, the northern, and the imber, may breed in the north of Scotland and its isles.

26. Terns. Every species breeds here, but leaves us in the winter.

27. Petrels. The fulmar breeds in the isle of St. Kilda, and continues there the whole year except September and part of October. The shearwater visits the Isle of Man in April; breeds there; and, leaving it in August or the beginning of September, disperses over all parts of the Atlantic ocean. The stormfinch is seen at all distances from land on the same vast watery tract; nor is ever found near the shore except by some very rare accident, unless in the breeding-season. Mr. Pennant found it on some little rocky isles, off the north of Skye. It also breeds in St. Kilda. He suspects too that it nestles on the Blasquet isles off Kerry, and that it is the gourder of Mr. Smith.

28. Mergansers. This whole genus is mentioned among the birds that fill the Lapland lakes during summer. Mr. Pennant has seen the young of the red-breasted in the north of Scotland; a few of these, and perhaps of the goosanders, may breed there.

29. Ducks. Of the numerous species that form this genus, we know of few that breed here; the swan and goose, the shield-duck, the eider-duck, a few shovellers, garganies, and teals, and a very small portion of the wild ducks.

The rest contribute to form that amazing multitude of water-fowl that annually repair from most parts of Europe to the woods and lakes of Lapland and other arctic regions, there to perform the functions of incubation and nutrition in full security. They and their young quit their retreat in September, and disperse themselves over Europe. With us they make their appearance the beginning of October; circulate first round our shores; and, when compelled by severe frost, betake themselves to our lakes and rivers. Of the web-footed fowl there are some of hardier constitutions than others; these endure the ordinary winters of the more northern countries; but when the cold reigns there with more than common rigour, they repair for shelter to these kingdoms: this regulates the appearance of some of the diver kind, as also of the wild swans, the swallow-tailed shield-duck, and the different sorts of goosanders which then visit our coasts. Barentz found the barnacles with their nests in great numbers in Nova Zembla.

30. Corvorants. The corvorant and shag breed on most of our high rocks: the gannet in some of the Scotch isles, and on the coast of Kerry; the two first continue on our shores the whole year. The gannet disperses itself all round the seas of Great Britain, in pursuit of the herring and pilchard, and even as far as the Tagus to prey on the sardina.

MILE, a measure of length or distance, containing eight furlongs.

The English statute-mile is fourscore chains, or 1760 yards; that is, 5280 feet. See Chain, Yard, and Foot.

We shall here give a table of the miles in use among the principal nations of Europe, in geometrical paces, 60,000 of which make a degree of the equator.

	Geometrical paces.
Mile of Russia	750
of Italy	1000
of England	1250
of Scotland and Ireland	1500
of Poland	3000
of Spain	3428
of Germany	4000
of Sweden	5000
of Denmark	5000
of Hungary	6000

MILIARY FEVER, a malignant fever, so called from the eruption of certain pustules resembling millet-seeds. See Medicine.

MILIUM, millet, a genus of the digynia order, in the triandria class of plants; and in the natural method ranking under the 4th order, gramina. The calyx is bivalved and uniflorous; the corolla is very short; the stigmata pencil-like. There are 12 species, of which the most remarkable is the effusum, or common millet.

MILK, is a fluid secreted by the female of all those animals denominated mammalia, and intended evidently for the nourishment of her offspring.

The milk of every animal has certain peculiarities which distinguish it from every other milk. But the animal whose milk is most made use of by man as an article of food, and with which, consequently, we are best acquainted, is the cow. Chemists, therefore, have made choice of cow's milk for their experiments.

Milk is an opaque fluid, of a white colour, a slight peculiar smell, and a pleasant sweetish taste. When newly drawn from the cow, it has a taste very different from that which it acquires after it has been kept for some hours.

It is liquid, and wets all those substances which can be moistened in water; but its consistence is greater than that of water, and it is slightly unctuous. Like water, it freezes when cooled down to about 30°; but Parmentier and Deyeux, to whom we are indebted for by far the completest account of milk hitherto published, found that its freezing-point varies considerably in the milk of different cows, and even of the same cow at different times. Milk boils also when sufficiently heated; but the same variation takes place in the boiling-point of different milks, though it never deviates very far from the boiling-point of water. Milk is specifically heavier than water, and lighter than blood; but the precise degree cannot be ascertained, because almost every particular milk has a specific gravity peculiar to itself.

When milk is allowed to remain for some time at rest, there collects on its surface a thick unctuous yellowish-coloured substance, known by the name of cream. The cream appears sooner on milk in summer than in winter, evidently owing to the difference of temperature. In summer, about four days of repose are necessary before the whole of the cream collects on the surface of the liquid; but in winter it requires at least double the time.

After the cream is separated, the milk which remains is much thinner than before, and it has a blueish-white colour. If it is heated to the temperature of 100°, and a little rennet (which is water digested with the inner coat of a calf's stomach, and preserved with salt) is poured into it, coagulation ensues; and if the coagulum is broken, the milk very soon separates into two substances; a solid white part known by the name of curd, and a fluid part called whey.

Thus we see that milk may be easily separated into three parts; namely, cream, curd, and whey.

1. Cream is of a yellow colour, and its consistence increases gradually by exposure to the atmosphere. In three or four days it becomes so thick that the vessel which contains it may be inverted without risking any loss. In eight or ten days more, its surface is covered over with mucors and byssi, and it has no longer the flavour of cream, but of very fat cheese. This is the process for making what in this country is called a cream-cheese.

Cream possesses many of the properties of an oil. It is specifically lighter than water; it has an unctuous feel; stains clothes precisely in the manner of oil; and if it is kept fluid, it contracts at last a taste which is very analogous to the rancidity of oils. When kept boiling for some time, a little oil makes its appearance, and floats upon its surface. Cream is neither soluble in alcohol nor in oils. These properties are sufficient to shew us, that it contains a quantity of oil; but this oil is combined with a part of the curd, and mixed with some serum; cream, then, is composed of a peculiar oil, curd, and serum. The oil may be easily obtained separate by agitating the cream for a considerable time. This process, known to every body, is called churning. After a certain time, the cream separates into two portions; one fluid, and resembling creamed milk; the other solid, and called butter.

Butter is of a yellow colour, possesses the properties of an oil, and mixes readily with other oily bodies. When heated to the temperature of 96°, it melts, and becomes transparent; if it is kept for some time melted, some curd and water, or whey, separates from it, and it assumes exactly the appearance of oil. But this process deprives it in a great measure of its peculiar flavour.

When butter is kept for a certain time, it becomes rancid, owing in a good measure to the presence of these foreign ingredients; for if butter is well-washed, and a great portion of these matters separated, it does not become rancid nearly so soon as when it is not treated in this manner. It was formerly supposed that this rancidity was owing to the developement of a peculiar acid; but Parmentier and Deyeux have shewn that no acid is present in rancid butter. When butter is distilled, there comes over water an acid, and an oil, at first fluid, but afterwards concrete. The carbonaceous residuum is but small.

Butter may be obtained by agitating cream newly taken from milk, or even by agitating milk newly drawn from the cow; but it is usual to allow cream to remain for some time before it is churned. Now cream, by standing, acquires a sour taste; butter, therefore, is commonly made from sour cream. Fresh cream requires at least four times as much churning before it yields its butter, as sour cream does; consequently cream acquires, by being kept for some time, new properties, in consequence of which it is more easily converted into butter. When very sour cream is churned, every one who has paid the smallest attention must have perceived, that the buttermilk, after the churning, is not nearly so sour as the cream had been. The butter, in all cases, is perfectly sweet; consequently the acid which had been evolved has in a great measure disappeared during the process of churning. It has been ascertained, that cream may be churned, and butter obtained, though the contact of atmospheric air should be excluded. On the other hand, it has been affirmed, that when cream is churned in contact with air, it absorbs a considerable quantity of it.

In all cases there is a considerable extrication of gas during the churning of butter. From the phenomena, it can scarcely be doubted that this gas is carbonic acid. Dr. Young affirms, that during the churning there is an increase of temperature amounting to four degrees.

These facts shew that considerable chemical changes go on during the process of churning. The agitation keeps the different substances in contact, and enables them to act upon each other. The expulsion of carbonic acid accounts for the diminution of acidity after churning; while the other phenomena would lead us to suppose that the cream, before it becomes butter, unites to a new portion of oxygen.

The affinity of the oil of cream for the other ingredients is such, that it never separates completely from them. Not only are curd and whey always found in the cream, but some of this oil is constantly found in creamed milk and whey; for it has been ascertained by actual experiment, that butter may be obtained by churning whey. 27 Scotch pints of whey yield at an average about a pound of butter. This accounts for a fact well known to those who superintend dairies, that a good deal more butter may be obtained from the same quantity of milk, provided it is churned as drawn from the cow, than when the cream alone is collected and churned.

The buttermilk, as Parmentier and Deyeux ascertained by experiment, possesses precisely the properties of milk deprived of cream.

2. Curd, which may be separated from creamed milk by rennet, has many of the properties of coagulated albumen. It is white and solid; and when all the moisture is squeezed out, it has a good deal of brittleness. It is insoluble in water; but pure alkalies and lime dissolve it readily, especially when assisted by heat; and when fixed alkali is used, a great quantity of ammonia is emitted during the solution. The solution of curd in soda is of a red colour, at least if heat is employed; owing probably to the separation of charcoal from the curd by the action of the alkali. Indeed, when a strong heat has been used, charcoal precipitates as the solution cools. The matter dissolved by the alkali may be separated from it by means of an acid; but it has lost all the properties of curd. It is of a black colour, melts like tallow by the application of heat, leaves oily stains on paper, and never acquires the consistence of curd. Hence it appears that curd, by the action of a fixed alkali, is decomposed, and converted into two new substances; ammonia, and oil or rather fat.

Curd is soluble also in acids. If, over curd newly precipitated from milk, and not dried, there are poured eight parts of water, containing as much of any of the mineral acids as gives it a sensibly acid taste, the whole is dissolved after a little boiling. Acetic acid and lactic acid do not dissolve curd, when very much diluted; but these acids, when concentrated, dissolve it readily, and in considerable quantity. It is remarkable enough, that concentrated vegetable acids dissolve curd readily, but have very little action on it when they are very much diluted; whereas the mineral acids dissolve it when much diluted; but when concentrated, have either very little effect on it, as sulphuric acid, or decompose it, as nitric acid. By means of this last acid, as Berthollet discovered, a quantity of azotic gas may be obtained from curd.

Curd, as is well known, is used in making cheese; and the cheese is the better the more it contains of cream, or of that oily matter which constitutes cream. It is well known to cheesemakers, that the goodness of it depends in a great measure on the manner of separating the whey from the curd. If the milk is much heated, the coagulum broken in pieces, and the whey forcibly separated, as is the practice in many parts of Scotland, the cheese is scarcely good for any thing; but the whey is delicious, especially the whey last squeezed out, and butter may be obtained from it in considerable quantity. This is a full proof that nearly the whole creamy part of the milk has been separated with the whey. Whereas if the milk is not too much heated (about 100 degrees is sufficient), if the coagulum is allowed to remain unbroken, and the whey separated by very slow and gentle pressure, the cheese is excellent; but the whey is almost transparent, and nearly colourless.

Good cheese melts at a moderate heat; but bad cheese, when heated, dries, curls, and exhibits all the phenomena of burning horn. Hence it is evident, that good cheese contains a quantity of the peculiar oil which constitutes the distinguishing characteristic of cream; whence its flavour and smell.

This resemblance of curd and albumen makes it probable that the coagulation of milk and albumen depends upon the same cause. Heat, indeed, does not coagulate milk, because the curd in it is diluted with too large a quantity of water; but if milk is boiled in contact with air, a pellicle soon forms on its surface, which has the properties of curd. If this pellicle is removed, another succeeds; and by continuing the boiling, the whole of the curdy matter may be separated from milk. When this pellicle is allowed to remain, it falls at last to the bottom of the vessel; where, being exposed to a greater heat, it becomes brown, and communicates to milk that disagreeable taste which, in this country, is called a *singed* taste. It happens more readily when milk is boiled along with rice, flour, &c.

If to boiling milk there is added as much of any neutral salt as it is capable of dissolving, or of sugar, or of gum arabic, the milk coagulates and the curd separates. Alcohol also coagulates milk; as do all acids, rennet, and the infusion of the flowers of artichoke and of the thistle. If milk is diluted with ten times its weight of water, it cannot be made to coagulate at all.

3. Whey, after being filtred to separate a quantity of curd which still continues to float through it, is a thin pellucid fluid, of a yellowish-green colour and pleasant sweetish taste, in which the flavour of milk may be distinguished. It always contains some curd: nearly the whole may be separated by keeping the whey for some time boiling; a thick white scum gathers on the surface, which is known by the name of skim-curd. When this scum, which consists of the curdy part, is carefully separated, the whey, after being allowed to remain at rest for some hours, to give the remainder of the curd time to precipitate, is decanted off almost as colourless as water, and scarcely any of the peculiar taste of milk can be distinguished in it. If it is now slowly evaporated, it deposits at last a number of white-coloured crystals, which are sugar of milk. Towards the end of the evaporation, some crystals of muriat of potass and of muriat of soda make their appearance. According to Scheele, it contains also a little phosphat of lime, which indeed may be precipitated by ammonia.

After the salts have been obtained from whey, what remains concretes into a jelly on cooling. Hence it follows that whey also contains gelatine. Whey, then, is composed of water, sugar of milk, gelatine, muriat of potass, and phosphat of lime. The other salts which are sometimes found in it, are only accidentally present.

If whey is allowed to remain for some time, it becomes sour, owing to the formation of a peculiar acid known by the name of lactic acid. It is to this property of whey that we are to ascribe the acidity which milk contracts; for neither curd nor cream, perfectly freed from serum, seems susceptible of acquiring acid properties. Hence the reason also that milk, after it becomes sour, always coagulates. Boiled milk has the property of continuing longer sweet, but it is singular enough that it runs sooner to putrefaction, than ordinary milk.

The acid of milk differs considerably from the acetic: yet vinegar may be obtained from milk by a very simple process. If to somewhat more than 8 lbs. troy of milk six spoonfuls of alcohol are added, and the mixture well corked is exposed to a heat sufficient to support fermentation, provided attention is paid to allow the carbonic acid gas to escape from time to time, the whey, in about a month, will be found converted into vinegar.

Milk is almost the only animal substance which may be made to undergo the vinous fermentation, and to afford a liquor resembling wine or beer, from which alcohol may be separated by distillation. This singular fact seems to have been first discovered by the Tartars; they obtain all their spirituous liquors from mare's milk. It has been ascertained, that milk is incapable of being converted into wine till it has become sour; after this nothing is necessary but to place it in the proper temperature; the fermentation begins of its own accord, and continues till the formation of wine is completed. Scheele had shewed that milk was capable of fermenting, and that a great quantity of carbonic acid gas was extricated from it during this fermentation; but he did not suspect that the result of this fermentation was the formation of an intoxicating liquor similar to wine. The Tartars call the vinous liquid which they prepare koumiss. A very exact account of its preparation and medical uses has been published by Dr. Guthrie.

When milk is distilled by the heat of a water-bath, there comes over water having the peculiar odour of milk: which putrefies; and consequently contains, besides mere water, some of the other constituent parts of milk. After some time the milk coagulates, as always happens when hot albumen acquires a certain degree of concentration. There remains behind a thick unctuous yellowish-white substance, to which Hoffman gave the name of franchippan. This substance, when the fire is increased, yields at first a transparent liquid, which becomes gradually more coloured; some very fluid oil comes over, then ammonia, an acid, and at last a very thick black oil. Towards the end of the process carbureted hydrogen gas is disengaged. There remains in the retort a coal which contains carbonat of potass, muriat of potass, and phosphat of lime; and sometimes magnesia, iron, and muriat of soda.

Thus we see that cow's milk is composed of the following ingredients:

1. Water,	6. Muriat of soda,
2. Oil,	7. Muriat of potass,
3. Curd,	8. Sulphur,
4. Gelatine,	9. Phosphat of lime.
5. Sugar of milk.	

The milk of all other animals, as far as it has hitherto been examined, consists nearly of the same ingredients: but there is a very great difference in their proportion.

Woman's milk has a much sweeter taste than cow's milk. When allowed to remain at rest for a sufficient time, a cream gathers on its surface. This cream is more abundant than in cow's milk, and its colour is usually much whiter. After it is separated, the milk is exceedingly thin; and has the appearance rather of whey with a blueish-white colour, than of cream-milk.

None of the methods by which cow's milk is coagulated succeed in producing the coagulation of woman's milk. It is certain, however, that it contains curd; for if it is boiled, pellicles form on its surface, which have all the properties of curd. Its not coagulating, therefore, must be attributed to the great quantity of water with which the curd is diluted.

Though the cream is churned ever so long, no butter can be obtained from it; but if, after being agitated for some hours, it is allowed to remain at rest for a day or two, it separates into two parts: a fluid which occupies the inferior part of the vessel, pellucid and colourless like water; and a thick white unctuous fluid which swims on the surface. The lowermost fluid contains sugar of milk and some curd; the uppermost does not differ from cream except in consistence. The oily part of the cream, then, cannot be separated by agitation from the curd. This cream contains a greater portion of curd than the cream of cow's milk.

When this milk, after the curd is separated from it, is slowly evaporated, it yields crystals of sugar of milk and of muriat of soda. The quantity of sugar is rather greater than in cow's milk. According to Haller, the sugar obtained from cow's milk is to that obtained from an equal quantity of woman's milk as 35 to 58, and sometimes as 37 to 67, and in all the intermediate ratios.

Thus it appears that woman's milk differs from that of cow's in three particulars:

It contains a much smaller quantity of curd. Its oil is so intimately combined with its curd that it does not yield butter. It contains rather more sugar of milk.

Parmentier and Deyeux ascertained, that the quantity of curd in woman's milk increases in proportion to the time after delivery. Nearly the same thing has been observed with respect to cow's milk.

Ass's milk has a very strong resemblance to human milk. It has nearly the same colour, smell, and consistence. When left at rest for a sufficient time, a cream forms upon its surface, but by no means in such abundance as in woman's milk. This cream, by very long agitation, yields a butter, which is always soft, white, and tasteless; and, what is singular, very readily mixes again with the buttermilk; but it may be again separated by agitation, while the vessel which contains it is plunged in cold water. Creamed ass's milk is thin, and has an agreeable sweetish taste. Alcohol and acids separate from it a little curd, which has but a small degree of consistence. The serum yields sugar of milk and muriat of lime.

Ass's milk therefore differs from cow's milk in three particulars:

Its cream is less abundant and more insipid. It contains less curd. It contains more sugar of milk: the proportion is 35 to 80.

Goat's milk, if we except its consistence, which is greater, does not differ much from cow's milk. Like that milk it throws up abundance of cream, from which butter is easily obtained. The creamed milk coagulates just as cow's milk, and yields a greater quantity of curd. Its whey contains sugar of milk, muriat of lime, and muriat of soda.

Ewe's milk resembles almost precisely that of the cow. Its cream is rather more abundant, and yields a butter which never acquires the consistence of butter from cow's milk. Its curd has a fat and viscid appearance, and is not without difficulty made to assume the consistence of the curd of cow's milk. It makes excellent cheese.

Mare's milk is thinner than that of the cow, but scarcely so thin as human milk. Its cream cannot be converted into butter by agitation. The creamed milk coagulates precisely as cow's milk, but the curd is not so abundant. The serum contains sugar of milk, sulphat of lime, and muriat of lime.

MILKY-WAY, in astronomy, a broad track or path, encompassing the whole heavens, distinguishable by its white appearance: whence it obtains its name. See Astronomy.

MILL, a machine or engine for grinding corn, &c. of which there are several kinds, according to the various methods of applying the moving power; as water-mills, wind-mills, mills worked by horses, &c.

In water-mills the momentum of the water is the moving power; and the attrition of the two stones in grinding is the force to be overcome. Of these there are two kinds, viz. those where the force of the water is applied above the wheel, and those where it is applied below the wheel; the former being called overshot, and the latter undershot mills: and to these we may add a breast-mill, where the water strikes against the middle of the wheel.

Few people are ignorant that corn is ground by two mill-stones, placed one above the other, without touching. The lower, or nether, mill-stone, is immoveable; but the upper one turns upon a spindle. The opposite surfaces of the two stones, which act to grind the corn, are not plane or flat; but the upper one is hollow, and the under one swells upwards; each of them being of a conic figure, whose axis indeed is very short in proportion to the diameter of its base: for the upper one, being six feet in diameter, is hollowed but about one inch at its centre; and the lower one rises but about three-fourths of an inch. These two mill-stones come nearer and nearer towards their circumference, whereby the corn that falls from the hopper has room to insinuate between them as far as two-thirds of the radius, which is the place where it begins to be ground, and where it makes the greatest resistance that it is capable of; the space between the stones being in that place but about two-thirds or three-fourths of the thickness of a grain of corn. But as the millers have the means of raising or sinking the upper stone a little, they can proportion its distance from the lower one, according as they would have the flour finer or coarser.

The circular motion of the upper mill-stone brings the corn out of the hopper by jerks, and causes it to recede from the centre towards the circumference; where being quite reduced to flour, it is thrown out of the mill, by the centrifugal force of the stone, through a hole provided on purpose.

As the water acts upon an overshot-mill both by impulse and weight, so does it likewise upon a breast-mill, or that where the water comes upon the breast or middle part of the wheel: and here, though the weight of the water is not so great as in the overshot mill, being contained in the buckets of the lower quarter only; yet the impulse of the water is much greater, the height of the water being increased nearly the semidiameter of the great wheel, all other things being equal. If the height of the water remains the same, the aperture of the penstock, or flood-gate, must be enlarged to nearly twice the area, that the force may be the same; so that to produce the same effect, twice as much water is necessary for a breast-mill as for an overshot one, every thing else being the same.

As to the undershot-mill, it is evident that there can be only the impulse from the water; and therefore the height of the water remaining the same, there must be a larger aperture of the penstock for the discharge of a greater quantity of water in the same time, in order to produce the same effect, as in the overshot, or breast-mill: whence a greater expence of water will be made here than in any other mill, and can only be supplied for a constancy by a river; and where this can be had, the undershot is the easiest, cheapest, and most simple structure a mill is capable of.

Mr. Smeaton has considered the best methods of constructing all these mills from machines and models made on purpose; but, conscious of the inferiority of models to actual practice, did not venture to give his opinion without having seen them actually tried, and the truth of his doctrines established by practice.

Having described the machines and models used for making his experiments, he observes, that, with regard to power, it is most properly measured by the raising of a weight; or, in other words, if the weight raised is multiplied by the height to which it can be raised in a given time, the product is the measure of the power raising it; and, of consequence, all those powers are equal whose products made by such multiplication are equal: for if a power can raise twice the weight to the same height, or the same weight to twice the height, in the same time that another can, the former power will be double the latter; but if a power can only raise half the weight to double the height, or double the weight to half the height, in the same time that another can, the two powers are equal. This, however, must be understood only of a slow and equable motion, without acceleration or retardation; for, if the velocity is either very quickly accelerated or retarded, the vis inertiæ, in our author's opinion, will produce an irregularity.

To compute the effects of water-wheels exactly, it is necessary to know, in the first place, what is the real velocity of the water which impinges on the wheel; 2. The quantity of water expended in a given time; and, 3. How much of the power is lost by the friction of the machinery.

1. With regard to the velocity of the water, Mr. Smeaton determined by experiments with machinery, that with a head of water 15 inches in height, the velocity of the wheel is 8.96 feet in a minute. The area of the head being 105.8 inches; this multiplied by the weight of a cubic inch of water, equal to .579 of an ounce avoirdupoise, gives 61.26 ounces for the weight of as much water as is contained in the head upon one inch in depth; and by further calculations derived from the machinery made use of, he computes that 264.7 pounds of water descend in a minute through the space of 15 inches. The power of the water, therefore, to produce mechanical effects in this case, will be 264.7×15, or 3970. From the result of the experiment, however, it appeared that a vast quantity of the power was lost; the effect being only to raise 9.375 pounds to the height of 135 inches: so that the power was to the effect as 3970 to $9.375 \times 135 = 1266$, or as 10 to 3.18.

This, according to our author, must be considered as the greatest single effect of water upon an undershot-wheel, where the water descends from a height of 15 inches; but as the force of the current is not by any means exhausted, we must consider the true proportion betwixt the power and effect to be that betwixt the quantity of water already mentioned, and the sum of all the effects producible from it. This remainder of power, it is plain, must be equal to that of the velocity of the wheel itself multiplied into the weight of the water. In the present experiment, the circumference of the wheel moved with the velocity of 3.123 feet in a second, which answers to a head of 1.82 inches; and this height being multiplied by 264.7, the quantity of water expended in a minute, gives 481 for the power of the water after it has passed the wheel; and hence the true proportion betwixt the power and the effect will be as 3849 to 1266; or as 11 to 4.

As the wheel revolved 86 times in a minute, the velocity of the water must be equal to 86 circumferences of the wheel; which, according to the dimensions of the apparatus used by Mr. Smeaton, was as 86 to 30, or as 20 to 7. The greatest load with which the wheel would move was 9 lb. 6 oz.; and by 12 lb. it was entirely stopped. Whence our author concludes, that the impulse of the water is more than double of what it ought to be according to theory; but this he accounts for by observing, that in his experiment the wheel was placed not in an open river, where the natural current, after it has communicated its impulse to the float, has room on all sides to escape, as the theory supposes, but in a conduit, to which the float being adapted, the water cannot otherwise escape than by moving along with the wheel. It is observable, that a wheel working in this manner, as soon as the water meets the float, receiving a sudden check, it rises up against the float like a wave against a fixed object; insomuch that, when the sheet of water is not a quarter of an inch thick before the float, yet this sheet will act upon the whole surface of a float whose height is three inches; and, consequently, was the float no higher than the thickness of the sheet of water, as the theory also supposes, a great part of the force would have been lost by the water dashing over the float.

Mr. Smeaton next proceeds to give tables of the velocities of wheels with different heights of water; and from the whole deduces the following conclusions: 1. The virtual or effective head being the same, the effect will be nearly as the quantity of water expended. 2. The expence of water being the same, the effect will be nearly as the height of the virtual, or effective head. 3. The quantity of water expended being the same, the effect is nearly as the square of the velocity. 4. The aperture being the same, the effect will be nearly as the cube of the velocity of the water. Hence, if water passes out of an aperture in the same section, but with different velocities, the expence will be proportional to the velocity; and therefore, if the expence is not proportional to the velocity, the section of the water is not the same. 5. The virtual head, or that from which we are to calculate the power, bears no proportion to the head-water; but when the aperture is larger, or the velocity of the water less, they approach nearer to a coincidence; and consequently, in the large openings of mills and sluices, where great quantities of water are discharged from moderate heads, the head of water, and virtual head determined from the velocity, will nearly agree: which is also confirmed by experience. 6. The most general proportion betwixt the power and effect is that of 10 to 3; the extremes 10 to 3.2, and 10 to 2.8. But it is observable, that where the power is greatest, the second term of the ratio is greatest also: hence we may allow the proportion subsisting in great works to be as three to one. 7. The proportion of velocity between the water and wheel is, in general, about five to two. 8. There is no certain ratio between the load that the wheel will carry at its proper maximum, and what will totally stop it; though the proportions are contained within the limits of 20 to 19, and 20 to 15: but as the effect approaches nearest to the ratio of 20 to 15, or of 4 to 3, when the power is greatest, either by increase of velocity, or quantity of water, this seems to be the most applicable to large works; but as the load that a wheel ought to have, in order to work to the best advantage, can be assigned by knowing the effect that it ought to produce, and the velocity it ought to have in producing it, the exact knowledge of the greatest load it will bear is of the least consequence in practice.

Mr. Smeaton, after having finished his experiments on the undershot-mills, reduced the number of floats, which were originally 24, to 12; which caused a diminution in the effect, by reason that a greater quantity of water escaped between the floats and the floor than before: but on adapting to it a circular sweep of such a length, that one float entered into the curve before the other left it, the effect came so near that of the former, as not to give any hopes of advancing it by increasing the number of floats beyond 24 in this particular wheel.

Our author next proceeds to examine the power of water when acting by its own gravity, in turning an overshot-wheel: "In reasoning without experiment," says he, "one might be led to imagine, that however different the mode of application is, yet that, whenever the same quantity of water descends through the same perpendicular space, the natural effective power would be equal, supposing the machinery free from friction, equally calculated to receive the full effect of the power, and to make the most of it: for, if we suppose the height of a column of water to be 30 inches, and resting upon a base or aperture of one inch square, every cubic inch of water that departs therefrom will acquire the same velocity or momentum from the uniform pressure of 30 cubic inches above it, that one cubic inch let fall from the top will acquire in falling down to the level of the aperture: one would therefore suppose that a cubic inch of water let fall through a space of 30 inches, and there impinging upon another body, would be capable of producing an equal effect by collision, as if the same cubic inch had descended through the same space with a slower motion, and produced its effects gradually. But, however conclusive this reasoning may seem, it will appear in the course of the following deductions, that the effect of the gravity of descending bodies is very different from the effect of the stroke of such as are non-elastic, though generated by an equal mechanical power."

Having made such alterations in his machinery as were necessary for overshot-wheels, our author next gives a table of experiments with the apparatus so altered. In these the head was six inches, and the height of the wheel 24 inches, so that the whole descent was 30 inches; the quantity of water expended in a minute was $96\frac{2}{3}$ pounds; which, multiplied by 30 inches, gives the power $= 2900$: and, after making the proper calculations, the effect was computed at 1914; whence the ratio of the power to it comes to be nearly as 3 to 2. If, however, we compute the power from the height of the wheel only, the power will be to the effect nearly as 5 to 4.

From another set of experiments the following conclusions were deduced:

1. The effective power of the water must be reckoned upon the whole descent; because it must be raised to that height, in order to be able to produce the same effect a second time. The ratios between the powers so estimated, and the effects at a maximum, differ nearly from 4 to 3, and from 4 to 2. Where the heads of water and quantities of it expended are the least, the proportion is nearly from 4 to 3; but where the heads and quantities are greatest, it comes nearer to that of 4 to 2; so that by a medium of the whole the ratio is nearly as 3 to 2. Hence it appears that the effect of overshot-wheels is nearly double to that of undershot ones: the consequence of which is, that non-elastic bodies, when acting by their impulse or collision, communicate only a part of their original impulse, the remainder being spent in changing their figure in consequence of the stroke. The ultimate conclusion is, that the effects as well as the powers are as the quantities of water and perpendicular heights multiplied together respectively.

2. By increasing the head, it does not appear that the effects are at all augmented in proportion; for, by raising it from 3 to 11 inches, the effect was augmented by less than one-seventh of the increase of perpendicular height. Hence it follows, that the higher the wheel is in proportion to the whole descent, the greater will be the effect; because it depends less upon the impulse of the head, and more upon the gravity of the water in the buckets: and if we consider how obliquely the water issuing from the head must strike the buckets, we shall not be at a loss to account for the little advantage that arises from the impulse thereof, and shall immediately see of how little consequence this is to the effect of an overshot-wheel. This, however, as well as other things, must be subject to limitation; for it is necessary that the velocity of the water should be somewhat greater than the wheel, otherwise the latter will not only be retarded by the striking of the buckets against the water, but some of the power will be lost by the dashing of the water over the buckets.

3. To determine the velocity which the circumference of the wheel ought to have, in order to produce the greatest effect, Mr. Smeaton observes, that the more slowly any body descends by the force of gravity, when acting upon any piece of machinery, the more that force will be spent upon it; and consequently the effect will be greater. If a stream of water falls into the bucket of an overshot-wheel, it will be there retained till the wheel discharges it by moving round; and of consequence, the slower the wheel moves, the more water will it receive: so that what is lost in velocity is gained by the greater pressure of water upon the buckets. From the experiments, however, it appears, that when the wheel made about 20 turns in a minute the effect was greatest; when it made only $18\frac{3}{4}$ the motion was irregular; and when loaded so as not to admit its turning 18 times, the wheel was overpowered with the load. When it made 30 turns, the power was diminished by about one-twentieth; and when the number of turns was increased to 40, it was diminished by one-fourth. Hence we see that, in practice, the velocity of the wheel should not be diminished farther than what will procure some solid advantage in point of power; because, cæteris paribus, the buckets must be larger as the motion is slower; and the wheel being more loaded with water, the stress will be proportionably increased upon every part of the work. The best velocity for practice, therefore, will be that when the wheel makes 30 turns in a minute, which is little more than three feet in a second. This velocity is applicable to the highest overshot-wheels as well as the lowest. Experience however determines, that high wheels may deviate farther from this rule before they will lose their power by a given aliquot part of the whole, than low ones can be permitted to do; for a wheel of 24 feet high may move at

the rate of six feet per second, while our author has seen one of 33 feet high move very steadily and well with a velocity of little more than two feet. The reason of this superior velocity in the 24-feet wheel, may probably be owing to the small proportion that the head requisite to give the proper velocity to the wheel bears to the whole height.

4. The maximum load for an overshot-wheel is that which reduces the circumference of the wheel to its proper velocity; which is known by dividing the effect it ought to produce in a given time, by the space intended to be described by the circumference of the wheel in the same time: the quotient will be the resistance overcome at the circumference of the wheel, and is equal to the load required, including the friction and resistance of the machinery.

5. The greatest velocity that an overshot-wheel is capable of, depends jointly upon the diameter, or height of the wheel, and the velocity of falling bodies; for it is plain that the velocity of the circumference can never be greater than to describe a semicircumference, while a body let fall from the top describes the diameter, nor even quite so great; as the difference in point of time must always be in favour of that which falls through the diameter. Thus, supposing the diameter of the wheel to be 16 feet and an inch in diameter, a heavy body would fall through this space in one second; but such a wheel could never arrive at this velocity, or make one turn in two seconds, nor could an overshot-wheel ever come near it: because, after it has acquired a certain velocity, great part of the water is prevented from entering the buckets, and part is thrown out again by the centrifugal force; and as these circumstances have a considerable dependance upon the form of the buckets, it is impossible to lay down any general rule for the velocity of this kind of wheels.

6. Though in theory we may suppose a wheel to be made capable of overcoming any resistance whatever, yet as, in practice, it is necessary to make the wheel and buckets of some certain and determinate size, we always find that the wheel will be stopped by such a weight as is equal to the effort of the water in all the buckets of a semicircumference put together. This may be determined from the structure of the buckets themselves; but, in practice, an overshot-wheel becomes unserviceable long before this time: for when it meets with such an obstacle as diminishes its velocity to a certain degree its motion becomes irregular; but this never happens till the velocity of the circumference is less than the two feet per second, when the resistance is equable.

7. From the above observations we may easily deduce the force of water upon breast-wheels, &c. But, in general, all kinds of wheels where the water cannot descend through a given space unless the wheel moves with it, are to be considered as overshot-wheels; and those which receive the impulse or shock of the water, whether in an horizontal, oblique, or perpendicular direction, are to be considered as undershots. Hence in a wheel in which the water strikes at a certain point below the surface of the head, and after that descends in the arch of a circle, pressing by its gravity upon the wheel, the effect of such a wheel will be equal to that of an undershot whose head is equal to the difference of level between the surface of the water in the reservoir and the point where it strikes the wheel, added to that of an overshot whose height is equal to the difference of level between the point where it strikes the wheel and the level of the tail-water.

In the 66th volume of the Transactions our author considers some of the causes which have produced disagreements and disputes among mathematicians upon this subject. He observes, that soon after sir Isaac Newton had given his definition, "that the quantity of motion is the measure of the same, arising from the velocity and quantity of matter conjointly," it was controverted by his contemporary philosophers. They maintained, that the measure of the quantity of motion should be estimated by taking the quantity of matter and the square of the velocity conjointly. On this subject he remarks, that from equal impelling powers acting for equal intervals of time, equal augmentations of velocity are acquired by given bodies when they are not resisted by a medium. Thus a body descending one second by the force of gravity, passes through a space of 16 feet and an inch; but at the end of that time it has acquired a velocity of 32 ft. 2 inc. in a second: at the end of 2 sec. it has acquired one that would carry it through 64 feet 4 inches in a second. If, therefore, in consequence of this equal increase of velocity, we define this to be a double quantity of motion generated in a given time in a certain quantity of matter, we come near to sir Isaac's definition: but in trying experiments upon the effects of bodies, it appears, that when a body is put in motion, by whatever cause, the impression it will make upon an uniformly resisting medium, or upon uniformly yielding substances, will be as the mass of matter of the moving body multiplied by the square of its velocity. The question therefore properly is, whether those terms, the quantity of motion, the momenta, or forces of bodies in motion, are to be esteemed equal, double, or triple, when they have been generated by an equable impulse acting for an equal, double, or triple time? or that it should be measured by the effects being equal, double, or triple, in overcoming resistances before a body in motion can be stopped? For, according to the meaning we put upon these words, the momenta of equal bodies will be as the velocities or squares of the velocities of the moving bodies.

Though by a proper attention to the terms employed, however, we shall find both these doctrines to be true; it is certain that some of the most celebrated writers upon mechanics have fallen into errors by neglecting to attend to the meaning of the terms they make use of. Desaguliers, for instance, after having been at pains to show that the dispute, which in his time had subsisted for 50 years, was a dispute merely about words, tells us, that both opinions may be easily reconciled in the following case, viz. that the wheel of an undershot water-mill is capable of doing quadruple work when the velocity of the water is doubled, instead of double work only: "For," says he, "the adjutage being the same, we find, that as the water's velocity is double, there are twice the number of particles that issue out, and therefore the ladle-board is struck by twice the matter; which matter moving with twice the velocity that it had in the first case, the whole effect must be quadruple, though the instantaneous stroke of each particle is increased only in a simple proportion of the velocity." In another place the same author tells us, that though "the knowledge of the foregoing particulars is absolutely necessary for setting an undershot-wheel to work, yet the advantage to be reaped from it would still be guess-work, and we should be at a loss to find out the utmost that it could perform, had it not been for an ingenious proposition of that excellent mechanic, M. Parent, of the royal academy of sciences, who has shewed, that an undershot-wheel can do the most work when its velocity is equal to the third part of that of the water; because then two-thirds of the water are employed in driving the wheel, with a force proportionable to the square of the velocity. By multiplying the surface of the adjutage or opening by the height of the water, we shall have the column of water that moves the wheel. The wheel thus moved will sustain on the opposite side only four-ninths of that weight which will keep it in equilibrio; but what it can move with the velocity it has, is only one-third of the equilibrium." This conclusion is likewise adopted by Mr. Maclaurin.

Mr. Smeaton, in the year 1759, instituted another set of experiments; the immediate object of which was, to determine what proportion or quantity of mechanical power is expended in giving the same body different degrees of velocity. Having constructed a proper apparatus for the purpose, and with it made a number of experiments, he concludes, "that time, properly speaking, has nothing to do with the production of mechanical effects, otherwise than as by equally flowing it becomes a common measure; so that, whatever mechanical effect is found to be produced in a given time, the uniform continuance of the action of the same mechanical power will, in a double time, produce twice that effect. A mechanical power, therefore, properly speaking, is measured by the whole of its mechanical effect produced, whether that effect be produced in a greater or less time: thus, having treasured up 1000 tuns of water, which I can let out upon the overshot-wheel of a mill, and descending through a perpendicular of 20 feet; this power, applied in a proper manner, will grind a certain quantity of corn in an hour: but, supposing the mill to be capable of receiving a greater impulse with as great advantage as a less; then, if the corn is let out twice as fast, the same quantity of corn will be ground in half an hour, the whole of the water being likewise expended in that time. What time has therefore to do in the case is this: Let the rate of doing the business, or producing the effect, be what it will; if this rate is uniform, when I have found by experiment what is done in a given time, then, proceeding at the same rate, twice the effect will be produced in twice the time; on supposition that I have a supply of mechanic power to go on with. Thus, 1000 tuns of water descending through 20 feet perpendicular, being, as has been shewn, a given mechanic power, let it be expended at what rate it will; if, when this is expended, we are to wait another hour till an equal quantity can be procured, then we can only expend 12 such quantities in 24 hours. But if, while the thousand tuns of water are expending in one hour, the same quantity is renewed, we can then expend 24 such in the 24 hours, or go on without intermission. The product or effect will then be in proportion to time, which is the common measure; but the quantity of mechanic power arising from the flow of the two rivers, compared by taking an equal portion of time, is double in the one to the other; though each has a mill that, when going, will grind an equal quantity of corn in an hour."

The following is a description of a corn-mill of the most common sort. See Plate, Mills.

AB (fig. 1) is the water-wheel, which is generally from 18 to 24 feet in diameter, reckoned from the outermost edge of any float-board at A, to that of the opposite one at B. The water striking on the floats of this wheel drives it round, and gives motion to the mill. The wheel is fixed upon a very strong axis or shaft, C, one end of which rests on D, and the other on E, within the mill-house.

On this shaft, or axis, and within the mill-house, is a wheel F, about eight or nine feet in diameter, having cogs all round, which work in the upright staves, or rounds, of a trundle G. This trundle is fixed upon a strong iron axis, called the spindle, the lower end of which turns in a brass foot fixed at H, in a horizontal beam H, called the bridge-tree; and the upper end of the spindle turns in a wooden bush fixed into the nether mill-stone, which lies upon beams in the floor I. The top of the spindle above the bush is square, and goes into a square hole in a strong iron cross, *abcd* (fig. 2), called the rynd; under which, and close to the bush, is a round piece of thick leather upon the spindle, which it turns round at the same time as it does the rynd.

The rynd is let into grooves in the under surface of the running mill-stone K, and so turns it round in the same time that the trundle G is turned round by the cog-wheel F. This mill-stone has a large hole quite through its middle, called the eye of the stone, through which the middle part of the rynd and upper end of the spindle may be seen; whilst the four ends of the rynd lie below the stone in their grooves.

One end of the bridge-tree, which supports the spindle, rests upon the wall, whilst the other is let into a beam, called the brayer, LM.

The brayer rests in a mortice at L; and the other end M hangs by a strong iron rod N, which goes through the floor I, and has a screw-nut on its top at O; by the turning of which nut, the end M of the brayer is raised or depressed at pleasure; and consequently the bridge-tree and the upper mill-stone. By this means the upper mill-stone may be set as close to the under one, or raised as high from it, as the miller pleases.

The nearer the mill-stones are to each other, the finer the corn is ground; and the more remote from one another, the coarser.

The upper mill-stone is inclosed in a round box, which does not touch it any where, and is about an inch distant from its edge all round. On the top of this box stands a frame for holding the hopper P, to which is hung the shoe Q, by two lines fastened to the hinder part of it, fixed upon hooks in the hopper, and by one end of the string R fastened to the fore part of it; the other end being twisted round the pin S. As the pin is turned one way, the string draws up the shoe closer to the hopper, and so lessens the aperture between them; and as the pin is turned the other way, it lets down the shoe, and enlarges the aperture.

If the shoe is drawn up quite to the hopper, no corn can fall from the hopper into the mill: if it is let down a little, some will fall; and the quantity will be more or less, according as the shoe is more or less let down; for the hopper is open at bottom, and there is a hole in the bottom of the shoe, not directly under the bottom of the hopper, but nearer to the lowest end of the shoe, over the middle eye of the mill-stone.

There is a square hole in the top of the spindle, in which is put the feeder F (fig. 2); this feeder, as the spindle turns round, jogs the shoe three times in each revolution, and so causes the corn to run constantly down from the hopper through the shoe into the eye of the mill-stone, where it falls upon the top of the rynd, and is, by the motion of the rynd, and the leather under it, thrown below the upper stone, and ground between it and the lower one. The violent motion of the stone creates a centrifugal force in the corn going round with it, by which means it gets farther and farther from the centre, as in a spiral, in every revolution, until it is quite thrown out; and being then ground, it falls through a spout, called the mill-eye, into a trough placed to receive it.

When the mill is fed too fast the corn bears up the stone, and is ground too coarse; and, besides, it clogs the mill, so as to make it go too slow. When the mill is too slowly fed, it goes too fast; and the stones, by their attrition, are apt to strike fire. Both these inconveniences are avoided by turning the pin S backward or forward, which draws up or lets down the shoe; and thus regulates the feeding, as the miller sees convenient.

The heavier the running mill-stone is, and the greater the quantity of water that falls upon the wheel, the faster will the mill bear to be fed, and consequently it will grind the more: and, on the contrary, the lighter the stone, and the less the quantity of water, so much the slower must the feeding be. But when the stone is considerably worn, and become light, the mill must be fed slowly at any rate; otherwise the stone will be too much borne up by the corn under it, which will make the meal coarse.

The quantity of power sufficient to turn a heavy mill-stone, is but very little more than what is necessary to turn a light one; for as it is supported upon the spindle by the bridge-tree, and the end of the spindle that turns in the brass foot therein being but small, the difference arising from the weight is but very inconsiderable in its action against the power or force of the water; and, besides, a heavy stone has the same advantage as a heavy fly, namely, that it regulates the motion much better than a light one.

The centrifugal force carrying the corn towards the circumference, it is natural it should be crushed, when it comes to a place where the interval between the two mill-stones is less than its thickness; yet the upper mill-stone being supported on a point which it can never quit, it does not so clearly appear why it should produce a greater effect when it is heavy than when it is light; since, if it were equally distant from the nether mill-stone, it could only be capable of a limited impression. But as experience proves that this is really the case, it is necessary to discover the cause. The spindle of the mill-stone being supported by a horizontal piece of timber, about nine or ten feet long, resting only on both its ends, by the elasticity of this piece, the upper mill-stone is allowed a vertical motion, playing up and down; by which movement, the heavier the stones are, the more forcibly is the corn wedged in between them.

In order to cut and grind the corn, both the upper and under mill-stones have channels or furrows cut into them, proceeding obliquely from the centre to the circumference. And these furrows are cut perpendicularly on one side, and obliquely on the other, which gives each furrow a sharp edge; and in the two stones they come against one another, like the edges of a pair of scissars; and so cut the corn, to make it grind the easier, when it falls upon the places between the furrows. These are cut the same way in both stones, when they lie upon their backs, which makes them run crossways to each other when the upper stone is inverted, by turning its furrowed surface towards that of the lower; for if the furrows of both stones lay the same way, a great deal of the corn would be driven onward in the lower furrows, and so come out from between the stones, without being either cut or bruised.

The grinding surface of the under stone is a little convex from the edge to the centre, and that of the upper stone a little concave; so that they are farthest from one another in the middle, and approach gradually nearer towards the edges. By this means the corn, at its first entrance between the stones, is only bruised; but as it goes farther on towards the circumference or edge, it is cut smaller and smaller; and, at last, finely ground, just before it comes out from between them.

When the furrows become blunt and shallow by wearing, the running-stone must be taken up, and both stones new drest with a chisel and hammer; and every time the stone is taken up there must be some tallow put round the spindle upon the bush, which will soon be melted by the heat the spindle acquires from its turning and rubbing against the bush, and so will get in betwixt them; otherwise the bush would take fire in a very little time.

The bush must embrace the spindle quite close, to prevent any shake in the motion, which would make some parts of the stones grate and fire against each other; whilst the other parts of them would be too far asunder, and by that means spoil the meal.

Whenever the spindle wears the bush, so as to begin to shake in it, the stone must be taken up, and a chisel driven into several parts of the bush; and when it is taken out, wooden wedges must be forced into the holes; by which means the bush will be made to embrace the spindle again, close all round. In doing this, great care must be taken to drive equal wedges into the bush on opposite sides of the spindle; otherwise it will be thrown out of the perpendicular, and so hinder the upper stone from being set parallel to the under one, which is absolutely necessary for making good work. When any accident of this kind happens, the perpendicular position of the spindle must be restored, by adjusting the bridge-tree with proper wedges put between it and the brayer.

It often happens that the rynd is a little wrenched in laying down the upper stone upon it, or is made to sink a little lower on one side of the spindle than on the other; and this will cause one edge of the upper stone to drag all round upon the other, while the opposite edge will not touch. But this is easily set to rights, by raising the stone a little with the lever, and putting bits of paper, cards, or thin chips, between the rynd and the stone.

A less quantity of water will turn an overshot-mill (where the wheel has buckets instead of float-boards) than a breast-mill, where the fall of water seldom exceeds half the height of the wheel; so that where there is but a small quantity of water, and a fall great enough for the wheel to lie under it, the bucket, or overshot, wheel, is always used: but where there is a large body of water with a little fall, the breast, or float-board, wheel must be used. Where the water runs only upon a small declivity, it can act but slowly upon the under part of the wheel; in which case the motion of the wheel will be slow: and therefore the floats ought to be very long, though not high, that a large body of water may act upon them; so that what is wanting in velocity may be made up in power; and then the cog-wheel may have a greater number of cogs, in proportion to the rounds in the trundle, in order to give the mill-stone a sufficient degree of velocity.

It was the opinion of Smeaton, that the powers necessary to produce the same effect on an undershot-wheel, a breast-wheel, and an overshot-wheel, must be to each other as the numbers 2.4, 1.75, and 1.

Practical rules for the construction of mills.—1. Measure the perpendicular height of the fall of water, in feet, above that part of the wheel on which the water begins to act, and call that the height of the fall.

2. Multiply this constant number 64.2882 by the height of the fall in feet, and the square root of the product will be the velocity of the water at the bottom of the fall, or the number of feet that the water there moves per second.

3. Divide the velocity of the water by three, and the quotient will be the velocity of the float-boards of the wheel, or the number of feet they must each go through in a second, when the water acts upon them so as to have the greatest power to turn the mill.

4. Divide the circumference of the wheel in feet by the velocity of its floats in feet per second, and the quotient will be the number of seconds in which the wheel turns round.

5. By this last number of seconds divide 60, and the quotient will be the number of turns of the wheel in a minute.

6. Divide 120 (the number of revolutions a mill stone four feet and a half diameter ought to have in a minute) by the number of turns of the wheel in a minute, and the quotient will be the number of turns the mill-stone ought to have for one turn of the wheel.

7. Then, as the number of turns of the wheel in a minute, is to the number of turns of the mill-stone in a minute, so must the number of staves in the trundle, be to the number of cogs in the wheel, in the nearest whole numbers that can be found.

By these rules the following table is calculated to a water-wheel 18 feet diameter, which may be a good size in general.

THE MILL-WRIGHT'S TABLE.

Height of the fall of water.	Velocity of the fall of water per second.		Velocity of the wheel per second.		Revolutions of the wheel per minute.		Revolutions of the mill-stone for one of the wheels.		Cogs in the wheel, and staves in the trundle.		Revolutions of the mill-stone per minute, by these staves and cogs.	
Feet.	Feet.	100 parts of a foot.	Feet.	100 parts of a foot.	Revolutions.	100 parts of a rev.	Revolutions.	100 parts of a rev.	Cogs.	Staves.	Revolutions.	100 parts of a rev.
1	8	02	2	67	2	83	42	40	254	6	119	84
2	11	34	3	78	4	00	30	00	210	7	120	00
3	13	89	4	63	4	91	24	44	196	8	120	28
4	16	04	5	35	5	67	21	16	190	9	119	74
5	17	93	5	98	6	34	18	92	170	9	119	68
6	19	64	6	55	6	94	17	28	156	9	120	20
7	21	21	7	07	7	50	16	00	144	9	120	00
8	22	68	7	56	8	02	14	96	134	9	119	34
9	24	05	8	02	8	51	14	10	140	10	119	14
10	25	35	8	45	8	97	13	38	134	10	120	18
11	26	59	8	86	9	40	12	76	128	10	120	32
12	27	77	9	26	9	82	12	22	122	10	119	80
13	28	91	9	64	10	22	11	74	118	10	120	36
14	30	00	10	00	10	60	11	32	112	10	118	72
15	31	05	10	35	10	99	10	98	110	10	120	96
16	32	07	10	09	11	34	10	58	106	10	120	20
17	33	06	11	02	11	70	10	26	102	10	119	34
18	34	02	11	34	12	02	9	98	100	10	120	20
19	34	95	11	65	12	37	9	70	98	10	121	22
20	35	86	11	95	12	68	9	46	94	10	119	18
1	2		3		4		5		6		7	

To construct a mill by this table, find the height of the fall of water in the first column, and against that height, in the sixth column, you have the number of cogs in the wheel, and staves in the trundle, for causing the mill-stone, four feet six inches diameter, to make about 120 revolutions in a minute, as near as possible, when the wheel goes with one-third part of the velocity of the water. And it appears by the 7th column, that the number of cogs in the wheel, and staves in the trundle, are so near the truth for the required purpose, that the least number of revolutions of the mill-stone in a minute is 118, and the greatest number never exceeds 121; which is according to the speed of some of the best mills.

One of the most usual communications of motion in machinery, is by means of toothed wheels acting on each other. It is of the greatest consequence to have the teeth so formed, that the pressure by which one of them urges the other round its axis is constantly the same. This is by no means the case when the common construction of a spur-wheel, acting in the cylindrical staves of a lantern, or trundle, is used. The ends of teeth should never be formed of parts of circles, but of a particular curve, called the epicycloid, which is formed by moving the circle, called the generating circle, round the circumference of another circle, while it turns also round its own centre; then any point will describe an epicycloid.

Emerson observes, that the teeth of wheels ought not to act upon each other before they arrive at the line which joins their centres; and though the inner or under sides of the teeth may be of any form, yet it is better to make both sides alike, which will serve to make the wheel turn backwards. The more teeth that work together the better; at least one tooth should always begin before the other has done working. The teeth ought to be so disposed as not to trouble or hinder one another before they begin to work.

If the cogs of a wheel and rounds of a trundle could be put in as exactly as the teeth are cut in the wheels and pinions of a clock, then the trundle might divide the wheel exactly, that is to say, the trundle might make a given number of revolutions for one of the wheel, without a fraction. But as any exact number is not necessary in mill-work, and the cogs and rounds cannot be set in so truly as to make all the intervals between them equal, a skilful mill-wright will always give the wheel what he calls a hunting-cog; that is, one more than what will answer to an exact division of the wheel by the trundle. And then as every cog comes to the trundle, it will take the next staff, or round, behind the one which it took in the former revolution; and by that means will wear all the parts of the cogs and rounds which work upon one another equally, and to equal distances from one another, in a little time. See Flour-mill.

Mills, Bark, like most other mills, are worked sometimes by means of horses, at others by water, and at others by wind. One of the best mills we have seen described for these purposes is that invented by Mr. Bagnall, of Worsley, in Lancashire: this machine will serve not only to chop bark, to grind, to riddle, and pound it, but to beam, or work green hides and skins out of the mastering, or drench, and make them ready for the ouse, or bark-liquor; to beam sheepskins and other skins for the skinner's use; and to scour and take off the bloom from tanned leather, when in the currying state. The nature and connection of the different parts of this contrivance may be understood from the figures and following description:

Fig. 3 is a horizontal plan of the mill. Fig. 4, a longitudinal section of it. Fig. 5, a transverse section of it.

A, the water-wheel, by which the whole machinery is worked.

B, the shafts.

C, the pit-wheel, which is fixed on the water-wheel shaft B, and turns the upright shaft E, by the wheel F, and works the cutters and hammer by tapets.

D, the spur and bevil-wheel at the top of the upright shafts.

E, the upright shaft.

F, the crown-wheel, which works in the pit-wheel C.

G, the spur-nut to turn the stones I.

P, the beam, with knives or cutters fixed at the end to chop or cut the bark; which bark is to be put upon the cutters or grating *i*, on which the beam is to fall.

Q, the tryal that receives the bark from the cutters *i*, and conveys it into the hopper H, by which it descends through the shoe J to the stones I, where it is ground.

K, the spout, which receives the bark from the stones, and conveys it into the tryal L; which tryal is wired to sift or dress the bark, as it descends from the stones I.

M, the trough to receive the bark that passes through the tryal L.

R, the hammer, to crush or bruise the bark that falls into the dish S, which said dish is on the incline, so that the hammer keeps forcing it out of the lower side of the said dish when bruised.

k, a trough to receive the dust and moss that passes through the tryal Q.

T, the bevil-wheel, that works in the wheel D, which works the beam-knife by a crank V, at the end of the shaft *u*.

W, the penetrating rod, which leads from the crank V to the start *x*.

x, the start, which has several holes in it to lengthen or shorten the stroke of the beam-knife.

y, the shaft, to which the slide rods *h*, *h*, are fixed by the starts *n*, *n*.

h, the slide-rod, on which the knife *f* is fixed; which knife is to work the hides, &c. On the knife are two springs *a*, *a*, to let it have a little play as it makes its stroke backwards and forwards, so that it may not scratch or damage the hides, &c.

z, is a catch in a slide-rod *h*, which catches on the arch-head *e*; and the said arch-head conveys the knife back without touching the hide, and then falls back to receive the catch again.

l, the roller to take up the slide-rod *h*, while the hides are shifting on the beam *b*, by pulling at the handle *m*.

b, the beam to work the hides, &c. on. Each beam has four wheels *p*, *p*, working in a trough-road *g*, *g*, and removed by the levers *c*, *c*. When the knife has worked the hide, &c. sufficiently in one part, the beam is then shifted by the lever *c* as far as is wanted.

d, a press, at the upper end of the beam, to hold the hide fast on the beam while working.

e an arch-head, on which the slide-rod *h* catches.

f, the knife fixed on the slide-rod *h*, to work the hides, &c.

i, cutters, or grating, to receive the bark for chopping.

The beam P, with knives or cutters, may either be worked by tapers, as described, or by the bevil-wheel T, with a crank, as V, to cut the same as shears.

The knife *f* is fixed at the bottom of the start, which is fixed on the slide-rod *h*; the bottom of the start is split open to admit the knife, the width of one foot; the knife should have a gudgeon at each end, to fix in the open part of the start; and the two springs *a*, *a*, prevent the knife from giving too much way when working; the knife should be one foot long, and four or five inches broad.

The arch-head *e* will shift nearer to, or further from, the beam *h*; and will be fixed so as to carry the knife back as far as is wanted, or it may be taken away till wanted.

The roller *l* is taken up by pulling at the handle *m*, which takes up the slide-rod so high as to give head-room under the beam-knife. The handle may be hung upon a hook for that purpose. The slide-rod will keep running upon the roller all the time the hide is shifting; and when the hide is fixed the knife is put on the beam again by letting it down by the handle *m*. There may be two or more knives at work on one beam at the same time, by having different slide-rods. There should be two beams, so that the workmen could be shifting one hide, &c. while the other was working. The beam must be flat, and a little on the incline. As to the breadth it does not matter; the broader it is the less shifting of the hides will be wanted, as the lever *c* will shift them as far as the width of the hide, if required. Mr. Bagnall has formed a kind of press *d*, to let down, by a lever, to hold the hide fast on each side of the knife, if required, so that it will suffer the knife to make its back stroke without pulling the hide up as it comes back. The slide-rod may be weighted, to cause the knife to lay stress on the hide, &c. according to the kind and condition of the goods to be worked.

Hides and skins for the skinner's use are worked in the same way as for the tanners.

Scouring of tanned leather for the currier's use will be done on the beam, the same as working green hides. It is only taking the knife away, and fixing a stone in the same manner as the knife by the said joint, and to have a brush fixed to go either before or after the stone. The leather will be better secured this way than by hand, and much sooner.

The whole machinery may be worked by water, wind, steam, or any other power. And that part of the machinery which relates to the beaming part of the hides may be fixed to any horse bark-mill, or may be worked by a horse, or other power, separately. See Gregory's valuable work on Mechanics, to which we have been indebted for this part of the present article and some others, particularly the table of specific gravities in vol. 1.

The following is a description of Mr. Terry's improved mill for grinding hard substances: Fig. 6, A, is the hopper; B, a spiral wire, in the form of a reversed cone, to regulate the delivery of the articles to be ground; C, an inclined iron plate, hung upon a pin on its higher end: the lower end rests on the grooved axis D, and agitates the wire B; D is the grinding cylinder, which acts against the channeled iron plate E; F, a screw on the side of the mill, by means of which the iron plate E is brought nearer to, or removed farther from, the axis D, according as the article is wanted finer or coarser; G, the handle by which motion is given to the axis; H, the tube whence the articles, when ground, are received.

Mill *for grinding colours*. A machine of this kind was invented a few years ago by Mr. Rawlinson, for which he was presented with the gold medal by the society for the encouragement of arts, manufactures, &c. the description of which is as follows:

A, fig. 7, is the roller, or cylinder, made of marble; B is the concave muller, covering one-third of the roller of the same marble, and is fixed in a wooden frame *b*, which is hung to the frame E, at *ii*. C is a piece of iron about an inch broad, to keep the muller steady, and is fixed to the frame with a joint at *f*. The small binding screw, with the fly-nut that passes through the centre of the iron plate at *c*, is for the purpose of laying more pressure on the muller, if required, and to keep it more steady. D is a taker-off, made of a clock-spring, about half an inch broad, and fixed to a similar frame-saw, in an iron frame K, in an inclined position to the roller, and turning on pivots at *dd*. G is a slide-board, to draw out occasionally, to clean, and to sustain the plate H, to catch the colour on as it falls from the taker-off. F is a drawer, for the purpose of containing curriers' shavings, which are the best things for cleaning paint-mills.

We shall now add an account of an improved mill for grinding indigo, or other dry colours. L, fig. 8, represents a mortar made of hard marble, or hard stone; M, a muller, nearly in the form of a pear, in the upper part of which an iron axis is firmly fixed; which axis, at the parts NN, turns in grooves or slits, cut in two pieces of oak, projecting horizontally from a wall; and when the axis is at work, it is secured in the grooves by iron pins, OO. P, the handle, which forms part of the axis, and by which the grinder is worked. Q, the wall, in which the oak pieces, NN, are fixed. R, a weight, which may occasionally be added, if more power is wanted. Fig. 9 shews the muller, with its axis, separate from the other machinery; its bottom should be made to fit the mortar. S is a groove cut through the stone. The indigo, &c. to be ground, is thrown above the muller into the mortar; on turning the handle the lumps fall into the groove cut through the muller, and are thence drawn under its action, and driven to the outer edge within the mortar, from whence the coarser particles again fall into the groove of the muller, and are again ground under it. A wooden cover, in two halves, with a hole for the axis, is usually placed upon the mortar, during the operation, to prevent loss of colour, or bad effect to the operator.

Mill, Foot, is a mill for grinding corn or any other substance, moved by the pressure of the feet of men or animals. In some foot-mills a horse or an ox is fixed to a stall upon a floor above a vertical wheel; and a hole is made in the floor in the place where the hind feet of the animal should stand; thus admitting those feet to press upon the rim of a wheel, and cause the wheel to turn upon its axle, and give motion to the whole mill. But in this kind of machine the animal will be obliged very unnaturally to move his hind feet while his fore feet will be at rest; and further, the motive force being applied near the vertex of the wheel will act but with little advantage; and the work done will be comparatively trifling.

Hand-Mill, or *horse-mill*, is that worked by the hand, or by horses, &c. There is a long beam or lever for moving it, so attached that it may receive many men or horses, to drive several mills at once. There is the cog-wheel, placed horizontally, with pins fixed, not on its plane, but on the outside, at the circumference of the joints. There are also the trundle-head, the support, the iron axis, and the drum where the mill-stones are inclosed.

MILLENARIANS, or Chiliasts, a name given to those who, in the primitive ages, believed that the saints will one day reign on earth with Jesus Christ a thousand years.

MILLEPES. See Oniscus.

MILLEPORA. See Madrepore, Zoophites, and Plate Nat. Hist. figs. 266, 267.

MILLERIA, a genus of the syngenesia polygamia necessaria class of plants, the compound flower of which is radiated; there is scarcely any visible receptacle of the seeds, which are single after each particular flower, and have no pappus or down. There are three species.

MILLET. See Millium, and Panicum.

Millet-grass. See Milium.

MILLING. See Fulling.

MIMOSA, the *sensitive plant*, a genus of the polygamia order, in the monœcia class of plants, and in the natural method ranking under the 33d order, lomentaceæ. The hermaphrodite calyx is quinquedentate; the corolla quinquefid; there are five or more stamina, one pistil, and a legumen; the male calyx is quinquedentate; the corolla quinquefid, with five, ten, or more stamina.

The name mimosa signifies "mimic;" and is given to this genus on account of the sensibility of the leaves, which, by their motion, mimic or imitate the motion of animals. This genus comprises 85 different species, all natives of warm climates. Of the sorts cultivated here in our stoves, &c. some are of the shrub and tree kind, and two or three are herbaceous perennials and annuals. The sensitive kinds are exceedingly curious plants in the very singular circumstance of their leaves receding rapidly from the touch, and running up close together; and in some sorts the footstalks and all are affected, so as instantly to fall downward as if fastened by hinges, which last are called humble sensitives. They have all winged leaves, each wing consisting of many small pinnæ. The following are the most remarkable:

1. The sensitiva, or common sensitive humble plant, rises with an under-shrubby prickly stem, branching six or eight feet high, armed with crooked spines; conjugated, pinnated leaves, with bijugated partial lobes or wings, having the inner ones the least, each leaf on a long footstalk; and at the sides and ends of the branches many purple flowers in roundish heads; succeeded by broad, flat, jointed pods, in radiated clusters. This is somewhat of the humble sensitive kind; the leaves, footstalks and all, receding from the touch, though not with such facility as in some of the following sorts.

2. The pudica, or bashful humble plant, rises with an under-shrubby, delineated, prickly stem, branching two or three feet round, armed with hairy spines. This is truly of the humble sensitive kind; for by the least touch the leaves instantly recede, contract, close, and, together with the footstalk, quickly decline downward, as if ashamed at the approach of the hand.

3. The pernambuca, or pernambuca slothful mimosa, recedes very slowly from the touch, only contracting its pinnæ a little when smartly touched: hence the name slothful mimosa.

4. The asperata, or Panama sensitive plant, seldom rises above three feet in height; but its slender branches extend considerably on the neighbouring bushes. It is armed with crooked sharp spines, so thickly set on the trunk, branches, and leaves, that there is no touching it with safety. But the plant has a beautiful appearance; the flowers are yellow and globular, growing at the extremity of the branches. The pods are hairy, brown, and jointed; each containing a small, flat, and brown seed. The leaves are numerous, small, and winged: next to those of the mimosa pudica they are the most irritable; contracting with the least touch, and remaining so for several minutes after. This species would form a good hedge or fence round a garden.

5. The punctata, or punctated sensitive mimosa, rises with a shrubby, upright, taper, spotted, unarmed stem, branching erectly five or six feet high; bipinnated leaves, of four or five pair of long winged folioles, having each about 20 pair of pinnæ; and at the axillas and termination of the branches oblong spikes of yellowish decandrious flowers, the inferior ones castrated; succeeded above by oblong seed-pods. This sort, tho' naturally shrubby and perennial in its native soil, yet in this country sometimes decays in winter. It is only sensitive in the foliola, but quick in the motion.

6. The viva, lively mimosa, or smallest sensitive weed, has many creeping roots, and spreads itself so as to cover large spots of ground. It rises at most to two inches, and has winged leaves, with numerous small pinnæ. The flower is globular, of a blueish colour, and grows in clusters from the axillæ: these are followed by little, short, hairy pods, containing smooth shining seeds. This is the most sensible of all the mimosas, the pudica not excepted. By running a stick over the plant, a person may write his name, and it will remain visible for ten minutes.

7. The quadrivalvis, perennial, or quadrivalve humble mimosa, has herbaceous, slender, quadrangular, prickly stems, branching and spreading all around, armed with recurved spines; bipinnated leaves of two or three pair of winged lobes, having each many pinnæ; and at the axillas globular heads of purple flowers, succeeded by quadrivalvular pods. This is of the humble sensitive kind, both leaves and footstalks receding from the touch.

8. The plena, annual, or double-flowered sensitive mimosa, rises with an herbaceous, erect, round, unarmed stem, closely branching and spreading every way, three or four feet high; bipinnated leaves of four or five pair of winged lobes, of many pairs of pinnæ; and at the axillas and termination of the branches, spikes of yellow pentandrous flowers, the lower ones double, succeeded by short broad pods. This annual is only sensitive in the foliola, but extremely sensible of the touch or air.

9. The cornigera, or horned Mexican mimosa, commonly called great horned acacia, has a shrubby, upright, deformed stem, branching irregularly, armed with very large horn-like white spines, by pairs, connected at the base; bipinnated leaves thinly placed; and flowers growing in spikes. This species is esteemed a curiosity for the oddity of its large spines, resembling the horns of animals, and which are often variously wreathed, twisted, and contorted.

10. The farnesiana, or fragrant acacia, grows in woodlands and waste lands in most parts of Jamaica; rising to 25 or 30 feet, with suitable thickness. Formerly the flowers of this tree were used as an ingredient in the theriaca andromachi of the old dispensatories. The tree is sometimes planted for a hedge or fence round inclosures; and the timber, though small, is useful in rural economy.

11. The arborea, or wild tamarind-tree, is common in all the woodlands, and especially near where settlements have been made, in Jamaica. It rises to a considerable height, and is proportionably thick. The timber is excellent, and serves many purposes in rural economy: it is of the colour of cedar, pretty hard, and takes a good polish. The leaves are numerous; the flowers globular and white. The pods are about a foot in length, of a fine scarlet colour; when they are ripe they open and become twisted. The seeds then appear.

12. The latifolia, shag-bark, or white wild tamarind. This excellent timber-tree is very common in Jamaica, and rises to a moderate height and good thickness. The trunk is rough and scaly: the leaves are numerous, of a rhomboidal figure, and yellowish cast. The flower-spikes are from the axillæ; their colour is yellow. The seed-vessels are flat, jointed, and twisted. The seeds are of the bigness of a vetch, white, and finely streaked with blue.

13. The lebeck, or ebony-tree. This is a native of the East Indies, but raised from seeds in Jamaica and St. Vincent's.

14. The scandens, cacoons, or mafootoo wyth, is frequent in all the upland valleys and woodlands on the north side of Jamaica. It climbs up the tallest trees, and spreads itself in every direction by means of its cirrhi, or claspers, so as to form a complete arbour, and to cover the space of an English acre from one root. This circumstance has a bad effect on the trees or bushes so shaded; light, air, and rain, (so necessary for all plants,) being shut out, the leaves drop off, the tree gradually rots, and the limbs fall down by the weight of this parasite.

The roots of this plant run superficially under the ground or herbage. The trunk is seldom thicker than a man's thigh; and sends off many branches, with numerous shining green leaves, each of which terminates in a tendril or clasper, that serves to fasten it to trees or bushes. The flower-spikes are from the axillæ: they are slender, and the florets on them small and numerous. The pod is perhaps the largest and longest in the world; being sometimes eight or nine feet in length, five inches broad, jointed, and containing 10 or 15 seeds. These seeds are brown, shining, flattened, and very hard, and called cacoons. They are the same as mentioned in the Philosophical Transactions, No. 222, page 298, by sir Hans Sloane, as being thrown ashore on the Hebrides and Orkneys.

This bean, after being long soaked in water, is boiled and eaten by some negroes; but, in general, there seems to be no other use made of it than as a sort of snuff-box.

15. The catechu, according to Mr. Ker (Med. Obs. and Inquir. vol. v. p. 151, &c.), grows only to 12 feet in height, and to one foot in diameter; it is covered with a thick, rough, brown bark, and towards the top divides into many close branches: the leaves are bipinnated, or doubly winged, and are placed alternately upon the younger branches: the partial pinnæ are nearly two inches long, and are commonly from 15 to 30 pair, having full glands inserted between the pinnæ: each wing is usually furnished with about 40 pair of pinnulæ, or linear lobes, beset with short hairs: the spines are short. From this tree, which grows plentifully on the mountainous parts of Indostan, where it flowers in June, is produced the officinal drug long known in Europe by the name of terra japonica.

16. The nilotica, or true Egyptian acacia, rises to a greater height than the preceding. The fruit is a long pod, resembling that of the lupin, and contains many flattish brown seeds. It is a native of Arabia and Egypt, and flowers in July. Although the mimosa nilotica grows in great abundance over the vast extent of Africa, yet gum arabic is produced chiefly by those trees which are situated near the equatorial regions; and we are told that in Lower Egypt the solar heat is never sufficiently intense for this purpose. The gum exudes in a liquid state from the bark of the trunk and branches of the tree, in a similar manner to the gum which is often produced upon the cherry-trees, &c. in this country; and by exposure to the air it soon acquires solidity and hardness. In Senegal the gum begins to flow when the tree first opens its flowers; and continues during the rainy season till the month of December, when it is collected for the first time. Another collection of the gum is made in the month of March, from incisions in the bark, which the extreme dryness of the air at that time is said to render necessary. Gum arabic is now usually imported into England from Barbary, in large casks or hogsheads. The common appearance of this gum is well known; and the various figures which it assumes seem to depend upon a variety of accidental circumstances attending its transudation and concretion. Gum arabic of a pale yellowish colour is most esteemed; on the contrary, those pieces which are large, rough, of a roundish figure, and of a brownish or reddish hue, are found to be less pure, and are said to be produced from a different species of mimosa; but the Arabian and Egyptian gum is commonly intermixed with pieces of this kind, similar to that which comes from the coast of Africa near the river Senegal.

Gum arabic does not admit of solution by spirit or oil; but in twice its quantity of water it dissolves into a mucilaginous fluid, of the consistence of a thick syrup; and in this state answers many useful pharmaceutical purposes, by rendering oily, resinous, and pinguious substances, miscible with water. The glutinous quality of gum arabic is preferred to most other gums and mucilaginous substances, as a demulcent in coughs, hoarsenesses, and other catarrhal affections, in order to obtund irritating acrimonious humours, and to supply the loss of abraded mucus. It has been very generally employed in cases of ardor urinæ and strangury; but it is the opinion of Dr. Cullen, "that even this mucilage, as an internal demulcent, can be of no service beyond the alimentary canal."

17. The senegal is a native of Guinea, and was some time ago introduced into Jamaica. The flowers are globular, yellow, and fragrant. The pods are brown, and of the size of a goose-quill. The tree, on being wounded, exudes gum arabic, though in less quantity, and less transparent, than that of the shops, which is obtained from the nilotica above described.

There are above 40 other species characterised in the Systema Vegetabilium.

MIMULUS, *monkey flower*, a genus of the didynamia angiospermia class of plants, with double stigmata, and a ringent monopetalous flower; the fruit is a bilocular capsule, with several seeds in each cell. There are three species.

MIMUSOPS, a genus of the octandria monogynia class of plants, the corolla of which consists of eight petals; and its fruit is a drupe. There are three species, trees of the East Indies.

MINA, in Grecian antiquity, a money of account, equal to a hundred drachms.

MINE, a deep pit under ground, whence various kinds of minerals are dug out; but the term is more particularly applied to those which yield metals. Where stones only are procured, the appellation of quarries is universally bestowed upon the places from which they are dug out, however deep they may be.

The internal parts of the earth, as far as they have been yet investigated, do not consist of one uniform substance, but of various strata or beds of substances, extremely different in their appearances, specific gravities, and chemical qualities, from one another. Neither are these strata similar to one another, either in their nature or appearance, in different countries; so that, even in the short extent of half a mile, the strata will be found quite different from what they are in another place. As little are they the same either in depth or solidity. Innumerable cracks and fissures, by the miners called lodes, are found in every one of them; but these are so entirely different in size and shape, it is impossible to form any inference from their size in one place to that in another. In these lodes or fissures the metallic ore is met with; and, considering the great uncertainty of the dimensions of the lodes, it is evident that the business of mining, which depends on that size, must in like manner be quite uncertain and precarious.

The insides of the fissures are commonly coated over with a hard, crystalline, earthy substance or rind, which very often, in the breaking of hard ore, comes off along with it; and is commonly called the capels or walls of the lode.

The breadth of a lode is easily known by the distance betwixt the two incrusted sides of the stones of ore; and if a lode yields any kind of ore, it is a better sign that the walls are regular and smooth, or at least that one of them is so, than otherwise; but there are not many of these fissures which have regular walls until they have been sunk down some fathoms.

Thus the inner part of the fissure in which the ore lies is all the way bounded by two walls of stone, which are generally parallel to one another, and include the breadth of the vein or lode. Whatever angle of inclination some fissures make in the solid strata at their beginning, they generally continue to do the same all along. Some are very uncertain in their breadth, as they may be small at their upper part and wide underneath; and vice versa. Their regular breadth, as well as their depth, is subject to great variation; for though a fissure may be many fathoms wide in one particular place, yet a little farther east or west it may not perhaps be one inch wide. This excessive variation happens generally in very compact strata, when the vein or fissure is squeezed, in a manner, through hard rocks which seem to compress and straiten it. A true vein or fissure, however, is never entirely obliterated, but always shews a string of metallic ore, or of a veiny substance; which often serves as a leader for the miners to follow, until it sometimes leads them to a large and richly impregnated part. Their length is, in a great measure, unlimited, though not the space best fitted for yielding metal. The richest state for copper is from 40 to 80 fathoms deep; for tin, from 20 to 60; and though a great quality of either may be raised at 80 or 100 fathoms, yet "the quantity is often too much decayed and dry for metal."

The fissures or veins of the Cornish mines extend from E. to W.; or, more properly, one end of the fissure points W. and by S., or W. and by N., while the other trends E. and by S. or E. and by N. Thus they frequently pass through a considerable tract of country with very few variations in their directions, unless they are interrupted by some intervening cause. But, besides this east and west direction, we are to consider what the miners call the underlying, or hade, of the vein or lode, viz. the deflection or deviation of the fissure from its perpendicular line, as it is followed in depth like the slope of the roof of a house, or the descent of the steep side of a hill. This slope is generally to the north or south; but varies much in different veins, or sometimes even in the same vein: for it will frequently slope or underlie a small space in different ways, as it may appear to be forced by hard strata on either side. Some of the fissures do not vary much from a perpendicular, while some deviate more than a fathom; that is, for every fathom they descend in perpendicular height, they deviate likewise as much to the south or north. Others differ so much from the perpendicular that they assume a position almost horizontal; whence they are also called horizontal or flat lodes, and sometimes lode-plots. Another kind of these has an irregular position with regard to the rest, widening horizontally for a little way, and then descending perpendicularly almost like stairs, with only a small string or leader to follow after; and thus they alternately vary, and yield ore in several flat or horizontal fissures. This, by the Cornish tinners, is called a floor or squat; which, properly speaking, is a hole or chasm impregnated with metal, making no continued line of direction or regular walls. Neither does a floor of ore descend to any considerable depth; for underneath it there appears no sign of a vein or fissure, either leading directly down, or any other way. This kind of vein is very rare in Britain. The fissures most common in Britain are the perpendicular and inclined, whether their direction is north or south, east or west.

The perpendicular and horizontal fissures probably remain little altered from their first position, when they were formed at the induration of the strata immediately after the waters left the land. The perpendicular fissures are found more commonly situated in level ground, at a distance from hills, and from the sea-shore; but with regard to the latter, we find that the upper and under masses of strata differ in their solidity and other properties. "Hence it is very plain that inclined fissures owe their deflection or underlie to some secondary cause, violence, or subsidence of the earth; for though perpendicular fissures are seldom to be seen, yet such as are inclined at very considerable depths become more and more perpendicular, as the more central strata, from the vast superincumbent weight, do not seem so likely to be driven out of their position as those which lie nearer the surface."

The fissures are often met with fractured as well as inclined; the reason of which has probably been a subsidence of the earth from some extraordinary cause. Though the metallic veins generally run from east to west, they are frequently intersected by veins or lodes of other matters, which run from north to south. Some of these cross veins contain lead or antimony, but never tin or copper. Sometimes one of these unmetallic veins intersects the true one at right angles; sometimes obliquely; and sometimes the mixture of both is so intimate, that the most expert miners are at a loss to discover the separated part of a true vein. When this last is intercepted at right angles, it is moved, either north or south, a very little way, perhaps not more than one fathom; in which case the miners having worked to a small distance in one of these directions, if they find themselves disappointed, turn to the other hand, and seldom fail of meeting with what they expected. Sometimes they are directed in their search by the pointing of a rib or string of the true vein; but when the interruption happens in an oblique direction, the difficulty of finding the vein again is much greater.

When two metallic veins in the neighbourhood of each other run in an oblique direction, and of consequence meet together, they commmonly produce a body of ore at the place where they intersect; and if both are rich, the quantity will be considerable; but if one is poor and the other rich, then both are either enriched or impoverished by the meeting. After some time they separate again, and each will continue its former direction near to the other; but sometimes, though rarely, they continue united.

It is a sign of a poor vein when it separates or diverges into strings; but, on the contrary, when several of them are found running into one, it is accounted a promising sign. Sometimes there are branches without the walls of the vein in the adjacent strata, which often come either obliquely or transversely into it. If these branches are impregnated with ore, or if they underlie faster than the true vein (that is, if they dip deeper into the ground), then they are said to overtake or come into the lode, and to enrich it; or if they do not, then they are said to go off from it, and to impoverish it. But neither these, nor any other, marks, either of the richness or poverty of a mine, are entirely to be depended upon: for many mines, which have a very bad appearance at first, do nevertheless turn out extremely well afterwards; while others, which in the beginning seemed very rich, turn gradually worse and worse: but, in general, where a vein has had a bad appearance at first, it will be imprudent to be at much expence with it.

Veins of metal, as has been already observed, are frequently so compressed betwixt hard strata that they are not an inch wide; nevertheless, if they have a string of good ore, it will generally be worth while to pursue them; and they frequently turn out well at last, after they have come into softer ground. In like manner, it is an encouragement to go on if the branches or leaders of ore enlarge either in width or depth as they are worked; but it is a bad sign if they continue horizontal without inclining downwards; though it is not proper always to discontinue the working of a vein which has an unfavourable aspect at first. Veins of tin are worth working when only three inches wide, provided the ore is good; and copper ores when six inches wide will pay very well for the working. Some of the great mines, however, have very large veins, with a number of other small ones very near each other. There are also veins crossing one another sometimes met with, which are called contras, vulgarly caunters. Sometimes two veins run down into the ground in such a manner that they meet in the direction of their depth; in which case the same observations apply to them as are applicable to those that meet in an horizontal direction. Sometimes a vein will suddenly disappear without giving any warning, by becoming narrower, or of worse quality; which by the miners is called a start or leap, and is very common in the mines of Cornwall. In one day's time they may thus be disappointed in the working a rich vein of tin, and have no further sign of any thing to work upon: at the fractured extremity of their vein they perceive a body of clay or other matter; and the method of recovering their vein is to drive on their work in the direction of the former part, so that their new work shall make the same angle with the clay that the other part of the vein does. Sometimes they sink a shaft down from the surface; but it is generally a matter of difficulty to recover a vein when thus lost.

The method of discovering mines is a matter of so much difficulty, that it seems surprising how those who were totally unacquainted with the nature of metals first came to think of digging them out of the earth. In modern times we know that mines have been frequently discovered by accident; as in sea-cliffs, among broken craggy rocks, by the washing of the tides or floods; also by irruptions and torrents of water issuing out of hills and mountains, and sometimes by the wearing of high roads.

Mines, however, are now most commonly discovered by investigating the nature of such veins, ores, and stones, as may seem most likely to turn to account: but there is a particular sagacity, or habit of judging from particular signs, which can be acquired only by long practice. Mines, especially those of copper, may also be discovered by the harsh and disagreeable taste of the waters which issue from them; though it is probable that this only happens when the ore lies above the level of the water which breaks out; for it does not seem likely that the taste of the ore could ascend, unless we were to suppose a pond or lake of water standing above it. The presence of copper in any water is easily discovered by immerging in it a bit of polished iron, which will thus instantly be turned of a copper colour, from the precipitation of the metal upon it. A candle, or a piece of tallow, put into water of this kind, will in a short time be tinged of a green colour.

After the mine is found, the next thing to be considered is, whether it may be dug to advantage. In order to determine this, we are duly to weigh the nature of the place, and its situation, as to wood, water, carriage, healthiness, and the like; and compare the result with the richness of the ore, the charge of digging, stamping, washing, and smelting.

The form and situation of the spot should be particularly well considered. A mine must either happen, 1. in a mountain; 2. in a hill; 3. in a valley; or, 4. in a flat. But mountains and hills are dug with much greater ease and convenience, chiefly because the drains and burrows, that is, the adits or avenues, may be here readily cut, both to drain the water, and to form gangways for bringing out the lead, &c. In all the four cases, we are to look out for the veins which the rains or other accidental circumstances may have laid bare; and if such a vein is found, it may often be proper to open the mine at that place, especially if the vein proves tolerably large and rich: otherwise the most commodious place for situation is to be chosen for the purpose, viz. neither on a flat, nor on the top of mountains, but on the sides. The best situation for a mine is a mountainous, woody, wholesome spot; of a safe easy ascent, and bordering on a navigable river. The places abounding with mines are generally healthy, as standing high, and every where exposed to the air; yet some places where mines are found prove poisonous, and can upon no account be dug.

Devonshire and Cornwall, where there are a great many mines of copper and tin, are a very mountainous country, which gives an opportunity in many places to make adits or subterraneous drains to some valley at a distance, by which to carry off the water from the mine, which otherwise would drown them out from getting the ore. These adits are sometimes carried a mile or two, and dug at a vast expence, as from 2000*l*. to 4000*l*. especially where the ground is rocky; and yet they find this cheaper than to draw up the water out of the mine quite to the top, when the water runs in plenty, and the mine is deep. Sometimes, indeed, they cannot find a level near enough to which an adit may be carried from the very bottom of the mine; yet they find it worth while to make an adit at half the height to which the water is to be raised, thereby saving half the expence.

The late Mr. Costar, considering that sometimes from small streams, and sometimes from little springs or collections of rainwater, one might have a good deal of water above ground, though not a sufficient quantity to turn an overshot-wheel thought, that if a sufficient fall might be had, this collection of water might be made useful in raising the water in a mine to the adit, where it might be carried off. But now the most general method of draining mines is by the steam-engine.

A Mine (in military affairs) is also a subterraneous cavity made according to the rules of art, in which a certain quantity of powder is lodged, which by its explosion blows up the earth above it.

It has been found by experiment that the figure produced by the explosion is a paraboloid; and that the centre of the powder, or charge, occupies the focus.

The place where the powder is lodged is called the chamber of the mine, or forneau.

The passage leading to the powder is called the gallery.

The line drawn from the centre of the chamber, perpendicular to the nearest surface of the ground, is called the line of least resistance.

The pit or hole, made by springing the mine, is called the excavation.

The fire is communicated to the mine by a pipe or hose, made of coarse cloth, whose diameter is about one inch and a half, called a saucisson (for the filling of which near half a pound of powder is allowed to every foot), extending from the chamber to the entrance of the gallery; to the end of which is fixed a match, that the miner who sets fire to it may have time to retire before it reaches the chamber.

To prevent the powder from contracting any dampness, the saucisson is laid in a small trough, called an auget, made of boards, three inches and a half broad, joined together lengthwise, with straw in it, and round the saucisson, with a wooden cover nailed upon it.

Galleries and chambers of mines.—Galleries made within the fortification, before the place is attacked, and from which several branches are carried to different places, are generally four feet or four and a half wide, and five feet or five and a half high. The earth is supported from falling in by arches and walls, if they are to remain for a considerable time; but when mines are made to be used in a short time, then the galleries are but three feet or three and a half wide, and five feet high, and the earth is supported by wooden frames or props.

The gallery being carried on to the place where the powder is to be lodged, the miners make the chamber. This is generally of a cubical form, large enough to hold the wooden box, which contains the powder necessary for the charge: the box is lined with straw and sand-bags, to prevent the powder from contracting dampness.

The chamber is sunk something lower than the gallery, if the soil permits; but where water is to be apprehended, it must be made higher than the gallery; otherwise the besieged will let in the water, and spoil the mine.

Quantities of powder to charge mines.—Before any calculation can be made of the proper charge for a mine, the density and tenacity of the soil in which it is to be made must be ascertained, either by experiment, or otherwise; for in soils of the same density, that which has the greatest tenacity will require the greatest force to separate its parts. The density is determined by weighing a cubic foot (or any certain quantity) of the soil; but the tenacity can only be determined by making a mine. The following table contains experiments in six different soils, which may be of some assistance to form a judgment of the nature of the soil, when an actual experiment cannot be had:

Nature of the Soil.	Density. Weight of 1 cubic foot.	Tenacity. Quantity of powder to raise 1 cub. fath.
1. Loose earth or sand	95 pds.	8 pds.
2. Common light soil	124	10
3. Loam, or strong soil	127	$12\frac{1}{4}$
4. Potter's clay, or stiff soil	135	$13\frac{1}{2}$
5. Clay, mixed with stones	160	16
6. Masonry - -	205	$21\frac{1}{2}$

Loading and stopping of mines.—The gallery and chamber being ready to be loaded, a strong box of wood is made of the size and figure of the chamber, being about one-third or one-fourth bigger than is required for containing the necessary quantity of powder: against the sides and bottom of the box is put some straw; and this straw is covered over with empty sand-bags, to prevent the powder from contracting any dampness: a hole is made in the side next the gallery, near the bottom, for the saucisson to pass through; which is fixed to the middle of the bottom, by means of a wooden peg, to prevent its loosening from the powder: or that, if the enemy should get to the entrance, he may not be able to tear it out. This done, the powder is brought in sand-bags, and thrown loose in the box, and covered also with straw and sand-bags; upon this is put the cover of the box, pressed down very tight with strong props; and, to render them more secure, planks are also put above them, against the earth, and wedged in as fast as possible.

This done, the vacant spaces between the props are filled up with stones and dung, and rammed in the strongest manner: the least neglect in this work will considerably alter the effect of the mine.

The auget is then laid from the chamber to the entrance of the gallery, with some straw at the bottom; and the saucisson laid in it, with straw over it: lastly, it must be shut with a wooden cover nailed upon it. Great care must be taken, in stopping up the gallery, not to press too hard upon the auget, for fear of spoiling the saucisson; which may hinder the powder from taking fire, and so prevent the mine from springing. The gallery is stopped up with stones, earth, and dung, well rammed, six or seven feet further from the chamber than the length of the line of least resistance.

MINERAL WATERS. See Waters.

MINERALOGY, is that science which treats of the solid and inanimate materials of which our globe consists; and these are usually arranged under four classes: the earthy, the saline, the inflammable, and the metallic, which are thus distinguished:

1. The earthy minerals compose the greater part of the crust of the earth, and generally form a covering to the rest. They are not remarkable for being heavy, brittle, or light-coloured. They are little disposed to chrystallize, are uninflammable in a low temperature, insipid, and without much smell.

2. The saline minerals are commonly moderately heavy, soft, sapid, and possess some degree of transparency.

3. The inflammable class of minerals is light, brittle, mostly opaque, of a yellow, brown, or black colour, seldom chrystallize, and never feel cold.

4. Metallic minerals are characterized by being heavy, generally opaque, tough, malleable, cold, not easily inflamed, and by exhibiting a great variety of colours, of a peculiar lustre.

Under each of these classes are various genera, species, sub-species, and kinds, which will be noticed in order. Sometimes, as in the vegetable kingdom, we find a strict affinity between different species of minerals, and in that case they are said to belong to the same family; but in mineralogy, one class does not always blend with another in a chemical point of view, or furnish that beautiful gradation and almost imperceptible union which is to be traced in the other kingdoms of nature.

As the external characters are of the first importance in facilitating our acquaintance with minerals, we shall briefly explain this subject, before we proceed to the classification of the different substances.

Of the external characters of Minerals.

The external characters of minerals are either generic or specific. The generic characters are certain properties of minerals, without any reference to their differences, as colour, lustre, weight, &c.; and the differences between these properties form the specific characters.

Generic characters may be general or particular. In the first division are comprehended those that occur in all minerals, in the last those that are found only in particular classes of minerals.

The particular generic external characters are thus advantageously arranged:

1. Colour.

2. Cohesion of particles; distinguished into solid, friable, and fluid.

In solid minerals are to be regarded the external shape, the external surface, and the external lustre. When broken, the lustre of the fracture, the fracture itself, and the shape of the fragments, are to be noticed. In distinct concretions, regard must be paid to the shape of the concretions, their surface, their lustre, transparency, streak, and soiling. All these may be ascertained by the eye. By the touch, we may discover the hardness of minerals their tenacity, frangibility, flexibity, their unctuosity, coldness, weight, and their adhesion to the tongue. By the ear we distinguish their sound, and by the smell and taste the qualities which these two senses indicate.

In friable minerals, external shape, lustre, aspect of particles, soiling, and degree of friability, are to be attended to.

In fluid minerals the lustre, transparency, and fluidity, are principal objects to be regarded.

The specific external characters of minerals are founded on the distinctions and varieties of the two great generic divisions. And first, of colours, the names of which are derived from certain bodies in which they most generally occur, either in a natural or artificial state, or from different mixtures and compositions of both.

I. Colour.

1. White. This may be snow-white, reddish-white, yellowish-white, silver-white, greyish-white, greenish-white, milk-white, or tin-white.

2. Grey. Lead-grey, blueish-grey, pearl-grey, reddish-grey, smoke-grey, greenish-grey, yellowish-grey, steel-grey, and ash-grey.

3. Black. Greyish-black, brownish-black, dark-black, iron-black, greenish-black, and blueish-black.

4. Blue. Indigo-blue, Prussian-blue, lavender-blue, smalt-blue, sky-blue.

5. Green. Verdigris-green, celaden-green, mountain-green, emerald-green, leek-green, apple-green, grass-green, pistachio-green, asparagus-green, olive-green, blackish-green, canary-green.

6. Yellow. Sulphur-yellow, lemon-yellow, gold-yellow, bell-metal-yellow, straw-yellow, wine-yellow, Isabella-yellow, ochre-yellow, orange-yellow, honey-yellow, wax-yellow, brass-yellow.

7. Red. Morning-red, hyacinth-red, brick-red, scarlet-red, copper-red, blood-red, carmine-red, cochineal-red, crimson-red, columbine-red, flesh-red, rose-red, peach-blossom-red, cherry-red, brownish-red.

8. Brown. Reddish-brown, clove-brown, hair-brown, yellowish-brown, tombac-brown, wood-brown, liver-brown, blackish-brown.

Besides these distinctions, colours may be clear, dark, light, or pale; they may have a tarnished appearance, a play, a changeability, an iridescence, an opalescence, a permanent alteration, and a delineation of figure or pattern, such as dotted, spotted, clouded, flamed, striped, veined, dendritic, or ruiniform.

II. Cohesion of Particles.

Minerals are divided into, 1. Solid, or such as have their parts coherent, and not easily moveable; 2. Friable, or that state of aggregation in which the particles may be overcome by simple pressure of the finger; and, 3. Fluid, or such as consist of particles which alter their place in regard to each other by their own weight.

1. *Solid Minerals.*

External aspect has three things to be regarded, 1. The shape; 2. The surface; and 3. The lustre. The external shape again may be common, particular, regular, or extraneous; and hence arise the specific differences.

1. The common external shape may be massive; disseminated coarsely, minutely, or finely; in angular pieces, sharp-cornered or blunt-cornered; in grains, large, coarse, small, fine, angular, flat, round; in plates, thick or thin; in membranes or flakes, thick, thin, or very thin.

The particular external shape may be longish, as dentiform, filiform, capillary, reticulatic, dendritic, coralliform, stalactitic, cylindrical, tubiform, claviform, or fruticose; roundish, as globular, spherical, ovoidal, spheroidal, amygdaloidal, botryoidal, reniform, tuberose, or fused-like; flat, as specular, or in leaves; cavernous, as cellular in various forms, with impressions, perforated, corroded, amorphous, or vesicular; entangled, as ramose, &c.

In the regular external shape or chrystallization are to be regarded its genuineness, according to which it may be either true or suppositious; its shape, made up of planes, edges, angles, in which are to be observed the fundamental figure and its parts, the kind of fundamental figure, the varieties of each kind of fundamental figure, with their accidents and distinctions, and the alterations which the fundamental figure undergoes by truncation, by bevelment, by acumination, or by a division of the planes. There are a variety of figures under each of these subdivisions.

It must be remarked also that the external shape may be extraneous, or derived from the animal and vegetable kingdoms, as in fossils and petrifications.

2. The external surface contains several varieties of distinctions. It may be uneven, granulated, rough, smooth, or streaked in various ways and directions.

3. The external lustre is the third generic external character, and is of much importance to be attended to. In this we have to consider the intensity of the lustre, whether it is splendent, shining, glistening, glimmering, or dull; next the sort of lustre, whether metallic or common. The latter is distinguished into semimetallic, adamantine, pearly, resinous, and vitreous.

Aspect of the Fracture of solid Minerals.

After the external aspect, the fracture forms no inconsiderable character in minerals. Its lustre may be determined as in the external lustre; but the fracture itself admits of great varieties. It may be compact, splintery, coarsely splintery, finely splintery, even, conchoidal, uneven, earthy, hackly. If the fracture is fibrous, we are to consider the thickness of the fibres, if coarse or delicate; the direction of the fibres, if straight or curved; and the position of the fibres, if parallel or diverging.

In the radiated fracture we are to regard the breadth of the rays, their direction, their position, their passage or cleavage. In the foliated fracture, the size of the folia, their degree of perfection, their direction, position, aspect of their surface, passage or cleavage, and the number of cleavages, are to be noted.

The shape of the fragments may also be very various-regular, as cubic, rhomboidal, trapezoidal, &c. or irregular, as cuneiform, splintery, tabular, indeterminately angular.

Aspect of the distinct Concretions.

The shape of the distinct concretions forms very prominent external characters. They may be granular, different in shape, or in magnitude; they may be lamellar, distinct, concretious, differing in the direction of the lamellæ, in the thickness, with regard to shape, and in the position.

The surface of the distinct concretions may be smooth, rough, streaked, or uneven; as for their lustre, it may be determined in the same manner as the external lustre.

General Aspect as to Transparency.

Minerals, as is well known, have different degrees of transparency, which may be considered among their external characters. They may be transparent, semitransparent, translucent, translucent at the edges, or opaque.

The Streak.

The colour of this external character may be either similar or different. It is presented to us when a mineral is scraped with the point of a knife: and is similar, when the powder that is formed is of the same colour with the mineral, as in chalk; or dissimilar or different, as in cinnabar, orpiment, &c.

The Soiling or Colouring

Is ascertained by taking any mineral substance between the fingers, or drawing it across some other body. It may soil strongly, as in chalk, slightly, as in molybdena, or not at all, which is a quality belonging to most of the solid minerals. All the preceding external characters are recognized by the eye.

External Characters from the Touch.

These are eight in number, and are not destitute of utility to the mineralogical student. 1. Hardness; 2. Tenacity; 3. Frangibility; 4. Flexibility; 5. Adhesion to the tongue; 6. Unctuosity; 7. Coldness; 8. Weight.

Hardness may be tried by a capacity to resist the file, yielding a little to it, by being semi-hard, soft, or very soft. Tenacity has different degrees, in substances being brittle, sectile or mild, or ductile. The frangibility consists in minerals being very difficultly frangible, difficultly frangible, easily frangible, or very easily frangible. The flexibility is proved by being simply flexible, elasticly flexible, commonly flexible, or inflexible. The adhesion to the tongue may be strongly adhesive, pretty strongly, weakly, very weakly, or not at all. Unctuosity may be meagre, rather greasy, greasy, or very greasy. Coldness is subdivided into cold, pretty cold, rather cold. Weight may be distinguished into swimming or supernatant, light, rather light, heavy, very heavy. The three last divisions from the touch, are in the Wernerian system regarded as anomalous; but they seem properly to be classed under this head.

External Characters from the Sound or Hearing.

The different kinds of sound which occur in the mineral kingdom are, 1. A ringing sound, as in native arsenic and thin splinters of horn-stone; 2. A grating sound, as in fresh-burnt clay; 3. A creaking sound, as that of natural amalgam.

2. Friable Minerals.

The external characters drawn from minerals of this class are derived, first, from the external shape, which may be massive, disseminated, thinly coating, spumous, or dendritic: secondly, from the lustre, regarded under its intensity, whether glimmering or dull, and its sort, whether common glimmering or metallic glimmering: thirdly, from the aspect of the particles, as being dusty or scaly: fourthly, from soiling or colouring, as strongly or lightly: and lastly, from the friability, which may be loose or cohering.

3. Fluid Minerals.

Of external characters drawn from fluid minerals, there are only two kinds, which include three varieties: 1. The lustre, which is either metallic, as in mercury, or resinous, as in rock oil. 2. The transparency, which is transparent, as in naphtha; turbid, as in mineral oil; or opaque, as in mercury. 3. The fluidity, which may be fluid, as in mercury, or viscid, as in mountain tar.

External Characters from the Smell.

These may be spontaneously emitted and described, as bituminous, faintly sulphureous, or faintly bitter; or they may be produced by breathing on, and yield a clay-like smell; or they may be excited by friction, and smell urinous, sulphureous, garlick-like, or empyreumatic.

External Character from the Taste.

This character prevails chiefly in the saline class, and it contains the following varieties: a sweetish taste, sweetish astringent, styptic, saltly bitter, saltly cooling, alkaline, or urinous.

Having now given a synoptical view of the external characters of minerals, we shall proceed to their classification, and in this we shall chiefly follow the names and arrangement of professor Jameson.

CLASS I.

EARTHY FOSSILS.

First Genus. DIAMOND.

Diamond.

This precious stone has great variety of shades, exhibiting a beautiful play of colours. It occurs in indeterminately angular and completely spherical grains, which present planes of chrystallization, or are actually chrystallized. Its fundamental chrystal is the octaedron, which passes into various forms. It is hard in the highest degree, brittle, not very difficultly frangible, and has a specific gravity of 3.600.

The diamond has, by modern experiments, been proved to be nearly pure carbon, and begins to burn at 14° or 15° of Wedgewood. See Plate I. Mineralogy, figs. 1. and 2.

Second Genus. ZIRCON.

First Species. Zircon.

The prevailing colour is grey, but it occurs likewise green, blue, red, yellow, and brown, with various intermediate tints.

It is found most commonly in roundish angular pieces, with rounded angles and edges. When chrystallized, the figure is generally a rectangular four-sided prism, somewhat flatly acuminated by four planes, set on lateral planes; but of this figure there are several varieties. The chrystals are almost always very small, have a smooth surface, bordering on strongly splendent. Internally, the lustre is strongly splendent, passing into adamantine. Fig. 3.

Zircon is hard in a very high degree, brittle, frangible without great difficulty. Specific gravity 4.700. It forms a colourless transparent mass with borax, but is infusible by the blowpipe without addition.

Found in the island of Ceylon, where it was first discovered, and lately in Norway, imbedded in a rock composed of hornblende and felspar.

Frequently cut as a precious stone, and used as an inferior kind of diamond, of which it was once considered as a variety. Its play of colours very considerable.

Second Species. Hyacinth.

The chief colour is red, passing to reddish-brown, and to orange-yellow. The figure a rectangular four-sided prism, flatly acuminated by four planes, which are set in the lateral edges. Of this figure, however, several varieties occur.

The chrystals are generally small, and always imbedded. The lateral planes smooth, and externally shining. Internally it is splendent and glassy, inclining somewhat to resinous. Fig. 4.

The hyacinth is transparent, very hard, frangible without particular difficulty; feels a little greasy when cut, and has a specific gravity of about 4.000.

Is fusible with borax. Exposed to the blowpipe it loses its colour, but not its transparency.

Occurs in rocks of the newest floetz trap formation, and sometimes in sand. Is a native of Ceylon, the country of gems; of Spain, of Portugal, France, Italy, Saxony, and probably Scotland.

It takes a fine polish, and when the colours are good, it is highly valued. A third species, called cinnamon stone, has lately been discovered at Columbo, in Ceylon.

Third Genus. FLINT.

First Species. Chrysoberyl.

The prevailing or general colour is asparagus-green, passing into a variety of allied shades. It exhibits a milk-white light; occurs in roundish and angular grains, which sometimes approach in shape to the cube. It is seldom chrystallized; but when in this state, it commonly presents a longish six-sided table, having truncated lateral edges, and longitudinally streaked lateral planes. The chrystals are small, externally shining, and internally splendent. Fig. 5.

It is hard, brittle, not very easily frangible, with a specific gravity of 3.600. Without addition, it is infusible.

The chrysoberyl is found in Brazil, and in the sand of Ceylon. It is sometimes set in rings with a yellow foil, but is rarely in the possession of our jewellers.

Second Species. Chrysolite.

The chief colour is pistachio-green, of all degrees of intensity. It occurs in original angular sharp-edged pieces, with a rough, scaly, splintery surface, and when chrystallized, exhibits a broad rectangular four-sided prism, with its lateral edges sometimes truncated, sometimes bevilled, and acuminated by six planes. Fig. 6.

The external surface of the chrystals is splendent, internally splendent, and vitreous.

Third Species. Olivine.

The colour is generally asparagus-green, of various degrees of intensity. It is found imbedded also in roundish pieces and grains; and when chrystallized, which is rare, in rectangular four-sided prisms.

Internally, it is shining, varying between glistening and splendent. It is semitransparent, very easy frangible; in a low degree hard, and not particularly heavy. It is nearly infusible without addition. Occurs imbedded in basalt; is frequently found in Bohemia, and also in Hungary, Austria, France, England, Ireland, Scotland, Sweden, Iceland, and Norway. Pieces as large as a man's head have been found in some parts of Germany.

Fourth Species. Augite.

The general colour is blackish-green. It occurs chiefly in indeterminate angular pieces and roundish grains. Occasionally it is chrystallized, and presents broad rectangular six-sided prisms. The chrystals are mostly small. Internally the lustre is shining, approaching sometimes to splendent.

The augite is only translucent, and but faintly transparent. It is hard, not very easily frangible, and not particularly heavy.

It is found in basalt, either singly or accompanied with olivine, in Bohemia, Hungary; at Arthur's-seat, near Edinburgh; in some of the Hebrides, and in Norway. From olivine it is distinguished by its darker colours, the form of its chrystallization, and its greater hardness.

Fifth Species. Vesuviane.

Its principal colour is dark olive-green, passing into other allied shades. It occurs massive, and often chrystallized in rectangular four-sided prisms. The chrystals are mostly short, and placed on one another. Externally their surface alternates between glistening and splendent. Internally they are glistening, with a lustre between vitreous and resinous.

The vesuviane is translucent, hard in a moderate degree, and approaching to heavy. Before the blowpipe it melts without addition.

It is found among the exuviæ of Vesuvius, from whence it derives its name, in Siberia and Kamtschatka. At Naples, it is cut into ring-stones, and sold under various names.

Sixth Species. Leuzite.

The colours are yellowish and greyish-white. It occurs mostly in original round and angular grains. When chrystallized, it exhibits acute double eight-sided pyramids. Internally it is shining, and approaching to glistening, with a vitreous lustre, inclining somewhat to resinous.

The leuzite is translucent and semitransparent. It is hard in a low degree, brittle, easily frangible, and not very heavy. It is infusible without addition. With borax, it forms a brownish transparent glass.

It is found in rocks of the newest floetz trap formation, particularly in basalt, near Naples, and in the vicinity of Rome. Bergman gave it the name of white garnet; but Werner has ascertained it to be a distinct species of itself.

Seventh Species. Melanite.

The general colour is velvet-black. It occurs chrystallized in a six-sided prism. The chrystals are middle-sized or small. Externally they are smooth and shining, approaching to splendent; internally shining, inclining to glistening.

The melanite is opaque, hard, pretty easily frangible, and not very heavy. It occurs imbedded in rocks of the newest floetz trap formation, and hitherto has been found only at Frescati and St. Albano, near Rome.

Eighth Species. Garnet.

This is divided into two sub-species, the precious garnet and the common garnet. See Garnet, and fig. 7.

Ninth Species. Pyrope.

The colour is dark blood-red. It occurs in small and middle-sized roundish and angular grains; but never chrystallized. Its lustre is splendent and vitreous. It is completely transparent, hard so as to scratch quartz, and not particularly heavy.

The pyrope is found imbedded in serpentine in Saxony and Bohemia. In Fifeshire, Scotland, it is found in the sand on the sea shore. It is employed in various kinds of jewellery, and is generally set in a good foil.

Tenth Species. Grenatite.

The colour is a dark reddish-brown. It is always chrystallized in broad six-sided prisms. The chrystals are small and middle-sized, internally glistening, with a lustre between vitreous and resinous.

The grenatite varies from opaque to translucent, is hard, brittle, easily frangible, and not particularly heavy.

It is found imbedded in mica slate, in St. Gothard, Switzerland; and is also met with in Britanny and in Spain.

Eleventh Species. Spinelle.

The predominant colour is red, which passes on into blue, green, yellow, and brown. It occurs in grains, and likewise chrystallized in octaedrons with several variations. The chrystals are very rarely middle-sized. Externally and internally the lustre is splendent and vitreous.

The spinelle alternates from transparent to vitreous: it is hard in a pretty high degree, and approaches to heavy. It is fusible with borax: occurs in rocks belonging to the newest floetz trap formation; and is found in Pegu and Ceylon. It is used as a precious stone, and considerably valued, though possessing neither the hardness nor the fire of the oriental ruby.

Twelfth Species. Sapphire.

The principal colour Berlin blue; but it is found also red, with all the intermediate shades between these two colours. It occurs in small rolled pieces, and chrystallized in double three-side pyramids, of which there are several varieties in figure.

The chrystals are small and middle-sized. Internally the lustre is splendent and vitreous. It is more or less transparent in different specimens. Some varieties, when cut, exhibit a star of six rays. Fig. 8.

The sapphire is hard in the highest degree, but yields to the diamond; it is easily frangible, and rather heavy, having a specific gravity of about 4.000.

It is infusible without addition: occurs in rocks of the newest floetz trap formation, and is supposed to be an inmate of granite, syenite, and other primitive rocks.

This precious stone is found in the utmost beauty in Pegu and Ceylon. It is also a native of Portugal, of France, and of Bohemia. Next to the diamond, it is the most valuable of gems, and is used in the finest kind of jewellery.

It should be observed, that the violet-coloured sapphire is the oriental amethyst; that the yellow is the oriental chrysolite and topaz; and that the green is the oriental emerald.

Thirteenth Species. Corundum.

The principal colour is a greenish-white, of various degrees of intensity. It occurs massive, disseminated, in rolled pieces, and chrystallized. The chrystallizations resemble those of the sapphire, and the chrystals are middle-sized and imbedded.

The corundum is duplicating translucent, hard in a high degree, pretty easily frangible, and approaches to heavy. It is supposed to occur imbedded in granite, syenite, or green-stone, and is found in the Carnatic and on the coast of Malabar. See Corundum.

Fourteenth Species. Diamond Spar.

The colour is a dark hair-brown. It occurs massive, disseminated, in rolled pieces, and chrystallized in six-sided prisms, or very acute six-sided pyramids. Internally, its lustre is splendent, approaching in a slight degree to adamantine. It may be cut so as to present an opalescent star of six rays, of a peculiar pearly light.

It is translucent on the edges, hard in a high degree, easily frangible, and not particularly heavy.

The diamond spar probably occurs in granite. It has hitherto been found only in China. Both this stone and corundum are employed in cutting and polishing hard minerals, and they seem to be nearly allied to each other.

Fifteenth Species. Emery.

Emery is hard in the highest degree, not very easily frangible, and is heavy. It occurs in beds of talc and steatite, and is frequently accompanied with calcspar and blende. It is found in Saxony, in the islands of the Archipelago, in Spain, Normandy, and is said also to be a native of the isles of Guernsey and Jersey.

It is of great use in cutting and polishing hard bodies.

Sixteenth Species. Topaz.

The chief colour is a wine-yellow, of all degrees of intensity. It is found massive, disseminated, and sometimes rolled, but most commonly chrystallized in oblique eight-sided or four-sided prisms, which exhibit several varieties. The chrystals are small and middle-sized, externally splendent; internally splendent, and shining: lustre vitreous.

The topaz alternates from translucent to transparent, and is duplicating transparent. It is hard in a high degree, easily frangible, and is not particularly heavy. It is fusible with borax; and some kinds in a gentle heat turn white, and are sometimes sold for diamonds.

It is commonly found in veins that traverse primitive rocks in Brazil, Siberia, in Pegu, and Ceylon; in Bohemia, Saxony, and in Cornwall. Exhibiting various forms and tints, it has often been confounded with other precious stones. It is much used in seals and rings.

Seventeenth Species. Emerald.

The green called emerald is the characteristic colour of this species, but it has all degrees of intensity from deep to pale. It is said to occur massive and in rolled pieces, but most commonly chrystallized in low equiangular six-sided prisms. The chrystals are middle-sized and small. Internally the lustre is intermediate between shining and splendent, and is vitreous. It alternates from transparent to translucent, and is duplicating transparent.

The emerald is hard, not particularly heavy, melts easily with borax, but is scarcely fusible before the blowpipe. It occurs in veins that traverse clay-slate, and at present is only found in South America, particularly in Peru, though the Romans are said to have procured it from Egypt and Ethiopia.

From the beauty and vivacity of its colour, the charming emblem of the vegetable kingdom, this precious stone is much admired, and employed in the most expensive kinds of jewellery. See Emerald.

Eighteenth Species. Beryl.

This is divided into two sub-species, the precious and the schorlous beryl. See Beryl, and fig. 9.

Nineteenth Species. Schorl.

This is divided into two sub-species, common schorl and tourmaline. Fig. 10.

Twentieth Species. Thumerstone.

The colour is commonly clove-brown, of various degrees of intensity. It is occasionally found massive, more frequently disseminated; but generally chrystallized in very flat and oblique rhombs. Externally, its lustre is generally splendent; internally, it alternates from glistening to shining, and is vitreous.

This species alternates from perfectly transparent to weakly translucent. It is pretty hard, very easily frangible, and not particularly heavy. It appears to be peculiar to the primitive mountains, and is found imbedded in limestone in Saxony, Dauphiny, Norway, Siberia, and Cornwall. Fig. 11.

Twenty-first Species. Iron-Flint.

The colour a yellowish-brown, bordering on liver-brown. It occurs commonly massive, but also chrystallized in small equiangular six-sided prisms. Externally, its lustre is splendent; internally, shining, and is intermediate between vitreous and resinous.

Iron-flint is opaque, and slightly translucent on the edges. It is pretty hard, somewhat difficultly frangible, and approaching to heavy. It occurs in iron-stone veins, and is found in Saxony, and, according to Karsten, at Bristol. It renders the iron ore, along with which it is dug, very difficult of fusion.

Twenty-second Species. Quartz.

Werner divides this into five sub-species, amethyst, rock chrystal (fig. 12), milk-quartz, common quartz, and prase. The first sub-species is again subdivided into common amethyst and thick fibrous amethyst. See QUARTZ, AMETHYST, &c.

Twenty-third Species. Horn-Stone.

Horn-stone is divided into three sub-species, splintery horn-stone, conchoidal horn-stone, and wood-stone.

First Sub-species. Splintery Horn-Stone.

The common colour grey, but often red, with various shades of each. It is usually found massive, or in large balls. Internally its lustre is dull; but glimmering when it approaches to the nature of quartz. It is more or less translucent on the edges, hard, brittle, very difficultly frangible, and not particularly heavy.

The substance is infusible without addition; and is found in the shape of balls in limestone, and sometimes forming the basis of porphyry. It is a native of Bavaria, Sweden, and the Shetland islands; and appears to differ from quartz in containing a larger proportion of alumina.

Second Sub-species. Conchoidal Horn-Stone.

The colour runs from greyish-white to yellowish and greenish-white. It occurs massive. Internally, it is a little glistening, strongly translucent on the edges, hard, easily frangible, and not particularly heavy.

Conchoidal horn-stone is found in beds or in veins, accompanied with agate, at Goldberg, in Saxony.

Third Sub-species. Wood-Stone.

The prevailing colour is ash-grey, but with many different shades. Its shape is exactly conformable to its former woody form, whether trunk, branches, or roots. Internally, it is sometimes dull, and sometimes glimmering and glistening; slightly translucent on the edges, pretty hard, easily frangible, and not particularly heavy.

It is found insulated in sandy loam in Saxony, Bohemia, Russia, Hungary, and at Loch Neagh in Ireland. It receives a good polish, and is applied to the same purposes as agate.

Twenty-fourth Species. Flint.

The general colour is grey, but with many varieties. It occurs massive, in regular plates, in angular grains and species, in globular and elliptical rolled pieces, in the form of sand, and tuberose and perforated. Sometimes it is chrystallized, when it exhibits double six-sided prisms, or flat double three-sided pyramids. Internally, the lustre is glimmering, translucent on the edges, hard, easily frangible, and not particularly heavy.

Twenty-fifth Species. Chalcedony.

This is divided into two sub-species, chalcedony and carnelian.

First Sub-species. Common Chalcedony.

The most common colour is grey. The external shape is various, being massive, in blunt-edged grains and rolled pieces, in original round balls, &c. &c. Internally, the chalcedony is almost always dull, commonly semitransparent, hard, brittle, rather difficultly frangible, and not particularly heavy. It occurs in amygdaloid, and in porphyry; and is found in Transylvania, in Iceland, Siberia, Cornwall, Scotland, and the Hebrides. Being susceptible of a fine polish, it is employed as an article of jewellery.

Second Sub-species. Carnelian.

The principal colour is a blood-red, of all degrees of intensity. It commonly occurs in roundish pieces, and also in layers: the lustre is glistening, bordering on glimmering, and is semitransparent. See CARNELIAN.

Agate.

The fossils known under this name are all compound substances; and hence cannot have a particular place in any systematic arrangement. Werner therefore has placed them as a supplement to the species chalcedony, which forms a principal constituent part of them, and disposes them according to their colour-delineations, thus: 1. Fortification agate; 2. Landscape agate; 3. Ribbon agate; 4. Moss agate; 5. Tube agate; 6. Clouded agate; 7. Land agate; 8. Star agate; 9. Fragment agate; 10. Punctated agate; 11. Petrifaction agate; 12. Coal agate; 13. Jasper agate. They are all compounded of chalcedony, carnelian, jasper, horn-stone, quartz, heliotrope, amethyst, indurated lithomarge, and opal, in different quantities and proportions; and are found in great abundance in Germany, France, England, Scotland, Ireland, and the East Indies.

The uses of agate are various. It is cut into vases, mortars, snuff-boxes, seals, handles to knives, and for many other useful purposes. See AGATE.

Twenty-sixth Species. Heliotrope.

The principal colour is intermediate between leek and dark celadon green, or mountain green. It occurs massive, and in angular as well as rolled pieces. Internally the lustre is glistening, and is always resinous. It is commonly translucent in the edges; is easily frangible, hard, and not particularly heavy.

Heliotrope is found in rocks belonging to the floetz trap formation, in Asia, Persia, Siberia, Saxony, and Iceland.

On account of its beautiful colour and its hardness, it is employed for nearly the same purposes as agate. See HELIOTROPE.

Twenty-seventh Species. Plasma.

The usual colour is intermediate between grass and leek-green, and of different degrees of intensity. It occurs in indeterminably angular pieces, which have a rough earthy crust. Internally its lustre is glistening. It is intermediate between semitransparent and strongly translucent, hard, brittle, frangible without great difficulty, and not particularly heavy.

Hitherto it has only been found among the ruins of Rome, and constituted a part of the ornamental dress of the antient Romans.

Twenty-eighth Species. Chrysopras.

Its characteristic colour is apple-green, of all degrees of intensity. It is found massive in angular pieces, and in thick plates. Internally it is dull; the lustre intermediate between translucent and semitransparent. It is hard, not very difficultly frangible, nor particularly heavy; and is found along with quartz, opal, chalcedony, &c. at Kosemuctz, in Lower Silesia.

Chrysopras is principally used for ring-stones, and some varieties are highly esteemed; but it is difficult to cut and polish.

Twenty-ninth Species. Flinty Slate.

This has been divided into two sub-species, common flinty slate, and Lydian stone.

First Sub-species. Common Flinty Slate.

The principal colour is grey, but there are many varieties of shades. It occurs massive in whole beds, and frequently in blunt-angled pieces, with a smooth and glimmering surface. Internally, it is faintly glimmering; more or less translucent on the edges; hard, brittle, difficultly frangible, and not particularly heavy.

It occurs in beds in transitive mountains in Saxony, at the lead-hills in Scotland, and other places.

Second Sub-species. Lydian Stone.

The colour is greyish-black, passing into velvet-black. It occurs massive, and is frequently found in trapezoidal-shaped rolled pieces. Internally, it is glimmering; opaque, hard, pretty easily frangible, and not particularly heavy. It is found in similar formations with the preceding, near Prague and Carlsbad in Bohemia, in Saxony, and in the Moorfoot and Pentland hills, near Edinburgh.

When polished, it is used as a test-stone for determining the purity of gold and silver; but is less suited for this purpose than basalt, and some kind of clay slate.

Thirtieth Species. Cat's Eye.

The principal colour is grey, of which it presents many varieties. It occurs in blunt-edged pieces, in rolled pieces, and likewise massive. Internally, it is shining; usually translucent, and sometimes also semitransparent. It is hard, easily frangible, and not particularly heavy.

Its geognostic situation is unknown. It is imported from Ceylon and the coast of Malabar; and is usually cut for ring-stones. Some of the varieties are highly valued.

Thirty-first Species. Prehnite.

The colours are various shades of green, white, and yellow. It is sometimes massive, and sometimes chrystallized in oblique four-sided tables. Externally, the chrystals are smooth and shining; internally, inclining to glistening and pearly.

Prehnite is translucent, sometimes passing into semitransparent and transparent: it is hard, easily frangible, and not very heavy. It occurs in Dauphiny in veins of the oldest formation; in Scotland in rocks belonging to the newest floetz trap formation; and was first discovered in Africa by colonel Prehn, from whom it receives its appellation.

Thirty-second Species. Zeolite.

This species is divided by Werner into five sub-species, 1. Mealy zeolite; 2 Fibrous zeolite; 3. Radiated zeolite; 4. Foliated zeolite; 5. Cubec zeolite. As they are principally distinguished from each other by fracture, hardness, and lustre, we shall only observe, that the chief colours of all are yellowish, whitish, and reddish, with a variety of intermediate shades; that zeolite occurs massive, in angular pieces, in balls, and sometimes chrystallized in short and oblique four-sided prisms, and in perfect smooth planed cubes; that it is according to the sub-species opaque, translucent, or even transparent; and that it is semihard, easily frangible, and not particularly heavy.

Zeolite occurs in rocks belonging to the newest formation, but is sometimes, though rarely, found in primitive green stone, either disseminated, in cotemporaneous balls, or lining or filling up air cavities or veins. All the different sub-species are natives of Scotland. The mealy zeolite is found in the Isle of Sky; the fibrous and radiated in the isles of Canary and Sky; the foliated in Staffa, and the cubic in the same isle, and likewise in Sky. They are likewise met with in Iceland, in Sweden, in Germany, and the East Indies. Figs. 13 and 14.

Thirty-third Species. Cross-Stone.

The colour is a greyish-white. It occurs chrystallized, either in broad rectangular four-sided prisms, or in twin chrystals. The chrystals are mostly small, and aggregated on one another. Both the internal and the external lustre is shining, inclining to splendent or glistening.

The cross-stone is translucent passing to transparent, semi-hard, easily frangible, and not particularly heavy. It has hitherto been found only in mineral veins, and in agate-balls, at Strontian, in Argyleshire, and at Andreasberg, in Hartz, as well as some other places.

Thirty-fourth Species. Agate-Stone.

The colour is a perfect azure blue, of different shades. It is found massive, disseminated, and in rolled pieces. The lustre is glistening and glimmering. It is translucent on the edges, pretty hard, brittle, easily frangible, and not particularly heavy.

The geognostic situation is not correctly ascertained. It is said to have been found near the lake of Baikal, in Siberia, in a vein accompanied with garnet, felspar, and pyrites. It occurs in Persia, China, Tartary, and Siberia; in South America; but in Europe has only been found among the ruins of Rome.

Its beautiful colour renders it an object of attraction, and being capable of receiving a high polish, it is applied to various useful purposes, and enters into the composition of many diffe ent ornaments. It is the lapis lazuli of painters. Werner is constantly making additions to his species under every genus.

Of those belonging to the flint genus, which are less known, and have been described with less precision than the preceding, are coccolite, found in Sweden and Norway; pistazite, found in Norway, Bavaria, and France; ceylanite, in Ceylon; enclase, in Peru; hyalite, near Franckfort; menilite, near Paris; lomonite, in Lower Britanny; natrolite, in Suabia; azurite, in Stiria, &c.; andalusite, or hardspar, in Saxony, France, and Spain; chiastolite, or hollow spar, in France and Spain, and probably in Cumberland; scapolite, in Norway; and arctizite, or wernerite, in Sweden, Norway, Switzerland, and lazulite.

FOURTH GENUS.

Clay *Genus.*

First Species. Jasper.

This is dividedinto six sub-species; Egyptian jasper, striped jasper, porcelain jasper, common jasper, agate jasper, and opal jasper.

Second Species. Opal.

Werner divides this into four sub-species, precious opal, common opal, semi-opal, and wood opal.

Third Species. Pitch-Stone.

The colours are black, green, brown, red, and occasionally grey. It occurs always massive in great beds and rocks. Internally, its lustre is shining. It is commonly translucent in a small degree, brittle, and pretty easily frangible.

Pitch-stone is fusible without addition; occurs in beds in the newest porphyry and floetz trap formation; and is found in Saxony, Hungary, in several of the Hebrides, and in Dumfriesshire. Some of its varieties bear a striking resemblance to pitch, from whence it receives its appellation.

Fourth Species. Obsidian.

The principal colour is velvet-black. It always occurs in angularly roundish-pieces. Internally it is splendent. Some of the varieties are translucent, others semi-transparent. It is hard, easily frangible, and not very heavy.

Obsidian occurs insular in the newer porphyry formation, and is found in Hungary, Iceland, in Peru, and various other countries. When cut and polished, it is sometimes used for ornamental purposes, and mirrors for telescopes have been formed of it. It probably owes its origin to fire.

Fifth Species. Pearl Stone.

Its colour is generally grey, sometimes black and red. It occurs vesicular, and the vesicles are long and roundish, with a shining pearly lustre. It is translucent on the edges, not very brittle, very easily frangible, and rather light.

Pearl stone is found in beds of porphyry, near Tokay, in Hungary, in the north of Ireland, and the Hebrides.

Sixth Species. Pumice Stone.

Its usual colour is a light yellowish-grey, passing into different neighbouring shades. It is small, and lengthened vesicular: its internal lustre glistening, generally translucent in the edges, soft, and seldom semi-hard, very brittle, easily frangible, and swims in fluids.

It occurs in various situations, generally accompanied by rocks that belong to the floetz trap formation; and though usually classed among volcanic productions, in some situations it evidently is of aquatic origin. It is found in the Lipari islands, in Hungary, Iceland, and on the banks of the Rhine; and is used for polishing stones, metals, glass, and ivory; and also for preparing parchment.

Seventh Species. Felspar

Is divided into four sub-species; compact felspar, common felspar, adularia, and Labradore stone. Fig. 15.

Eighth species. Pure Clay

Is snow white, with occasionally a yellowish tinge, and occurs in kidney-shaped pieces, which have no lustre. It is opaque, soils very little, adheres slightly to the tongue, is light, and intermediate between soft and friable.

Pure clay is found immediately under the soil, accompanied with foliated gypsum and selenite, at Halle, in Saxony, only.

Ninth species. Porcelain Earth.

The colour is generally a reddish-white, of various degrees of intensity. It occurs massive and disseminated; its particles are fine and dusty, slightly cohering, and feeling fine and light.

It is found in beds in gneiss, accompanied with quartz and other substances, in Saxony, at Passau, Limoges, and in Cornwall. In China and Japan, where it is called kaolin, it is very abundant. It forms the basis of china ware.

Tenth species. Common Clay.

This is divided into six sub-species, as follow:

1. Loam, of a yellowish-grey colour, frequently spotted with yellow and brown, and occurring massive. It is dull and weakly glimmering, colours a little, adheres pretty strongly to the tongue, and feels slighty greasy. It is often mixed with sand, gravel, and iron ochre.

2. Potter's clay is of two kinds, earthy and slaty. The earthy is of a yellowish and greyish-white colour in general; occurs massive; is opaque, colours a little, feels somewhat greasy, and adheres strongly to the tongue. Slaty potter's clay is generally of a dark ash-grey colour, and feels more greasy than the preceding. It occurs in great rock masses, and in alluvial land. Both kinds are universally distributed, and are of great importance in the arts and in domestic economy.

3. Pipe clay is greyish-white, passing into yellowish-white, occuring massive, of a glimmering lustre, and having its particles pretty coherent. It feels rather greasy, is easily frangible, and adheres pretty strongly to the tongue.

4. Variegated clay is commonly white, red, and yellow, striped, veined, and spotted. It occurs massive, is soft, passing into triable, feels a little greasy, and adheres somewhat to the tongue. It is found in Upper Lusatia.

5. Clay-stone is commonly grey or red, with various intermediate tints. It occurs massive, is dull, opaque, soft, pretty easily frangible, feels rather meagre, and does not adhere to the tongue. It forms vast rock masses, occurs in beds and veins, and is found in Saxony, in Scotland, and in Shetland.

6. Slate clay is of a grey colour, presenting several varieties. It is massive, internally

dull, opaque, pretty soft, mild, easily frangible, adheres a little to the tongue, and feels meagre. It is generally found wherever the oval, floetz trap, and alluvial formations occur.

Eleventh species. Polier, or Polishing-Stone,

Is of a yellowish-grey colour, striped, and the colours alternate in layers. It occurs massive, is dull, very soft, adheres to the tongue, feels fine but meagre, and is nearly swimming. It is found in the vicinity of pseudo-volcanoes, though hitherto it has only been discovered in Bohemia.

Twelfth species. Tripoli

Is of a yellowish-grey colour, passing into ash-grey; occurs massive, is internally dull, very soft, feels meagre and rough, does not adhere to the tongue, and is rather light. It is found in veins and beds in floetz rocks in Saxony, in Derbyshire, and many other countries besides Tripoli, from whence it was first brought. Its use in polishing metals and minerals is well known.

Thirteenth species. Alum-Stone

Is of a greyish-white colour, occurs massive, shews a tendency to chrystallization, is soft, passing to friable, and light. It is found at Tolfa, near Rome, from whence the famous Roman alum is manufactured.

Fourteenth species. Alum Earth.

The colour is a blackish-brown, and brownish-black; it is massive, dull, feels a little meagre, and somewhat greasy; is intermediate between soft and friable, and light. It is found in beds of great magnitude in alluvial land, and in floetz trap formation in several parts of Germany, in Naples, and in France. It is lixiviated to obtain the alum it contains.

Fifteenth species. Alum-Slate

Is divided into two sub-species, as follow:

1. Common alum-slate is between a greyish and bluish-black colour, occurs massive, and in balls, is soft, not very brittle, easily frangible, and not very heavy.

2. Glossy alum-slate is of an intermediate colour, between blueish and iron-black; occurs massive, with a shining semi-metallic lustre, and in other respects resembles the former. It is found in beds and strata in Saxony, France, Scotland, and Hungary; and affords considerable quantities of alum.

Sixteenth species. Bituminous Shale

Is of a brownish-black colour, and occurs massive. Internally, its lustre is glimmering; it is very soft, rather mild, feels rather greasy, is easily frangible, and not particularly heavy.

It is found with clay-slate in the coal formation, in Bohemia, England, Scotland, and other coal countries.

Seventeenth species. Drawing Slate, or Black Chalk.

Its colour is a greyish-black, with a tinge of blue; it occurs massive, is opaque, colours and writes, is soft, mild, easily frangible, feels meagre but fine, and is rather light.

It is found in primitive mountains in France, Germany, Iceland, Scotland, and the Hebrides. When of a middling degree of hardness, it is used for drawing.

Eighteenth species. Whet-Slate.

The common colour is greenish-grey; it is massive; internally, weakly glimmering, semi-hard, feels rather greasy, and is not particularly brittle or heavy. It occurs in primitive mountains in Saxony, Bohemia, and the Levant. When cut and polished, it is used for sharpening knives and tools.

Nineteenth species. Clay-Slate.

Its principal colour is grey, of which there are many varieties. It occurs massive; internally, its colour is glistening, the substance opaque, soft, pretty easily frangible. It is found in vast strata in primitive and transition mountains in many different countries, but particularly in Scotland. When split into thin and firm tables, it is used for roofing houses, and other purposes.

Twentieth species. Lepidolite.

Its colour is a kind of peach-blossom, red, verging on lilac-blue, and occurs massive. Its internal lustre is glistening; it is translucent, soft, easily frangible, and easily melts before the blowpipe. Hitherto it has only been found in Moravia, where it lies in gneiss.

Twenty-first species. Mica, or Glimmer.

Its common colour is grey, of great variety of shades. It occurs massive, disseminated in thin tables and layers in other stones, and chrystallized either in equilateral six-sided tables, or in six-sided prisms. The surface of the chrystals is splendent; internally, shining and splendent. In thin plates, it is transparent; but in larger masses only translucent on the edges. It is semi-hard, feels smooth, but not greasy, elastically flexible, and more or less easily frangible.

It forms one of the constituent parts of granite, gneiss, and mica slate, and is almost peculiar to the primitive mountains. It was formerly used instead of glass, for windows and lanterns. Fig. 16.

Twenty-second species. Pot-Stone.

Its colour is a greenish-grey, of different degrees of intensity; is massive; lustre, internally, glistening and pearly, translucent on the edges; soft, feels greasy, and is very difficultly frangible.

It occurs in beds, or is indular; and is found in the country of the Grisons, in Saxony, and probably in Hudson's-bay, and is nearly allied to indurated talc.

Twenty-third species. Chlorite,

Which see.

Twenty-fourth species. Hornblende,

Which see. See also fig. 17.

Twenty-fifth species. Basalt.

The usual colour is greyish-black, of various degrees of intensity. It occurs massive, in blunt and rolled pieces, and sometimes vesicular. Internally, it is commonly dull. It is usually found in distinct concretions, which are generally columnar, and sometimes upwards of 100 feet in length. Commonly opaque, semi-hard, brittle, very difficultly frangible, melts without addition, and is almost exclusively confined to the floetz trap formation. It occurs in strata, beds, and veins, in almost every quarter of the globe, and is very abundant in Scotland, Ireland, and in other parts of the British European dominions. It is useful for building, as a touch-stone, as a flux, and in glass manufactures.

Twenty-sixth species. Wacce.

The colour is a greenish-grey, of various degrees of intensity. It occurs massive and vesicular, is dull, somewhat glimmering, opaque, usually soft, more or less easily frangible, and not particularly heavy.

It is said to belong exclusively to the floetz trap formation, where it occurs in beds and above clay, and also in veins. It is found in Saxony, Bohemia, and Sweden.

Twenty-seventh species. Clink-Stone

Is commonly of a dark greenish-grey colour, always massive, and occurring in irregular columns, and tabular distinct concretions. It is usually translucent on the edges, brittle, easily frangible, and when struck with a hammer, sounds like a piece of metal.

It is said to belong to the floetz trap formation, and generally rests on basalt. It is found in Lusatia, Bohemia, South America, and in the isle of Lambash, in the frith of Clyde.

Twenty-eighth species. Lava

Is divided into two sub-species.

1. Slag lava is of a greyish-black colour, passing into other shades. Externally, it is spotted, occurs vesicular and knotty, is generally opaque, semi-hard, brittle, easily frangible, and not particularly heavy.

2. Foam lava is of a dark greenish-grey colour, occurs small and fine, vesicular; externally, glimmering, slightly translucent on the edges, brittle, easily frangible, and light. It has often been confounded with pumice-stone, from which, however, it differs very much. On account of its lightness, it is used with advantage in arching vaults, and other kinds of building.

Twenty-ninth species. Green Earth.

Its colour is a celaden green, of various degrees of intensity. It occurs massive, in angular and globular pieces, and also disseminated. Internally, it is dull, streak glistening, very soft, easily frangible, and light.

It is principally found in amygdaloid, in Saxony, Bohemia, Scotland, and other places, and is used by painters.

Thirtieth species. Lithomage

Is divided into two sub-species.

1. Friable lithomage, or rockmarrow, is snow-white, or yellowish-white, occurs massive, as a crust, and disseminated; is generally coherent, feels greasy, and adheres to the tongue. Is found in tin veins, in Saxony.

2. Indurated lithomage is most commonly white, of which it presents several varieties; is massive; internally, dull; streak shining, very soft, easily frangible, feels greasy, and adheres strongly to the tongue. It occurs in veins of porphyry, &c. in Saxony, Bohemia, Bavaria, &c.

Thirty-first species. Rock Soap

Is of a brownish or pitch-black colour,

massive and disseminated, dull, opaque, does not soil, writes like drawing-slate, is easily frangible, and adheres strongly to the tongue.

It is found imbedded in rocks of the floetz trap formation, in Poland, and in the isle of Sky, but is very rare, and found only in small quantities.

Thirty-second species. Yellow Earth.

The colour is ochre-yellow, of different degrees of intensity; it is massive, streak somewhat shining, soils, writes, is very soft, adheres pretty strongly to the tongue, and feels somewhat greasy. It occurs in beds with iron-stone, in Upper Saxony, and is employed as a pigment.

To the clay genus, likewise, belong adhesive slate, float-stone, pinite, and umber, which may be considered as recent discoveries.

FIFTH GENUS.

TALC *Genus.*

First species. Bole.

Its colour is cream-yellow, passing into various other shades; is commonly massive, very soft, easily frangible, feels greasy, gives a shining streak, adheres to the tongue, and is light. It occurs in rocks belonging to the newest floetz trap formation, and is found in beds of wacce or basalt, in Silesia, Italy, &c. It was formerly employed in medicine, but is now used only as a pigment.

Second species. Native Talc Earth.

The colour is yellowish-grey, passing into cream-yellow. It occurs massive, tuberose, and of other shapes; is internally dull, almost opaque, soft, frangible without much difficulty, and adheres a little to the tongue.

It is found in beds of serpentine, but only hitherto in Moravia.

Third species. Meerschaum.

The usual colour is yellowish-white. It occurs massive, is internally dull, opaque, streak shining, is soft, adheres strongly to the tongue, feels a little greasy, and is nearly swimming. It is principally found in Natolia, in Samos, Hungary, Moravia, Spain, and America. It is much used in the manufacture of heads of tobacco-pipes. It is said that the Turks eat it as a medicine.

Fourth species. Fuller's Earth.

The colours are greenish-white, grey, olive, and oil-green. It is massive; internally dull, usually opaque, gives a shining streak, is very soft, feels greasy, and is not particularly heavy.

It is found in different situations in England, Saxony, Alsace, and Sweden; and is of essential use in cleansing woollen cloth, from which property it receives its name.

Fifth species. Neaphrite,

Which see.

Sixth species. Steatite.

The principal colour is white, of which it presents many varieties. It occurs massive, disseminated, in crusts, and chrystallized in six-sided prisms. Internally it is dull, streak shining, very soft, rather difficultly frangible, and feels greasy.

It is found in beds and veins in serpentine in Norway, Sweden, Saxony, England, Scotland, and China. It is used in the manufacture of porcelain, and for other purposes.

Seventh species. Serpentine,

Which see.

Eighth species. Schiller-Stone.

Its colour is olive-green, usually disseminated and massive; lustre shining, is soft, slightly brittle, and easily frangible. It occurs imbedded in serpentine, and is found in the Harz, in Saxony, Cornwall, and Ayrshire. It is often confounded with Labradore hornblende.

Ninth species. Talc.

This is divided into three sub-species.

1. Earthy talc is of an intermediate colour between greenish-white and light greenish-grey; friable, strongly glimmering, soils a little, feels rather greasy, and occurs in tin veins near Freyberg in Saxony.

2. Common, or Venetian talc, is principally of an apple-green colour, massive and disseminated, and in delicate and small tabular chrystals. It is almost always splendent and shining, translucent, in thin leaves transparent, flexible, but not elastic; soft, easily frangible, feels very greasy, and approaches to light.

It is almost wholly confined to the primitive mountains, where it is found imbedded in serpentine, and also in veins. It is found in the Tyrolese Alps, in Switzerland, and in Saxony.

3. Indurated talc is of a greenish-grey colour, of various degrees of intensity, occurs massive, is shining, passing to glistening, strongly translucent on the edges, soft, feels rather greasy, and is frangible without particular difficulty. It is found in primitive mountains in Tyrol, Austria, Scotland, and the Shetland isles.

Tenth species. Asbest.

See ASBESTOS.

Eleventh species. Cyanite,

Which see.

Twelfth species. Actynolite

Is divided into the following sub-species:

1. Asbestous actynolite is of a greenish-grey colour, occurs massive, disseminated, and in capillary chrystals; is internally glistening, translucent on the edges, soft, brittle, not easily frangible, nor particularly heavy. It is found in mineral beds in Saxony, and other parts of Germany.

2. Common actynolite is generally of a green leek-colour, passing into other shades of the same; it occurs massive, and likewise chrystallized in very oblique six-sided prisms, is splendent externally, semi-hard, rather brittle, and not easily frangible.

It is found in beds in primitive mountains, in Saxony, Switzerland, Norway, and Scotland.

3. Glassy actynolite is principally of a mountain-green colour, of various degrees of intensity; occurs massive, or in thin six-sided acicular chrystals, is shining and vitreous, strongly translucent, brittle, easily frangible, semi-hard, and is found in similar situations with the preceding.

Thirteenth species. Tremolite.

This is divided into the following sub-species:

1. Asbestous tremolite is of a whitish colour with a tinge of yellow, grey, red, or green: it occurs massive, and in capillary and acicular chrystals; internally glistening, very soft, easily frangible, and translucent on the edges.

2. Common tremolite is nearly of the same colour as the preceding, occurs massive, and in long and very oblique four-sided prisms: internally, is shining and glistening, translucent and semi-transparent, semi-hard, and pretty easily frangible.

3. Glassy tremolite is yellowish, reddish, greyish, and greenish-white; occurs massive, and chrystallized. Internally, is shining and pearly; is composed of very thin prismatic concretions, which are again collected into very thick prismatic concretions. It is translucent, brittle, and pretty easily frangible, and is said to emit a phosphoric light when rubbed in the dark.

Tremolite is principally found imbedded in primitive mountains, particularly the mountains of Tremola, in Switzerland. It is also found in different parts of Germany, and in Scotland.

Sahlite, lately discovered in Sweden, likewise belongs to the talc genus.

SIXTH GENUS.

CALC *Genus.*

First species. Rock Milk.

Its colour is yellowish-white; it is composed of dully, dusty particles generally weakly cohering, feels meagre yet fine, soils very much, and is very light. It is found in fissures and holes of mountains composed of floetz lime-stone, in Switzerland.

Second species. Chalk.

Its colour is principally all yellowish-white: it occurs massive, disseminated, and as crust over flint. Internally, is dull, opaque, soils, writes, soft, sometimes very soft, very easily frangible, feels meagre, and rather rough; effervesces strongly with acids, and is found principally on the sea-coast, though the Chiltern range in England is wholly composed of it. It is used for polishing and cleansing metals, glass, &c. and in some places as a manure, and cement in building.

Third species. Lime-Stone

Is divided into several sub-species:

1. Compact lime-stone is of two varieties, common compact lime-stone, and roe-stone. The former is generally of a grey colour, but is frequently veined, zoned, striped, or clouded; occurs massive, and in rolled pieces; is translucent on the edges, semi-hard, brittle, pretty easily frangible; is almost entirely confined, like lime in general, to the floetz mountains; occurs in sand, stone, and coal formations, in England, Scotland, and many other countries; and is frequently used for building or making roads, or, when burnt, for manure and cement.

The latter, or roe-stone, is of a chesnut-brown colour, is massive; internally dull, composed of small and fine-grained globular distinct concretions; semihard, brittle, not very easily frangible; occurs in beds in considerable quantities in Saxony, and is solely used for manure, for which its admixture with marl admirably fits it.

2. Foliated limestone is likewise of two kinds, granular limestone, and calc spar (figs. 18. and 19.). The former is commonly whitish, but presents many varieties of that colour; is massive, occurs almost always in

granular distinct concretions, is more or less translucent, semihard, brittle, easily frangible, is peculiar to the primitive and transitive mountains, and is chiefly found in Italy, whence it is distributed over Europe, for the purpose of statuary. The white marble of Paros, or granular limestone, has long been celebrated. Scotland furnishes some beautiful varieties of marbles, whose uses are well-known.

The latter, or calc spar, is principally white, but has many shades. It occurs massive, disseminated, and chrystallized, either in six-sided prisms, or three-sided prisms. The lustre alternates from splendent to shining and glistening, and is most commonly vitreous. The massive varieties are translucent, and sometimes even transparent. It is found veinigenous in almost every rock from granite to the newest floetz trap, occurs in a great variety of mineral veins, and is very universally disseminated, but is found particularly beautiful in Derbyshire, in Ireland, Saxony, France, and Spain.

3. Fibrous limestone, is of two varieties, common fibrous limestone, and fibrous limestone, or calc sinter. The former is commonly greyish, reddish, or yellowish-white; massive, lustre glistening, fragments splintery, more or less translucent, semihard, and occurs only in small veins.

The latter, or calc sinter, is principally white, of which it exhibits several beautiful varieties; occurs massive, and also in many particular external forms; internally is glimmering and pearly. It is commonly found in curved lamellar distinct concretions, is more or less translucent, semihard, brittle, and easily frangible; it is discovered in almost every limestone country. The grotto of Antiparos, and similar situations, afford striking instances of calc sinter. It is the alabaster of the ancients, and is still used in statuary.

4. Pea-stone is commonly yellowish-white, massive, internally dull, opaque or translucent on the edges; soft, very easily frangible; and is found in great masses in the vicinity of the hot springs at Carlsbad in Bohemia. It is composed of spherically round distinct concretions. All the varieties of limestone effervesce with acids.

Fourth species. Schaum, or foaming earth,

Is principally of a light yellowish colour; occurs massive and disseminated; is intermediate between shining and glistening; presents large, coarse, small, and fine-grained distinct concretions; is generally opaque, soft, completely friable; feels fine, but not greasy, and cracks a little. It is found in cavities of the oldest floetz limetone in Thuringia, and in the north of Ireland.

Fifth species. Slate spar.

Its colour milky, and greenish or reddish-white; occurs massive; lustre intermediate between shining and glistening, and completely pearly; fragments slaty, translucent, soft, and pretty easily frangible. It is found in limestone-beds in primitive mountains, and is produced in Norway, Saxony, and Cornwall.

Sixth species. Brown spar.

This is divided into the following sub-species:

1. Foliated brown spar, is principally white and red, with several varieties of each. It occurs massive, globular, with tabular impressions, and frequently chrystallized, externally shining, internally alternating from shining to splendent. It is found in granular distinct concretions of all magnitudes; is more or less translucent, semihard; a little difficultly frangible, and occurs in veins generally accompanied with calc spar, &c. in the mines of Norway, France, Germany, England, and other countries.

2. Fibrous brown spar is of a flesh-red, passing into rose-red; occurs massive, lustre glistening, fragments splintery, in other respects resembling the preceding. Hitherto it has been found only in Hungary and Transylvania.

Seventh species. Rhomb spar.

Its colours are yellowish and greyish-white; occurs only in regular middle-sized rhombs; lustre splendent, generally intermediate between translucent and semitransparent; is semihard, brittle, easily frangible, and is found imbedded in rocks belonging to the talc genus in Switzerland, Sweden, and on the banks of Loch-lomond in Scotland.

Eight species. Schaalstone.

The most common colour is greyish-white; it occurs massive, is shining and nearly pearly, translucent, pretty hard, brittle, easily frangible, and has been hitherto found only in the Bannat of Tameswar, accompanied by copper ore.

Ninth species. Stink-stone.

Its colour is wood-brown, passing into various other shades. It occurs massive, and sometimes disseminated through gyps, is dull or glimmering internally, translucent on the edges, rather soft, easily frangible, and when rubbed, emits an urinous smell. It is found in considerable quantities in the district of Mansfield in Thuringia.

Tenth species. Marle,

Which see.

Eleventh species. Bituminous marle slate.

Its colour is intermediate between greyish and brownish-black; it is massive, from glimmering to shining, fragments slaty, usually soft, not very brittle, easily frangible, and streak shining. It is found in beds along with the oldest floetz limestone, and contains much copper intermixed with it, on account of which it is usually smelted in Thuringia.

Twelfth species. Calc tuff.

The colour is yellowish-grey; it is generally perforated or marked with the impressions of other substances, also amorphous, ramose, and corroded. Internally dull, substance opaque, soft, easily frangible, and approaching to swimming. It occurs in alluvial land, and is found in Thuringia, at Gotha, and other places in Germany.

Thirteenth species. Arragone.

The principal colours are greenish-grey, and iron-grey. It occurs chrystallized in perfect equiangular six-sided prisms; the lustre is glistening, passing into shining, and is vitreous; it is semihard, brittle, not particularly heavy, and plurpluresces a little. It was first discovered in the province of Arragon, whence its name, imbedded in gyps, but has since been found in some other countries of the continent.

Fourteenth species. Appatite.

The usual colours are white, green, blue, and red; it generally occurs chrystallized, the radical form of which is the equiangular six-sided prism. Externally it is splendent, internally shining and resinous. It is commonly transparent, semihard, brittle, easily frangible, and occurs in tin veins in Saxony, Bohemia, and in Cornwall. It has been confounded with schorl, &c. Fig. 20.

Fifteenth species. Asparagus or spargel stone.

The principal colour is asparagus-green; it occurs only chrystallized in equiangular six-sided prisms, is internally shining, most frequently translucent, semihard, easily frangible, and brittle. Hitherto it has been found only in Murcia in Spain, though supposed to be produced in Norway. It is nearly allied to appatite. Fig. 21.

Sixteenth species. Boracite.

Its colours are yellowish, smoke and greyish white, passing to asparagus-green; it occurs in chrystallized cubes, with the edges and angles truncated, internally shining, commonly semitransparent, semihard, brittle, and easily frangible. Hitherto it has been discovered only at Luneburg in Hanover. Fig. 22.

Seventeenth species. Fluor,

Which see, also fig. 23.

Eighteenth species. Gyps.

This is divided into the following sub-species:

1. Gyps earth is of a yellowish-white colour, passing into some allied shades, is intermediate between fine scaly and dusky, dull and feebly glimmering, soils a little, feels meagre but soft and fine, and is light. It is found, though rarely, in gyps countries, and is formed in the same manner as rock milk. It is used as a manure.

2. Compact gyps, is commonly ash-grey, passing into smoke and yellowish-grey, is massive, internally dull, feebly translucent on the edges, very soft, frangible without great difficulty, and is employed in architecture and sculpture, under the name of alabaster.

3. Foliated gyps is commonly white, grey, or red, presenting spotted, striped, and veined colour delineations. It occurs massive, and in blunt-edged pieces, but seldom in chrystals. Internally it alternates from shining and glistening to glimmering, is translucent and duplicating, very soft, and not particularly difficultly frangible. It has been confounded with granular limestone.

4. Fibrous gyps is principally white, grey, and red, with various shades of each. It occurs massive and dentiform, the internal lustre is usually glistening and pearly, commonly semitransparent and translucent, very soft, and easily frangible.

Fossils belonging to the gyps formation, occupy different situations. They are found in Switzerland, Thuringia, Derbyshire, Cornwall, Moffat in Scotland, and other places.

Gyps, when burnt, forms an excellent cement, and is used for many ornamental purposes.

Nineteenth species. Selenite.

Its principal colour is snow-white, passing into other neighbouring shades: is generally massive, but not unfrequently chrystallized in pretty oblique six-sided prisms, the chrystals seldom large, but internally shining and splendent. Fig. 24.

Selenite is completely transparent, soft, somewhat flexible, not very frangible, and is found in the oldest gyps formation, in single chrystals in clay beds in the newest formation, and in other situations. It is common in Thuringia, at Montmartre near Paris, Shotover near Oxford, and in the isle of Sheppy. It is employed in taking the most delicate impressions, for crayons and other purposes.

Twentieth species. Cube spar.

The colour is milk-white with various allied shades. It is massive, occurring in large, coarse, and small ground distinct concretions. The lustre is shining, passing into splendent, translucent, softish, very easily frangible, and not particularly heavy. It is found in salt rocks in Salzbourg.

To the calc genus are also referred phosphorite, which forms a great bed in Estremadura in Spain; and the anhydrite, found in the duchy of Wirtemberg.

Seventh genus.

Baryte *Genus.*

First species. Witherite

Is commonly of a light yellowish-grey colour, generally massive, but sometimes chrystallized in six-sided prisms, or double six-sided pyramids. The lustre of the principal fracture is shining; the fragments generally wedge-shaped. It is translucent, somewhat semihard, brittle, easily frangible, and pretty heavy. Figs. 25 and 26.

It melts, without addition, before the blowpipe, into a white enamel, and occurs in veins along with heavy spar, lead-glance, &c. at Anglesark in Lancashire. Combined with muriatic acid, it may be used in medicine, though a very active poison of itself.

Second species. Heavy spar or baryte.

See Barytes.

Eighth genus.

Strontian *genus.*

First species. Strontian.

The usual colour is intermediate between asparagus and apple-green; it occurs most commonly massive, but sometimes chrystallized in a circular six-sided prism. The chrystals are scopiformly and manipularly aggregated. The lustre of the principal fracture is shining, of the cross fracture glistening. It is translucent in a greater or less degree, soft and semihard, brittle, easily frangible, dissolves in acids with effervescence, and occurs along with lead-glance, heavy spar, &c. at Strontian in Argyleshire, the only place where it has yet been found.

Second species. Celestine

Is divided into two sub-species:

1. Fibrous celestine, is of an intermediate colour, between indigo-blue and blueish-grey; it occurs massive and in plates, and also chrystallized, shewing a tendency to prismatic distinct concretions; is translucent, soft or semi-hard, easily frangible, and pretty heavy. It is found in Pennsylvania and in France.

2. Foliated celestine, is of a milky-white colour, falling into blue; it occurs massive, and also chrystallized in six-sided tables intersecting each other. It has a glistening lustre, is strongly translucent, softish, not particularly brittle, easily frangible, and hard. It occurs sometimes in sulphur beds, and is found very finely chrystallized in Sicily, and likewise near Bristol. Fig. 27.

CLASS II.

Fossil Salts.

The substances included in this class are confined to those which are found in a natural state only; and the greater part of them appear to be formed by the agency of water, air, &c.

The distinguishing characters of fossil salts are, their taste and easy solution. They resemble each other so closely, that the term *saline consistence* is used to express whatever relates to hardness, tenacity, and frangibility.

First species. Natron, or *Natural Soda.*

It may be divided into the two following sub-species:

1. Common natron, is of a yellowish or greyish-white colour, occurs in fine flakes or in dusty particles, has a sharp alkaline taste, effervesces with nitric acid, is easily soluble in water, and strikes blue vegetable tinctures green. It occurs as an efflorescence in the surface of soil, or on the sides and bottoms of lakes that occasionally become dry. It is found in very large quantities in Hungary, Bohemia, and Egypt, and in many other countries of the Old World.

2. Radiated natron, or natural soda, is of a greyish or yellowish-white colour, occurs in crusts or chrystallized in capillary or acicular chrystals, is glistening and translucent, and is found in large quantities in the province of Sukana in Barbary, and in Southern Africa.

Natron is principally employed in the manufacture of glass, soap, and for washing. It is also used as a flux after being purified.

Second species. Natural nitre.

The colour is greyish or yellowish-white, approaching to snow-white; it is flaky, sometimes verges to solid and massive, is of a saline consistence, and tastes saltly cooling. Placed on hot iron, it hisses and detonates; is usually found in thin crusts on the surface of the soil at particular seasons of the year, particularly in hot climates. It is also met with in various countries of Europe, and is much used in making gunpowder, in medicine, and the arts. The greatest part, however, employed for those purposes, is an artificial preparation from the refuse of animal and vegetable bodies undergoing putrefaction, and mixed with calcareous and other earth.

Third species. Natural Rock-salt

Is divided into two sub-species:

1. Rock or stone-salt, which is of two kinds, foliated and fibrous. The former is commonly of a white or grey colour, occurs massive and disseminated, and also chrystallized in cubes; in general is strongly translucent, rather hard, easily frangible, and feels somewhat greasy. The latter is greyish, yellowish, and snow-white; occurs massive, is strongly translucent, verging to semitransparent, decrepitates when laid on burning coals, and is found in beds lying over the first or oldest floetz trap formation. It forms whole hills at Cordova in Spain, is found also in Germany, and almost every country in the world. At Nantwich in Cheshire it has long been dug. Its use is as general as its dissemination. It is employed as a daily seasoning for our food, as a manure, in various manufactures, and for purposes too numerous to mention.

2. Lake-salt occurs either in thin plates, which are formed on the surface of salt-lakes, or in grains at their bottom. It is translucent, and of a saline consistence. It is found in Cyprus, near the Caspian Sea, and in various parts of Africa.

Fourth species. Natural sal ammoniac.

The colour is commonly greyish or yellowish-white. It is of a saline consistence, and is flaky, with an urinous taste. It is sometimes found massive, stalactitic, tuberose, botryoidal, and chrystallized. It is the product of volcanoes and pseudo-volcanoes, and is found in Italy, Sicily, in the vicinity of inflamed beds of coal both in England and Scotland, and in several countries of Asia.

Fifth species. Natural Epsom salt.

Colour a greyish-white. It occurs in capillary efflorescences, and is mealy or flaky, of a saline consistence, and taste saltly bitter. It is found as an efflorescence on clayey stones or gyps rocks, at Sena, at Solfatara, in Hungary, and Bohemia. It is also contained in many mineral springs, particularly those of Epsom, whence it derives its name. Epsom salts are much used as an easy purgative. Considerable quantities of magnesia may be obtained from them.

Sixth species. Natural Glauber salt.

The colour is usually greyish and yellowish-white. It occurs in the form of mealy efflorescences, in crusts, and sometimes chrystallized in acicular and in six-sided prismatic chrystals. Internally it is shining, with a vitreous lustre, is soft, brittle, easily frangible, and has a cooling but a saltly bitter taste.

It is found on the borders of salt-lakes, on moorish ground, on old and new-built walls in different countries of Europe, Asia, and Africa, and is used as a purgative medicine, and in some places as a substitute for soda in the manufacture of white glass.

Seventh species. Natural alum

Is of a yellowish or greyish-white colour; occurs as a mealy efflorescence, or in delicate capillary chrystals; has a sweetish astringent taste, and is produced in various situations in Scotland, Germany, Italy, Spain, Sweden, and in Egypt.

Alum is employed as a mordant in dyeing, in the manufacture of leather, as a medicine, for preventing wood from catching fire, and for preserving animal substances from putrefaction.

Eighth species. Hair salt.

The principal colours are snow, yellowish, and greyish-white. It occurs in delicate capillary chrystals, has a saline consistence, and a sweetish astringent taste.

Hair salt is found in different mine countries on the continent, at Whitehaven in England, and near Paisley in Scotland, and bears a striking resemblance to fibrous gyps.

Ninth species. Rock butter.

The colour is light-yellow or greyish-white. It occurs massive and tuberose, is translucent, has a saline consistence, or sweetish-sour astringent taste, and feels a little greasy. It oozes out of fissures of rocks of alum slate, and is found in Lusatia, Thuringia, Denmark, Siberia, and near Paisley in Scotland.

Tenth species. Natural vitriol

Is divided into the three following sub-species:

1. Iron vitriol, is commonly of an emerald and verdigris green. It occurs massive, tuberose, stalactitic, and chrystallized in different figures; is splendent and vitreous, has a saline consistence, and a sourish astringent taste. It is found usually along with iron pyrites, by the decomposition of which it is formed, in different countries of continental Europe, in many of the English mines, and in America. It is employed to dye linen yellow, and wool and silk black, in the preparation of ink, as a paint, &c.

2. Copper vitriol, is usually of a dark sky-blue colour. It occurs massive, disseminated, stalactitic, dentiform, and chrystallized; is translucent, soft, very brittle, and has a styptic taste. It is found in various mining countries, in Wicklow, and in Anglesea. It is used in cotton and linen printing, and when prepared is employed by painters.

3. Zinc vitriol, is of a greyish, yellowish, reddish, and greenish-white colour. It occurs tuberose, stalactitic, and coralloidal, is translucent, of a saline consistence, and a styptic taste. It is produced most abundantly where much blende occurs, and is found in Austria, Hungary, and Sweden.

Here it must be remarked, that borax, though so well known by name, is without a place in the Wernerian system, as it is uncertain whether or not it occurs in a solid state. It is most probable that it occurs only in solution in certain lakes. See Borax.

The new genus stallite, of which only one species, cryolite, has been found in Greenland, seems properly to come under this head.

CLASS III.

Inflammable Fossils.

Fossils belonging to this class are light, brittle, mostly opaque, yellow, brown, or black, seldom chrystallized, and never feel cold. They are more nearly allied to the metallic than to the earthy or saline classes.

First Genus.

Sulphur *Genus.*

First species. Natural sulphur.

It contains the two following sub-species:

1. Common natural sulphur, is of the colour the name expresses, but of different degrees of intensity. It occurs massive, disseminated, and chrystallized in octahedrons or double six-sided pyramids, is internally between shining and glistening, translucent, in chrystals frequently transparent, very soft, easily frangible, and light.

It is found in masses in gyps, in veins that traverse primitive rocks, in nests of limestone, and in other situations, and is produced in every quarter of the world, though in the British dominions it seems to be confined to Ireland.

2. Volcanic natural sulphur is of the colour the name imports, but with a considerable tinge of green. It occurs corroded, vesicular, perforated, amorphous, and sometimes as a sublimate in flowers, is glistening and resinous, and translucent in a slight degree. It is found only in volcanic countries, and among lava, but is produced in great abundance; and is employed in medicine, in the composition of gunpowder, and as a vapour in whitening wool and silk.

Second Genus.

Bituminous *Genus.* See Bitumens.

First species. Brown coal. See Coal.

Fourth Genus.

Graphite *Genus.*

First species. Glance coal.

This is divided into two sub-species:

1. Conchoidal glance coal, is of an iron-black colour, of different degrees of intensity, occurs massive and vesicular, internally shining, bordering sometimes on semihard, brittle, easily frangible, and light. It burns without flame or smell, and has hitherto been found only in the newest floetz mass formation, accompanied with other kinds of coal, at Meissner in Hessia. The fracture is conchoidal.

2. Slaty glance coal, is of a dark iron-black colour, occurs massive, is shining and glistening, soft, very easily frangible, light, and intermediate between sectile and brittle. It is found imbeded in masses, beds, and veins, in primitive, transitive, and floetz rocks, and is produced in Spain, Savoy, Saxony, Bohemia, and in the isle of Arran in Scotland. Its principal fracture is more or less slaty.

Second species. Graphite.

This contains two sub-species:

1. Scaly graphite, is commonly of a dark steel-grey colour. It occurs massive and disseminated, is usually glistening, fracture scaly-foliated, is very soft, perfectly sectile, writes and soils, feels very greasy, and is rather difficultly frangible.

2. Compact graphite, is rather blacker than the preceding, is internally glimmering with a metallic lustre, fracture fine-grained, in other respects agreeing with the preceding. It usually occurs in beds, and is found near Keswick in England, in Ayrshire in Scotland, and in various other parts of Europe, Asia, and Africa. The finer kinds are first boiled in oil, and then cut into pencils. The coarser parts and sawings are melted with sulphur, and then cast into coarse pencils for the use of artificers. It is likewise applied to various other purposes, under the vulgar name of black lead.

Third species. Mineral charcoal.

The colour is a greyish-black. It occurs in small angular and somewhat cubical-shaped pieces, is glimmering, with a silky lustre, soils strongly, is soft, and light. It is found in thin layers in different kinds of coal, and is widely disseminated.

Fifth Genus.

Resin *Genus.* See Resins.

First species. Amber.

This is divided into the two following sub-species:

1. White amber, is of a straw-yellowish colour. It occurs massive, and sometimes associated with the following sub-species, is glistening with a resinous lustre, fracture conchoidal, and simply translucent.

2. Yellow amber, is of a wax-yellow colour, passing into several neighbouring shades. It occurs always in indeterminately angular blunt-edged pieces, is externally dull, internally splendent, with a vitreous and resinous lustre. It is transparent, soft, rather brittle, pretty easily frangible, light, and swimming. It burns with a yellow-coloured flame, emitting an agreeable odour; when rubbed, it acquires a strong negative electrical virtue; is found in layers of bituminous wood, and in moor coal, on sandy sea-shores, and frequently floating on the sea. It is chiefly produced on the coasts of Prussia, in Sweden, Norway, &c. and according to some, has been found in the alluvial land near London. It admits of a fine polish, and is cut into necklaces, bracelets, snuff-boxes, and various other articles. The oil and acid obtained from it are used in medicine.

Second species. Honey-stone.

See Mellite.

CLASS IV.

Metallic Fossils.

First, Platina *Genus.*

First species. Native platina.

The colour is very light steel-grey, approaching to silver-white. It occurs in flat, smooth, and smallish grains, externally shining, lustre metallic, intermediate between semihard and soft, completely malleable, pretty flexible, and very heavy, its specific gravity being about 15.6.

Platina is the least fusible of metals, and does not amalgamate with mercury. It has hitherto been found only in sand accompanied with other metals, and is produced in South America, and probably also in St. Domingo and Barbadoes. From the peculiar qualities it possesses of resisting the action of many salts, of remaining unaltered in the air, and of receiving a fine polish, it has been rendered subservient to several purposes in chemistry and the arts. See Platina.

Second Genus. *Gold.*

First species. Native gold.

This is divided into three sub-species:

1. Gold-yellow native gold, is of a perfect colour, corresponding to its name. It seldom occurs massive, often disseminated in membranes, in roundish and flattish pieces, in grains, and also chrystallized in cubes, octahedrons, simple three-sided pyramids, garnet dodecahedrons, and acute double eight-sided pyramids. External lustre of the chrystals is splendent; internally it is glimmering, passing into glistening. It is soft, completely malleable, flexile, and uncommonly heavy. It is found in veins, beds, disseminated in rocks, and in grains, in almost every country of the world, but commonly in too small quantities to be collected for use. America and Africa supply the largest quantities.

2. Brass-yellow native gold, is principally of the colour of brass, occurs disseminated, capillary, moss-like, reticulated, and in leaves, also chrystallized in thin six-sided cubes, and is rather lighter than the preceding. It is found in different situations in Bohemia, Transylvania, and Norway.

3. Greyish-yellow native gold, is of a brass-yellow colour falling into steel-grey, occurs in very small flattish grains like platina, and is found with that metal.

Third Genus. *Mercury,* which see.

First species. Native mercury, or quick-silver.

The colour is tin-white; it occurs perfectly fluid in globules, is splendent, and has a metallic lustre, does not wet, feels very cold, and is uncommonly heavy. Before the blow-pipe it is volatilized, without any smell. It is usually found in cinnabar at Idria. It occurs in a compact limestone, and here it is very abundant. It is likewise produced in different parts of Germany, France, Spain, and in very large quantities in Peru.

The uses of quicksilver are multifarious, and cannot be enumerated in this place.

Second species. Natural amalgam.

Fluid or semi-fluid amalgam is of an intermediate colour between tin and silver-white. It occurs in small massive pieces and in balls, also disseminated and chrystallized in different forms. Externally it is shining and splendent, is soft and somewhat fluid; when cut or pressed, it emits a creaking sound like natural amalgam, and is uncommonly heavy.

Third species.. Mercurial horn-ore, or corneous mercury,

Is of an ash-grey colour, of various degrees of intensity; occurs very rarely massive, but commonly in small vesicles, internally chrystallized and splendent. It is soft, sectile, easily frangible, and heavy. It is usually found with the other species of mercury, and is produced in the same countries. It was first discovered in the mines of the Palatinate.

Fourth species. Mercurial liver-ore, or mercurial hepatic ore.

Compact mercurial liver-ore, is of an intermediate colour between dark-red and lead-grey, occurs massive, is glistening and glimmering internally, opaque, soft, sectile, easily frangible, and uncommonly heavy. It is the most common ore of mercury at Friaul in Idria.

Fifth species. Cinnabar.

Dark-red cinnabar, is principally of a perfect cochineal red, occurs massive, disseminated, in blunt-cornered pieces, in membranes, amorphous, dendritic, fruticose, and chrystallized. The chrystals are small, splendent externally, and shining internally. The massive cinnabar is opaque or translucent on the edges, very soft, sectile, easily frangible, and uncommonly heavy.

Bright-red cinnabar is of a lively scarlet-red colour. It occurs massive and disseminated, is internally glimmering, substance opaque, streak shining, soils, is very soft, sectile, very easily frangible, and very heavy. Both belong to the same countries with quicksilver. In Idria, Spain, and Peru, this genus is most abundant. It does not occur in Norway, Sweden, Great Britain, or Ireland. From the ore of cinnabar the greatest part of the mercury used in commerce is obtained.

FOURTH GENUS. *Silver.*

First species. Native Silver.

Common native silver is of the colour the name expresses. It occurs massive, disseminated, in pieces, plates, and membranes, as well as in other forms, besides being chrystallized in cubes, octahedrons, four-sided rectangular prisms, double six-sided pyramids, double three-sided pyramids, and hollow four-sided pyramids. It is soft, perfectly malleable, common flexible, and very heavy when pure. It appears to belong to the newer primitive rocks, where it occurs in veins, and is usually accompanied with heavy spar and quartz.

Second species. Antimonial silver.

The colour is intermediate between tin-white and silver-white. It occurs massive, disseminated, and chrystallized, is externally glistening, internally shining and splendent, with a metallic lustre. It is found in coarse, small, and fine granular distinct concretions, is sectile, not very difficultly frangible, soft, and uncommonly heavy. It contains upwards of 80 parts of silver. It occurs in veins composed of calx, spar, &c. in Spain, Germany, and other countries.

Third species. Arsenical silver.

The colour is tin-white, passing into silver-white. It occurs massive, disseminated, globular, and chrystallized; is softish, sectile, and very heavy. It contains about 12 parts of silver, much arsenic and iron, and is usually found with native arsenic and other minerals in Germany and Spain, but is a rare mineral.

Fourth species. Corneous silver-ore, or horn-ore.

The colour is most frequently a pearl-grey, of all degrees of intensity. It occurs massive, disseminated, in membranes, balls, and also chrystallized in cubes and in acicular and capillary chrystals. It is more or less translucent, soft, perfectly malleable, and heavy. It contains upwards of 60 parts of silver, and is found always in veins. It is widely distributed over the globe, but is most abundant in South America. It is sometimes found in Cornwall, and receives its name from cutting like horn.

Fifth species. Silver-black.

The colour is a blueish-black, whence its name. It occurs massive, disseminated, and in various other forms, of all degrees of consistence, from friable to solid. It gives a shining metallic streak, soils very little, is easily frangible, sectile, and heavy. It is found with silver-glance and horn-ore in Hungary, Bohemia, Norway, and Siberia.

Sixth species. Silver-glance

Is of a dark-blackish lead-grey colour, occurs usually massive, disseminated, in membranes, &c. and also chrystallized in cubes, octahedrons, garnet dodecahedrons, and double eight-sided pyramids. Externally it is shining and glistening; internally it alternates from shining to glistening, and has a metallic lustre. It is soft, completely malleable, pretty flexible, and uncommonly heavy, containing upwards of 80 parts of pure silver; and is found in veins, along with native silver and other minerals, in Hungary, Austria, and other countries of Europe, but more particularly in Mexico and Peru.

Seventh species. Brittle silver-glance.

The colour is intermediate between iron-black and dark lead-grey. It occurs massive, disseminated, in membranes, and frequently chrystallized in equiangular six-sided prisms, and rectangular four-sided tables. Externally it is highly splendent, internally shining and glistening. It is soft, brittle, easily frangible, and uncommonly heavy, containing upwards of 60 parts of silver. It is found always in veins, accompanied with other minerals, and principally in Hungary and Saxony.

Eighth species. Red silver-ore.

Dark-red silver-ore is intermediate between cochineal-red and lead-grey. It occurs massive, disseminated, dendritic, in membranes, and chrystallized in equiangular six-sided prisms. It is externally splendent; internally it alternates from shining to glimmering. The massive varieties are opaque; the chrystallized passing from semi to transparent. It is soft, sectile, easily frangible, and heavy.

This species occurs always in veins, accompanied with other minerals, and is found in Bohemia, Hungary, Norway, and other countries.

Ninth species. White silver-ore.

The colour is a very light lead-grey. It occurs massive and disseminated, has a metallic lustre, a shining streak, is soft, slightly flexible, easily frangible, and heavy. It contains large quantities of lead, sulphur, and antimony, and scarcely 10 parts of silver. It is always found in veins, and chiefly near Freyberg.

Tenth species. Black silver-ore.

The principal colour is iron-black, inclining to steel-grey. It occurs massive, disseminated, and chrystallized in three-sided pyramids. Internally it is shining with a metallic lustre. It is semihard, sectile, easily frangible, and heavy.

FIFTH GENUS. *Copper*, which see.

First species. Native copper.

The colour is copper-red, but frequently tarnished. It occurs massive, disseminated, and in various other forms, besides being chrystallized in cubes, dodecahedrons, &c. It is intermediate between semihard and soft, completely malleable, common flexible, difficultly frangible, and very heavy. It is usually found in veins and sometimes in beds, and is produced in Cornwall, Anglesea, the Shetland islands, and many other countries of Europe, Asia, and America. Copper may be applied to a vast number of useful purposes, and is next to iron the most necessary of metals.

Second species. Copper-glance.

Compact copper-glance is usually of a dark lead-colour, passing into blackish-grey. It occurs massive, disseminated, in membranes, and occasionally chrystallized; externally shining, internally between shining and glistening. It is soft, perfectly sectile, easily frangible, and heavy.

Third species. Variegated copper ore.

Its colour, when dug, is intermediate between copper-red and pinchbeck-brown, but it soon becomes tarnished. It occurs massive, disseminated in plates, membranes, and chrystallized in octahedrons. It is soft, slightly sectile, easily frangible, and heavy; and is found in beds, veins, and rocks of different formations, in Cornwall, and various parts of continental Europe. It yields about 70 parts of pure copper.

Fourth species. Copper pyrites.

When fresh, its colour is brass-yellow, of different shades according to its richness. It occurs massive, disseminated in membranes, &c. and also chrystallized in various figures. Externally it is intermediate between glistening and shining, internally soft; is between semihard and soft, brittle, easily frangible, and heavy.

Fifth species. White copper ore

Is of an intermediate colour between silver-white and bronze-yellow: occurs massive and disseminated; is internally glistening, with a metallic lustre; rather soft, brittle, easily frangible, and heavy. It is found in veins and mineral beds in primitive mountains, and is produced in Cornwall, in different parts of Germany, in Siberia, and in South America; but it is one of the rarest species of copper ore.

Sixth species. Grey copper ore, or Fahl ore.

The most common colour is steel-grey: it occurs massive, disseminated, and also crystallized in tetrahedrons, octahedrons, and garnet dodecahedrons. It is more or less semihard, brittle, easily frangible, and heavy; and is found in the newer primitive rocks, and likewise in transitive and floetz rocks, in several mines of Cornwall, in Germany, Italy, Sweden, Norway, Siberia, and Chili. It is usually smelted on account of the copper it contains.

Seventh species. Copper black.

The colour is usually intermediate between bluish and brownish-black: it occurs massive, or disseminated, and as a coating, to other ores of copper; is always more or less cohering, and heavy, containing from 40 to 50 parts of copper. It is usually found with copper pyrites, &c. and is produced in Silesia, Germany, France, Sweden, Norway, and Siberia. Sometimes it is very beautiful.

Eighth species. Red copper ore.

Compact red copper is usually of a dark cochineal-red colour: occurs massive, in membranes, crowded, amorphous, and also disseminated. Internally it is glimmering, inclining to glistening, with a semimetallic lustre: it is opaque, semihard, brittle, easily frangible, and heavy.

Ninth species. Tile ore.

Earthy tile ore is usually of a red hyacinth colour; massive, disseminated, and incrusting copper pyrites; is intermediate between friable and solid, soils slightly, is almost always coherent, and is heavy. It is found in veins; commonly accompanied with native copper ore and malachite.

Tenth species. Copper azure.

Earthy copper azure is of a smalt-blue colour; usually friable, and disseminated; is composed of dusty particles, does not soil, is chiefly cohering, and approaches to heavy. It is found in small quantities, usually accompanied with malachite and copper green, in different parts of Germany, in Norway, and Siberia.

Eleventh species. Malachite, which see.

Twelfth species. Copper green.

The principal colour is verdigris-green, of different degrees of intensity: it usually occurs massive, disseminated, and coating malachite; is internally shining; more or less transluscent, soft, not very brittle, easily frangible, and intermediate between heavy and not particularly heavy. It is found in the same geognostic situation with malachite, in Cornwall and other countries, but is rare.

Thirteenth species. Iron-shot copper green.

Earthy iron-shot copper green is usually of an olive-green colour: occurs massive, and disseminated; is dull, soils a little, soft, passing into friable, not very brittle, easily frangible, and not particularly heavy.

Fourteenth species. Copper emerald.

The colour is an emerald-green. It occurs in chrystallized six-sided prisms, which are externally and internally shining, with a vitreous lustre, and transluscent. It is semihard, brittle, and not particularly heavy; and is found in the remoter parts of the Russian dominions, and on the Chinese frontiers.

Fifteenth species. Copper mica

Is usually of an emerald-green colour: it occurs massive, disseminated, and occasionally chrystallized in very thin six-sided tables. Externally it is smooth and splendent, internally splendent with a pearly lustre. The massive varieties are transluscent; the chrystallized transparent. It is soft, sectile, not very brittle, nor particularly heavy; and has hitherto been found only in veins in Cornwall, where it passes under the unscientific name of foliatic arseniat of copper.

Sixteenth species. Lenticular ore.

The colour is sky-blue, sometimes passing into verdigris green. It occurs chrystallized in small, flat, double, four-sided pyramids; is externally shining; translucent, soft, rather brittle, and very easily frangible. Hitherto it has been found only in Cornwall.

Seventeenh species. Oliven ore.

Foliated oliven ore is of a perfect olive-green: seldom occurs massive, usually in drusy crusts, and in small chrystals, presenting acute rhomboids, and oblique four-sided prisms. Internally it is glistening, with an adamantine lustre. It is very soft, sectile, and heavy in a low degree; and has hitherto been found only in Cornwall.

SIXTH GENUS. *Iron.*

First species. Native iron

Is of a light steel-grey colour, inclining to silver white: it has hitherto been found only ramose; internally it is intermediate between glimmering and glistening, with a perfect metallic lustre, and a hackly fracture. It is between soft and semihard, perfectly malleable, common flexible, difficultly frangible, and uncommonly heavy. Hitherto it has been found only in loose masses on the surface of the earth, and is a rare production.

Second species. Iron pyrites.

Common iron pyrites is usually of a perfect bronze-yellow colour: it occurs massive, disseminated, in membranes, and also chrystallized in cubes, octahedrons, dodecahedrons, icosahedrons, and leuzite chrystals. It is hard, brittle, and heavy, and when rubbed or struck with steel, emits a strong sulphureous smell. It occurs in almost every kind of mineral repository, but most commonly in granite: its geographic distribution is equally extensive, but it is principally valued on account of the sulphur which may be extracted from it by sublimation.

Third species. Magnetic pyrites

Is of an intermediate colour between bronze-yellow and copper-red: it occurs massive and disseminated; is internally shining, with a metallic lustre, passes from hard to semihard, is brittle, easily frangible, and heavy. It is attracted by the magnet; is found only in primitive mountains, in Caernarvonshire, in several parts of Germany, in Norway, and Siberia; and is used for the same purposes as common pyrites.

Fourth species. Magnetic iron-stone.

Common magnetic iron-stone is of an iron-black colour: is massive, disseminated, and also chrystallized in cubes, octahedrons, and garnet dodecahedrons, and rectangular four-sided prisms. It is externally shining; internally between splendent and glistening, with a metallic lustre; is intermediate between hard and semihard, brittle, and heavy. It occurs most frequently in primitive mountains, and is found in the Shetlands, many parts of Germany, and other countries, particularly Sweden. When pure it affords excellent bar iron.

Fifth species. Iron glance.

Common iron glance is usually of a dark steel-grey colour, with several different shades. It commonly occurs massive and disseminated, and also chrystallized in flat, double, three-sided pyramids, and in double three-sided pyramids. Externally it alternates from splendent to glistening; internally it is most commonly glistening. It is hard, brittle, heavy, and rather difficultly frangible. It occurs in beds and veins in primitive and transitive mountains, and is found in considerable quantities in Sweden and other countries, and affords, when smelted, an excellent malleable iron.

Sixth species. Red iron-stone.

Red iron froth. The colour is intermediate between cherry-red and brownish-red. It occurs commonly friable, massive, sometimes coating and disseminated, and is composed of scaly particles, which are glimmering, and have a semi-metallic lustre. It soils strongly, feels greasy, and is pretty heavy. It is found usually in veins, and chiefly in primitive mountains in Lancashire, Cornwall, Norway, Germany, and Chili, and produces good iron.

Seventh species. Brown iron-stone.

Brown iron froth is of an intermediate colour between steel-grey and clove-brown, and is between friable and solid. It occurs massive, coating, spumous, &c. and is composed of scaly particles, shining and glistening, with a metallic lustre. It soils strongly, feels greasy, and is very light. It is commonly found lining drusy cavities, in brown hematite, in the Shetland isles, in various parts of Germany, and in Chili.

Eighth species. Sparry iron-stone.

The principal colour is a light yellowish-grey, which, on exposure to the air or heat, changes into brown or black. It occurs massive, disseminated, with pyramidal impressions, in plates, and chrystallized. It is found in granular distinct concretions, commonly translucent on the edges, semihard, not very brittle, easily frangible, and heavy. It is chiefly confined to the primitive and floetz mountains, and is produced in small quantities in England, Scotland, and Ireland; but on the continent it is in some places very abundant, and affords an iron which is excellently adapted for steel-making.

Ninth species. Black iron-stone.

Compact black iron-stone, is of an intermediate colour between bluish-black, and dark steel-grey: it occurs massive, tuberose, reniform, &c. is semihard, brittle, easily frangible, and heavy.

Tenth species. Clay iron-stone.

Reddle is of a light brownish-red, passing into cherry-red: it occurs only massive; soils strongly, and writes, is sectile, easily frangible, and rather heavy. It is chiefly found in the newer clay-slate, and is produced pretty abundantly in Germany and Siberia. The coarser varieties are used by the carpenter, the finer by the painter, under the name of red-chalk.

Eleventh species. Bog iron-ore.

Morass ore is of a yellow-brown colour, sometimes friable, sometimes coherent, and occurs massive, corroded, in grains, and tuberose. It soils pretty strongly, feels meagre but fine, and is lightish.

Twelfth species. Blue iron-earth.

When fresh it is whitish, but soon becomes of an indigo-blue colour, of different degrees of intensity; it occurs massive, disseminated, and thinly coating; the particles are dull and dusty; it soils slightly, feels fine, and is lightish. It is found in nests in clay-beds, and other situaions, in the Shetland isles, Iceland, Sweden, and Siberia.

Thirteenth species. Green iron-earth.

Friable green iron-earth is of a siskin-green colour, occurs massive and disseminated, is more or less cohering, soft, fine, easily frangible, and intermediate between particularly heavy and heavy.

Fourteenth species. Cube ore.

The colour is olive-green, of different degrees of intensity; it occurs massive, and chrystallized in small cubes, is translucent, soft, brittle, and not particularly heavy. It is found in veins, but hitherto only in Cornwall.

SEVENTH GENUS. *Lead.*

First species. Lead glance.

Common lead glance is of a fresh lead-grey colour, of different degrees of intensity; it occurs massive, disseminated, in membranes, &c. and also chrystallized in cubes, octahedrons, four-sided prisms, six-sided prisms, and three-sided tables. It is soft, sectile, externally easily frangible, and uncommonly heavy; and is found in veins and beds in primitive, transitive, and floetz mountains, at lead-hills in Lanarkshire, Derbyshire, and several other counties of England, Scotland, and Wales; besides being widely diffused over other parts of the globe. It is most frequently worked as an ore of lead, but sometimes as an ore of silver.

Second species. Blue-lead ore.

Is of an intermediate colour between dark indigo-blue and lead-grey; it occurs massive, and chrystallized in perfect six-sided prisms, is soft, sectile, easily frangible, and heavy, and is found in veins with other minerals of the same class, but is altogether a rare fossil, nor has it hitherto been discovered in Britain.

Third species. Brown-lead ore.

Is of a hair-brown colour of different degrees of intensity; it occurs massive, and chrystallized in six-sided prisms, is feebly translucent, soft, not very brittle, easily frangible, and intermediate between heavy and uncommonly heavy. It is found in veins, accompanied with other minerals, in Bohemia, Hungary, Brittany, and Saxony.

Fourth species. Black-lead ore.

The colour is greyish-black, of different degrees of intensity; it occurs massive, disseminated, and chrystallized in six-sided prisms; externally is usually splendent, internally shining with an adamantine lustre, is rather brittle, easily frangible, and heavy. It is found in veins, and almost always accompanied with other kinds of lead ore, at lead-hills in Scotland, in Bohemia, Saxony, and other mineral countries.

Fifth species. White-lead ore.

The colour is white, but has various shades; it occurs massive, disseminated, in membranes, but most commonly chrystallized in prisms and pyramids, of different figures. Externally, it is specular splendent, internally between splendent and glistening, with an adamantine lustre. It is soft, brittle, very easily frangible, and heavy, and is found in most places where the other species occur, in England, Wales, Scotland, Ireland, &c. Next to lead glance it is the most common of the lead ores, but is seldom in sufficient abundance to become an object to the metallurgist.

Sixth species. Green-lead ore.

Its colour is grass-green, of various shades; it generally occurs chrystallized, in six-sided prisms, is always translucent, soft, rather brittle, very easily frangible, and heavy. It is produced in Scotland and other countries, and is sometimes confounded with the preceding species.

Seventh species. Red-lead ore.

Its general colour is a hyacinth-red; it occurs massive but rarely, sometimes in membranes, but most commonly chrystallized in broad oblique four-sided prisms, is both externally and internally splendent, very soft, between brittle and sectile, easily frangible, and heavy. It is found in veins in gneiss and mica slate, accompanied with other fossils of the same kind, in Austria, Savoy, and Siberia, and on account of its beautiful colour is chiefly used as a pigment.

Eighth species. Yellow-red ore.

Its principal colour is wax-yellow; it is generally chrystallized in rectangular four-sided tables, cubes, octahedrons, equiangular eight-sided tables, and double eight-sided pyramids. Externally, it is shining and smooth, internally glistening, with a resinous lustre; it is translucent, soft, between brittle and sectile, easily frangible, and heavy. It is found in compact lime-stone in Carinthia, and some other countries of the continent.

Ninth species. Lead vitriol, or vitriol of lead.

The colour is yellowish-grey and greyish-white; it occurs only chrystallized in octahedrons of different figures. Externally it is shining, internally splendent, with an adamantine lustre. It is often semi-transparent, rather brittle, and heavy, and is found in Scotland, Anglesea, and Spain.

Tenth species. Lead earth.

Coherent lead earth is usually of a yellowish-grey colour; it occurs massive, is internally glimmering, usually opaque, soft, inclining to sectile, easily frangible, and heavy. It is found in primitive lime-stone in Derbyshire, Scotland, and many other countries.

EIGHTH GENUS. *Tin.*

First species. Tin pyrites.

The colour is intermediate between steel-grey and brass-yellow; it occurs massive and disseminated. Internally is glistening, and has a metallic lustre, is semihard, brittle, easily frangible, and heavy. It melts easily, and has hitherto been found only in Cornwall.

Second species. Tin stone.

The most common colour is blackish-brown; it oecurs massive, disseminated, in rolled pieces, in grains, like sand, but most frequently chrystallized in prisms and pyramids of different figures. Internally it is shining and glistening, it yields a greyish-white streak, is hard, easily frangible, brittle, and very heavy. It is found only in primitive rocks, and is confined to a few situations, like all the tin genus.

Third species. Cornish tin ore, or wood tin.

The most usual colour is hair-brown, of different degrees of intensity; it occurs usually in rolled pieces, sometimes reniform with impressions. It is found usually in large and coarse granular distinct concretions, is opaque, hard, brittle, easily frangible, and uncommonly heavy. It is infusible, and hitherto has only been found in Cornwall in alluvial land, accompanied with tin stone.

NINTH GENUS. *Bismuth.*

First species. Native bismuth.

Its colour is silver-white, with an inclination to red; it occurs massive, disseminated in leaves, reticulated, and chrystallized in small four-sided tables, and in small and indistinct cubes, and three-sided pyramids. It is soft, sectile, rather difficultly frangible, and uncommonly heavy; and is found in veins in primitive mountains in Saxony, and other parts of the continent; but it is doubtful if produced in Britain.

Second species. Bismuth glance.

The colour is a light lead-grey; it occurs massive, disseminated, and in acicular and capillary chrystals; it soils, inclines to sectile, is easily frangible, and heavy. It is found always in veins, and is usually accompanied with native bismuth, chiefly in Saxony, Bohemia, and Hungary.

Third species. Bismuth-ochre.

The colour is a straw-yellow, passing into other neighbouring shades; it is massive and disseminated, opaque, soft, not very brittle, easily frangible, and heavy. This mineral is rare, and seems to be confined to a few places in Saxony and Bohemia.

TENTH GENUS. *Zinc.*

First species. Blende.

Yellow blende is of a dark wax and sulphur yellow colour; it usually occurs massive and disseminated, but is sometimes chrystallized in rectangular four-sided prisms; it is shining and splendent both externally and internally, with an adamantine lustre; is found in large and coarse granular distinct concretions, is usually translucent, semihard, brittle, easily frangible, and heavy. It phosphoresces when rubbed in the dark; occurs most frequently in transitive mountains in Bohemia, and other parts of Germany.

Second species. Calamine.

The general colour is yellowish-grey, which passes into other neighbouring shades; it occurs massive, disseminated, cellular, corroded, &c. and chrystallized in tables, cubes, pyramids, and prisms. Externally the chrystals are splendent and shining; internally, between shining and glimmering. It is usually found in small and fine granular distinct concretions, is semihard, not very brittle, rather difficultly frangible, and heavy; and is produced in beds in a floetz limestone formation, accompanied with iron-ochre, lead-glance, &c. It is met with in all the mine counties of England and Scotland, in Germany, and other parts of the continent; and when purified and roasted, is used for the fabrication of brass, which is a compound of zinc and copper.

ELEVENTH GENUS. *Antimony.*

First species. Native antimony.

The colour is perfect tin-white: it occurs massive, disseminated, reniform, and probably chrystallized; in the fresh fracture it is splendent, and has a metallic lustre. It is found usually in coarse, small, and fine granular distinct concretions, is soft, sectile, easily frangible, and heavy in a low degree. It is produced in veins in Dauphiny and in the Harz, and disseminated in calx-spar in Westermanriland, in Sweden; but is a rare mineral.

Second species. Grey antimony ore.

Compact grey antimony-ore is usually of a light lead-grey colour, occurs massive, disseminated, and occasionally in membranes; internally is shining and glistening with a metallic lustre, is soft, not very heavy, easily frangible, soils, and becomes more shining in the streak. It is found in Sweden and some other countries, but is the rarest sub-species.

Third species. Black antimony ore.

Is of an iron-black colour, occurs only chrystallized in rectangular four-sided tables, is internally shining with a metallic lustre; is soft, rather sectile, and heavy. In Cornwall it is found of peculiar beauty.

Fourth species. Red antimony-ore.

Its colour is cherry-red; it occurs massive, often in membranes, but most frequently in delicate capillary chrystals; both externally and internally it is shining, and has an adamantine lustre. It is found in coarse, small, and longish granular distinct concretions, is opaque, not very brittle, and easily frangible; but is a very rare species.

Fifth species. White antimony ore.

It passes in colour from snow-white to several neighbouring shades; occurs massive and in membranes occasionally, but most commonly chrystallized in rectangular four-sided tables, cubes, and acicular and capillary chrystals. It is found in coarse and small granular distinct concretions, is translucent, soft, rather sectile and heavy. Before the blowpipe, it becomes wholly volatilized. It is found in veins in Bohemia, Hungary, and Saxony.

Sixth species. Antimony-ochre.

The colour is a straw-yellow, of various degrees of intensity; it seldom occurs massive and disseminated, but usually as a coating on chrystals of grey antimony ore. It is dull, soft, not very brittle, nor particularly heavy. It is found always in veins, in different parts of Germany, and is evidently found by the decomposition of grey antimony ore.

TWELFTH GENUS. *Cobalt.*

First species. White cobalt ore.

When fresh fractured the colour is usually tin-white; it occurs massive, disseminated, &c. and also chrystallized in cubes and double four-sided pyramids. It is found in coarse, small, and fine granular distinct concretions; is semihard, brittle, not very difficultly frangible, and heavy. It easily melts before the blowpipe, emits a strong arsenical smell, and yields a white metallic globule. It usually occurs in beds in primitive mountains, and is found in Sweden, Norway, and Silesia.

Second species. Grey cobalt ore.

On the fresh fracture its colour is light steel-grey inclining to white, but it becomes tarnished by exposure; it occurs only massive, disseminated, tubiform and specular; internally it is glimmering or glistening with a metallic lustre, is found in thick and curved lamellar distinct concretions, and is produced in Cornwall, Norway, and various other countries.

Third species. Cobalt glance.

The colour is a silver-white, slightly inclining to reddish: it is commonly massive and disseminated, sometimes chrystallized in different forms; is externally splendent, internally between shining and glistening, and has a metallic lustre. It is semihard, brittle, not very easily frangible; and when struck with steel, emits an arsenical smell. It is found in veins in various formations, in the different mine countries of the continent of Europe; and from it the greatest part of the cobalt in commerce is obtained, which is highly useful in the manufacture of glass, and as a paint.

Fourth species. Black cobalt ore.

Earthy black cobalt ore is of an intermediate colour between brownish and blueish-black, is composed of dull, dusky particles, which soil a little, usually cohering, streak shining, and very light.

Fifth species. Brown cobalt ochre

Is of a liver-brown colour, passing sometimes into other neighbouring shades; it occurs massive and disseminated, is internally dull, soft, sectile, easily frangible, and light; and appears to be peculiar to the floetz mountains in some parts of Germany and Spain.

Sixth species. Yellow cobalt ochre

Is usually of a dirty straw-yellow, occurs massive, frequently much bursten and corroded; it is internally dull, streak shining, soft, and rather friable, sectile, easily frangible, and light. It is the rarest species of cobalt ore, but most valued on account of its purity.

Seventh species. Red cobalt ochre.

Cobalt crust is of a peach blossom-red colour, of different degrees of intensity, occurs most frequently in velvety drusy coatings, and disseminated, is feebly glimmering, bordering on dull, scarcely soils, has a shining streak, and is very soft and light.

THIRTEENTH GENUS. *Nickel.*

First species. Copper nickel

Is of a red copper-colour of different degrees of intensity; it occurs usually massive and disseminated, is internally glistening, and has a metallic lustre. It is usually unseparated; sometimes, however, it is found in coarse and small granular distinct concretions, is semihard in a high degree, brittle, not very easily frangible, and heavy. Before the blowpipe it emits an arsenical smell and odour, and afterwards melts, though with difficulty. It is found in Cornwall, Norway, and many other countries, and is nearly allied to cobalt.

Second species. Nickel ochre

Is of an apple-green colour, occurs always as a coating or efflorescence, is composed of dull dusty particles, loose, or little cohering, feels meagre, and is light. It is found in the same situations with the preceding species. It is not certain that native nickel has yet been discovered, though it is mentioned by some mineralogists.

FOURTEENTH GENUS. *Manganese.*

First species. Grey manganese ore.

Radiated grey manganese ore is of a dark steel-grey colour, occurs massive, disseminated, and chrystallized in prisms of different varieties. It is found in coarse, large, and small granular distinct concretions; soils strongly when rubbed, is soft, brittle, rather difficultly frangible, and not particularly heavy. It is produced in several counties of England and Scotland, and in different parts of Germany.

Second species. Black manganese ore

Is of an intermediate colour between brownish-black and dark-greyish black, occurs massive, disseminated, and in octahedral chrystals. It is found in small and fine granular concretions; is opaque, semihard, brittle, and heavy; but is a rare mineral, and hitherto found only in a few places of Germany and Spain.

Third species. Red manganese ore

Is of a light rose-red colour, occurs massive and disseminated, is internally dull, translucent in a slight degree, hard, brittle, easily frangible, and heavy. It is found in veins in Norway, France, and some other countries.

FIFTEENTH GENUS. *Molybdena.*

First species. Molybdena.

Its colour is a fresh burning lead-grey; it occurs usually massive and disseminated, but also chrystallized in six-sided tables, and short six-sided prisms; internally it is splendent, the fracture perfectly foliated, and is found in large and coarse granular distinct concretions. It soils a little, is very soft, easily frangible, its thin leaves common flexible, sectile, feels greasy, and is heavy. It is one of the oldest of metals, and occurs only in primitive mountains, disseminated, or in veins; and is produced in Norway, Sweden, Bohemia, and other countries.

Sixteenth Genus. *Arsenic.*

First species. Native arsenic.

When fresh broken it is of a light whitish lead-grey colour, but it speedily tarnishes; it occurs massive, disseminated, reniform, and in plates, with various impressions. It is found in thin, curved, lamellar, distinct concretions; in the streak it becomes shining and metallic, semihard in a high degree, very easily frangible, and between sectile and malleable. It occurs only in primitive mountains, and in veins of a newer formation, and is found in various parts of Germany, in France, and in Chili.

Second species. Arsenic pyrites.

Common arsenic pyrites is, when fresh, of a silver-white colour, but soon acquires a yellowish tarnish; it occurs massive, disseminated, and also in chrystals of various figures. Internally, it is shining, with a metallic lustre; and is found usually unseparated, is hard, brittle, not easily frangible, and heavy. It occurs only in primitive mountains and in beds, and is produced in Norway, Germany, and Siberia. From this ore the white oxide of arsenic is principally obtained.

Third species. Orpiment.

Red orpiment is of an aurora-colour, of different degrees of intensity: it occurs massive, disseminated in membranes, and also chrystallized in oblique four-sided and six-sided prisms. It is translucent, but the chrystals are transparent, is very soft, yields a lemon or orange-coloured streak, and is easily frangible. It is found both in primitive and floetz mountains, and is produced in Germany, France, Italy, and the West Indies. It is used as a pigment.

Yellow orpiment is of a perfect lemon-yellow colour, occurs massive, and in very minute chrystals, is found in large, coarse, and small angular granulated distinct concretions, is translucent, very soft, sectile, and common flexible. It occurs principally in floetz mountains, in several parts of Germany and the East.

Fourth species. Arsenic bloom.

The colour is a reddish-white and snow-white; it occurs as a coating, in small balls, &c. and in very delicate capillary shining chrystals, is translucent on the edges, very soft, easily frangible, and soils. It is produced in rents of a granite rock, and hitherto has only been discovered in Swabia.

Seventeenth Genus. *Scheele.**

First species. Tungsten.

The colour is usually yellowish and greyish-white, which pass into several other neighbouring shades; it occurs massive, disseminated, and frequently chrystallized. Internally it is shining, with a vitreous lustre; is more or less translucent, soft, not very brittle, and uncommonly heavy. It is found in primitive mountains, and belongs to the oldest metalliferous formations, and is produced in Cornwall, Sweden, Saxony, and Bohemia.

Second species. Wolfram

Is of an intermediate colour between dark greyish-black, and brownish-black; it occurs massive, and also chrystallized in broad six-sided prisms, and rectangular four-sided tables; and is found in fortification-wise curved lamellar distinct concretions. It is opaque, yields a reddish-brown streak, is soft, brittle, and uncommonly heavy. It is produced in the primitive mountains, almost always accompanied with tin, in Cornwall, and some other countries.

* So called in honour of the illustrious Scheele.

Eighteenth Genus. *Menachine.*

First species. Menachanite

Is of a greyish-black colour, inclining to iron-black, occurs only in small flattish angular grains. Internally is glistening, with an adamantine lustre, is perfectly opaque, soft, brittle, retains its colour in the streak, is easily frangible, and moderately heavy. It is attractable by the magnet, and is found in Cornwall, accompanied by fine quartz-sand, in the isle of Providence in America, and at Botany Bay.

Second species. Octrahedrite.

Its colour passes from indigo-blue to many other shades; it occurs only chrystallized, and that in very acute octahedrons. It is chiefly translucent, and semitransparent, semihard, brittle, and borders on heavy. It is found in Dauphiny, and appears from accurate experiments to be an oxide of menachine mixed with silica.

Third species. Rutile

Is of a dark blood-red colour, of various degrees of intensity; it occurs always chrystallized in four-sided and six-sided prisms, and also in compressed acicular and capillary chrystals. Externally it is shining, internally splendent, translucent in a slight degree, hardish, easily frangible, and not very heavy. It is found imbedded in drusy cavities of granite, &c. in different parts of Germany, France, Spain, Siberia, and South Carolina.

Fourth species. Nigrine

Is of a dark brownish-black colour, passing to velvet-black; it occurs in larger and smaller angular grains, and in rolled pieces. Externally moderately glittering, internally the same, with an adamantine lustre, is opaque, semihard, brittle, and yields a yellowish-brown streak. It is found in alluvial hills in several parts of Germany, and also in Ceylon.

Fifth species. Iserine

Is of an iron-black colour, somewhat inclining to brownish-black; it occurs usually in small obtuse angular grains, and in rolled pieces, internally glistening, with a semi-metallic lustre, is completely opaque, hard, brittle, and retains its colour in the streak. Hitherto it has been found only in the stream called Iser in Germany, from which it receives its appellation. It bears a great resemblance to iron-sand.

Nineteenth Genus. *Uran.*

First species. Pitch ore

Is usually of a velvet-black colour; it occurs almost always massive and disseminated. Internally is shining, soft, brittle, uncommonly heavy, and completely infusible without addition. It is found in veins of primitive mountains along with lead and silver ores, and is produced in Saxony and Norway.

Second species. Uran mica.

The principal colour is a grass-green, passing into various allied shades; it occurs sometimes in membranes, but commonly chrystallized in rectangular four-sided tables. The fracture is foliated, the fragments and distinct concretions are too minute to be determined. It is more or less translucent, soft, sectile, easily frangible, and is found in iron-stone veins in Cornwall, Saxony, and France.

Third species. Uran Ochre.

Friable uran ochre is usually of a straw-yellow colour: it generally occurs as a coating or efflorescence on pitch ore; is friable, and composed of dull dusty particles, which feel meagre, and are not particularly heavy.

Indurated uran ore is of the same colour as the preceding: occurs massive and disseminated, is generally dull, internally opaque, soft, brittle, and soils a little, and is found along with the other ores of uran.

Twentieth Genus. *Sylvan.*

First species. Native Sylvan.

Is of an intermediate colour between white and silver-white: occurs massive and disseminated, and also chrystallized in four and six-sided prisms, in small three-sided pyramids, in cubes, and in short acicular chrystals. It is soft, not very brittle, easily frangible, and heavy; and before the blowpipe melts as easily as lead, burning with a light green colour, and emitting a sharp, disagreeable odour. Hitherto it has only been found at Face-bay, in Transylvania.

Second species. Graphic Ore.

Its colour is a light steel-grey: it occurs massive and chrystallized; externally is splendent, internally glistening. When massive, it shews a tendency to fine granular distinct concretions: it is soft, brittle, sectile, and heavy, and is worked as an ore of gold in Transylvania, where alone it has yet been found.

Third species. Yellow Sylvan Ore

Is of a silver-white colour, inclining to brass-yellow: it occurs disseminated and chrystallized in very small and rather broad four-sided prisms; is soft, rather sectile, and uncommonly heavy. It is found along with the other species of the genus, and contains a considerable portion both of gold and silver.

Fourth species. Black Sylvan Ore

Is of an intermediate colour between iron-black and blackish lead-grey: it occurs massive, and in small, thin, and longish six-sided tables, which are usually imbedded. Externally it is splendent; internally shining, soils a little, is very soft, sectile, splits easily, and in thin leaves is common flexible. It melts easily before the blowpipe; occurs in veins along with other minerals, but is only found in Transylvania, where it is worked for the gold and silver it contains.

Twenty-first Genus. *Chrome.*

First species. Acicular, or Needle Ore.

Its colour is dark steel-grey: occurs in imbedded acicular chrystals: internally shines with a metallic lustre, is soft, not very brittle, heavy, and is always accompanied with chrome ochre, and sometimes with native gold. It is found in Siberia.

Second species. Chrome Ochre

Is of a verdigris-green, passing through several neighbouring shades: it occurs massive, disseminated, and in membranes; is dull, soft, not very heavy, and is found with the preceding species.

Having already extended this article to a greater length than was intended, in order that we might be able to give a satisfactory view of the beautiful system of Werner, we shall only subjoin the names of some other minerals, which either have not been regularly classed, or are but recently discovered, and therefore have not been accurately investigated: these are

Earthy fossils, foliated prehnite, schmelzstein, spodumene, meionite, sommite, glassy felspar, spinthere, metallic fossils, pitchy iron ore, gadolinite, copper sand or muriate of copper, phosphat of copper, corneous lead ore, reniform lead ore, bournonite, columbite, tantalite, yttertantalite.

To which may be added loisite, needle or acicular-stone, fish eye-stone, iron-clay, figure-stone, granular actynolite, dolomite, foliated celestine and its varieties, silver black with its sub-species.

EXPLANATION OF PLATE II.

FIG. 1. The Icosahedron.
2. The Dodecahedron.
The Hexahedron, as
3. Cube.
4. Rhomb.
5. Rectangular tetrahedral prism.
6. Oblique-angular tetrahedral prism.
7. Oblique-angular tetrahedral prism, in which the terminal planes are set obliquely on the lateral planes.
8. Equiangular hexahedral prism.
9. Tetrahedron, or simple three-sided pyramid.
10. Double three-sided pyramid, in which the lateral planes of the one pyramid are set on the lateral edges of the other.
11. Octahedron.
12. Simple six-sided pyramid.
13. Double six-sided pyramid, in which the lateral planes of the one pyramid are set on the lateral planes of the other.
14. Double six-sided pyramid, in which the planes of the one pyramid are set obliquely on those of the other, so that the common base forms a zig-zag line.
15. Rectangular four-sided table.
16. Oblique-angular four-sided table.
17. Equiangular six-sided table.
18. Lengthened six-sided table.
19. and 20. Common lens.

Alteration of the Fundamental Figures by Truncation.

21. Cube truncated on all its angles.
22. Cube truncated on all its edges.

By Bevelment.

23. The cube bevelled on all its edges.
24. Three-sided prism having its lateral edges bevelled.
25. Oblique-angular four-sided prism bevelled on its extremities.
26. Six-sided table, with bevelled terminal planes.
27. Octahedron, with bevelled angles.

By Acumination.

28. Cube, with the angles acuminated by three planes which are set on the lateral planes.
29. Cube, with the angles acuminated by three planes which are set on the lateral edges.
30. Rectangular four-sided prism acuminated by four planes, which are set on the lateral planes.
31. Equiangular six-sided prism, acuminated on both extremities by six planes, which are set on the lateral planes.
32. Four-sided prism, acuminated on both extremities by four planes, which are set on the lateral edges.
33. Six-sided prism, acuminated on both extremities by three planes, which are set on the alternate lateral planes.
34. Six-sided prism, acuminated on both extremities by three planes, which are set on the alternate lateral edges.
35. Double eight-sided pyramid, acuminated on both extremities by four planes, which are set on the alternate lateral edges.

MINIMUM, in the higher geometry, the least quantity attainable in a given case.

MINOR, in law, is an heir, either male or female, before they arrive at the age of twenty-one; during the minority of such, they are usually incapable of acting for themselves.

MINOR, in logic, the second proposition of a regular syllogism.

MINOR, in music, signifies less, and is applied to certain concords or intervals which differ from others of the same denomination by half a tone: thus we say a third minor, meaning a less third; a sixth major and minor.

MINT, the place in which the public money is coined. See COINING.

The officers of the mint are, 1. The warden of the mint, who is chief; he oversees the other officers, and receives the bullion. 2. The master worker; who receives the bullion from the warden, causes it to be melted, delivers it to the moneyers, and when it is coined receives it again. 3. The comptroller, who is the overseer of all the inferior officers, and sees that all the money is made to the just assize. 4. The assay-master; who weighs the gold and silver, and sees that it is according to the standard. 5. The auditor; who takes the accounts. 6. The surveyor of the melting; who, after the assay-master has made trial of the bullion, sees that it is cast out, and not altered after it is delivered to the melter. 7. The engraver; who engraves the stamps and dyes for the coinage of the money. 8. The clerk of the irons; who sees that the irons are clean and fit to work with. 9. The melter; who melts the bullion before it is coined. 10. The provost of the mint; who provides for, and oversees all the moneyers. 11. The blanchers; who anneal and clease the money. 12. The moneyers; some of whom forge the money, some shear it, some round and mill it, and some stamp or coin it. 13. The porters; who keep the gate of the mint.

MINT. See MENTHA.

MINUASTIA, a genus of the triandria trigynia class and order. The cal. is 5-leaved; cor. none; caps. 1-celled, 3-valved. There are three species, herbs of Spain.

MINUTE, in geometry, the sixtieth part of a degree of a circle.

Minutes are denoted by one acute accent, thus ($'$); as the second, or sixtieth part of a minute, is by two such accents, thus ($''$); and the third by three ($'''$), &c.

MINUTE of time, the sixtieth part of an hour.

MIRABILIS, *marvel of Peru*; a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking with those of which the order is doubtful. The corolla is funnel-shaped above; the calyx inferior; the nectarium globular, containing the germen. The most remarkable species are, 1. The jalapa, or common marvel of Peru. Of this there are varieties, with white flowers, with yellow flowers, with purple flowers, with red flowers, with white and yellow flowers, white and purple flowers, purple and yellow flowers, red and yellow flowers. 2. The longiflora, or long-flowered mirabilis, with all the branches and shoots terminated by white flowers in clusters, having very long tubes, nodding downward. 3. The dichotoma, dichotomous, or forked mirabilis, with smallish red flowers at the axillas, singly and close-sitting.

The roots of all these plants are purgative; but require to be given in a great quantity to operate equal to the true jalap, which is a species of convolvulus. See CONVOLVULUS.

MIRROR, a speculum, looking-glass, or any polished body, whose use is to form the images of distinct objects by reflection of the rays of light.

Mirrors are either plane, convex, or concave. The first sort reflects the rays of light in a direction exactly similar to that in which they fall upon it, and therefore represents bodies of their natural magnitude. But the convex ones make the rays diverge much more than before reflexion, and therefore greatly diminish the images of those objects which they exhibit; while the concave ones, by collecting the rays into a focus, not only magnify the objects they shew, but will also burn very fiercely when exposed to the rays of the sun; and hence they are commonly known by the name of burning mirrors.

In antient times the mirrors were made of some kind of metal; and from a passage in the mosaic writings we learn, that the mirrors used by the Jewish women, were made of brass; a practice doubtless learned from the Egyptians.

Any kind of metal, when well polished, will reflect very powerfully; but of all others, silver reflects the most, though it has always been too expensive a material for common use. Gold is also very powerful; and all metals, or even wood, gilt and polished, will act very powerfully as burning mirrors. Even polished ivory, or straw nicely plaited together, will form mirrors capable of burning, if on a large scale.

Some of the more remarkable laws and phenomena of plane mirrors are as follow:

1. A spectator will see his image of the same size, and erect, but reversed as to right and left, and as far beyond the speculum as he is before it. As he moves to or from the

speculum, his image will, at the same time, move towards or from the speculum also on the other side. In like manner if, while the spectator is at rest, an object be in motion, its image behind the speculum will be seen to move at the same rate. Also when the spectator moves, the images of objects that are at rest will appear to approach or recede from him, after the same manner as when he moves towards real objects.

2. If several mirrors, or several fragments or pieces of mirrors, be all disposed in the same plane, they will only exhibit an object once.

3. If two plane mirrors, or speculums, meet in any angle, the eye, placed within that angle, will see the image of an object placed within the same, as often repeated as there may be perpendiculars drawn determining the places of the images, and terminated without the angle. See OPTICS.

MISCHNA, or MISNA, the code or collection of the civil law of the Jews. The Jews pretend, that when God gave the written law to Moses, he gave him also another not written, which was preserved by tradition among the doctors of the synagogue, till rabbi Juda, surnamed the Holy, seeing the danger they were in, through their dispersion, or departing from the traditions of their fathers, judged it proper to reduce them to writing.

The misna is divided into six parts: the first relates to the distinction of seeds in a field, to trees, fruits, tythes, &c. The second regulates the manner of observing festivals: the third treats of women, and matrimonial cases: the fourth of losses in trade, &c. the fifth is on obligations, sacrifices, &c. and the sixth treats of the several sorts of purification. See TALMUD.

MISDEMEANOUR. A crime or misdemeanour is an act committed or omitted, in violation of a public law, either forbidding or commanding it.

MISLETOE. See VISCUM.

MISNOMER, the using of one name for another.

Where a person is described so that he may not be certainly distinguished and known from other persons, the omission, or in some cases the mistake of the name shall not avoid the grant. 11 Rep. 20.

If the christian name is wholly mistaken, this is regularly fatal to all legal instruments, as well declarations and pleadings as grants and obligations.

The mistake of the surname does not vitiate, because there is no repugnancy that a person shall have different surnames; and therefore, if a man enter into an obligation by a particular name, he may be impleaded by that name in the deed, and his real name brought in by an alias; and then the name in the deed he cannot deny, because he is estopped to say any thing contrary to his own deed. 2 Rol. Abr. 146.

MISPRISION, is generally understood to be of all such high offences as are under the degree of capital, but bordering thereon, and it is said that a misprision is contained in every treason and felony whatsoever; and, that if the king please, the offender may be proceeded against for the misprision only. 4 Black. 119.

MIS-RECITAL, in deeds, is sometimes injurious, and sometimes not; if a thing be referred to time, place, and number, and that is mistaken, all is void.

MITCHELLA, a genus of the tetrandria monogynia class and order. The cor. is 1-petalled; stigmas 4; berry trifid, 2-seeded. There is 1 species, an herb of N. America.

MITE, a small coin formerly current, equal to about one third part of a farthing.

It also denotes a small weight used by the moneyers. It is equal to the twentieth part of a grain, and is divided into twenty-four doits.

MITE. See ACARUS.

MITELLA, *bastard American sanicle;* a genus of the digynia order, in the decandria class of plants; and in the natural method ranking under the 13th order, succulentæ. The calyx is quinquefid; the corolla pentapetalous, and inserted into the calyx; the petals pinnatifid; the capsule unilocular and bivalved, with the valves equal. There are two species, both natives of North America, rising with annual herbaceous stalks from five or six to eight or nine inches in height, and producing spikes of small whitish flowers, whose petals are fringed on their edges.

MITHRIDATEA, a genus of the monandria monogynia class and order. The cal. is four-cleft; cor. none; fruit globular, depressed. There is one species, a tree of Madagascar.

MITTIMUS, a writ by which records are transferred from one court to another. This word is also used for the precept directed to a gaoler, under the hand and seal of a justice of the peace, for the receiving and safe keeping a felon, or other offender, by him committed to goal.

MIZEN, in the sea-language, is a particular mast or sail. The mizen-mast stands in the sternmost part of the ship. Its length is by some accounted the same with the height of the main-top-mast, from the quarter-deck; or half the length of the main-mast, and half as thick. The sail which belongs to the mizen-mast, is called the mizen-sail: and when the word mizen is used at sea, it always means the sail.

MNASIUM, a genus of the hexandria monogynia class and order. The cal. is 1-leaved, 3-parted; cor. 1-petalled, 3-parted; antheræ 4-cornered; germ 3-lobed; stigmas 3. There is 1 species, an aquatic of Guiana.

MNIARUM, a genus of the monandria digynia class and order. The cal. is 4-parted, superior; cor. none; seed 1. There is one species, an herb of New Zealand.

MNIUM, *marsh-moss*; a genus of the natural order of musci, belonging to the cryptogamia class of plants. The anthera is operculated; the calyptra smooth; the female capitulum naked and powdery, remote. There are 24 British species, but none have any remarkable property except the two following: 1. The fontanum is an elegant moss, frequent in bogs, and on the borders of cold springs. It is from two to four inches high: the stalks are simple at the base, and covered with a rusty down; but higher up are red, and divided into several round, single, taper branches, which proceed nearly from the same point. The leaves are not more than $\frac{1}{12}$th of an inch long, lanceolate and acute, of a whitish-green colour, and so thinly set, that the red stalk appears between them. This moss, as it may be seen at a considerable distance, is a good mark to lead to the discovery of clear and cold springs. Dr. Withering informs us, that wherever this moss grows, a spring of fresh-water may be found without much digging. 2. The hygrometricum grows in woods, heaths, garden-walks, walls, old trees, decayed wood, and where coals or cinders have been laid. It is stemless, has tips inversely egg-shaped, nodding, and bright yellow. If the fruit-stalk is moistened at the base with a little water or steam, the head makes three or four revolutions; if the head is moistened, it turns back again.

MOAT, or DITCH, in fortification, a deep trench dug round the rampart of a fortified place, to prevent surprizes.

The brink of the moat, next the rampart, is called the scarpe; and the opposite one, the counterscarpe.

A dry moat round a large place, with a strong garrison, is preferable to one full of water, because the passage may be disputed inch by inch; and the besiegers, when lodged in it, are continually exposed to the bombs, grenades, and other fire-works, which are thrown incessantly from the rampart into their works. In the middle of dry moats there is sometimes another small one, called cunette; which is generally dug so deep, till they find water to fill it.

The deepest and broadest moats are accounted the best, but a deep one is preferable to a broad one: the ordinary breadth is about twenty fathoms, and the depth about sixteen.

To drain a moat that is full of water, they dig a trench deeper than the level of the water, to let it run off; and then throw hurdles upon the mud and slime, covering them with earth or bundles of rushes, to make a sure and firm passage.

MODE, in logic, called also syllogistic mood, a proper disposition of the several propositions of a syllogism, in respect of quantity and quality.

As in all the several dispositions of the middle term, the propositions of which a syllogism consists may be either universal or particular, affirmative or negative; the due determination of these, and putting them together as the laws of argumentation require, constitute what logicians call the moods of syllogisms. Of these moods there are a determinate number to every figure, including all the possible ways in which propositions, differing in quantity or quality, can be combined, according to any disposition of the middle term, in order to arrive at a just conclusion. There are two kinds of moods, the one direct, the other indirect.

The direct mood is that wherein the conclusion is drawn from the premises directly and immediately, as, "Every animal is a living thing, every man is a living animal; therefore every man is a living thing." There are fourteen of these direct moods, four whereof belong to the first figure, four to the second and six to the third. They are denoted by so many artificial words framed for that purpose, viz. 1. Barbara, celarent, darii, ferioque. 4. Baralip, celantes, dabitis, fapesmo, frisesom. 2. Cesare, camestres, festino, baroco. 3. Darapti, felapton, disamis, datisi, bocardo, ferison. The use and effect of which words lie wholly in the syllables, and the letters of which the syllables consist; each word, for instance, consists of three syllables, denoting the three propositions of a syllogism, viz. major, minor, and conclusion: add, that the letters of each syllable are either vowels or consonants; the vowels are A, which denotes an universal affirmative; E, an universal negative; I, a particular affirmative; and O, a particular negative: thus, Barbara is a syllogism or mood of the first figure, consisting of three universal affirmative propositions: Baralip, one of the fourth figure, consisting of two universal affirmative premises, and a particular affirmative conclusion. The consonants are chiefly of use in the reduction of syllogisms. The indirect mood, is that wherein the conclusion is not inferred immediately from the premises, but follows from them by means of a conversion; as, "Every animal is a living thing, every man is an animal; therefore some living thing is a man."

Mode, in music, a particular system, or constitution of sounds, by which the octave is divided into certain intervals, according to the genus. The doctrine of the antients respecting modes is rendered somewhat obscure, by the difference among their authors as to the definitions, divisions, and names of their modes. Some place the specific variations of tones, or modes, in the manner of division, or order of the concinnous parts; and others merely in the different tension of the whole: *i. e.* as the whole series of notes are more acute or grave, or as they stand higher or lower in the great scale of sounds.

MODEL, in a general sense, an original pattern, proposed for any one to copy or imitate. This word is particularly used in building, for an artificial pattern made in wood, stone, plaster, or other matter, with all its parts and proportions, in order for the better conducting and executing some great work, and to give an idea of the effect it will have in large. In all great buildings, it is much the surest way to make a model in relievo, and not to trust to a bare design or draught. There are also models for the building of ships, &c. and for extraordinary staircases, &c.

They also use models in painting and sculpture; whence, in the academies, they give the term model to a naked man or woman, disposed in several postures, to afford an opportunity to the scholars to design him in various views and attitudes.

Models in imitation of any natural or artificial substance, are most usually made by means of moulds composed of plaster of Paris. For the purpose of making these moulds, this kind of plaster is much more fit than any other substance, on account of the power it has of absorbing water, and soon condensing into an hard substance, even after it has been rendered so thin as to be of the consistence of cream. This happens in a shorter or longer time, as the plaster is of a better or worse quality; and its good or bad properti s depend very much upon its age, to which, therefore, particular regard ought to be had. It is sold in the shops at very different prices; the finest being made use of for casts, and the middling sort for moulds. It may be very easily coloured by means of almost any kind of powder excepting what contains an alkaline salt; for this would chemically decompose the substance of it, and render it unfit for use, the gypsum or plaster being a sulphat of lime, which would be decomposed by the alkali precipitating the lime. A very considerable quantity of chalk would also render it soft and useless, but lime hardens it to a great degree. The addition of common size will likewise render it much harder than if mere water is made use of. In making either moulds or models, however, we must be careful not to make the mixture too thick at first; for if this is done, and more water added to thin it, the composition must always prove brittle, and of a bad quality.

The particular manner of making models (or casts, as they are also called) depends on the form of the subject to be taken. The process is easy where the parts are elevated only in a slight degree, or where they form only a right or obtuse angle with the principal surface from which they project; but where the parts project in smaller angles, or form curves inclined towards the principal surface, the work is more difficult. This observation, however, holds good only with regard to hard and inflexible bodies; for such as are soft may often be freed from the mould, even though they have the shape last mentioned. But though this is the case with the soft original substance, it is not so with the inflexible model when once it is cast.

The moulds are to be made of various degrees of thickness, according to the size of the model to be cast; and may be from half an inch to an inch, or, if very large, an inch and an half. Where a number of models are to be taken from one mould, it will likewise be necessary to have it of a stronger contexture than where only a few are required, for very obvious reasons.

It is much more easy to make a mould for any soft substance than a rigid one, as in any of the viscera of the animal body: for the fluidity of the mixture makes it easily accommodate itself to the projecting parts of the substance; and as it is necessary to inflate these substances, they may be very readily extracted again, by letting out the air which distended them.

When a model is to be taken, the surface of the original is first to be greased, in order to prevent the plaster from sticking to it; but if the substance itself is slippery, as is the case with the internal parts of the human body, this need not be done: when necessary, it may be laid over with linseed oil by means of a painter's brush. The original is then to be laid on a smooth table, previously greased, or covered with a cloth, to prevent the plaster sticking to it; then surround the original with a frame or ridge of glazier's putty, at such a distance from it as will admit the plaster to rest upon the table on all sides of the subject for about an inch, or as much as is sufficient to give the proper degree of strength to the mould. A sufficient quantity of plaster is then to be poured as uniformly as possible over the whole substance, until it is every where covered to such a thickness as to give a proper substance to the mould, which may vary in proportion to the size. The whole must then be suffered to remain in this condition till the plaster has attained its hardness: when the frame is taken away, the mould may be inverted, and the subject removed from it; and when the plaster is thoroughly dry, let it be well seasoned.

Having formed and seasoned the moulds, they must next be prepared for the casts by greasing the inside of them with a mixtu e of olive oil and lard in equal parts, and then filled with fine fluid plaster, and the plane of the mould formed by its resting on the surface of the table, covered to a sufficient thickness with coarse plaster, to form a strong basis or support for the cast where this support is requisite, as is particularly the case where the thin and membranous parts of the body are to be represented. After the plaster is poured into the mould, it must be suffered to stand until it has acquired the greatest degree of hardness it will receive; after which the mould must be removed: but this is attended with some difficulty when the shape of the subject is unfavourable; and in some cases the mould must be separated by means of a small mallet and chisel. If by these instruments any parts of the model should be broken off, they may be cemented by making the two surfaces to be applied to each other quite wet; then interposing betwixt them a little liquid plaster; and lastly, the joint smoothed, after being thoroughly dry. Any small holes that may be made in the mould can be filled up with liquid plaster, after the sides of them have been thoroughly wetted, and smoothed over with the edge of a knife.

In many cases it is altogether impracticable to prepare a mould of one piece for a whole subject; and therefore it must be considered how this can be done in such a manner as to divide the mould into the fewest pieces. This may be effected by making every piece cover as much of the pattern as possible, without surrounding such projecting parts, or running into such hollows as would not admit a separation of the mould. Where any internal pieces are required, they are first to be made; and then the outer pieces, after the former have become hard.

Besides the models which are taken from inanimate bodies, it has been frequently attempted to take the exact resemblance of people while living, by using their face as the original of a model, whence to take a mould; and the operation, however disagreeable, has been submitted to by persons of the highest ranks in life. A considerable difficulty occurs in this, however, from the person's being apt to shrink and distort his features when the liquid is poured upon him; neither is he altogether without danger of suffocation, unless the operator well understands his business.

To avoid the former inconvenience, it will be proper to mix the plaster with warm instead of cold water, by which means the person will be under no temptation to shrink; and to prevent any danger of a fatal accident, the following method is to be practised: Having laid the person horizontally on his back, the head must first be raised by means of a pillow to the exact position in which it is naturally carried when the body is erect; then the parts to be represented must be very thinly covered over with fine oil of almonds, by means of a painter's brush: the face is then to be first covered with fine fluid plaster, beginning at the upper part of the forehead, and spreading it over the eyes, which are to be kept close, that the plaster may not come in contact with the globe; yet not closed so strongly as to cause any unnatural wrinkles. Cover then the nose and ears, plugging first up the meatus auditorii with cotton, and the nostrils with a small quantity of tow rolled up, of a proper size to exclude the plaster. During the time that the nose is thus stopped, the person is to breathe through the mouth: in this state the fluid plaster is to be brought down low enough to cover the upper lip, observing to leave the rolls of tow projecting out of the plaster. When the operation is thus far carried on, the plaster must be suffered to harden; after which the tow may be withdrawn, and the nostrils left free and open for breathing. The mouth is then to be closed in its natural position, and the plaster brought down to the extremity of the chin. Begin then to cover that part of the breast which is to be represented, and spread the plaster to the outsides of the arms and upwards, in such a manner as to meet and join that which is previously laid on the face: when the whole of the mass has acquired its due hardness, it is to be cautiously lifted, without breaking or giving pain to the person. After the mould is constructed, it must be seasoned in the manner already directed; and when the mould is cast, it is to be separated from the model by means of a small mallet and chisel. The eyes, which are necessarily shown closed, are to be carved, so that the eye-lids may be represented in an elevated posture; the nostrils hollowed out, and the back part of the head, from which, on account of the hair, no mould can be taken, must be finished according to the skill of the artist. The edges of the model are then to be neatly smoothed off, and the bust fixed on its pedestal.

MODULATION, in music, the art of conducting harmony, in composition, or extemporary performance, through those keys and modes which have a due relation to the fundamental, or original key. Though every piece, as is well known, has its principal or governing key, yet, for the sake of contrast and relief, it is not only allowable but necessary to pass from key to key, and from mode to mode; to assume different sharps or flats, and lead the ear through those transitions of tone and harmony which interest the feelings and delight the ear. But though in grand compositions there is no quality of a greater importance than that of a masterly modulation, it is not easy to lay down rules for its accomplishment. Sometimes a gradual and almost insensible evolution of harmony is requisite to the composer's object; at other times, a bold and sudden change can alone produce the necessary effect.

MODULE. See ARCHITECTURE.

MODUS DECIMANDI, in law, is where money, land, or other valuable consideration, has been given, time out of mind, to the minister or parson of any certain place, in the room of tithes. A clergyman may sue in a spiritual court for a modus decimandi; yet if the modus is denied there, or a custom is to be tried, the trial thereof belongs to the courts of common law. When lands are converted to other uses, as in the case of hay-ground turned into tillage, the modus may be discharged, and the tithes paid again in kind.

MOERHINGIA, mossy chickweed, in botany, a genus of the octandria digynia class of plants, the flower of which is composed of four short, undivided petals; and its fruit is a subglobose capsule, with one cell, in which are contained numerous roundish seeds. There is one species.

MOLE. See ZALPA.

MOLLUGO, African chickweed; a genus of the tryginia order, in the triandria class of plants; and in the natural method ranking under the 22d order, caryophyllei. The calyx is pentaphyllous; there is no corolla; the capsule is trilocular, and trivalved. There are six species, annuals of the Cape, and of the E. and W. Indies.

MOLUCCELLA, in botany, a genus of the didynamia-gymnospermia class of plants, the flower of which is monopetalous and labiated; the upper lip being entire, and the lower one trifid: the seeds are turbinated, and contained in the bottom of the cup. One annual species.

MOLYBDATS. These salts, composed of molybdic acid combined with the alkalies and earths, were formed by Scheele; but their properties are still almost completely unknown. The supermolybdat of potass alone has been described with some detail. It is formed by detonating one part of sulphuret of molybdenum and three parts of nitre in a crucible. By dissolving the reddish mass which remains after this operation, and filtering, a solution of sulphat of potass and molybdat of potass is obtained. By evaporating the solution, the sulphat of potass is separated; when sulphuric acid is dropt into the remaining liquid, supermolybdat of potass is precipitated. This salt is soluble in water. Its solution chrystallizes by evaporation in small rhomboidal plates inserted into each other. They are bright, and have a metallic taste. When exposed to the blowpipe upon charcoal, they melt without swelling, and are converted into small globules, which are quickly absorbed by the charcoal. When melted with a mixture of phosphat of soda and of ammonia (or microcosmic salt), they communicate a green tinge. Hot water dissolves them completely, and prussiat of potass occasions in this solution a reddish brown precipitate. When a solution of muriat of tin is poured upon them, they acquire a blue colour.

MOLYBDENUM. The Greek word μολυβδαινα, and its Latin translation plumbago, seem to have been employed by the antients to denote various oxides of lead; but by the moderns they were applied indiscriminately to all substances possessed of the following properties: light, friable, and soft, of a dark colour and greasy feel, and which leave a stain upon the fingers. Scheele first examined these minerals with attention. He found that two very different substances had been confounded together. To one of these, which is composed of carbon and iron, he appropriated the word plumbago; the other he called molybdena.

Molybdena is composed of scaly particles adhering slightly to each other. Its colour is blueish, very much resembling that of lead. Scheele analysed it in 1778, and obtained sulphur and a whitish powder, which possessed the properties of an acid, and which, therefore, he called acid of molybdena. Bergman suspected this acid, from its properties, to be a metallic oxide; and at his request, Hielm, in 1782, undertook the laborious course of experiments by which he succeeded in obtaining a metal from this acid. His method was to form it into a paste with linseed oil, and then to apply a very strong heat. This process he repeated several times successively. To the metal which he obtained he gave the name of molybdenum. The experiments of Scheele were afterwards repeated by Pelletier, Ilseman, and Heyer; and not only fully confirmed, but discovered many new facts, and the metallic nature of molybdic acid was put beyond a doubt: though, in consequence of the very violent heat necessary to fuse molybdenum, only very minute grains of it have been hitherto obtained in the state of a metal. Still more lately, Mr. Hatchett has published a very valuable set of experiments, which throw much new light upon the nature of this metal.

Molybdenum is externally of a whitish-yellow colour, but its fracture is a whitish-grey. Hitherto it has only been procured in small grains, agglutinated together in brittle masses. Its specific gravity is 7.500. It is almost infusible in our fires.

When exposed to heat in an open vessel, it gradually combines with oxygen, and is converted into a white oxide, which is volatilized in small brilliant needle-form crystals. This oxide, having the properties of an acid, is known by the name of molybdic acid.

From the experiments of Mr. Hatchet, it follows that molybdenum is capable of combining with four different proportions of oxygen, and of forming four oxides; namely, 1. The black; 2. The blue; 3. The green, to which Mr. Hatchet has given the name of molybdous acid; and, 4. The yellow or white, or the molybdic acid.

1. The protoxide, or black oxide, may be obtained by mixing molybdic acid with charcoal powder in a crucible, and applying heat. A black mass remains, which is the black oxide. It seems to contain only a very minute quantity of oxygen.

2. The blue oxide may be obtained by the same process not carried so far: it is formed also whenever a plate of tin is plunged into a solution of molybdic acid.

3. The peroxide, or molybdic acid, is obtained by distilling six parts of diluted nitric acid repeatedly off native molymbdena in powder. A white mass is left behind, composed of sulphuric and molybdic acids. A little pure water washes away the sulphuric acid, and molybdic acid remains behind. This acid has at first a white colour; but when melted and sublimed, it becomes yellow.

Molybdenum combines readily with sulphur; and the compound has exactly the properties of molybdena, the substance which Scheele decompounded. Molymbdena is therefore sulphuret of molybdenum. The reason that Scheele obtained from it molybdic acid was, that the metal combined with oxygen during his process. Sulphuret of molybdenum may be formed also by distilling together one part of molybdic acid and five parts of sulphur. Molybdenum is also capable of combining with phosphorus.

Few of the alloys of this metal have been hitherto examined.

It seems capable of uniting with gold. The alloy is probably of a white colour. It combines readily with platinum in the state of an oxide. The compound is fusible. Its specific gravity is 20.000.

The alloys of molybdenum with silver, iron, and copper, are metallic and friable; those with lead and tin are powders which cannot be fused. Several other combinations have been made both by Hielm and Richter; but as the metals which they tried were alloyed not with molybdenum, but with molymbdic acid, they cannot be considered as by any means the same with the alloys formed by molybdenum itself.

Molybdenum, *Ores of.* These are very scarce, having been found only in Sweden, Germany, Carniola, among the Alps, near Inverness, and in the island of Lewis, in Scotland. The only species known is molybedna, which is found commonly massive: sometimes, however, it is chrystallized in hexædral tables. Colour light lead-grey; sometimes with a shade of red. Streak blueish-grey, metallic. Powder blueish texture, foliated lamellæ, slightly flexible. Specific gravity 4.5 to 4.73. Marks blueish-black. A piece of resin rubbed with this mineral becomes positively electric. Insoluble in sulphuric and muriatic acids. Composed of about

60 molybdenum
40 sulphur
———
100

MOMENT, in the doctrine of infinites, denotes the same with infinitesimal.

Moment, momentum, in mechanics, signifies the same with impetus, or the quantity of motion in a moving body; which is always equal to the quantity of matter, multiplied into the velocity; or, which is the same thing, it may be considered as a rectangle under the quantity of matter and velocity.

MOMORDICA, male balsam apple; a genus of the syngenesia order, in the monœcia class of plants; and in the natural method ranking under the 34th order, cucurbitaceæ. The male calyx is quinquefid; the corolla sexpartite; the filaments are three in number. The female calyx is trifid; the corolla quinquepartite; the style trifid; the fruit is an apple parting asunder with a spring. There are eight species, the most remarkable of which are, 1. The balsamina, or male balsam apple. This is a native of Asia; and has a trailing stalk like those of the cucumber or melon, with smooth leaves, cut into several segments, and spread open like a hand. The fruit is oval, ending in acute points, having several deep angles, with sharp tubercles placed on their edges. It changes to a red or purplish colour when ripe, opening with elasticity, and throwing out its seeds. 2. The elaterium, wild or spurting cucumber, has a large fleshy root, somewhat like briony, whence come forth, every spring, several thick, rough, trailing stalks. The flowers come out from the wings of the stalks: these are male and female, growing at different places on the same plant like those of the common cucumber: but they are much less, of a pale yellow colour, with a greenish bottom; the male flowers stand upon thick, short, foot stalks, but the female flowers sit upon the young fruit; which, after the flower is faded, grows of an oval form, an inch and a half long, swelling like a cucumber, of a grey colour, like the leaves, and covered over with short prickles. This species has one of its names from the property of casting out its seeds, together with the viscid juice in which the seeds are lodged, with a violent force, if touched while ripe.

The first species is famous in Syria for curing wounds. The natives cut open the unripe fruit, and infuse it in sweet oil, which they expose to the sun for some days, until it becomes red; and then present it for use. Dropped on cotton, and applied to a fresh wound, the Syrians reckon this oil the best vulnerary next to balsam of Mecca, having found by experience that it often cures large wounds in three days. The leaves and stems of this plant are used for arbours or bowers. The elaterium of the shops is the fruit, or rather the inspissated fæcula, of the juice of the unripe fruit of the wild cucumber. It is usually sent us from Spain and the southern parts of France, where the plant is common. We receive it in small, flat, whitish lumps, or cakes, that are dry, and break easily between the fingers. It is of an acrid, nauseous, bitter taste, and has a strong offensive smell when newly made; but these, as well as its other properties, it loses, after being kept for some time. It is a very violent purge and vomit, and is now but seldom used.

MOMOTUS, a genus of birds of the order picæ. The generic character is, bill strong, slightly curved, serrate at the edges; nostrils feathered; tongue feathered; tail wedged; feet formed for walking. There is but one species, the Brasiliensis, that inhabits Brasil; size of a blackbird; eighteen inches long; lives solitarily in unfrequented forests; building a nest of dry grass on the ground, or in holes abandoned by the armadillo, and lays two eggs; feeds on insects and raw flesh, the fragments of which it macerates in water; when taken, it strikes violently with its bill. Its voice is harsh, weak, tremulous.

MONADELPHIA, (from μονος *alone*, and αδελφια a *brotherhood;*) a "single brotherhood." The name of the 16th class in Linnæus's sexual system, consisting of plants with hermaphrodite flowers; in which all the stamina, or male organs of generation, are united below into one body or cylinder, through which passes the pointal or female organ. See Botany.

MONANDRIA, (from μονος *alone*, and ανηρ a *man* or *husband:*) The name of the first class in Linnæus's sexual system; consisting of plants with hermaphrodite flowers, which have only one stamen or male organ.

MONARDA, Indian horehound; a genus of the monogynia order, in the diandria class of plants; and in the natural method ranking under the 42d order, verticillatæ. The corolla is unequal, with the upper lip linear, involving the filaments; there are four seeds. There are seven species; the most remarkable is the didyma, a native of North America. It is herbaceous. The flowers, which are of a bright red, surround the stalk in whorls, each whorl containing about 14 flowers; and are succeeded by four small kidney-shaped shining seeds, lodged in the bottom of the permanent flower-cup. The Indians superstitiously believe that a fumigation of this plant is effectual for driving away the devil.

MONAS, a genus of vermes, order infusoria. The generic character is worm invisible to the naked eye, most simple, pellucid, resembling a point. There are five species: the termo is a most minute, simple gelatenous point: to be found in most animal and vegetable infusions: of all animals the most minute, being so extremely delicate and transparent, as often to elude the most highly magnifying powers, blending in a manner with the water in which it swims.

MONETIA, a genus of the class and order tetrandria monogynia. The cal. is four-cleft; petals four; berry two-celled; seeds solitary. There is one species, a shrub of the E. Indies.

MONEY. The æra of the invention of money is not easy to be settled. There is no room to doubt, but that in the earliest ages the ordinary way of traffic among men was by trucking or exchanging one commodity for another; but in course of time it was found necessary, in the way of commutative justice, to have some common measure or standard, according to which all things should be estimated.

Money is usually divided into real and imaginary. Real money includes all coins, whether of gold, silver, copper, or the like; such as guineas, crowns, pistoles, pieces of eight, ducats, &c. for an account of which we refer the reader to the article Coin.

Imaginary money, or money of account, is that which never existed, or, at least, which does not exist in real specie; but is a denomination invented or retained to facilitate the stating of accounts, by keeping them still on a fixed footing, not to be changed like current coins, which the authority of the sovereign sometimes raises or lowers, according to the exigencies of the state, of which kinds are pounds, livres, marks, maravedies, &c. See Pound, &c.

No person is obliged to take in payment any money which is not lawful metal, that is, of silver and gold, except for sums under sixpence. 2 Inst. 577.

But it was decided in Hilary term, 1790, that bank notes were considered as money, and therefore a proper tender in payment.

English Money *of account*, is the pound, shillings, and pence; the pound contains twenty shillings, and the shilling twelve pence.

The old Scotch Money *of account* was the pound, shilling, and penny; the pound containing twenty shillings, being equivalent to one shilling and eightpence English; and the shilling containing twelve pennies, equal to a penny English. There is also among them an account of marks, the mark being equivalent to one shilling $1\frac{1}{3}$ penny English: of this last kind they had formerly a silver coin.

French Money *of account*, in France, sous, cents, &c.

Dutch MONEY *of account*, is kept at Amsterdam and Rotterdam, the two chief trading places, in guilders, stivers, and penins; so that though goods are sold for other species, such as livre de gros, &c. yet all are reduced to the above denominations for the entries into their books. The exchanges are made with us in so many shillings to a pound sterling, though in most other places in deniers-de-gros.

Spanish MONEY *of account*, is at Cadiz kept in rials of plate and its fractions; at Castile, in maravedies; at Valencia, in livres or dollars, sueldos and dineros; of which last twelve make a sueldo, and twenty sueldos a livre or dollar. Seventeen quartos, at Cadiz and Castile, make two rials vellon, which is now an imaginary coin, though formerly it was the principal one of the kingdom. A maravedie is another imaginary specie, of which seventeen is reckoned to a rial vellon. The ducat is also a fictitious coin of eleven rials of plate in purchases, sales, and other mercantile transactions, except in exchanges, when it is valued at eleven rials of plate and one maravedie, or 575 maravedies.

Portuguese MONEY *of account*, is kept in reas, or res, making a separation at every hundred, thousandth, &c. 800 reas go to a moidore.

German and Swiss MONEY *of account*. At Coningsberg, Elbing, and Dantzic, accounts are kept in rixdollars and gros, or in Polish guilders, gros, and deniers, or penins. They exchange on Amsterdam in Polish gros for a livre de gros of six guilders current money of Amsterdam, and on Hamburg for the rixdollar. At Lubec, accounts are kept in marks, schellings, and deniers or penins-lubs, in which their exchanges are made. At Breslaw, accounts are kept in rixdollars and silver gros and penins; in the first of which species exchanges are made on Amsterdam for a certain number of stivers, bank money, and on Hamburg for rixdollars of Breslaw against rixdollars of Hamburg bank. At Hamburg, accounts are kept in marks, schellings, and deniers-lubs bank money, by those who have cash in the bank; but by those who have not, their books are generally kept in rixdollars, schellings, and denier current money. At Bremen, accounts are kept in rixdollars and gros, and it exchanges on Amsterdam rixdollars of seventy-gros for rixdollars of fifty stivers banco. At Leipsic and Naumbourg, accounts are kept in rixdollars, crowns, gros, and penins. At Berlin, and in all this kingdom, accounts are kept in guilders, gros, and penins. At Zurich, accounts are kept in rixdollars, creutzers, and hellers; reckoning their rix dollars (worth about 4*s*. 6*d*. sterling) at 108 of their creutzers. At Frankfort on the Maine, and Hanaw, accounts are kept in rixdollars and creutzers. At Vienna, accounts are kept in guilders, creutzers, and penins, reckoning eight penins to a creutzer, and sixty creutzers to a guilder. At Nuremberg and Augsbourg, accounts are kept in guilders, creutzers, and hellers; at Liege, in livres, sols, and deniers.

In the canton of St. Gall, in Switzerland, accounts are kept in guilders, creutzers, and penins; or under the same denomination with the coins of the empire. In the canton of Basil, accounts are variously kept, some in rixdollars, schellings, and deniers; some in livres, schellings, and deniers; some in rixdollars, creutzers, and penins; and some in guilders, creutzers, and penins.

Italian MONEY *of account*. In the cities of Genoa and Novi, accounts are kept in livres, soldi, and denari; or in dollars of 100 soldis. At Milan, accounts are kept in livres, soldis, and denari, to be counted like pounds, shillings, and pence, viz. twelve denaris to a soldi, &c. At Rome, accounts are kept in crowns, julios, and bajoches, or grains and quartrins; the crown is divided into ten julios, and the julio into ten bajoches. At Leghorn, accounts are generally kept in dollars, soldi, and denari. At Florence, they keep their books and accounts in crowns, soldi, and denari, picoli or current money. At Naples, accounts are kept in ducats, florins, and grains. The accounts in Sicily are kept the same as at Naples. At Lucca they keep their accounts in crowns, livres, soldi, and denari; the crown is worth 7 livres 10 soldi; the livre, 20 soldi; and the soldi, 12 denari. At Venice, accounts are kept in livres, soldi, and denari, picoli or current; but the bank-entries are in livres, soldi, and grosses: both the current and bank-ducats of Venice make 24 soldi, or six livres and 4 soldi. At Bologna, accounts are kept in livres, soldi, and denari; the livre being 20 soldi, and the soldi 12 denari. At Bergam, the money of account is the same as at Bologna, and its proportions the same. At Parma accounts are kept in crowns, soldi, and denari; the crown is 20 soldi, and the soldi 20 denari. At Modena and Mantua, accounts are kept in livres, soldi, and denari. In Savoy and Piedmont, accounts are kept in livres or lires, soldi, and quartrins. At Placentia, accounts are kept in crowns, soldi, and denari of mark; of which 12 denari make a soldi, and 20 soldi the crown. In the island of Sardinia, accounts are kept as in most parts of Italy, in livres, soldi, and denari. In the island of Malta, the money of account is the same with that of Sicily. In the island of Candia, the account is the same as at Venice.

Russian, Swedish, Danish, and Polish MONEY *of account*. In the trading places of the Russian empire, accounts are kept in roubles, grives, and moscosques, or in roubles and coppecks; 10 coppecks (each of which is equal to 2 moscosques) make a grive, and 100 coppecks, or 10 grives, is a rouble. In the kingdom of Sweden, accounts are kept in dollars, marks, and oorts; the dollar being worth 4 marks, and the mark 8 oorts. In Denmark, accounts are kept in marks and schellings: the rixdollar is worth 6 marks; the mark, 16 schellings; and the schelling, 3 penins. Accounts are kept at Bergen, and in other places in Norway, in Danish rixdollars, marks, and schellings. In Poland, accounts are kept in guilders, gros, and deniers, of which 18 deniers make a gros, and 30 gros a guilder: they here keep accounts also in rixdollars and gros, reckoning 90 of the latter to one of the former. At Riga, accounts are kept in rixdollars and gros, the former of which species consists of 90 of the latter.

Turkish MONEY *of account*. The Turks, both in Europe, Asia, and Africa, account by purses, either of silver or gold (the last being only used in the seraglio), with half purses of gold, called also rizes: the purse of silver is equal to 1500 French livres, or about 65*l*. sterling; and the half purse in proportion: the purse of gold is 15,000 sequins, equal to 30,000 French crowns, or about 3,750*l*. sterling: this is seldom used but for presents to favourites, so that a purse simply signifies a purse of silver, or 1,500 livres. The merchants also use Dutch dollars, called astani or abouquels, with medins and aspers: the dollar is equal to 35 medins, and the medin to 3 aspers; the asper to a halfpenny sterling money.

Asiatic MONIES *of account* are as follow. In Persia, they account by the taman (called also man and tumein) and dinar-bisti; the taman is composed of 50 abassis, or 100 mamodies, or 200 chapes, or 10,000 dinars; which, accounting the abassi on the foot of 18 French sols, or the dinar or that of a denier, amounts to 3*l*. 12*s*. 6*d*. sterling the taman. They also account by larins, especially at Ormus, and on the coast of the Persian gulph: the larin is equivalent to 11*d*. sterling; and on that footing is used also in Arabia, and through a great part of the East-Indies. Chinese moneys of account are the pic, picol, and tael; which, though in effect weights, do likewise serve as money of account, obtaining in Tonquin as well as China: the pic is divided into 100 catis, some say 125; the cati into 16 taels, each tael equal to one ounce two drachms: the picol contains 66¾ caties; the tael is equivalent to 6*s*. 8*d*. sterling.

Japanese moneys of account are the schuites, cockiens, oebans or oubans, and taels: 200 schuites are equal to 500 Dutch pounds, the cockien equal to 10 low-country pounds, 1000 oebans make 45,000 taels.

Mogul money of account: at Surat, Agra, and the rest of the estates of the great mogul, they use lacres, acrees, or leeths, implying one hundred thousand; thus a lacre of rupees is 100,000 rupees; the lacre being nearly on the footing of the tun of gold in Holland, and the million of France.

Monies of account of other islands and coasts of India. Throughout Malabar, and at Goa, they use tangas, vintins, and pardos-xeraphim: the tanga is of two kinds, viz. of good and bad alloy; hence their custom is to count by good or bad money; the tanga of good alloy is better by one-fifth than the bad, so that 4 tangas good being allowed the pardos-xeraphim, there will be required 5 of the bad; 4 vintins good make a tanga likewise good; 15 barucos, a vintin; a good baruco is equal to a Portuguese ree, a French denier, or one-thirteenth of a penny sterling. In the island of Java they use the santasapacou, fardos, and catis; which last money, together with the leeth or lacre, is much used throughout all the East Indies: the santa is 200 caxas, or little pieces of that country, hung on a string, and is equal to eleven-twelfths of a penny sterling: five sentas make the sapacou. The fardos equal to 2*s*. 8*d*. sterling; the cati contains 20 taels; the tael 6*s*. 8*d*. sterling. There are islands, cities, and states, of the East Indies, whose monies of account are not here expressed, partly because reducible to some of the above-mentioned, and partly because we find no certain consistent account of them.

African Money *of account*. From Cape Verd to the Cape of Good Hope, all exchanges and valuations of merchandize are made on the foot of the macoute and piece; which, though no monies of account (for those barbarians have no real monies, and therefore need no imaginary ones to estimate them by) yet serve in lieu thereof. At Loango de Boirie, and other places on the coast of Angola, the estimations are made by macoutes; and at Malimbo and Cabindo, on the same coast, the negroes reckon by pieces: among the first the macoute is equal to 10 pieces; ten macoutes make 100, which likewise gives us a kind of imaginary money, to estimate any purchase, exchange, &c. they fix on the one side the number of macoutes required; *e. gr.* for a negro; so that there are several bargains made for one; suppose, for instance, the slave to be fixed at 3,500 pieces, this amounts to 350 macoutes; to make up this number of macoutes in merchandize, they fix the price of each in macoutes. Two Flemish knives, *ex. gr.* are accounted one macoute; a copper bason, 2 pound weight, three; a barrel of gunpowder, three, &c. For the piece, it serves in like manner to estimate the value of goods, duties, &c. on either side: thus the natives require 10 pieces for a slave; and the Europeans put, for instance, a fusee at 1 piece, a piece of salampours at 4 pieces, &c. The cities of Barbary and Egypt, whither the Europeans traffic, reckon much after the same manner as in the Levant and the dominions of the grand seignor; for the rest, through that vast extent of coast where we trade for negroes, gold-dust, elephant's teeth, wax, leather, &c. either the miserable inhabitants do not know what money of account is, or, if they have any, it is only what strangers, settled among them, have introduced.

Monies *of account in America*. Here they have no money of their own; the respective monies of account of the Europeans, who have made settlements there, being established among them.

MONKEY. See Simia.

MONOCHORD, a musical instrument, composed of one string, used to try the variety and proportion of sounds.

It is formed of a rule, divided and subdivided into several parts, on which there is a moveable string stretched upon two bridges at each extreme. In the middle between these is a moveable bridge, by means of which, in applying it to the different divisions of the line, the sounds are found to bear the same proportion to each other as the division of the line, cut by the bridge. There are also monochords with forty-eight fixed bridges. The following is the account of a monochord invented by earl Stanhope:

1. The wire is not made either of brass or of iron, but of steel, which is very far superior. For, steel wire does not keep continually lengthening, as brass and iron wires do when they are stretched considerably. 2. The wire in this monochord does not, as usual, pull downwards on the bridges, but the whole wire forms one straight and horizontal line, by which means the moveable bridge, which determines the exact length of the wire, can be moved without altering the tension of the wire. This is not the case when the wire pulls downwards on the bridges. 3. The ends of the wire are not twisted round the two stout steel pins which keep it stretched; but each end of the wire is soft-soldered in a long groove formed in a piece of steel which goes over its corresponding pin. This is a great improvement. 4. One of those two steel pins is strongly fastened on a brass slider, which is moved by means of a screw with very fine threads, which screw has a large micrometer head minutely divided on its edge, and a corresponding nonius; so that the tension of the wire may be adjusted with the greatest precision, in order to obtain its exact pitch. 5. A slider is fixed across the top of the moveable bridge, and is moved by means of another screw with very fine threads; so that the length of the wire may be regulated with the greatest nicety in all cases. 6. The above-mentioned slider, which is on the top of the moveable bridge, is adjusted to the steel rod or scale, not by sight, or by the coincidence of lines, but by means of mechanical contact against projecting pieces of steel firmly fixed on that steel scale, which method is incomparably more correct. 7. Each bridge carries a metallic finger, which keeps the wire close to the top of the bridge, whilst the wire is made to vibrate. 8. The vibrations of the wire are produced by touching it with a piece of cork, with the same elastic force, and on the very same spot each time, namely, at the distance of one inch from the immoveable bridge.

MONNIESIA, a genus of the class and order, diadelphia pentandria. The calyx is five-parted; corolla stringent; stamina 3, capsules 5, 1-seeded. There is one species, an American annual.

MONOCULOS. Monoculus, a genus of the order aptera: the generic character is, feet formed for swimming; body covered by a crustaceous tegument; eyes, in most species, approximated, and imbedded in the shell.

Of the monoculi, by far the major part are very small water-insects, requiring the assistance of a microscope for the investigation of their particular organs: some however are so large as to require no very minute inspection; and one species in particular, (if, indeed, it can be allowed to stand with propriety in the genus) is of a size so gigantic, that it is generally considered as the largest of the crustaceous tribe. This animal is the monoculus polyphemus of Linnæus, commonly distinguished by the title molucca or king-crab. Specimens are sometimes seen of two feet in length, exclusive of the tail. It is a native of the Indian ocean, and is said to be generally found in pairs, or male and female swimming together. The colour of the whole animal is a yellowish-brown: the shell is very convex, rounded in front, and lunated behind, where it joins the lower part of the body: this, which is of the same crustaceous nature, is marked on each side into several spiny incisions; the legs, which are seven on each side, are situated beneath the concavity of the large or rounded part of the shell, and are each terminated by a double claw, those of the lowest pair having some additional processes: the branchiæ, or respiratory, organs are disposed in the form of several flat, rounded, imbricated lamellæ on each side the lower part of the body; the tail, which is strait, triangular, and of the same crustaceous nature with the rest of the shell, is equal in length to the whole body, and gradually tapers to a sharp point. The eyes in this species, instead of being approximated, as required in the Linnæan generic character, are extremely distant from each other, being situated towards the sides of the shell: they are of a semilunar form, and the surface is divided into a great number of minute conical convexities: this part however should be considered as only constituting the cornea or exterior covering of each eye; the organs themselves being, according to the observations of Mr. Petiver, in the Philosophical Transactions, placed on a pedicle beneath each of the above-mentioned semilunar corneæ. Petiver's words are these. "The whole structure of this animal is very remarkable, and particularly his eyes, viz. between the fourth and last pair of claws on each side, reckoning from his mouth, and excluding the small pair there placed, are inserted the rudiments of another pair, or a claw broken off on each side at the second joint or elbow; on these extremities are the eyes, like those of the horns of snails, but under the covert of a thick and opaque shell, Nature in that place has wonderfully contrived a transparent lantern, through which the light is conveyed, whose superficies very exactly resembles the great eyes of our large libellæ or adderbolts, which to the naked eye are plainly perceived to be composed of of innumerable globuli: these, like them, are oblong, and guarded by a testaceous supercilium."

Of the European monoculi, by far the largest is the monoculus apus, which, when full-grown, measures nearly an inch and three quarters from the front to the end of the body, exclusive of the forked divisions of the tail. It is found in muddy stagnant waters, but is a rare species in this country, having been only observed in a few particular situations. In its general shape, it is considerably allied to the large exotic species before described, but the body is of a more lengthened form in proportion, with the hinder part naked, and divided into numerous joints: the branchiæ, or respiratory organs, are large, and are distributed into numerous imbricated rows on the under part of the body: beneath the front is a pair of jointed, trifid arms, extending on each side to a considerable distance; the eyes are placed near each other in front of the shell: the tail is terminated by a pair of long forks or cetaceous processes. The colour of the whole insect is a pale greenish-brown above, and reddish beneath. We are informed in vol. 40 of the Philosophical Transactions that this insect has been found in great plenty in a pond on Bexley's common, in Kent. It is also added that the same pond, having been perfectly dried, and being suddenly filled during a heavy thunder-storm, swarms of the same animal were again observed in it within the space of two days after.

Monoculus pulex, called, from its peculiar starting or springing motion, the water-flea, is an almost universal inhabitant of stagnant waters, appearing sometimes in such vast swarms as to cause an apparent discoloration of the water itself. It is an insect of a highly singular and elegant appearance, exhibiting, when magnified, a beautiful distribution of internal organs. Its general length is about the tenth of an inch, but it is sometimes seen considerably larger: its shape is oval, somewhat truncated in front, and sharply pointed behind: the body is inclosed in a bivalve, transparent shell, which, when examined by the microscope, appears finely reticulated: on each side the head is a strong transparent jointed arm, forking into two divisions, and terminating in several cetaceous branches: the tail, which is generally inclosed within the shell, is occasionally protruded in the form of a strong curved and pointed process: the eyes of this animal are of a singular construction; they are large in proportion to the insect, placed very near each other, appear to consist of many separate globules, of a black colour united under a common skin.

MONODON MONOCEROS, UNICORN NARWHAL, is a native of the northern seas, where it is sometimes seen of the length of more than twenty feet from the mouth to the tail; and is at once distinguishable from every other kind of whale by its very long, ivory-like tooth, which is perfectly straight, of a white or yellowish-white colour, spirally wreathed throughout its whole length, and gradually tapering to a sharp point. It measures from six to nine or ten feet in length, and proceeds from a socket on the one side of the upper jaw, having a large cavity at its base or root, running through the greater part of the whole length. In the young animals and occasionally even in the full grown ones, more especially in the males, there are two of these teeth, sometimes nearly of equal length, and sometimes very unequal in this respect: they are seated very close to each other at the base, and as their direction is nearly in a straight line, they diverge but little in their progress towards the extremites. The head of the narwhal is short, and convex above; the mouth small; the spiracle or breathing-hole duplicated within; the tongue long; the pectoral fins small; the back, finless, widish, convex, becoming gradually accuminated towards the tail, which, as in other whales, is horizontal. The general form of the animal is rather long than thick in proportion to its size. The colour, when young, is said to be nearly black, but lighter on the belly: but as the animal advances in age, it becomes marbled or variegated with black and white on the back and sides, while the belly is nearly white. The skin is smooth, and there is a considerable depth of oil or blubber beneath it.

The narwhal chiefly inhabits the northern parts of Davis's Streights. Its food is said to consist of the smaller kind of flat-fish, as well as of actiniæ, medusæ, and many other marine animals. It is principally seen in the small open or unfrozen spots towards the coasts of the northern seas. To such places it resorts in multitudes, for the conveniency of breathing, while at the same time it is sure of finding near the shores a due supply of food, and is very rarely seen in the open sea. It is taken by means of harpoons, and its flesh is eaten by the Greenlanders, both raw, boiled, and dried: the intestines and oil are also used as a food; the tendons make a good thread, and the teeth serve the purpose of hunting-horns as well as the more important ones of building tents and houses: but before this animal became distinctly known to the naturalists of Europe, they were held in high estimation, as the supposed horns of unicorns. Various medical virtues were also attributed to them, and they were even numbered among the articles of magnificence. A throne made for the Danish monarchs is said to be still preserved in the castle of Rosenberg, composed entirely of narwhals' teeth; the material being antiently considered as more valuable than gold.

A specimen of this whale, measuring about eighteen feet, exclusive of the horn or tooth, was some time ago stranded on the coast of Lincolnshire, at no great distance from Boston, and was said to have been taken alive.

2. Monodon spurius, spurious narwhal. A species most allied to the narwhal, but not perhaps, strictly speaking, of the same genus: no teeth in the mouth, but from the extremity of the upper mandible project two minute, conic, obtuse teeth, alike curved at the tips, weak, and not above an inch long: body elongated, cylindric, black. Besides the pectoral fins, and horizontal tail, is also a minute dorsal fin. It must be numbered among the rarest of the whales. Its flesh and oil are considered as very purgative: inhabits the main ocean, seldom coming towards shore: feeds on the loligo: has a spiracle like other whales. Both flesh and oil are eaten, but not without apprehension, for the reason already mentioned.

MONODON narwhal, a genus of mammalia of the order cete; the generic character is, teeth two in the upper jaw, extending straight forward, long, spiral: spiracle on the fore and upper part of the head. It inhabits the Atlantic, swims rapidly, and is from 18 to 40 feet long and 12 broad. Skin white, spotted on the back with black: dorsal fins: pectoral, two small: head small: eyes very minute: what are commonly exhibited as the unicorns horns. See Plate Nat Hist. fig. 269.

MONOECIA, from μονος alone, and οικια, a house; the name of the 21st class of Linnæus's sexual method. See BOTANY.

MONOGYNIA from μονος alone, and γυνη a woman; the name of the first order or subdivision in the first 13 classes of Linnæus's sexual method; consisting of plants, which, besides their agreement in their classic character, generally derived from the number of their stamina, have only one style, or female organ. See BOTANY.

MONOGRAM, a character or cypher, composed of one, two, or more letters interwoven; being a kind of abbreviation of a name, antiently used as a seal, badge, arms, &c.

MONOPOLY, is an allowance by the king, by his grant, commission, or otherwise, to any person or persons, bodies politic or corporate; or of, or for, the sole buying, selling, making, working, or using of any thing, whereby any person or persons, bodies politic or corporate, are sought to be restrained of any freedom or liberty they had before, or hindered in their lawful trade. 3 Inst. 181.

But it seems that the king's charter, impowering particular persons to trade to and from such place is void, so far as it gives such persons an exclusive right of trading, and debarring all others; and it seems now agreed, that nothing can exclude a subject from trade but an act of parliament. Raym. 489.

MONOPTERUS. Monoptere, a genus of the fishes of the order apodal; the generic character is, body anguilliform; nostrils placed between the eyes; fin caudal.

1. The monopterus Javanicus, the only animal of this genus hitherto discovered, is thus described by the count de la Cepede, from the manuscripts of Commerson, by whom it was considered as a species of Muræna. The body is serpentiform, viscous, and destitute of conspicuous scales: the head thick, compressed, enlarging towards the back part, and terminated in front by a rounded muzzle: the gape is rather wide; the upper jaw scarcely projecting beyond the lower; both being furnished with close teeth: the gill membrane has only three rays, and the branchiæ are only three in number on each side; the lateral line, which is nearer the back than the belly, extends from the gills to the extremity of the tail, and is almost of a gold-colour: the back is of a livid brown or blackish colour. This fish is a native of the Indian seas and is very common about the coasts of Java, where it is considered as an excellent food.

MONSONIA, a genus of the dodecandria order, in the polyadelphia class of plants. The calyx is pentrophyllous; the corolla pentapetalous and irregular; the stamina are 15 in number, and coalited into five filaments; the style bifid; the capsule pentacoccous. There are three species.

MONSOON. See WIND.

MONTH, the twelfth part of a year. See CHRONOLOGY.

MONTIA, water chickweed, a genus of the trigynia order, in the triandria class of plants; and in the natural method ranking with those two of which the order is doubtful. The calyx is dyphyllous; the corolla monopetalous and irregular; the capsule unilocular and trivalved. There is one species.

MOOD, or *Mode*, in grammar, the different manner of conjugating verbs, serving to denote the different affections of the mind.

MOON. See ASTRONOMY.

MOONSTONE. This is the purest felspar hitherto found. It occurs in Ceylon and Switzerland; and was first mentioned by Mr. Pini. Specific gravity, 2.559. Colour white; sometimes with a shade of yellow, green, or red. Its surface is sometimes iriddescent. A specimen of it analysed by Vauquelin, yielded.

64	silica
20	alumina
14	potass
2	lime
100	

The whitish felspar, called petunze, yielded to the same chemist

74.0	silica
14.5	alumina
5.5	lime
94.0	

MOORING, in the sea-language, is the laying out the anchors of a ship in a place where she can ride secure. Mooring across, is laying out on each side; and mooring along, is to have an anchor in a river and a hawser on shore. When ships are laid up in ordinary, or are under orders of fitting for sea, the moorings are laid out in harbours; and consist of claws, pendant chains, cables, bridles, anchors, swivels, jews-harps, buoys, and chains.

MORDELLA, a genus of insects of the order coleoptera. The antennæ are thread-shaped and serrated; the head is deflected under the neck: the pappi are elevated, compresed, and obliquely blunted; and the elytra are bent backwards near the apex. There are six species.

MORÆA, a genus of the monogynia order, in the triandria class of plants; and in the natural method ranking under the 6th order, ensatæ. The corolla is hexapetalous; the three interior petals, patent; the rest like those of the iris. There are 17 species, beautiful exotics, resembling the iris.

MORINA, a genus of the monogynia order, in the triandria class of plants; and in the natural method ranking under the 48th order, aggregatæ. The corolla is unequal; the calyx of the fruit is monophyllous and dented; the calyx of the flower bifid; there is one seed under the calyx of the flower. There is one species.

MORINDA, a genus of the monogynia order, in the pentandria class of plants; and in the natural method ranking under the 48th order, aggregatæ. The flowers are aggregate and monopetalous; the stigmata bifid; the fruit plums aggregate or in clusters. There are 3 species, trees of the East Indies.

MORISONIA, a genus of the polyandria order, in the monadelphia class of plants; and in the natural method ranking under the 25th order, putamineæ. The calyx is single and bifid; the corolla tetrapetalous; there is one pistil: the berry has a hard bark, is unilocular, polyspermous, and pedecellated. There is one species, a tree of South America.

MORMYRUS, a genus of fishes of the branchiostegeous order, the generic character is, head smooth; teeth numerous, notched; aperture of the gills linear, without a cover; gill membrane with one ray; body scaly. There are three species. The kannume has the tail bifid, obtuse; dorsal fin with 63 rays. It inhabits the Nile; body whitish and much compressed.

MOROCCO, *maroquin*, in commerce, a fine kind of leather prepared of the skin of an animal of the goat-kind, and imported from the Levant, Barbary, &c.

The name was probably taken from the kingdom of Morocco, whence the manner of preparing it was borrowed, which is this: the skins being first dried in the hair, are steeped in water three days and nights; then stretched on a tanner's horse, beaten with a large knife, and steeped afresh in water every day: they are then thrown into a large vat in the ground, full of water, where quicklime has been slaked, and there lie fifteen days; whence they are taken, and again returned every night and morning. They are next thrown into a fresh vat of lime and water, and shifted night and morning for fifteen days longer; then rinsed in clear water, and the hair taken off on the leg with the knife, returned into a third vat, and shifted as before for eighteen days; steeped twelve hours in a river, taken out, rinsed, put in pails, where they are pounded with wooden pestles, changing the water twice; then laid on the horse, and the flesh taken off; returned into pails of new water, taken out, and the hair-side scraped; returned into fresh pails, taken out, and thrown into a pail of a particular form, having holes at bottom: here they are beaten for the space of an hour, and fresh water poured on from time to time; then being stretched on the leg, and scraped on either side, they are returned into pails of fresh water, taken out, stretched and sewed up all around in manner of bags, leaving out the hinder legs as an aperture for the conveyance of a certain mixture.

The skins thus sewed are put in lukewarm water, where dogs excrements have been dissolved. Here they are stirred with long poles for half an hour, left at rest a dozen, taken out, rinsed in fresh water, and filled by a tunnel with a preparation of water and sumac, mixed and heated over the fire till ready to boil; and, as they are filled, the hind legs are sewed up to stop the passage. In this state they are let down into the vessel of water and sumac, and kept stirring for four hours successively; taken out and heaped on one another; after a little time their sides are changed, and thus they continue an hour and a half till drained. This done, they are loosened, and filled a second time with the same preparation, sewed up again, and kept stirring two hours, piled up and drained as before. This process is again repeated, with this difference, that they are then only stirred a quarter of an hour; after which they are left till next morning, when they are taken out, drained on a rack, unsewed, the sumac taken out, folded in two from head to tail, the hair-side outwards, laid over each other on the leg, to perfect their draining, stretched out and dried; then trampled under foot by two and two, stretched on a wooden table, what flesh and sumac remains scraped off, the hair-side rubbed over with oil, and that again with water.

They are then wrung with the hands, stretched, and pressed tight on the table with an iron-instrument like that of a currier, the flesh side uppermost; then turned, and the hair-side rubbed strongly over with a handful of rushes, to squeeze out as much of the oil remaining as possible. The first curse of black is now laid on the hair-side, by means of a lock of hair twisted and steeped in a kind of black dye, prepared of sour beer, wherein pieces of old rusty iron have been thrown. When half-dried in the air, they are stretched on a table, rubbed over every way with a paumelle, or wooden-toothed instrument, to raise the grain, over which is past a light couch of water, then sleeked by rubbing them with rushes prepared for the purpose. Thus sleeked, they have a second couche of black, then dried, laid on the table, rubbed over with a paumelle of cork, to raise the grain again; and, after a light couche of water, sleeked over anew; and to raise the grain a third time, a paumelle of wood is used.

After the hair-side has received all its preparations, the flesh-side is pared with a sharp knife for the purpose: the hair-side is strongly rubbed over with a woollen cap, having before given it a gloss with barberries, citron, or orange. The whole is finished by raising the grain lightly, for the last time, with the paumelle of cork; so that they are now fit for the market.

Manner of preparing red MOROCCO: after steeping, stretching, scraping, beating, and rinsing the skins, as before, they are at length wrung, stretched on the leg, and passed after each other into water where alum has been dissolved. Thus alumed, they are left to drain till morning, then wrung out, pulled on the leg, and folded from head to tail, the flesh inwards.

In this state they receive their first dye, by passing them after one another into a red liquor prepared with laque, and some other ingredients, which the marowquineers keep a secret. This they repeat again and again, till the skins have got their first colour; then they are rinsed in clear water, stretched on the leg, and left to drain twelve hours; thrown into water through a sieve, and stirred incessantly for a day with long poles; taken out, hung on a bar across the water all night, white against red, and red against white, and in the morning the water stirred up, and the skins returned into it for twenty-four hours.

MORTALITY, *Bills of*, accounts of the numbers of deaths or burials in any parish or district. The establishment of registers of this kind in Great Britain, was occasioned by the plague, and an abstract of them was published weekly, to shew the increase or decrease of the disorder, that individuals might judge of the necessity of removal, or of taking other precautions against it, and government be informed of the propriety or success on any public measures relating to the disorder. The first directions for keeping registers of births and burials were contained in the injunctions to the clergy, issued in the year 1538, which not being properly attended to, were enforced in 1547, and again in the beginning of the reign of Elizabeth, who also appointed a protestation to be made by the clergy, in which, among other things, they promise to keep the register-book in a proper manner. One of the canons of the church prescribes very minutely in what manner entries are to be made in the parish-registers, and orders an attested copy of the register of each successive year to be annually transmitted to the bishop of the diocese or his chancellor, and to be preserved in the bishop's registry. These registers have only been occasionally communicated to the public, and that without sufficient particulars to supply much information; but in London, and the surrounding parishes, the parish-clerks are required to make a weekly return of burials, with the age and disease of which the person died; a summary of which account is published weekly; and on the Thursday before Christmas-day, a general account is made up for the whole year. These accounts of christenings and burials, taken by the company of parish clerks of London, were began 21st Dec. 1592, but were not made public till 1594; and towards the end of the following year, upon the ceasing of the plague, they were discontinued; at this time the London bills of mortality comprehended but 109 parishes. In 1603, the weekly bills of mortality were resumed, and have been regularly continued ever since; the number of parishes included in them has been increased at different times, and at present is 146.

Bills of mortality, especially such as give the ages of the dead and the disorders of which they died, furnish much useful information; they shew the different degrees of healthiness of seasons or districts, the progress of population, and the probabilities of the duration of human life in any part of the usual term of existence; they are the foundations on which all tables of the value of annuities on lives, or depending on survivorship, have been constructed.

In 1662, Mr. John Graunt published some ingenious observations on the London Bills of Mortality, which were much enlarged in subsequent editions. Sir William Petty, in 1683, made considerable use of the information afforded by them, in his Political Arithmetic. In 1742, Mr. T. Simpson published his Treatise on Annuities, in which he inserted a table formed by Mr. Smart from the London bills of mortality, with some corrections which appeared necessary: in 1746, Mr. De Parcieux, in an Essai sur les Probabilités de la Vie humaine, made some objections to Mr. Simpson's alterations in the London bills, but without sufficient foundation; and in 1752, Mr. Simpson, in a supplement to his Treatise on Annuities, made use of the same table from the London bills, but adapted to a different radix. In 1769, Dr. Price published his treatise on Reversionary Payments, in which, particularly in the subsequent editions, many valuable observations are to be found on the bills of mortality of different places, and very accurate tables are given of the expectation of life, and the value of annuities, according to these bills.

Dr. Price remarks, that in every place which just supports itself in the number of its inhabitants, without any recruits from other places; or where, for a course of years, there has been no increase or decrease, the number of persons dying every year at any particular age, and above it, must be equal to the number of the living at that age. The number, for example, dying every year, at all ages, from the beginning to the utmost extremity of life, must, in such situation, be just equal to the whole number born every year. And for the same reason, the number dying every year at one year of age and upwards, at two years of age and upwards, at three and upwards, and so on, must be equal to the numbers that attain to those ages every year; or, which is the same, to the numbers of the living at those ages. It is obvious, that unless this happens, the number of inhabitants cannot remain the same; it follows, therefore, that in a town or country, where there is no increase or decrease, bills of mortality which give the ages at which all die, will shew the exact number of inhabitants; and also the exact law, according to which human life wastes in that town or country. In order to find the number of inhabitants, the mean numbers dying annually at every particular age and upwards, must be taken as given by the bills, and placed under one another in the order of the second column: see Table I, article EXPECTATION. These numbers will be the numbers of the living at 1, 2, 3, &c. years of age; and, consequently, the sum, diminished by half the number born annually, will be the whole number of inhabitants.

The bills of mortality, in some parts of Great Britain, are known to be materially defective; the deficiencies may chiefly be ascribed to the following circumstances: 1. Many congregations of dissenters, inhabiting towns, have their own peculiar burying-grounds; as have the Jews, and the Roman Catholics, who reside in London. 2. Some persons, from motives of poverty or convenience, inter their dead without any religious ceremony; this is known to happen in the metropolis, in Bristol, and Newcastle-upon-Tyne, and may happen in a few other large towns. 3. Children who die before baptism are interred without any religious ceremony, and consequently are not registered. 4. Negligence may be supposed to cause some omissions in the registers, especially in those small benefices, where the officiating minister is not resident. 5. Many persons employed in the army and in navigation die abroad, and consequently their burials remain unregistered. Whatever may be the total number of deaths and burials, which from these several circumstances are not brought to account, it has been computed that about 5000 of them may be attributed to the metropolis, and a large portion of the rest may be ascribed to the other great towns, and to Wales, where the registers are less carefully kept than in England.

The annual amount of the burials, as collected conformably to the population act, authorizes a satisfactory inference of diminishing mortality in England since the year 1780; the number of marriages and baptisms, indicates that the existing population in 1801, was to that of 1780, as 117 to 100, while the amount of registered burials remained stationary during the same period; the first five years of which, as well as the last five years, and all the 21 years taken together, equally averaged about 186,000 per annum.

The whole number of baptisms, collected for the purposes of the population act, was 6,436,110; of these 3,285,188 were males, and 3,150,922 females; so that the baptisms of males were 10,426 to 10,000 baptisms of females. The whole number of the burials appeared to be 5,165,844; of which 2,575,762 were males, and 2,590,082 females, so that the burials of males were 9,944 to 10,000 burials of females. It may be interred hence, that of 10,426 males born in England, only 9,944 die at home; therefore, about one in twenty-two dies abroad in the employments of war and commerce; a proportion which strongly marks the enterprising character of the nation.

MORTAR-PIECE, a short piece of ordnance, considerably thick and wide; serving to throw bombs, carcases, fire-pots, &c. See GUNNERY.

MORTGAGE, signifies a pawn of land or tenement, or any thing immoveable, laid or bound for money borrowed, to be the creditor's for ever, if the money is not paid at the day agreed upon; and the creditor holding land and tenement upon this bargain, is called tenant in the mortgage. He who pledges this pawn, or gage, is called the mortgageor, and he who takes it, the mortagee.

The last and best improvement of mortgages seems to be, that in the mortgage-deed of a term for years, or in the assignment thereof, the mortgageor should covenant for himself and his heirs, that if default is made in the payment of the money at the day, then he and his heirs will, at the costs of the mortgagee and his heirs, convey the freehold and inheritance of the mortgaged lands to the mortgagee and his heirs, or to such person or persons (to prevent merger of the term) as he or they shall direct and appoint: for the reversion, after a term of fifty or a hundred years, being little worth, and yet the mortgagee for want thereof continuing but a termer, and subject to a forfeiture, &c. and not capable of the privileges of a freeholder; therefore when the mortgageor cannot redeem the land, it is but reasonable the mortgagee should have the whole interest and inheritance of it to dispose of it as absolute owner. 3 Bac. Abr. 633.

Although after breach of the condition, an absolute fee-simple is vested at common law in the mortgagee; yet a right of redemption being still inherent in the land, till the equity of redemption is foreclosed, the same right shall descend to, and is invested in, such persons as had a right to the land, in case there had been no mortgage or incumbrance whatsoever; and as an equitable performance as effectually defeats the interests of the mortgage, as the legal performance does at common law, the condition still hanging over the estate till the equity is totally foreclosed; on this foundation it has been held that a person who comes in under a voluntary conveyance, may redeem a mortgage; and though such right of redemption is inherent in the land, yet the party claiming the benefit of it, must not only set forth such right, but also shew that he is the person entitled to it. Hard. 465.

But if a mortgage is forfeited, and thereby the estate absolutely vested in the mortgagee at common law, yet a court of equity will consider the real value of the tenements, compared with the sum borrowed. And if the estate is of greater value than the sum lent thereon, they will allow the mortgageor, at any reasonable time, to recal or redeem the estate, paying to the mortgagee his principal, interest, and costs. This reasonable advantage, allowed to the mortgageors, is called the equity of redemption. 2 Black. 159.

It is a rule established in equity, analogous to the statute of limitation, that after twenty years possession of the mortagee, he shall not be disturbed, unless there are extraordinary circumstances; as in the case of femes covert, infants, and the like. 3 Atk. 313.

MORTISE, or *Mortoise*, in carpentry, &c. a kind of joint, wherein a hole of a certain depth is made in a piece of timber, which is to receive another piece called a tenon.

MORTMAIN, signifies an alienation of lands and tenements, to any guild, corporation, or fraternity, and their successors, as bishops, parsons, vicars, &c. which may not be done without the king's licence, and the lord of the manor; or of the king alone, if it is immediately holden of him.

But in order to prevent any imposition in respect to the disposal of lands to charitable uses, which might arise in a testator's last hours, and in some measure, from political principles, to restrain devises in mortmain, or the too great accumulation of land in hands where it lies dead, and not subject to change possession, it is provided by stat. 9 G. II. c. 36, (called the statute of mortmain), that no manors, lands, tenements, rents, advowsons, or other hereditaments, corporeal or incorporeal, whatsoever, nor any sum or sums of money, goods, chattels, stocks in the public funds, securities for money, or other personal estate whatsoever, to be laid out or disposed of in the purchase of any lands, tenements, or hereditaments, shall be given, limited, or appointed by will, to any person or persons, bodies politic or corporate, or otherwise for any estate or interest whatsoever; or any ways charged or incumbered by any person or persons whatsoever, in trust, or for the benefit of any charitable use whatsoever; but such gift shall be by deed indented, sealed and delivered in the presence of two or more credible witnesses, twelve calendar months at least before the debt of such donor, and be inrolled in the high court of chancery within six calendar months after execution for the charitable use intended; and be without any power of revocation, reservation, or trust, for benefit of the donor. And all gifts and appointments whatsoever, of any lands, tenements, or other hereditaments, or of any estate or interest therein, or of any charge or incumbrance affecting or to affect any lands, tenements, or hereditaments, or any personal estate to be laid out in the purchase of any lands, tenements, or hereditaments, or any estate or interest therein, or of any charge or incumbrance affecting or to affect the same, to or in trust for any charitable use whatsoever, made in any other manner than is directed by this act, shall be absolutely null and void. But the two universities, their colleges, and the scholars upon the foundation of the colleges at Eton, Westminster, and Winchester, are excepted out of this act; but with this proviso, that no college shall be at liberty to purchase more advowsons than are equal in number to one moiety of the fellows or students upon the respective foundations.

MORUS, the MULBERRY-TREE, a genus of the tetrandria order, in the monœcia class of plants; and in the natural method ranking under the 53d order, scabridæ. The male calyx is quadripartite; and there is no corolla: the female calyx is tetraphyllous; there is no corolla; two styles; the calyx like a berry, with one seed. There are seven species, viz. 1. The nigra, or common black-fruited mulberry-tree, rises with an upright, large, rough trunk, dividing into a branchy and very spreading head, rising 20 feet high, or more. 2. The alba, or white mulberry-tree, rises with an upright trunk, branching 20 or 30 feet high. There is a variety with purplish fruit. 3. The papyrifera, or paper mulberry-tree of Japan, grows 20 or 30 feet high; having large palmated leaves, some trilobate, others quinquelobed; and monœcious flowers, succeeded by small back fruit. 4. The rubra, or red Virginia mulberry-tree, grows 30 feet high; and has large reddish berries. 5. The tinctoria, dyer's mulberry, or fustic, has oblong leaves more extended on one side at the base, with axillary thorns. It is a native of Brasil and Jamaica. 6. The tartarica, or Tartarian mulberry, has ovate oblong leaves, equal on both sides, and equally serrated. It abounds on the banks of the Wolga and the Tanais. 7. the Indica, or Indian mulberry, has ovate oblong leaves, equal on both sides, but unequally serrated.

The last three species are tender plants in this country; but the four first are very hardy, and succeed in any common soil and situation. The leaves are generally late before they come out, the buds seldom beginning to till the middle or towards the latter end of May, according to the temperature of the season; and when these trees, in particular, begin to expand their foliage, it is a good sign of the near approach of fine warm settled weather; the white mulberry, however, is generally forwarder in leafing than the black.

Considered as fruit-trees, the nigra is the only proper sort to cultivate here; the trees being not only the most plentiful bearers, but the fruit is larger and much finer-flavoured than that of the white kind, which is the only other sort that bears in this country. The three next species are chiefly employed to form variety in our ornamental plantations; though abroad they are adapted to more useful purposes. The wood of the mulberry-tree is yellow, tolerably hard, and may be applied to various uses in turnery and carving: but in order to separate the bark, which is rough, thick, thready, and fit for being made into ropes, it is proper to steep the wood in water.

Mulberry-trees are noted for their leaves affording the principal food of that valuable insect the silkworm. The leaves of the alba, or white species, are preferred for this purpose in Europe; but in China where the best silk is made the worms are said to be fed with those of the morus tartarica. The advantages of white mulberry-trees are not confined to the nourishment of worms: they may be cut every three or four years like sallows and poplar trees, to make faggots; and the sheep eat their leaves in winter, before they are burnt. This kind of food, of which they are extremely fond, is very nourishing; it gives a delicacy to the flesh, and a fineness and beauty to the wool.

The papyrifera, or paper-mulberry, is so called from the paper chiefly used by the Japanese being made of the bark of its branches. The leaves of this species also serve for food to the silkworm, and it is now cultivated with success in France. It thrives best in sandy soils, grows faster than the common mulberry, and at the same time is not injured by the cold. M. de la Bouviere affirms that he procured a beautiful vegetable silk from the bark of the young branches of this species of mulberry, which he cut while the tree was in sap, and afterwards beat and steeped. The women of Louisiana procure the same kind of production from the shoots which issue from the stock of the mulberry, and which are four or five feet high. After taking off the bark, they dry it in the sun, and then beat it that the external part may fall off; and the internal part, which is fine bark, remains entire. This is again beaten, to make it still finer: after which they bleach it with dew. It is then spun, and various fabrics are made from it, such as nets and fringes: they even sometimes weave it, and make it into cloth. The finest sort of cloth among the inhabitants of Otaheite and others of the South Sea islands, is made of the bark of this tree.

The tinctoria is a fine timber-tree, and a principal ingredient in most of our yellow dyes, for which it is chiefly imported into Europe. The berries are sweet and wholesome; but not much used, except by the winged tribe, by whose care it is chiefly planted.

MOSAIC, or *mosaic-work*, an assemblage of little pieces of glass, marble, precious stones, &c. of various colours, cut square and cemented on a ground of stucco, in such a manner as to imitate the colours of painting.

MOSCHUS, musk, a genus of quadrupeds of the order pecora: the generic character is, horns none; front teeth in the lower jaw eight; tusks solitary, in the upper jaw exserted.

1. Moschus moschiferus, Tibetian musk. The musk is one of those quadrupeds whose true form and natural history appear to have continued in great obscurity long after the introduction and general use of the celebrated perfume which it produces. To the antients it was unknown, and was first mentioned by the Arabians, whose physicians used the drug in their practice. The animal was by some considered as a kind of goat, by others as a species of deer or antelope, and was, of course, supposed to be a horned animal; nor was it till about the decline of the seventeenth century that a tolerably accurate description or figure was to be found.

The size and general appearance of this animal resemble those of a small roebuck. It measures about three feet three inches in length, about two feet three inches in height from the top of the shoulders to the bottom of the fore-feet, and two feet nine inches from the top of the haunches to the bottom of the hind feet. The upper jaw is considerably longer than the lower, and is furnished on each side with a curved tusk about two inches long. These tusks are of a different form from those of any other quadruped; being sharp-edged on their inner or lower side, so as to resemble, in some degree, a pair of small crooked knives: their substance is a kind of ivory, as in the tusks of the babyrussa and some other animals.

The general colour of the whole body is a kind of deep iron-grey; the tips of the hairs being of a ferruginous cast, the remainder blackish, growing much paler or whitish towards the roots. See Plate Nat. Hist. fig. 279.

The female is smaller than the male, and wants the tusks: it has also two small teats.

They are hunted for the sake of their well-known perfume: which is contained in an oval receptacle about the size of a small egg, hanging from the middle of the abdomen, and peculiar to the animal. This receptacle is found constantly filled with a soft, unctuous, brownish substance, of the most powerful and penetrating smell; and which is no other than the perfume in its natural state. As soon as the animal is killed, the hunters cut off the receptacle or musk-bag, and tie it up ready for sale. The animals must of necessity be extremely numerous in some parts, since we are assured by Tavernier, the celebrated merchant and traveller, that he purchased, in one of his Eastern journeys, no less than seven thousand six hundred and seventy-three musk-bags.

So violent is the smell of musk, when fresh-taken from the animal, or from quantities put up by the merchants for sale, that it has been known to force the blood from the nose, eyes, and ears, of those who have imprudently inhaled its vapours.

As musk is an expensive drug, it is frequently adulterated by various substances; and we are assured that pieces of lead have been found in some of the receptacles, inserted in order to increase the weight. The smell of musk is so remarkably diffusive, that every thing in its neighbourhood becomes strongly infected with it; even a silver cup that has had musk in it does not part with the scent, though other odours are in general very readily discharged from metallic substances.

As a medicine it is held in high estimation in the Eastern countries, and has now been introduced into pretty general use among ourselves, especially in those disorders which are commonly termed nervous; and in convulsive and other cases, it is often exhibited in pretty large doses with great success.

2. Moschus Indicus, or the Indian musk. This species is said to be rather larger than the common or Tibetian musk, of the colour mentioned in the specific character, with the head shaped like that of a horse, upright oblong ears, and slender legs. It is a native of India.

3. Moschus pygmæus, or the pygmy musk, is considerably smaller than a domestic cat,

measuring little more than nine inches from the nose to the tail. Its colours is bright bay, white beneath and on the insides of the thighs. Its shape is beautiful, and the legs are so slender as not to exceed the diameter of a swan-quill; the head is rather large, and the aspect mild. It is a native of many parts of the East Indies and the Indian islands, and is said to be most common in Java, where the natives catch great numbers in snares, and carry them to the markets in their cages for sale. According to Mr. Pennant they may be purchased at so low a rate as two pence halfpenny a piece. There are three other species.

MOSQUE, a temple or place of religious worship among the Mahometans.

All mosques are square buildings, generally built with stone; before the chief gate there is a square court, paved with white marble, and low galleries round it, whose roof is supported by marble pillars. In these galleries the Turks wash themselves before they go into the mosque. In each mosque there are a great number of lamps; and between these hang many crystal rings, ostriches' eggs, and other curiosities, which, when the lamps are lighted, make a fine shew. As it is not lawful to enter the mosques with shoes or stockings on, the pavements are covered with pieces of stuff sewed together, each being wide enough to hold a row of men kneeling, sitting, or prostrate. The women are not allowed to enter the mosques, but stay in the porches without. About every mosque there are six high towers, called minarets, each of which has three little open galleries, one above another: these towers, as well as the mosques, are covered with lead, and adorned with gilding and other ornaments; and from thence, instead of a bell, the people are called to prayer by certain officers appointed for that purpose. Most of the mosques have a kind of hospital belonging to them, in which travellers, of what religion soever, are entertained during three days. Each mosque has also a place called tarbé, which is the burying-place of its founders; within which is a tomb six or seven feet long, covered with green velvet or satin, at the ends of which are two tapers, and round it several seats for those who read the koran, and pray for the souls of the deceased.

MOSS. See Muscus.

MOTACILLA, the *wagtail* and *warbler*, a genus of birds of the order of passeres, distinguished by a straight weak bill of a subulated figure, a tongue lacerated at the end, and very slender legs.

1. The alba, or white wagtail, frequents the sides of ponds and small streams, and feeds on insects and worms. The head, back, and upper and lower side of the neck as far as the breast, are black; in some the chin is white, and the throat marked with a black crescent; the breast and belly are white. The tail is very long, and always in motion. Mr. Willughby observed, that this species shifts its quarters in the winter, moving from the north to the south of England during that season. In spring and autumn it is a constant attendant on the plough, for the sake of the worms thrown up by that instrument.

2. The flava, or yellow wagtail, migrates in the north of England, but in Hampshire continues the whole year. The male is a bird of great beauty; the breast, belly, thighs, and vent-feathers, being of a most vivid and lovely yellow. The colours of the female are far more obscure than those of the male: it wants also those black spots on the throat.

3. The regulus, or gold-crested wren, is a native of Europe, and of the correspondent latitudes of Asia and America. It is the least of all the European birds, weighing only a single drachm. Its length is about four inches and a half, and the wings when spread out measure little more than six inches. On the top of its head is a beautiful orange-coloured spot, called its crest, which it can hide at pleasure; the margins of the crest are yellow, and it ends in a pretty broad black line; the sides of the neck are of a beautiful yellowish-green; the eyes surrounded with a white circle; the neck and back of a dark green mixed with yellow. In America it associates with the titmice, running up and down the bark of lofty oaks with them, and collecting its food in their company, as if they were all of one brood. It feeds on insects lodged in the winter dormitories in a torpid state. It is said to sing very melodiously.

4. The sutoria, or taylor-bird, is a native of the East Indies. It is remarkable for the art with which it makes its nest, seemingly in order to secure itself and its young, in the most perfect manner possible, against all danger from voracious animals. It picks up a dead leaf, and sews it to the side of a living one: its slender bill is the needle, and its thread is formed of some fine fibres; the lining is composed of feathers, gossamer, and down. The colour of the bird is light yellow; its length three inches, and its weight only three-sixteenths of an ounce; so that the materials of the nest and its own size are not likely to draw down a habitation depending on so slight a tenure.

5. The lucinia, or nightingale, exceeds in size the hedge-sparrow. The bill is brown; the irides are hazel; the head and back pale tawny, dashed with olive; the tail is of a deep tawny red; the under parts pale ash-colour, growing white towards the vent; the quills are cinereous brown. The male and female are very similar. This bird, the most famed of the feathered tribe for the variety, length, and sweetness of its notes, is supposed to be migratory. It is met with in Siberia, Sweden, Germany, France, Italy, and Greece. Hasselquist speaks of it as being in Palestine, and Fryer ascertains its being found about Chulminor in Persia; it is also spoken of as a bird of China, Kamtschatka, and Japan; at which last place they are much esteemed, and sell dear; as they are also at Aleppo, where they are "in great abundance kept tame in houses, and let out at a small rate to such as choose it in the city, so that no entertainment is made in the spring without a concert of these birds."

They are solitary birds, never uniting into even small flocks; and in respect to the nests, it is very seldom that two are found near each other. The female builds in some low bush or quickset edge, well covered with foliage, for such only this bird frequents; and lays four or five eggs of a greenish-brown. The nest is composed of dry leaves on the outside, mixed with grass and fibres, lined with hair or down within, though not always alike. The female alone sits on and hatches the eggs, while the male not far off regales her with his delightful song; but as soon as the young are hatched, he commonly leaves off singing, and joins with the female in the task of providing for and feeding them. After the young can provide for themselves, the old female provides for a second brood, and the song of the male recommences. They have been known to have three broods in a year, and in the hot countries even four. These birds are often brought up from the nest for the sake of their song. They are likewise caught at their first coming over; and though old birds, yet by management can be made to bear confinement, and to sing equally with those brought up from the nest. None but the vilest epicure, as Mr. Latham remarks, would think of eating these charming songsters: yet we are told that their flesh is equal to that of the ortolan, and they are fatted in Gascony for the table.

6. The medularis, or hedge-sparrow, a well-known bird, has the back and wing-coverts of a dusky hue, edged with reddish-brown; rump of a greenish-brown; throat and breast of a dull ash-colour; the belly a dirty white; and the legs of a dull flesh-colour. The note of this bird would be thought pleasant, did it not remind us of the approach of winter; beginning with the first frosts, and continuing till a little time in spring. Its often repeating the word tit, tit, tit, has occasioned its being called titling; a name it is known by in many places.

7. The phœnicurus, or redstart, is somewhat less than the redbreast; the forehead is white; the crown of the head, hind part of the neck, and back, are deep blue-grey; the cheeks and throat black; the breast, rump, and sides, red; and the belly is white; the two middle tail-feathers are brown; the rest red; and the legs are black. The wings are brown in both sexes.

This bird is migratory; coming hither in spring, and departing in autumn about October. It is not so shy as many birds in respect to itself; for it approaches habitations, and frequently makes its nest in some hole of a wall where numbers of people pass by frequently; yet it is content, if no one meddles with the nest. This bird frequently wags its tail; but does it sideways, like a dog, when he is pleased, and not up and down like the wagtail. It is with difficulty that these birds are kept in a cage; nor will they submit to it by any means if caught old. Their song has no great strength; yet it is agreeable enough; and they will, if taught young, imitate the notes of other birds, and sing by night frequently as well as in the day-time.

8. The rubecula, or redbreast, is universally known. It abounds in Burgundy and Lorraine, where numbers are taken for the table, and thought excellent. It builds not far from the ground if in a bush; though sometimes it fixes on an out-house, or retired part of some old building. The nest is composed of dried leaves, mixed with hair and moss, and lined with feathers. The eggs are of a dusky white, marked with irregular reddish spots; and are from three to seven in number. The young, when full-feathered, may be taken for a different bird, being spotted all over. The first rudiments of the red break forth on the breast about the end of August; but it is quite the end of September before they come to the full colour. Insects are

their general food; but in defect of these they will eat many other things. No bird is so tame and familiar as this; closely attending the heels of the gardener when he is using his spade, for the sake of worms; and frequently in winter entering houses where windows are open, when they will pick up the crumbs from the table while the family is at dinner. Its familiarity has caused a petty name to be given it in several countries. The people about Bornholm call it Tommi-liden; in Norway, Peter-ronsmad; the Germans, Thomas-gierdet; and we, the Robin-red-breast.

9. The œnanthe, or wheatear, is in length five inches and a half. The top of the head, hind part of the neck, and back, are of a blueish grey; and over the eye a streak of white; the under parts of the body yellowish-white: the breast is tinged with red; and the legs are black. This bird is met with in most parts of Europe, even as far as Greenland: and specimens have also been received from the East Indies. It visits England annually in the middle of March, and leaves us in September. It chiefly frequents heaths. The nest is usually placed under shelter of some turf, clod, stone, or the like, always on the ground, and not unfrequently in some deserted rabbit-burrow. It is composed of dry grass or moss, mixed with wool, fur of the rabbit, &c. or lined with hair and feathers. The eggs are from five to eight in number, of a light blue, with a deeper-blue circle at the large end. The young are hatched the middle of May. In some parts of England these birds are in vast plenty. About Eastbourn in Sussex they are taken in snares made of horsehair placed beneath a long turf: being very timid birds, the motion of a cloud, or the appearance of a hawk, will drive them for shelter into these traps, and so they are taken. The numbers annually ensnared in that district alone amount to about 1840 dozen, which usually sell at sixpence per dozen. Quantities of these are eaten on the spot by the neighbouring inhabitants; others are picked, and sent up to the London poulterers; and many are potted, being as much esteemed in England as the ortolan on the continent. Their food is insects only; though in rainy summers they feed much on earth-worms, whence they are fattest in such seasons.

10. The cyanea, or superb warbler, a most beautiful species, is five inches and a half long. The bill is black; the feathers of the head are long, and stand erect like a full crest; from the forehead to the crown they are of a bright blue; thence to the nape, black like velvet; through the eyes from the bill there runs a line of black; and beneath the eye springs a tuft of the same blue feathers; beneath which, and on the chin, it is of a deep blue, almost black, and feeling like velvet. The hind part of the neck, and upper parts of the body and tail, are of a deep blue-black, the under pure white; the wings are dusky; the shafts of the quills chesnut; the legs are dusky brown; the claws black. It inhabits Van Diemen's Land, the most southern part of New Holland. The female of this species, is discovered to be entirely destitute of all the fine blue colours, both pale and dark, by which the male is adorned, except that there is a very narrow circle of azure round each eye, apparently on the skin only.

11. The troglodytes, or wren, is a very small species, in length only three inches and three quarters, though some have measured four inches. It generally carries the tail erect. This minute bird is found throughout Europe; and in England it defies our severest winters. Its song is much esteemed, being, though short, a pleasing warble, and much louder than could be expected from the size of the bird; it continues throughout the year.

The sylvia builds in low bushes, and lays five pale-green eggs, sprinkled with reddish spots. See Plate Nat. Hist. fig. 271.

Above 150 other species, besides varieties, are enumerated by ornithologists.

MOTE, in law-books, signifies court, meeting, or convention, as a ward-mote, burghmote, swain-mote, &c.

MOTH. See PHALÆNA.

MOTION, has been defined to be "a change of place," or the act by which a body corresponds with different parts of space at different times.

We are principally acquainted with two sorts of motion in the beings that surround us; one is the motion by which an entire body is transferred from one place to another, as that of a stone when it falls, or of a ship under sail. It is this species of motion which most frequently comes under our observation, and with which we are best acquainted. But, besides this, there is another kind of motion, which, though not so obvious, is yet not less common nor important. This is a motion of the parts of bodies among themselves, which though sometimes the object of our senses, yet in other cases we require the aid of reflection to be convinced of its existence. It is by this imperceptible motion that plants and animals grow, and by which the greatest number of the compositions and decompositions throughout the globe take place. We may form some idea of this, by observing the continual motion of the light particles which sometimes float about in water, when it is held in the rays of the sun, which proves, that the parts of the water themselves are in constant motion. But if we reflect a little, we shall discover that the particles of the most solid bodies are also continually changing their situations. Heat expands, and cold contracts, the size of all bodies; now, we know from experience, that the temperature of bodies is constantly varying, consequently, the particles must be in continual agitation, in order to adapt themselves to the size of the body.

The communication of motion from one body to another, though a fact with which we are well acquainted, we are equally incapable of accounting for. It is, however, of the utmost importance in mechanics, which is indeed an art derived from the study of its laws. In considering motion, several circumstances must be attended to:

1. The force which impresses the motion. 2. The quantity of matter in the moving body. 3. The velocity and direction of the motion. 4. The space passed over by the moving body. 5. The time employed in going over this space. 6. The force with which it strikes another body that is opposed to it.

In a mechanical sense, every body, by its inertia, resists all change of state. If at rest, it will not begin to move of itself; and if motion is communicated to it by another body, it will continue to move for ever uniformly, except it is stopped by an external agent. It is true, we do not see any instances of bodies continuing to move for ever, after being once put in motion; but the reason of this is, that all the bodies which we see are acted upon in such a manner, as to have their motion gradually destroyed by friction, or the rubbing of other bodies upon them. For if you diminish the friction by any means, the motion will continue much longer; but as it is impossible to destroy it entirely, it diminishes, and at last destroys, all motions on the surface of the earth. To put a body in motion, therefore, there must be a sufficient cause. These causes are called motive powers, and the following are those generally used in mechanics; the action of men and other animals, wind, water, gravity, the pressure of the atmosphere, and the elasticity of fluids and other bodies.

The velocity of motion is estimated by the time employed in moving over a certain space, or by the space moved over in a certain time. To ascertain the degree of this swiftness or velocity, the space run over must be divided by the time. For example: suppose a body moves over 1000 yards in 10 minutes, its velocity will be 100 yards per minute. If we would compare the velocity of two bodies A and B, of which A moves over 54 yards in 9 minutes, and B 96 yards in 6 minutes, the velocity of A will be to that of B, in the proportion of 6 (the quotient of 54 divided by 9) to 16 (the quotient of 96 divided by 6).

To know the space run over, the velocity must be multiplied by the time; for it is evident, that if either the velocity or the time is increased, the space run over will be greater. If the velocity is doubled, then the body will move over twice the space in the same time; or if the time is twice as great, then the space will be doubled; but if the velocity and time are both doubled, then will the space be four times as great.

It follows from this, that when two bodies move over unequal spaces in unequal times, their velocities are to each other as the quotients arising from dividing the spaces run over by the times. If two bodies move over unequal spaces in the same time, their velocities will be in proportion to the spaces passed over. And if two bodies move over equal spacss in unequal times, then their respective velocities will be inversely as the time employed; that is, if A in one minute, and B in two minutes, run over 100 yards, the velocity of A will be to that of B as 2 to 1.

A body in motion must every instant tend to some particular point. It may either tend always to the same point, in which case the motion will be in a straight line; or it may be continually changing the point to which its motion is directed, and this will produce a curvilinear motion.

If a body is acted upon only by one force, or by several in the same direction, its motion will be in the same direction in which the moving force acts; as the motion of a boat which a man draws to him with a rope. But if several powers, differently directed, act upon it at the same time, as it cannot obey them all, it will move in a direction somewhere between them.

This is what is called the composition and resolution of motion, and is of the utmost importance in mechanics.

Suppose a body A (Plate Miscel. fig. 163) to be acted upon by another body in the direction AB, while at the same time it is impelled by another in the direction AC, then it will move in the direction AD; and if the lines AB, AC, are made of lengths proportionate to the forces, and the lines CD, DB, drawn parallel to them, so as to complete the parallelogram ABDC, then the line which the body A will describe, will be the diagonal AD; and the length of this line will represent the force with which the body will move. It is evident, that if a body is impelled by equal forces acting at right angles to each other, that it will move in the diagonal of a square; but whatever may be the direction, or degree of force by which the two powers act, the above method will always give the direction and force of the moving body.

It follows from this, that if we know the effect which the joint action of two powers has upon a body, and the force and direction of one of them, it is easy to find that of the other. For, suppose AD to be the direction and force with which the body moves, and AB to be one of the impelling forces, then, by completing the parallelogram, the other power AC is found.

Instances in nature of motion produced by several powers acting at the same time, are innumerable. A ship impelled by the wind and tide is one well known. A paper kite, acted upon by the wind and the string, is another.

Motion is said to be accelerated, if its velocity continually increases; to be uniformly accelerated, if its velocity increases equally in equal times.

Motion is said to be retarded, if its velocity continually decreases: and to be uniformly retarded, if its velocity decreases equally in equal times.

If you suppose a body to be put in motion by a single impulse, and moving uniformly, to receive a new impulse in the same direction, its velocity will be augmented, and it will go on with the augmented velocity.

If at each instant of its motion it receives a new impulse, the velocity will be continually increasing; and if this impulse is always equal, the velocity will be uniformly accelerated.

The regularly increasing velocity with which a body falls to the earth, is an instance of accelerated motion, which is caused by the constant action of gravity. To illustrate this, let us suppose the time of descent of a falling body to be divided into a number of very small equal parts; the impression of gravity, in the first small instant, would make the body descend with a proportionate and uniform velocity; but in the second instant, the body receiving a new impulse from gravity, in addition to the first, would move with twice the velocity as before; in the third instant, it would have three times the velocity, and so on.

To illustrate the doctrine of accelerated motion, let us suppose that, in the triangle ABC (fig. Miscel. 164), AB expresses the time which a body takes to fall, and BC the velocity acquired at the end of the fall. Let AB be divided into a number of equal parts, indefinitely small, and from each of these divisions suppose lines, as DE, drawn parallel to BC; it is evident from what has been said, that those lines will express the velocities of the falling body in the several respective points of time, each being greater than the other, by a certain quantity of increase, which follows from the nature of the triangle. Now, the spaces described in the same time, are in proportion to the velocities; and the sum of the spaces described in all the small portions of time, is equal to the space described from the beginning of the fall. But the sum of all the lines parallel to BC, taken indefinitely near to each other, constitutes the area of the triangle. Therefore the space described by a falling body, in the time expressed by AB, with an uniformly accelerated velocity, of which the last degree is expressed by BC, will be represented by the area of the triangle ABC.

Let us now suppose that gravity ceased to act, and that the body moved during another portion of time, BF, equal to AB, with the acquired velocity represented by BC. As the space moved over is found by multiplying the velocity by the time, the rectangle CF will represent the space moved over in this second portion of time, which is twice the triangle ABC, and consequently twice the space is moved over with the accelerating velocity in the same time.

But if we suppose gravity still to act, besides the space CF, which it would have moved over by its acquired velocity, we must add the triangle CGH, for the effect of the constant action of gravity; therefore, in this second portion of time, the body moves over three times the space as in the first. In like manner, it may be easily seen by the figure, that in the next portion it would move over five times the space; in the next seven times, and so on, in arithmetical progression. And as the velocities of falling bodies are in proportion to the spaces run over, it follows, that the velocities in each instant increase, as the numbers 1, 3, 5, 7, 9, &c.

It follows from this, that the space run over is as the square of the time; that is, in twice the time, a body will fall with four times the velocity; in thrice the time, with nine times the velocity, &c. for, in the first time, there was but one space run over: the square of 1 is 1: at the end of the second time there are four spaces run over, one in the first, and three in the second; the square of 2 is 4; at the end of the third time there are nine spaces run over; the square of 3 is 9: and so on. This may be seen in the figure.

It is found by experiment, that a body falling from a height, moves at the rate of $16\frac{1}{12}$ feet in the first second; and, as has been shewn above, acquires a velocity of twice that, or $32\frac{1}{6}$ feet in a second. At the end of the next second, it will have fallen $64\frac{1}{3}$ feet, the space being as the square of the time: the square of 2 is 4, and 4 times $16\frac{1}{12}$ is $64\frac{1}{3}$. By the same rule you may find, that in the third second it will fall 144 feet; in the next 256 feet, and so on. It is to be understood, however, that by this velocity is meant what bodies would acquire, if they were to fall through a space where there was no air; for its resistance considerably diminishes their velocity in falling.

It has been already shewn, that if two forces act uniformly upon a body, they will cause it to move in a straight line; but if one of the forces is not uniform, but either accelerating or retarding, the moving body will describe a curve line. If a ball is projected from a cannon, it receives from it an impulse, which, if there was no resistance from the air, and if it was not acted upon by gravity, would cause it to move always in a straight line; but as soon as it leaves the mouth of the cannon, gravity acts upon it, and makes it change its direction. It then describes a curve, called a parabola. This is the foundation of the theory of projectiles, and the art of gunnery; but it is not now considered to be of so much importance as it formerly was, as it is found that the resistance of the air, and other causes, have so much effect upon projected bodies, that they describe curves very different from what they ought to do according to this theory; and therefore it is much less applicable to practice than otherwise it would be.

The force with which a body moves, or which it would exert upon another body opposed to it, is always in proportion to its velocity multiplied by its weight, or quantity of matter. This force is called the momentum of the body: for if two equal bodies move with different velocities, it is evident that their forces, or momenta, are as their velocities; and if two bodies move with the same velocity, their momenta are as the quantities of matter; therefore, in all cases, their momenta must be as the products of their quantities of matter, and their velocities. This rule is the foundation of mechanics.

In consequence of the vis inertiæ of matter, all motion produced by one force only acting upon a body, must be rectilinear; for it must receive some particular direction from the power that impressed it, and must retain that direction until it is changed by some other power. Whenever, therefore, we see a body moving in a curvilinear direction, we may be certain that it is acted upon by two forces at least. When one of the two forces ceases to act, the body will move again in a straight line. Thus a stone in a sling is moved round by the hand, while it is pulled towards the centre of the circle, which it describes, by the string: but when the string is let go, the stone flies off in a tangent to the circle.

Every body moved in a circle has a tendency to fly off from its centre, which endeavour of receding is called the centrifugal force: and it is opposed to the centripetal force; or that which, by drawing bodies towards the centre, makes them revolve in a curve. These two forces are called together central forces.

The centre of gravity of a body is that point about which all the parts of a body do in any situation exactly balance each other.

Hence, if a body is suspended or supported by this point, the body will rest in any position in which it is put. Also, whatever supports that point bears the weight of the whole body; and while it is supported, the body cannot fall. We may therefore consider the whole weight of a body as centred in this point.

The common centre of gravity of two or more bodies is the point about which they would equiponderate, or rest, in any position. If the centre of gravity of two bodies, A and B, (Plate Miscel. fig. 165) is connected by the right line AB, the distances AC and BC, from the common centre of gravity C, are reciprocally as the weights of the bodies A and B, that is, AC : BC : B : A.

If a line is drawn from the centre of gravity of a body, perpendicular to the horizon, it is called the line of direction; because it is the line that the centre of gravity would describe if the body fell freely.

It is the property of this line, that while it falls within the base upon which the body stands, the body cannot fall; but if it fall without the base, the body will tumble. Thus the inclining body ABCD, (fig. 166) whose centre of gravity is E, stands firmly on its base CDIK, because the line of direction EF falls within the base. But if a weight, as ABGH, is laid upon the top of the body, the centre of gravity of the whole body and weight together is raised to L; and then, as the line of direction LD falls without the base at D, the centre of gravity is not supported, and the whole body and weight will tumble down together.

Hence appears the absurdity of people's rising hastily in a coach or boat, when it is likely to overset; for by that means they raise the centre of gravity so far as to endanger throwing it quite out of the base, and if they do, they overset the vehicle effectually. Whereas, had they clapped down to the bottom, they would have brought the line of direction, and consequently the centre of gravity, farther within the base, and by that means might have saved themselves.

The broader the base, and the nearer the line of direction is to the middle or centre of it, the more firmly does the body stand. On the contrary, the narrower the base, and the nearer the line of direction is to the side of it, the more easily may the body be overthrown, a less change of position being sufficient to remove the line of direction out of the base in the latter case than in the former. And hence it is, that a sphere is so easily rolled upon a horizontal plane; and that it is so difficult, if not impossible, to make things which are sharp pointed to stand upright on the point.

From what has been said, it plainly appears, that if a plane CD on which a heavy body is placed, was elevated at C, the body would slide down upon the plane, whilst the line of direction falls within the base; but it would tumble or roll down when that line falls without the base. Thus the body E (fig. 167) would only slide down, whilst the body B would roll down upon it.

When the line of direction falls within the base of our feet, we stand, and most firmly when it is in the middle; but when it is out of that base, we immediately fall. And it is not only pleasing, but even surprising, to reflect upon the various methods and postures which we use, to retain this position, or to recover it when lost, without our being sensible of it. Thus we bend our bodies when we rise from a chair, or when we go up stairs; and for this purpose a man leans forward when he carries a burden upon his back, and backward when he carries it on his breast, and to the right or left side as he carries it on the opposite side.

If a body is suspended freely from different centres, its centre of gravity will be in the intersection formed by lines drawn from those centres perpendicular to the horizon. Hence we obtain an easy practical method of finding the centre of gravity of any irregular plane figure. Suspend it by any point, with the plane perpendicular to the horizon, and from the point of suspension hang a plumb line, and draw a line upon the body where the string passes over; do the same for any other point of suspension, and where the two lines meet must be the centre of gravity; for the centre of gravity being in each line, it must be at the point where they intersect.

MOTION, *spontaneous* or *muscular*, is that performed by the muscles at the command of the will.

MOTION, *natural* or *involuntary*, that effected, without any such command, by the mere mechanism of the parts, such as the motion of the heart, pulse, &c.

MOTION, *intestine*, the agitation of the particles of which a body consists.

MOTION, in music, the manner of beating the measure, to hasten or slacken the time of the words or notes.

MOVEMENT, in mechanics, a machine that is moved by clockwork. See CLOCK-WORK.

MOULDINGS. See ARCHITECTURE.

MOUNTAINS. Elevations consisting chiefly of clay, sand, or gravel, are called hills. Those which consist chiefly of stone are called mountains. Mountains are divided into primæval, that is, of equal date with the formation of the globe, and secondary or alluvial. Among primæval, those of granite hold the first place. The highest mountains and most extensives ridges throughout the globe are of that kind; as the Alps and Pyrenees in Europe; the Altuischan, Uralian, and Caucasus, in Asia; and the Andes, in America. The highest of them never contain metallic ores; but some of the lower contain ores of copper and tin. The granite next the ore always abounds in mica. Petrifactions are never found in these primæval mountains.

That the formation of these mountains preceded that of vegetables and animals, is justly inferred from their containing no organic remains, either in the form of petrefaction or impression. Naturalists are agreed, that granites were formed by crystallization. This operation probably took place after the formation of the atmosphere, and the gradual excavation of the bed of the ocean, when the dry land appeared. For, by means of the separation of the aëriform fluids which constitute the atmosphere, the evaporation of part of the water into the atmosphere, and the gradual retreat of the remainder, the various species of earths, before dissolved or diffused through this mighty mass, were disposed to coalesce; and among these the siliceous must have been the first, as it is the least soluble; but as the siliceous earth has an affinity to the other earths with which it was mixed, some of these must have united in various proportions, and thus have formed, in distinct masses, the feldtspar, schorl, and mica, which compose the granite. Calcareous earth enters very sparingly into the composition of this stone; but as it is found in schorl, which is frequently a component part of granite, it follows that it must be one of the primitive earths, and not entirely derived from marine exuviæ, as some have supposed. Quartz can never be supposed to be a product of fire; for in a very low heat it bursts, cracks, and loses its transparency, and in the highest degree of heat that we can produce, is infusible, so that in every essential point it is different from glass, to which some have compared it. As granite contains earths of every genus, we may conclude, that all the simple earths are original. This, however, is no proof that they are in reality simple and uncompounded of other principles; but they must be considered as such in the present state of our knowledge. Though water undoubtedly dates from creation, yet late experiments have shewn it to be a compound, as was formerly stated.

Mountains which consist of limestone or marbles of a granular or scaly texture, and not disposed in strata, seem also to have preceded the creation of animals, for no organic traces are found in them. Some of those which consist of argillaceous stones, and some of the siliceous, contain also no organic remains. These often consist of parallel strata of unequal thickness; and the lower are harder and less thick than the upper, and therefore seem to have been formed earlier than the upper.

Alluvial mountains are evidently of posterior formation, as they contain petrifactions and other vestiges of organic substances, and these are always stratified.

Mountains, as to structure, are entire, stratified, and confused. Entire mountains are formed of huge masses of stone, without any regular fissures, and are mostly homogeneous. They consist chiefly of granite, sometimes gneiss, schistus, flag-stone, sand-stone, limestone, gypsum, porphyry, or trap. Some in Sweden and Norway consist of iron ore.

The stratified mountains are those whose mass is regularly divided by joints or fissures: these are called horizontal, rising, or dipping. Homogenous stratified mountains consist chiefly of stones of the argillaceous genus, or of the fissile compound species of the siliceous genus, as metallic rock; sometimes of limestone of a granular or scaly texture, in which no animal vestiges appear. This limestone reposes on the argillaceous or siliceous strata: sometimes the argillaceous are covered with masses of granite, sometimes of lava. These mountains, particularly those of gneiss, metallic rock, and horn-stone, are the chief seat of metallic ores. When covered with limestone, the ore is generally between the limestone and the argillaceous stones. These ores run in veins, not in strata. Petrifactions are found upon, but not in, these mountains.

Heterogeneous, or compound stratified mountains, consist of alternate strata of various species of stones, earths, sands, &c. The limestone here is always of the laminar, and not of the granular or scaly, kind; and when it contains any ore, it is placed between its laminæ. Stones of the siliceous genus seldom form strata in these mountains, except lavas; but the strata are frequently interrupted by siliceous masses, as jasper, porphyry, &c. Coal, bitumen, petrifactions, and organic impressions, are found in these mountains; also salts and calamine.

There are other mountains, which cannot properly be called stratified, as they consist only of three immense masses, the lowest granite, the middle argillaceous, and the upper limestone. Metallic ores are found in the argillaceous part, or between it and the limestone.

Confused mountains consist of stones heaped together without order, their interstices filled with clay, sand, and mica. They scarcely ever contain any ore.

Besides these, there are many mountains in different parts of the world, which derive their origin from volcanoes; but of these it will be necessary to treat in a succeeding article.

The height of mountains is usually calculated by means of the barometer. For this purpose two columns of mercury, or barometers, are provided, and one is kept at the foot of the mountain while the other is carried to its summit. The degree of heat, if not equal, is reduced by calculation to an equality, and for this purpose a thermometer is attached to each of the barometers. The degree of heat to which both are reduced, is 55°. if, however, either of the barometers stands at 30 inches, and the annexed thermometer at 55°, no reduction is to be made in the degrees indicated by that barometer; but if either of them is at 30°, and the thermometer below 55°, we must add the expansion the mercury in the barometer would have experienced at the heat of 55°. If the heat should, on the contrary, be above 55°, we must abstract the degree of expansion which it gains by that heat. Every degree of Fahrenheit's scale produces an expansion of 00.304 of the barometrical inch, when the barometer is at 30; when, therefore, the thermometer is at 11° below or above 55°, we must add in the former, or subtract in the latter case, eleven times that number from the barometrical height. In the same manner it may be calculated, whatever is the height of the barometer. When this matter is ascertained, the height is easily found by comparing the two barometers, and calculating the density of the air in the higher regions according to the principles of geometrical progression.

The highest mountains are those which are situated at or near the equator; and the Andes are generally allowed to be the highest of these. Catopaxi, one of the Andes, which was measured by Ulloa and the French academicians, was found to be some miles above the level of the sea; whereas the highest point of the Alps is not above a mile and a half. Mount Caucasus approaches nearest to the height of the Andes, of any of the Asiatic mountains. The Peak of Teneriff, which has been so much celebrated, is about a mile and a half in height. It is an extraordinary circumstance, that the moon, which is a body so much smaller than our earth, should have been thought to exceed it in the irregularities of its surface; some of the mountains in that planet being formerly supposed to exceed nine miles in height: but Dr. Herschel has proved that the highest of them is not equal to one mile.

The line of congelation, or of perpetual frost, on mountains, is calculated at 15,400 feet, at or near the equator; at the entrance of the temperate zone, at 13,428; on Teneriff, at 1,000; in Auvergne (lat. 45) 6,740; with us (lat. 52) 5,740. On the Andes, vegetation ceases at 14,697 feet; and on the Alps, at 9,585. The air is so dry in these elevated situations, that M. d'Arcet observed, that on the Pic de Midi, one of the Pyrenees, salt of tartar remained dry for an hour and a half, though it immediately moistened in the same temperature at the bottom of the mountain.

MOUNTING, in military affairs, signifies going upon duty. Thus, mounting a breach, is running up to it; mounting the guard, is going upon guard; and mounting the trenches, is going upon duty in the trenches; but mounting a cannon, mortar, &c. is the setting it on its carriage, or the raising its mouth.

MOUSE. See Mus.

MOUTH. See Anatomy.

MUCILAGE, a glutinous matter obtained from vegetables, transparent and tasteless, soluble in water, but not in spirit of wine. It chiefly consists of carbon, hydrogen, and a small quantity of oxygen. See Gluten.

MUCILAGINOUS GLANDS. See Anatomy.

MUCOR, in botany, a genus of the order of fungi, in the cryptogamia class of plants. The fungus has vesicular heads supported by footstalks. There are 17 British species: the most remarkable of which are: 1. The sphærocephalus, or grey round-headed mucor, growing upon rotten wood, and sometimes upon decayed plants and mosses. The stalks of this are generally black, about a line in height, bearing each at the top a spherical ball about the size of a pin's head; its coat or rind is covered with a grey powder, and containing within a black or fuscous spongy down. The coat bursts with a ragged, irregular margin. 2. The lichenoides, or little, black, pin-headed mucor. This species grows in groups near to each other, in chasms of the barks of old trees, and upon old park-pales. The stalks are black, about two lines in height, bearing each a single head, sometimes a double or treble one, of the size of mustard or poppy seeds, of a roundish figure at first, but when burst, often flattish or truncated, and of a black colour. The internal powdered down is black, with a tinge of green. 3. The mucedo, or common grey mould, grows on bread, fruits, plants, and other substances, in a putrid state. It grows in clusters; the stalks a quarter of an inch high, pellucid, hollow, and cylindrical; supporting each a single globular head, at first transparent, afterwards dark-grey; which bursts with elastic force, and ejects small round seeds discoverable by the microscope. 4. The glaucus, or grey cluster-headed mould, is found on rotten apples, melons, and other fruits; as also upon decayed wood, and the stalks of wheat. These are of a pellucid grey colour; the stalks are generally single, supporting a spherical ball, which, when magnified, appears to be compounded of numerous, fine, moniliform, necklace-like radii. 5. The crustaceus, or fingered mould, is frequent upon corrupted food of various kinds. It is of a white aqueous colour; the stalks single, each supporting at the top four or five necklace-like radii, diverging from the same point or centre. 6. The septicus, or yellow frothy mucor, is found on the leaves of plants, such as ivy and beech, &c. sometimes upon dry sticks, and frequently upon the tan or bark in hot-houses. It is of no certain size or figure, but of a fine yellow colour, and a substance resembling at first cream beaten up into froth. In the space of 24 hours it acquires a thin filmy coat, becomes dry, and full of a sooty powder adhering to downy threads. The seeds under the microscope appear to be globular. Haller ranks it under a new genus, which he terms fuligo; the characters of which are, that the plants contained under it are soft, and like butter at first, but soon change into a black sooty powder.

MUCOUS ACID. See Salactic acid.

Mucous gland. See Anatomy.

MUCUS, a fluid secreted by certain glands, and serving to lubricate many of the internal cavities of the body. In its natural state it is generally limpid and colourless; but from certain causes, will often assume a thick consistence and whitish colour like pus. As it is sometimes of very great importance in medicine to distinguish these two fluids from each other, this was lately proposed as the subject of a prize disputation by the Æsculapian Society of Edinburgh. The prize was gained by Mr. Charles Darwin, student of medicine from Litchfield.

The conclusions drawn from his experiments were, 1. Pus and mucus are both soluble in the vitriolic acid, though in very different proportions, pus being by far least soluble. 2. The addition of water to either of these compounds decomposes it. The mucus thus separated either swims in the mixture, or forms large flocculi in it; whereas the pus falls to the bottom, and forms, on agitation, an uniform turbid mixture. 3. Pus is diffusible through a diluted vitriolic acid, though mucus is not. The same also occurs with water, or with a solution of sea-salt. 4. Nitrous acid dissolves both pus and mucus. Water added to the solution of pus produces a precipitate, and the fluid above becomes clear and green, while water and the solution of mucus form a turbid dirty-coloured fluid. 5. Alkaline lixivium dissolves, though sometimes with difficulty, mucus, and generally pus. 6. Water precipitates pus from such a mixture, but does not mucus. 7. Where alkaline lixivium does not dissolve pus, it still distinguishes it from mucus, as it then prevents its diffusion through water. 8. Coagulable lymph is neither soluble in concentrated nor diluted vitriolic acid. 9. Water produces no change on a solution of serum in alkaline lixivium, until after long standing, and then only a very slight sediment appears. 10. Corrosive sublimate coagulates mucus, but does not pus.

From the above experiments, it appears that strong sulphuric acid and water, diluted sulphuric acid, and caustic alkaline lixivium and water, will serve to distinguish pus from mucus; that the vitriolic acid can separate it from coagulable lymph, and alkaline lixivium from serum. Hence, when a person has any expectorated matter, the decomposition of which he wishes to ascertain, let him dissolve it in vitriolic acid, and in caustic alkaline lixivium; and let him add pure water to both solutions. If there is a fair precipitation in each, he may be assured that some pus is present. But if there is a precipitation in neither, it is a certain test that the mixture is entirely mucus. If the matter cannot be made to dissolve in alkaline lixivium by time and trituration, we have also reason to believe that it is pus.

Mucus, nasal: this name is given to a liquid which is secreted in the cavities of the nose, and is discharged outwardly, either by the nostrils in the form of drops, or in that of masses more or less thick; or by the fauces when it descends by the posterior part of the nasal cavities, in which it is thrown out by spitting. This liquid is separated from the blood by the arteries, and appears to be formed in particular crypts, which we find abundantly disseminated in the nostrils: it is collected also from all the frontal sinuses. It is also mixed with the lachrymal juice, which descends by the channel which passes through the os unguis, and dilutes the thickened nasal mucus.

We must particularly consider both the abundance and the characters of this liquid in the catarrh, improperly called catarrh of the brain, in which the nasal mucus is separated in larger quantity, and remains a longer time in its ducts. "It is," says M. Fourcroy, "especially under this circumstance, that citizen Vauquelin and myself have examined it, as we then procured it with great facility. We have also availed ourselves of the considerable discharge of mucus which is produced by the contact of the oxigenated muriatic acid gas, in order to obtain a sufficient quantity of it for the experiments adapted for making us well acquainted with its nature. It has several times happened to citizen Vauquelin, who is very sensible to the action of the oxigenated muriatic acid gas, that he has collected by its effect 64 grammes of this liquid in less than an hour. By means of these circumstances we have been enabled to determine its nature in a considerably exact manner. It is known that this liquid is very abundant in children, that it is a little heavier than water, and adheres to most bodies, even the most polished."

The nasal mucus is at first liquid, clear and limpid, a little viscid and adhesive, without smell, of a saline and acrid taste, which irritates the most delicate part of the skin; it is then really the pituita vitrea of the antients. When exposed to the air and to the fire, it comports itself in the same manner as the tears, from which it differs only by the abundance of its residuum, which is thicker, and frequently more coloured. It affords crystals of muriate of soda, of soda in the state of carbonate, and of phosphates of lime and of soda; the last are much more abundant than the others. It turns paper stained with mallow-flowers green, by its salts: we also find in it an animal matter which is not albuminous, but quickly becomes thick and concrete by the oxigen of the air and of the oxigenated muriatic acid; it then acquires opacity, and a yellow or greenish colour, swells considerably, and becomes filled with bubbles by the action of fire, leaving but little residuum upon the ignited coals. This animal mucilage, which is more abundant than in the tears, appears to be of the same nature in both.

This liquid, being always exposed to the air, which continually passes through the nostrils, is constantly thicker, more viscid, and more adhesive, than the tears; and the carbonate of soda which it contains, whilst the latter contains only soda, announces that the air deposits in it a part of the carbonic acid which it contains, especially as it is expired out of the lungs. Consequently, it then renders the solutions of barytes, of strontian, and of lime, very sensibly turbid. In the nostrils, the heat of the plant, especially in catarrhs, and the current which incessantly acts upon it, contribute also to thicken it. The mucilage of the nasal humour, when it becomes thick in the air, frequently assumes in it the form of small, dry, brilliant, and, as it were, micaceous plates. If it has dried in very thin layers, it nearly resembles those brilliant and light marks which snails leave behind them upon the substances over which they crawl. The nasal mucus experiences no real putrefaction in the air; we should almost be induced to say that it was unalterable and imputrescible, when we see it remain without contracting any bad smell, even in the midst of water, and at a considerably elevated temperature. However, this property of preservation does not extend so far as to communicate itself to other bodies that are immersed in it.

Water does not dissolve the mucus of the nose. It is known that this matter remains viscid in that fluid, and that it cannot be diluted in water without much difficulty, even by agitation. Hot water and ebullition do not render this singular mixture more miscible or more soluble. In boiling water, it appears at first to form one body with the water; nevertheless, we see it separate and fall to the bottom of this liquid by cooling. It is probable that this insolubility is owing to the fixation of the oxigen. Neither has it the property of rendering oils miscible with water, nor of effecting their suspension by trituration, as a vegetable mucilage does. It is on this account that when we wash, or even boil, this thick humour in water, the salts which it contains are dissolved and separated, without affecting the mucilage which constitutes its base.

The acids thicken the nasal mucus when they are concentrated and employed in small proportions; but when we add a larger quantity, they redissolve and give it different shades of colour. The sulphuric acid tinges it purple, and renders it very liquid, forming however some flakes in it which sink to the bottom. The nitric acid, when rather strong, dissolves it of a yellow colour. The muriatic acid is that which effects its solution the most easily and the most completely of all, giving it a violet-colour. The alkaline, or earthy salts, do not cause it to undergo any alteration, nor do they dissolve it.

The mucus of the nostrils being especially distinguished from all the other animal liquids by the viscid mucilage which it contains in considerable abundance, it is evidently from the presence of this principle that we ought to seek its uses, and the function which it performs in the animal economy. Besides the kind of evacuation, sometimes very abundant, which it procures; and the proportion of the evacuated matter compared with that of the other excretory organs, which it carries out of the body; this liquid maintains the softness of the membranous sides of the nasal cavities, and prevents that dryness which the air passing in continual streams through these cavities tends to produce in them. It moderates the too great sensibility of the nervous papillæ which are spread out upon the olfactory membrane; it stops and fixes the odorous bodies, it blunts their too great activity; it purifies the air that is respired, by taking from it the pulverulent particles which it carries along with it, and which would be more hurtful in the lungs. Being always contained in a hot, humid, and arid place, three circumstances which would so eminently promote putrefaction, provident nature has given it a property which opposes the septicity which would have exposed man and the animals to a multitude of dangerous vitiations and maladies.

It is known that the mucus of the nostrils is capable of changing its nature, and assuming various properties, in the nasal affections. It thickens, becomes yellow, orange-coloured, or greenish, frequently tinges linen with a very lively green cast by drying upon it; it sometimes produces the sensation of the presence of copper; and sometimes it exhales a nauseous or fetid smell. In some affections it becomes so acrid that it seems to corrode the membrane of the nostrils, and produces excoriations round their orifices, as well as upon the upper lip. Lastly, it is sometimes liquid like water, at others ropy like oil: in several cases thick, viscid, and always transparent, like jelly; in other circumstances, semiconcrete, and white, yellow, or green, like a purulent humour. None of these changes have yet been chemically examined, and hardly even has the attention which they deserve been bestowed upon them.

MUFTI, or MUPHTI, the chief of the ecclesiastical order, or primate, of the mussulman religion. The authority of the mufti is very great in the Ottoman empire; for even the sultan himself, if he would preserve any appearance of religion, cannot, without hearing his opinion, put any person to death, or so much as inflict any corporal punishment. In all actions, especially criminal ones, his opinion is required by giving him a writing, in which the case is stated under feigned names, which he subscribes with the words, *He shall*, or *shall not, be punished*. Such outward honour is paid to the mufti, that the grand seignior himself rises up to him, and advances seven steps to meet him, when he comes into his presence. The election of the mufti is solely in the grand seignior, who presents him with a vest of rich sables, &c. If he is convicted of treason, or any great crime, he is put into a mortar, kept for that purpose in the Seven Towers at Constantinople, and pounded to death.

MUGGLETONIANS, a religious sect, which arose in England about the year 1657; so denominated from their leader Lodowick Muggleton, a journeyman taylor, who, with his associate Reeves, asserted, that they were the two last witnesses of God that should appear before the end of the world.

MUGIL, *mullet*, a genus of fishes of the order abdominales. The generic character is, lips membranaceous; the inferior carinated within: teeth none; at the corners of the mouth an inflicted callus: gill-membrane with six curved rays: body fleshy; scales large; dorsal fins two.

1. Mugil cephalus, common mullet. This fish, the mugil and mugilis of the antient Romans, is a very common inhabitant of the Mediterranean and northern seas, frequenting chiefly the shallow parts near the shores, and feeding on the smaller kind of worms, sea-insects, and vegetables. Its general length is from 12 to 15 or 16 inches, and its colour blueish-grey, darker on the back, and silvery on the abdomen; the sides are marked, like those of the grayling, with several dusky stripes, according to the rows of scales,

which are large and rounded; the fins are blueish; the first dorsal fin, which is situated on the middle of the back, consists of four very strong rays; the second dorsal fin is placed opposite the anal, and has only soft rays; the base of the dorsal and anal fin, as well as that of the tail, is scaly, and the tail is forked or lunated.

The mullet is found not only in the European seas, but in the Indian and Atlantic oceans. It is observed to assemble frequently in small shoals near the shore, in quest of food, burrowing into the soft mud, and leaving the trace of its head in the form of a round hole.

In the spring and early summer months, this fish, like the salmon, ascends rivers to a considerable distance; and when preparing for these expeditions, is observed in shoals near the surface of the water, at which time the fishermen endeavour to avail themselves of the opportunity of surrounding them with their nets, which the fish are said to shew great address in escaping from.

The mullet is considered as an excellent fish for the table, though not a fashionable one in our own country. Dr. Bloch informs us, that it is generally eaten with the addition of oil and lemon-juice. The spawn is often prepared into an inferior kind of caviar, called botargo, by drying and salting it; in which manner also the fish itself, in plentiful seasons, is occasionally preserved. See Plate Nat. Hist. *fig.* 272.

2. Mugil crenilabis, crenated mullet. Size of the common mullet; length about twelve inches; colour whitish; scales rather large, and marked by a dusky streak; upper lip gaping, lower bicarinated within, and both lips crenulated on the edges; fins glaucous white, the pectoral marked at the base by a round black spot; tail forked: native of the Red Sea. There are seven other species.

MUG-WORT, in botany. See ARTEMESIA.

MUHLENBERGIA, a genus of the class and order triandria digynia. The calyx is one-leaved, minute, lateral; corolla two-valved. There is one species, a grass of America.

MUID, a large measure in use among the French, for things dry. The muid is no real vessel used as a measure, but an estimation of several other measures, as the septier, mine, minot, bushel, &c.

MUID is also one of the nine casks, or regular vessels, used in France, to put wine and other liquors in. The muid of wine is divided into two demi-muids, four quarter-muids, and eight half-quarter muids, containing 36 septiers.

MULBERRY See MORUS.

MULE, in zoology, a mongrel kind of quadruped, usually generated between an ass and a mare, and sometimes between a horse and a she-ass; but the signification of the word is commonly extended to every kind of animal produced by a mixture of two different species. There are two kinds of these animals: one from the he-ass and mare, the other from the horse and the she-ass. We call them indifferently mules, but the Romans distinguished them by proper appellations. The first kind are the best and most esteemed, as being larger, stronger, and having least of the ass in their disposition. The largest and stoutest asses, and the fairest and finest mares, are chosen in those countries where these creatures are most in use; as in Spain, Italy, and Flanders. In the last especially, they succeed in having very stately mules from the size of their mares, some of them 16 and some 17 hands high, which are very serviceable as sumpter-mules in the army. But since the Low-countries are no longer under the dominion of Spain, they breed fewer mules. These creatures are very much commended for their being stronger, surer-footed, going easier, being more cheaply maintained, and lasting longer, than horses. They are commonly of a black brown, or quite black, with that shining list along the back and cross the shoulders which distinguishes asses. In former times they were much more common in this country than at present, being often brought over in the days of popery by the Italian princes. They continued longest in the service of millers, and are yet in use among them in some places, on account of the great loads they carry on their back. As they are capable of being trained for riding, bearing burdens, and for draught, there is no doubt that they might be usefully employed in many different services. But they are commonly found to be vicious, stubborn, and obstinate to a proverb; which whether it occasions or is produced by the ill usage they meet with, is a point not easily settled. Whatever may be the case of asses, it is allowed that mules are larger, fairer, and more serviceable, in mild than in warm climates. In the British American colonies, both on the continent and in the islands, but especially in the latter, they are much used and esteemed; so that they are frequently sent to them from hence; suffer less in the passage, and die much seldomer, than horses; and commonly yield, when they arrive, no inconsiderable profit.

It has commonly been asserted, that animals produced by the mixture of two heterogeneous species, are incapable of generating, and thus perpetuating the monstrous breed: but this, we are informed by M. Buffon, is now discovered to be a mistake.

MULES, among gardeners, denote a sort of vegetable monsters produced by putting the farina fecundans of one species of plant into the pistil or utricle of another. The carnation and sweet-william being somewhat alike in their parts, particularly their flowers, the farina of the one will impregnate the other, and the seed so enlivened will produce a plant differing from either. An instance of this we first had in Mr. Fairchild's garden at Hoxton, where a plant is seen neither sweet-william nor carnation, but resembling both equally: this was raised from the seed of a carnation that had been impregnated by the farina of the sweet-william. These couplings being not unlike those of the mare with the ass, which produce the mule, the same name is given them; and they are, like the others, incapable of multiplying their species. This furnishes a hint for altering the property and taste of any fruit, by impregnating one tree with the farina of another of the same class, *e. g.* a codlin with a pearmain, which will occasion the codlin so impregnated to last a longer time than usual, and to be of a sharper taste. Or if the winter fruits are fecundated with the dust of the summer kinds, they will ripen before their usual time. And from this accidental coupling of the farina of one with another, it may possibly be, that in an orchard where there is variety of apples, even the fruit gathered from the same tree differ in their flavour, and in the season of maturity. It is also from the same accidental coupling that the numberless varieties of fruits and flowers raised every day from seed proceed.

MULLER, or MULLAR, denotes a stone flat and even at the bottom, but round at top, used for grinding of matters on a marble. The apothecaries use mullers to prepare some of their testaceous powders; and painters for their colours, either dry or in oil.

MULLERIA, a genus of the class and order diadelphia decandria. The pericarp is elongated, fleshy, necklace-form, with one-seeded globules. There is one species, a tree of Surinam.

MULLET, or MOLLET, in heraldry, a bearing in form of a flat, or rather of the rowel of a spur, which it originally represented.

MULLUS, *surmullet*, a genus of fishes of the order thoracici. The generic character is, head compressed, scaly; mouth bearded; gill-membrane three-rayed; body covered with large subdeciduous scales.

1. Mullus ruber, the red surmullet, is principally found in the Mediterranean and northern seas, where it arrives at the length of 12 or 15 inches: its colour is an elegant rose-red, tinged with olive-colour on the back, and of a silvery cast towards the abdomen. The surmullet is a fish of a strong and active nature, swimming briskly, and feeding principally on the smaller fishes, worms, and sea-insects. It is generally considered as a very delicate fish, and is celebrated for having been the fashionable object of Roman luxury, and for which such enormous sums are reported to have been sometimes given; though it is probable that the high estimation in which it was held by the antient Greeks and Romans was more owing to a prejudice entertained on account of its elegant appearance, than to its real merit as a food. The Romans practised a singular refinement in luxury, by first bringing the fish alive to the table in a glass vessel, in order that the guests might enjoy the pleasure of contemplating the beautiful changes of its evanescent colours during the time of its gradual expiration; after which it was prepared for their repast.

2. Mullus surmuletus, striped surmullet, of similar size and general appearance with the preceding, but marked on each side by two and sometimes three longitudinal yellow stripes: native of the Mediterranean, but found occasionally in the Atlantic and other seas: in equal esteem as a food with the former, of which it has even been considered by some authors as a variety.

3. Mullus Indicus, Indian surmullet. Size and habit of the common or red mullet; colour extremely beautiful in the living fish, but fading very soon after death; upper part of the head and back dark changeable purple, growing faint on the sides, which are marked by a few longitudinal azure and golden lines, and by two oblong spots on each side; the first situated about the middle of the body, smallish, and of an opaline or changeable golden and white colour; the second situated near the tail, larger, and of a dark purple; abdomen white; dorsal fin

purple, streaked with light blue; pectoral and anal pink-colour: native of the Indian seas: observed by Dr. Russel near Visgapatam: inferior as a food to the red mullet, and not much esteemed.

4. Mullus barbatus, inhabits the European, Mediterranean, and Pacific seas: body, when deprived of its scales, red. Nothing can be more beautiful than the colours of this fish, when in the act of dying; and nothing more delicious than its flesh. The Romans held it in such repute, that prodigious sums were given for them: they were frequently bought at their weight in pure silver. See Plate Nat. Hist. fig. 273. There are two other species.

MULTILATERAL, in geometry, is applied to those figures which have more than four sides or angles, more usually called polygons.

MULTINOMIAL, or MULTINOMIAL ROOTS, in mathematics, such roots as are composed of many names, parts, or members; as, $a + b + d + c$, &c. See ROOT.

MULTIPLE, in arithmetic, a number which comprehends some other several times, thus 6 is a multiple of 2.

MULTIPLE RATIO, OR PROPORTION, is that which is between multiples. If the less term of the ratio is an aliquot part of the greater, the ratio of the greater to the less is called multiple, and that of the less to the greater submultiple. A submultiple number is that contained in the multiple; thus, the numbers 1, 2, and 3, are submultiples of 9. Duple, triple, &c. ratios, as also subduples, subtriples, &c. are so many species of multiple and submultiple ratios. See RATIO.

MULTIPLICAND. See ARITHMETIC.

MULTIPLICATION. See ARITHMETIC, and ALGEBRA.

MULTIPLYING GLASS. See OPTICS.

MUM, a kind of malt liquor, much drunk in Germany, and chiefly brought from Brunswick, which is the place of most note for making it.

MUMMY. See EMBALMING.

MUNCHAUSIA, a genus of the class and order polyadelphia polyandria. The calyx is six-cleft; petals clawed; stamina in six bodies; pistils superior. There is one species, a tree of Java.

MUNICIPAL, in the Roman civil law, an epithet which signifies invested with the rights and privileges of Roman citizens. Thus the municipal cities were those whose inhabitants were capable of enjoying civil offices in the city of Rome.

Municipal, among us, is applied to the laws that obtain in any particular city or province: and those are called municipal officers who are elected to defend the interest of cities, to maintain their rights and privileges, and to preserve order and harmony among the citizens; such as mayors, sheriffs, &c.

MUNTINGIA, a genus of the class and order polyandria monogynia. The calyx is five-parted; corolla five-petalled; berry five-celled; seeds many. There is one species, a shrub of Jamaica.

MURÆNA, a genus of fishes of the order apodal. The generic character is, body eel-shaped; pectoral fins none; spiracle on each side the neck.

1. Muræna Helena, Roman muræna. This fish, the celebrated favourite of the antient Romans, who considered it as one of the most luxurious articles of the table, is found in considerable plenty about several of the Mediterranean coasts, where it arrives at a size at least equal, if not superior, to that of an eel. Its colour is a dusky greenish-brown, pretty thickly variegated on all parts with dull-yellow subangular marks or patches, which are disposed in a somewhat different manner in different individuals, and are generally scattered over with smaller specklings of brown, the whole forming a kind of obscurely reticular pattern. The muræna is capable of living with equal facility both in fresh and salt water, though principally found at sea. In its manners, it much resembles the eel and the conger, being extremely voracious, and preying on a variety of smaller animals. The antients, who kept it in reservoirs appropriated for the purpose, are said to have sometimes tamed it to such a degree as to come at the signal of its master in order to receive its food. Pliny records a most disgusting and barbarous instance of tyranny practised by one Vedius Pollio, who was in the habit of causing his offending slaves to be thrown into the reservoirs in which he kept his murænæ; expressing a savage delight in thus being able to taste in an improved state their altered remains. The emperor Augustus, according to Seneca, honoured this man with his presence at one of his entertainments; when a slave happening to break a valuable chrystal vase, was immediately ordered to be thrown to the murænæ; but the poor boy, flying to the feet of Augustus, requested rather to die any death than thus to be made the food of fishes. The emperor, being informed of this extraordinary mode of punishment, immediately ordered all the chrystal vessels in the house to be broken before his face, and the ponds of the barbarous owner to be completely filled up; at the same time giving the slave his freedom, but sparing the life of the offender in consideration of former friendship. See Plate Nat. Hist. fig. 276.

2. Muræna ophis, spotted muræna. Observed by Forskal; native of the Red Sea; has a rising callus between the eyes, gold-coloured irides, upper lip shorter than the lower, and the dorsal and anal fins united at the tail. See Plate Nat. Hist. fig. 275.

3. Muræna catenata, chain-striped muræna. This species, of which the individuals hitherto described appear to be of the size of a smallish eel, is of a brown colour, crossed by large chainlike white bands, somewhat irregular in their form on different parts of the animal, and marked by numerous brown spots and freckles. This fish is a native of Surinam.

4. Muræna reticulata, reticulated muræna. In size and general form, this resembles the preceding species, but differs in colours and in the disposition of the dorsal fin, which commences immediately at the back of the head, and is continued round the tail, where it unites with the vent-fin. Native of the Indian seas.

5. Muræna conger, conger eel; inhabits the European seas and rivers; is extremely voracious, feeding on other fish, crabs in their soft state, and particularly carcases. It grows to a vast size. See Plate Nat. Hist. fig. 274. There are four other species.

MURDER, or MURTHER. See HOMICIDE.

MUREX, in natural history, a genus of univalve or simple shells, without any hinge, formed of a single piece, and beset with tubercles or spines. The mouth is large and oblong, and has an expanded lip, and the clavicle is rough.

The clavicle of the murex is in some species elevated, in others depressed; and the mouth is sometimes dentated, and at others smooth; the lip also in some is digitated, in others elated, and in some laciniated; and the columella is in some smooth, in others rugose.

MUREX, in zoology, a genus of insects belonging to the order of vermes testacea. This animal is of the snail kind: the shell consists of one spiral valve, rough, with membranaceous furrows; and the aperture terminates in an entire canal, either straight, or somewhat ascending. There are 60 species, particularly distinguished by peculiarities in their shells, &c. See Plate Nat. Hist. figs. 277, 278.

In the accounts of a Spanish philosopher it is mentioned, that on the coasts of Guayaquil and Guatimala in Peru, the murex is also found. The shell which contains it adheres to the rocks that are washed by the sea. It is of the size of a large walnut. The liquor may be extracted two ways: some kill the animal after they have drawn it out of the shell, then press it with a knife from head to tail, separate from the body the part where the liquor is collected, and throw away the rest. When this operation, after being repeated on several snails, has afforded a certain quantity of fluid, the thread intended to be dyed is dipped in it, and the process is finished. The colour, which is at first of the whiteness of milk, becomes afterwards green, and is not purple till the thread is dry. Those who disapprove of this method draw the fish partly out of the shell, and, squeezing it, make it yield a fluid which serves for dyeing: they repeat this operation four times at different intervals, but always with less success. If they continue it, the fish dies. No colour at present known, says the Abbé Raynal, can be compared to this, either as to lustre, liveliness, or duration. It succeeds better on cotton than wool, linen, or silk.

MURIAT, *green sand of Peru.* This ore, which was brought from Peru by Dombey, is a grass-green powder, mixed with grains of quartz. When thrown on burning coals, it communicates a green colour to the flame. It is soluble both in nitric and muriatic acids without effervescence. The solution is green. This mineral was first proved to contain muriatic acid by Berthollet. Afterwards Proust analyzed it. But Vauquelin announced that he considered it merely as an oxide of copper mixed with common salt. However, a subsequent examination convinced him that his opinion was unfounded; and that the mineral was really a carbonat, as had been affirmed by Berthollet and Proust. This conclusion has been confirmed by Klaproth, who found the green sand of Peru composed of

73.0	oxide of copper
10.1	muriatic acid
16.9	water.
100.0	

MURIATIC ACID. This substance may be procured by the following process: Let a small pneumatic trough be procured, hollowed out of a single block of wood, about 14 inches long, seven broad, and six deep. After it has been hollowed out to the depth of an inch, leave three inches by way of shelf on one side, and cut out the rest to the proper depth, giving the inside of the bottom a circular form. Two inches from each end cut a slit in the shelf to the depth of an inch, and broad enough to admit the end of small glass tubes, or the points of small retorts. This trough is to be filled with mercury to the height of one quarter of an inch above the surface of the shelf. Small glass jars are to be procured of considerable thickness and strength, and suitable to the size of the trough. One of them, being filled with mercury by plunging it into the trough, is to be placed on the shelf over one of the slits. It ought to be supported in its position; and the most convenient method of doing that is to have a brass cylinder two inches high screwed into the edge of the trough, just opposite to the border of the shelf. On the top of it are fixed two flat pieces of brass, terminating each in a semicircle, moveable freely upon the brass cylinder, and forming together a brass arm terminating in a circle, the centre of which is just above the middle of the slit in the shelf, when turned so as to be parallel to the edge of the shelf. This circle is made to embrace the jar: being formed of two distinct pieces, its size may be increased or diminished at pleasure; and by means of a brass slider it is made to catch the jar firmly.

The apparatus being thus disposed, two or three ounces of common salt are to be put into a small retort, and an equal quantity of sulphuric acid added; the beak of the retort plunged below the surface of the mercury in the trough, and the heat of a lamp applied to the salt in its bosom. A violent effervescence takes place; and air-bubbles rush in great numbers from its beak, and rise to the surface of the mercury in a visible white smoke, which has a peculiar odour. After allowing a number of them to escape, till it is supposed that the common air which previously existed in the retort has been displaced, plunge its beak into the slit in the shelf over which the glass jar has been placed. The air-bubbles soon displace the mercury and fill the jar. The gas thus obtained is called muriatic acid gas.

This substance, in a state of solution in water, was known even to the alchemists; but in a gaseous state it was first examined by Dr. Priestley, in an early part of that illustrious career in which he added so much to our knowledge of gaseous bodies.

1. Muriatic acid gas is an invisible elastic fluid, resembling common air in its mechanical properties. Its specific gravity, according to the experiments of Mr. Kirwan, is 0.002315, or nearly double that of common air. Its smell is pungent and peculiar; and whenever it comes in contact with common air, it forms with it a visible white smoke. If a bottle of it is drawn into the mouth, it is found to taste excessively acid; much more so than vinegar.

2. Animals are incapable of breathing it, and when plunged into jars filled with it, they die instantaneously in convulsions. Neither will any combustible burn in it. It is remarkable, however, that it has a considerable effect upon the flame of combustible bodies; for if a burning taper is plunged into it, the flame, just before it goes out, may be observed to assume a green colour, and the same tinge appears next time the taper is lighted.

3. If a little water is let up into a jar filled with this gas, the whole gas disappears in an instant, the mercury ascends, fills the jar, and pushes the water to the very top. The reason of this is, that there exists a strong affinity between muriatic acid gas and water; and whenever they come in contact, they combine and form a liquid, or, which is the same thing, the water absorbs the gas. Hence the necessity of making experiments with this gas over mercury. In the water cistern not a particle of gas would be procured. Nay, the water of the trough would rush into the retort and fill it completely. It is this affinity between muriatic acid gas and water which occasions the white smoke that appears when the gas is mixed with common air. It absorbs the vapour of water which always exists in common air. The solution of muriatic acid gas in water is usually denominated simply muriatic acid by chemists.

4. If a little of the blue-coloured liquid which is obtained by boiling red cabbage-leaves and water, is let up into a jar filled with muriatic acid gas, the usual absorption of the gas takes place, but the liquid at the same time assumes a fine red colour. This change is considered by chemists as a characteristic property of acids.

5. Muriatic acid gas is capable of combining with oxygen. To obtain the combination, we have only to put a quantity of the black oxide of manganese in powder into a retort, and pour over it liquid muriatic acid. Heat is then to be applied to the mixture, and the beak of the retort plunged under water. An effervescence takes place, and a green-coloured gas comes out at the beak of the retort, which may be received in the usual manner in jars. This gas has been ascertained to be a compound of muriatic acid and oxygen. It is called oxy-muriatic acid, and will come under our consideration hereafter.

6. It does not appear from any experiments that have been hitherto made, that any of the simple combustibles are capable of combining with muriatic acid gas. Dr. Priestley found, that sulphur absorbed slowly about the fifth part of it. What remained was inflammable air, burning with a blue flame, and not absorbed by water. He found that phosphorus scarcely absorbed any sensible quantity of it, and that charcoal absorbed it very fast. Hydrogen gas does not produce any sensible change in it. Neither does it seem capable of being affected by azotic gas.

Muriatic acid is capable of combining with two doses of oxygen only. With the first dose, it forms oxymuriatic acid; with the second, hyperoxymuriatic acid. The first of them ought, in strict propriety, to be termed an oxide rather than an acid.

MURIATS. The muriats are a genus of salts which have been long known, and from which indeed the whole of the class have borrowed their name; for to them belongs common salt, the most important and the most indispensably necessary of all the salts. They may be distinguished by the following properties:

When heated, they melt, and are volatilized, at least in part, without undergoing decomposition. The first portions which fly off contain an excess of acid.

Not in the least altered by combustibles, even when assisted by heat.

Soluble in water. For the most part they raise the boiling-point of water.

Effervesce with sulphuric acid, and white acrid fumes of muriatic acid are disengaged.

When mixed with nitric acid, they exhale the odour of oxymuriatic acid.

MURRAIN, or Gargle, a contagious disease among cattle, principally caused by a hot dry season, or rather by a general putrefaction of the air, which begets an inflammation of the blood, and a swelling in the throat, that soon proves mortal, and is communicated from one to another, though it generally goes no farther than to those of the same kind.

The symptoms of this disease are, a hanging down and swelling of the head, abundance of gum in the eyes, rattling in the throat, a short breath, palpitation of the heart, staggering, a hot breath, and a shining tongue.

MURRAYA, a genus of the class and order decandria monygynia. The calyx is five-parted; corolla bell-shaped, with a nectarium encircling the germ; berry one-seeded. There is one species, a tree of the East Indies.

MUS, *the rat*, a genus of quadrupeds of the order glires. The generic character is, upper front-teeth wedge-shaped; grinders on each side three, sometimes only two; clavicles or collar-bones in the skeleton.

This numerous tribe constitutes a formidable phalanx against which mankind find it necessary to employ the various artifices of extirpation, in order to lessen the ravages occasionally suffered by its depredations. In our own island, the black and the brown rats, the field and domestic mice, are the principal destroyers; but in other parts of Europe, as well as in the hotter regions of Asia, Africa, and America, many other species, still more noxious and formidable, are found. The different kinds vary considerably in their manner of life, some confining themselves entirely to vegetable food, while others are polyphagous, destroying with indiscriminate avidity almost any animal or vegetable substance to which they can gain access. Their pace is, in general, rather quick, and their most usual residence is in obscure subterraneous retreats, from which they principally emerge by night. They are of a prolific nature, and the females are furnished with numerous teats. Some species are migratory; others local or attached to the same residence. Lastly, some are of an uncouth form and disagreeable appearance, while others are remarkable for the elegance of their colours. In the 12th edition of the Systema Naturæ, Linnæus included in this genus the jerboas, the cavys, and several other animals which are now formed into distinct genera. This mode of distribution might perhaps be carried still farther, the habit or appearance of some species differing very considerably from that of the major part of the tribe.

1. Mus zibethicus, musk rat. In the Memoirs of the French Academy of Sciences for the year 1725, there is a complete and excellent description of this animal by Mons. Sarrazin, at that time king's physician at Quebec. It is from the above description that the count de Buffon has drawn up the major part of his own account, and indeed it does not appear possible to add any thing material to what Mons. Sarrazin has delivered. This animal is of the size of a small rabbit, and is extremely common in Canada. Its head is short, like that of a water-rat; the eyes large; the ears very short, rounded, and covered internally as well as externally with hair. It has, like the rest of this tribe, four very strong cutting teeth, of which those in the lower jaw are near an inch long; those in the upper somewhat shorter: the fur on the whole body is soft and glossy, and beneath is a fine fur, or thick down, as in the beaver; the toes on all the feet are simple, or without membranes, and are covered with hair; the tail is nearly as long as the body, and is of the same form with that of the sorex moschatus or musk shrew, being laterally compressed; it is nearly naked, and covered with small scales intermixed with scattered hairs. The general colour of the animal is a reddish brown; of the tail ash-colour. In its general appearance this animal greatly resembles the beaver, except in size, and in the form of its tail. It has also similar instincts and dispositions; living in a social state in the winter, in curiously-constructed huts or cabins, built near the edge of some lake or river. These huts are about two feet and a half or three feet in diameter, plaistered with great neatness in the inside, and covered externally with a kind of basket-work, of rushes, &c. interlaced together so as to form a compact and secure guard, impermeable by water. During the winter these receptacles are generally covered by several feet of snow, and the animals reside in them without being incommoded by it, several families commonly inhabiting each cabin. It is added that the insides of the receptacles are furnished with a series of steps, to prevent them from being injured by inundations. These animals do not lay up a stock of provisions like the beaver, but form subterraneous passages beneath and round their cabins, to give themselves an opportunity of procuring occasional supplies of roots, herbage, &c. According to Mons. Sarrazin the animal is particularly calculated by nature for its subterraneous habits, having a great muscular force in its skin, which enables it to contract its body occasionally into a small volume: it has also a great suppleness in the false ribs, which easily admit of contraction, so that it is enabled to pass through holes impervious to much smaller animals than itself.

During the summer these creatures wander about in pairs, feeding voraciously on herbs and roots. Their odour, which resembles that of musk, is so strong as to be perceived at a considerable distance; and the skin, when taken from the body, still retains the scent: this musky odour is owing to a whitish fluid deposited in certain glands situated near the origin of the tail. It has been supposed that the calamus aromaticus, or sweet flag (acorus calamus, Lin.), which these animals select as a favourite food, may contribute to their fragrant smell. They walk and run in an awkward manner, like the beaver, and they cannot swim so readily as that animal, their feet being unfurnished with webs. Their voice is said to resemble a groan. The females produce their young towards the beginning of summer, and have five or six at a time; and these, if taken early, are easily tamed, and become very sportive; and it is remarkable that the tail, which in the full-grown animal is as long as the body, is at that period very short.

The fur of this species is greatly esteemed as a commercial article, resembling that of the beaver. Linnæus, in the twelfth edition of the Systema Naturæ, ranked the animal under the genus castor; and Mr. Pennant has followed his example. Mr. Schreber, however, considers it as belonging in strict propriety to the present genus. See Plate Nat. Hist. fig. 279.

2. Mus decumanus, Norway rat. This domestic species, which is now become the common rat of our own island, and is popularly known by the name of the Norway rat, is supposed to be a native of India and Persia, from which countries it has been imported into Europe. In England it seems to have made a national conquest over the black rat, which is now become rare in comparison. The brown rat is larger than the black rat, measuring nine inches from the nose to the tail, which is of the same length, and marked into about 200 rings or circular spaces; the colour of the animal is a pale tawny-grey, whitish beneath; the fore feet have four toes, with a claw in place of a fifth. It is a bold and voracious animal, and commits great havoc in granaries, &c. Sometimes it takes up its residence in the banks of waters, and swims occasionally with almost as much facility as the water rat, or mus amphibius. In its general manner of life it agrees with the black rat; and not only devours grain and fruits, but preys on poultry, rabbits, and various other animals. It is a very prolific species, and produces from ten to twelve or fourteen, or even sometimes eighteen, young at a time. When closely pursued, it will sometimes turn upon its adversary, and bite with great severity. It seems to have made its first appearance in England about seventy years ago, and is still much less frequent in France and some other parts of the continent than the black rat.

3. Mus rattus, black rat. This species, like the former, though now so common in most parts of Europe, is supposed to have been originally introduced from India and Persia. Its general length from nose to tail is seven inches, and of the tail eight inches; the colour of the head and whole upper part of the body is a dark iron or blackish grey; the belly is of a dull ash-colour; the legs are dusky, and very slightly covered with hair; the fore feet, as in the brown rat, have only four toes, with a small claw in place of a fifth; the tail is nearly naked, coated with a scaly skin, and marked into numerous divisions or rings. Like the former species, this animal breeds frequently, and commonly brings about six or seven young at a time. Sometimes they increase so fast as to overstock the place of their abode, in which case they fight and devour each other. It is said that this is the reason why these animals, after being extremely troublesome, sometimes disappear suddenly. Various are the methods made use of for the expulsion of rats from the places they frequent; among which none is more singular than that mentioned by Gesner, who tells us he had been informed that if a rat is caught and a bell tied round its neck, and then set at liberty, it will drive away the rest wherever it goes. This expedient appears to be occasionally practised in modern times with success. A gentleman travelling through Mecklenburgh, about 30 years ago, was witness to the following curious circumstance in the post-house in New Stargard. After dinner the landlord placed on the floor a large dish of soup, and gave a loud whistle. Immediately there came into the room a mastiff, a fine Angora cat, an old raven, and a remarkably large rat, with a bell about its neck. The four animals went to the dish, and without disturbing each other, fed together; after which the dog, cat, and rat, lay before the fire, while the raven hopped about the room. The landlord, after accounting for the familiarity which existed among the animals, informed his guest that the rat was the most useful of the four, for the noise he made had completely freed the house from the rats and mice with which it was before infested.

4. Mus musculus, common mouse. The manners and appearance of this little animal are so universally known, that it seems almost unnecessary to particularise it by a formal description. It is a general inhabitant of almost every part of the Old Continent, but it is doubtful whether it is originally a native of America, though now sufficiently common in many parts of the New World, as well as in many of its scattered islands.

The mouse, though wild and extremely timid, is not of a ferocious disposition, but may be easily tamed, and soon after it has been taken, will begin to feed without fear, in the immediate presence of its captors. The white variety is frequently kept in a tame state, and receives an additional beauty from the bright red colour of its eyes; a particularity which generally accompanies the white varieties, not only of this tribe, but of many other quadrupeds.

The mouse is a prolific animal: the experiment of Aristotle is well known, and often quoted. He placed a pregnant mouse in a vessel of grain, and after a short space found in it no less than the number of 120, all which, he concluded, were the descendants of the mouse he had inclosed.

The fur of the mouse is remarkably soft and elegant, and the structure of the hair in this animal, as well as in the rat, and probably in many others of this genus, is singularly curious; each hair, when microscopically examined, appearing internally divided into a kind of transverse partitions, as if by the continuation of a spiral fibre; a structure very different from that of the hair of most other animals, and of which the particular nature seems not very distinctly understood.

Derham, in his Physico-Theology, conceives that this mechanism of a spiral fibre may serve for the "gentle evacuation of some humour out of the body;" and adds, that "perhaps the hair serves as well for the insensible perspiration of hairy animals as to fence against cold and wet." Whatever is the real nature or use of the above structure, its appearance cannot fail to excite astonishment in those who take the pains of examining it with a good microscope, by which they will obtain a clear idea of this curious appearance.

In Aldrovandus, who relates the circumstance from Gesner, we meet with a direction for changing, as it were, a mouse into a cat, by making it the incessant persecutor and enemy of the rest of its species. This is to be effected by placing several mice together in a vessel without food, when, after a certain space, they will be so stimulated by hunger as to destroy each other: the surviving animal being then liberated, will, according to this author, become the most destructive enemy of his own tribe, and will kill every one he meets. Another singular and most cruel experiment is quoted by Aldrovandus from Mizaldus, who tells us, that if two or three mice are shut up in an earthen pot, and placed over a fire, the shrill cries which they utter will attract the mice in the other parts of the house, and cause them to precipitate themselves into the fire. Whatever truth there may be in this experiment, it is certain that, on the shrill cry of distress uttered by one of these animals kept with several others in a cage, the rest will frequently attack and destroy it.

5. Mus sylvaticus, wood mouse. This animal chiefly frequents dry and elevated grounds, and is found in woods and fields in great plenty. It appears to be common in all the temperate parts of Europe, and even in Russia. It sometimes varies in size, individuals being occasionally met with which exceed the rest in magnitude, though differing in no other respect. Its general length is about four inches and a half from nose to tail, and the tail, which is slightly covered with hair, measures four inches. The colour of the animal is a yellowish brown above and whitish beneath; the colours being pretty distinctly marked or separated; the eyes are full and black, and the snout rather blunt. These animals retire into holes among brushwood, and under the trunks of trees, where they amass great quantities of acorns, nuts, and beech-mast. According to Buffon, a whole bushel has sometimes been found in a single hole. These holes are about a foot or more under ground, and are often divided into two apartments; the one for living in alone with their young, the other for a magazine of provisions. Considerable damage is often done to plantations by these animals, which carry off new-sown acorns, &c. The count de Buffon affirms, that in France more mischief is done by these creatures than by all the birds and other animals put together; and adds, that the only way to prevent this is by laying traps, at ten paces asunder, through the whole extent of the sown ground. No other apparatus, he says, is necessary than a roasted walnut, placed under a stone supported by a stick: the animals come to eat the walnut, which they prefer to acorns; and as the walnut is fixed to the stick, whenever they touch it, the stone falls and kills them. The same expedient may be as successfully used for the destruction of the short-tailed field mouse, which likewise commits great havoc in fields and plantations. When the count de Buffon first practised this experiment, he desired that all the field mice thus taken in traps might be brought to him, and found with astonishment, that above 100 were taken each day from a piece of ground consisting only of about 40 of our acres. From the 15th of November to the 8th of December, above 2000 were destroyed in this manner. When the frost becomes severe, they retire into their holes, and feed on the stores they have collected. They abound, like many other animals of this genus, chiefly in autumn, and are far less common in the spring; for if provisions happen to fail them in the winter, it is thought that they destroy each other; a circumstance which is known occasionally to take place in many other species.

The long-tailed field mouse is a very prolific animal, breeding more than once a year, and often producing litters of ten at a time. In one of their holes have been found two females, with 20 young. Specimens have sometimes been seen perfectly white, with red eyes.

6. Mus messorius, harvest mouse. This small species seems to have escaped the notice of British naturalists till it was observed by the late Mr. Gilbert White, of Selburne in Hampshire, in which county it is frequent. Mr. White, in the year 1767, communicated the animal to Mr. Pennant, who introduced it into the British Zoology.

"These mice," says Mr. White, "are much smaller and more slender than the mus domesticus medius of Ray, and have more of the squirrel or dormouse colour; their belly is white; a straight line along their sides divides the shades of their back and belly. They never enter into houses, are carried into ricks and barns with the sheaves, abound in harvest, and build their nest amidst the straws of corn above ground, and sometimes in thistles. They breed as many as eight at a litter, in a little round nest composed of the blades of grass or wheat. One of these nests was procured in the autumn of 1767, most artificially platted, and composed of the blades of wheat, perfectly round, and about the size of a cricket-ball, with the aperture so ingeniously closed, that there was no discovering to what part it belonged. It was so compact and well filled, that it would roll across the table without being discomposed, though it contained eight little mice that were naked and blind. As this nest was perfectly full, how could the dam come at her litter respectively, so as to administer a teat to each? Perhaps she opens different places for that purpose, adjusting them again when the business is over; but she could not possibly be contained herself in the ball with her young, which moreover would be daily increasing in bulk. This wonderful procreant cradle, an elegant instance of the effect of instinct, was found in a wheat-field, suspended in the head of a thistle."

Mr. White adds, that "though these animals hang their nests for breeding up amidst the straws of standing corn, above ground, yet in the winter they burrow deep in the earth, and make warm beds of grass; but their grand rendezvous seems to be in corn-ricks, into which they are carried in harvest." A neighbour of Mr. White's housed an oat-rick, in which were some hundreds assembled under the thatch. The measure of the animal is just two inches and a quarter from nose to tail, and the tail is just two inches long. Two of them in a scale just weighed down a copper halfpenny, which was about the third of an ounce avoirdupois; so that they may be considered as the smallest of the British quadrupeds.

7. Mus minutus, minute mouse. This species, according to Dr. Pallas, is frequent in the birch-woods of Siberia, as well as in many of the temperate parts of Russia, frequenting corn-fields and barns. Its general colour is a deep tawny above and white below; the nose is sharpish and of a dusky colour, with a whiteness at the corners of the mouth; the ears are hid in the fur; the feet grey; the length from nose to tail is little more than two inches, and the weight not half a dram. Those found in Siberia are of a richer or more fulvous colour than those of other regions. This animal, Dr. Pallas says, is very frequent in autumn and winter in corn-ricks and about granaries, and is often found intermixed with the mus agrarius, inhabiting similar places. It seems extremely nearly allied to the harvest mouse, and it is not impossible that it may in reality be the same animal, the differences appearing almost too slight for a specific distinction.

8. Mus amphibius, water rat. The water rat is a general inhabitant of the temperate, and even the colder, parts of Europe and Asia, and occurs also in North America, frequenting rivers and stagnant waters, and forming its burrows in the banks. It is of a thicker and shorter form than many others of this genus, and has somewhat of the shape of a beaver. Mr. Ray, following an error of Willughby, describes it as having the forefeet webbed; and Linnæus, in his Systema Naturæ, characterizes it from that very circumstance, but acknowledges that he had not himself examined the animal. In reality, however, there is no such appearance in the feet of the water rat, and the notion seems to have been hastily adopted from observing the facility with which it swims and dives. The general length of the water rat is about seven inches, and the tail about five. Its colour is blackish-ferruginous above, and deep cinereous beneath; the nose is thick and blunt, the eyes small, the ears rounded and hid in the fur. In colour it appears to vary in different regions, being sometimes nearly black, and sometimes paler than usual. It also varies as to size, and the varieties have been mistakenly considered as distinct species. This animal never frequents houses, but confines itself to the banks of waters, and is supposed to live on fish, frogs, &c. and probably on various roots and other vegetable substances. Dr. Pallas, however, is unwilling to admit that it preys at all upon fish, though reported so to do by the count de Buffon and others. At some seasons of the year it is observed to have a musky scent. The female produces her young in April, and generally brings about five or six at a time. The measures of this species, as given by Mr. Schreber, are as follow, viz. from nose to tail six inches and a half, and of the tail three inches.

9. Mus lemmus, lemming rat. The wonderful migrations of this species have long rendered it celebrated in the annals of natural history. It is remarkable, however, that no accurate figure of it was published till Dr. Pallas caused it to be engraved in his excellent work on the Glires.

The first describer of the lemming seems to have been Olaus Magnus, from whom several of the older naturalists have copied their accounts. Afterwards Wormius gave a more particular description; since which, Ricaut, in the Philosophical Transactions, Linnæus, in the Acta Holmiensia, and Dr. Pallas, in his publication before mentioned, have still farther elucidated its history and manners. See Plate Nat. Hist. fig. 280.

The lemming differs in size and colour according to the regions it inhabits: those which are found in Norway being almost as large as a water rat, while those of Lapland and Siberia are scarce larger than a field mouse; the Norwegian measuring more than five inches from nose to tail, while those of Lapland and Siberia scarce exceed three. The colour of the Norway kind is an elegant variegation of black and tawny on the upper parts, disposed in patches and clouded markings; the sides of the head and the under parts of the body being white, the legs and tail greyish. In the Lapland kind the colour is chiefly a tawny brown above, with some indistinct dusky variegations, and beneath of a dull white; the claws are also smaller than in the Norwegian animal. The head of the lemming is large, short, thick, and well furred; the snout very obtuse; the ears very small, rounded, and hid in the fur; the eyes small; the neck short and broad; the body thick; and the limbs short and stout, especially the fore legs; the fore-feet are broad, furnished with five toes, which have strong, compressed, and somewhat crooked claws, of which the three middle ones are longer than the rest; on the hind-feet are also five toes, with smaller claws than those of the fore-feet; the tail is very short, thick, cylindric, obtuse, and covered with strong hairs, disposed like those of a pencil at the tip.

The natural or general residence of the lemming is in the Alpine or mountainous parts of Lapland and Norway, from which tracts, at particular but uncertain periods, it descends into the plains below in immense troops, and by its incredible numbers becomes a temporary scourge to the country, devouring the grain and herbage, and committing devastations equal to those caused by an army of locusts. These migrations of the lemming seldom happen oftener than once in ten years, and in some districts still less frequently, and are supposed to arise from an unusual multiplication of the animals in the mountainous parts they inhabit, together with a defect of food; and, perhaps, a kind of instinctive prescience of unfavourable seasons, for it is observable that their chief migrations are made in the autumn of such years as are followed by a very severe winter. The inclination or instinctive faculty which induces them, with one consent, to assemble from a whole region, collect themselves into an army, and descend from the mountains into the neighbouring plains, in the form of a firm phalanx, moving on in a straight line, resolutely surmounting every obstacle, and undismayed by every danger, cannot be contemplated without astonishment. All who have written on the subject agree that they proceed in a direct course, so that the ground along which they have passed appears at a distance as if it had been ploughed; the grass being devoured to the very roots, in numerous stripes, or parallel paths, of one or two spans broad, and at the distance of some ells from each other. This army of mice moves chiefly by night, or early in the morning, devouring the herbage as it passes, in such a manner that the surface appears as if burnt. No obstacles which they happen to meet in their way have any effect in altering their route; neither fires, nor deep ravines, nor torrents, nor marshes or lakes: they proceed obstinately in a straight line; and hence it happens that many thousands perish in the waters, and are found dead by the shores. If a rick of hay or corn occurs in their passage, they eat through it; but if rocks intervene which they cannot pass, they go round, and then resume their former straight direction. If disturbed or pursued while swimming over a lake, and their phalanx separated by oars or poles, they will not recede, but keep swimming directly on, and soon get into regular order again; and have even been sometimes known to endeavour to board or pass over a vessel. On their passage over land, if attacked by men, they will raise themselves up, uttering a kind of barking sound, and fly at the legs of their invaders, and will fasten so fiercely at the end of a stick, as to suffer themselves to be swung about before they will quit their hold; and are with great difficulty put to flight. It is said that an intestine war sometimes takes place in these armies during their migrations, and that the animals thus destroy each other.

The major part, however, of these hosts, is destroyed by various enemies, and particularly by owls, hawks, and weazels, exclusive of the numbers which perish in the waters; so that but a small number survive to return, which they are sometimes observed to do, to their native mountains.

In their general manner of life they are not observed to be of a social disposition, but to reside in a kind of scattered manner, in holes beneath the surface, without laying up any regular provision, like some other animals of this tribe. They are supposed to breed several times in a year, and to produce five or six at once. It has been observed that the females have sometimes brought forth during their migrations, and have been seen carrying some in their mouths, and others on their backs. In some parts of Lapland they are eaten, and are said to resemble squirrels in taste.

It was once believed that these animals fell from the clouds at particular seasons, and some have affirmed that they have seen a lemming in its descent; but an accident of this kind is easily accounted for, on the supposition of a lemming escaping now and then from the claws of some bird which had seized it, and thus falling to the ground; a circumstance which is said not unfrequently to take place when the animals are seized by crows, gulls, &c.

10. Mus œconomicus, œconomic rat. The œconomic rat, so named from its provident disposition, and the skill with which it collects its provisions, is a native of Siberia, inhabiting that country in vast abundance, and even extending as far as Kamtschatka. Its curious history has been given with great exactness by Dr. Pallas: who informs us that these little animals make their burrows with wonderful skill, immediately below the surface, in soft turfy soils; forming a chamber, of a flattish arched form, of a small height, and about a foot in diameter, to which they sometimes add as many as thirty small pipes or entrances, and near the chamber they frequently form other caverns, in which they deposit their winter stores; these are said to consist of various kinds of plants, even of some species which are poisonous to mankind. They gather them in summer, harvest them with great care, and even sometimes bring them out of their cells in order to give them a more thorough drying in the sun. The chief labour rests on the females; the males during the summer wandering about in a solitary state, inhabiting some old nests occasionally, and living during that period on berries, without touching the hoards, which are reserved for winter, when the male and female reside together in the same nest. They are said to breed several times in the year, the female producing two or three young at a time.

The migrations of this little species are not less extraordinary than those of the lemming, and take place at uncertain periods. Dr. Pallas imagines that the migrations of those inhabiting Kamtschatka may arise from some sensations of internal fire in that volcanic country, or from a prescience of some unusual and bad season. Whatever is the cause, the fact is certain. At such periods they gather together, during the spring season, in surprising numbers, except the few that reside about villages, where they can pick up some subsistence; and this makes it probable that their migrations, like those of the lemming, are rather owing to want of food. The mighty host proceeds in a direct course westward, occasionally swimming with the utmost intrepidity over rivers, lakes, and even arms of the sea. During these perilous adventures, some are drowned, and others destroyed by water-fowl, fish, &c.: those which escape rest a while to bask, dry their fur, and refresh themselves, and then again set out on their migration. It is said that the inhabitants of Kamtschatka, when they happen to find them in this fatigued situation, treat them with the utmost tenderness, and endeavour by every possible method to refresh and restore them to life and vigour. Indeed none of the smaller animals are so much esteemed by the Kamtschadales as these, since to their labours they owe many a delicious repast, robbing their hoards in autumn, and leaving there some kind of provision in return, accompanied by some ridiculous presents by way of amends for the theft. As soon as the migrating host of these animals has crossed the river Penschim, at the head of the gulph of that name, it turns southward, and reaches the rivers Judoma and Ochot about the middle of July: the space thus traversed appears astonishing, on consulting the map of the country. The flocks during this time are so numerous that an observer has waited two hours to see them all pass. Their return into Kamtschatka is in October, and is attended with the utmost festivity and welcome on the part of the natives, who consider their arrival as a sure prognostic of a successful chace and fishery; and they are said equally to lament their migrations, which are usually succeeded by rainy and tempestuous weather.

This curious species is generally of a tawny colour, darker on the back, and lighter on more approaching to an ash-coloured whiteness beneath: its usual length is about four inches and a quarter, and the tail one inch; its limbs are strong; its eyes small, its ears naked, very short and round, and almost hid beneath the fur of the head.

This animal is also supposed to be an inhabitant of Iceland; at least a species which must be greatly allied to it is found in that country, and is said to be particularly plentiful in the wood of Husafels. In that country, where berries are but thinly dispersed, the little animals are obliged to cross rivers to make their distant foraging excursions, and in their return are obliged to repass the stream; their manner of performing which is thus related by Mr. Olaffen, from the accounts of others, communicated to himself:

"The party, consisting of from six to ten, select a flat piece of dried cow-dung, on which they place the berries they have collected in a heap, on the middle; and then, by their united force, drawing it to the water's edge, launch it, and embark, placing themselves round the heap, with their heads joined over it, and their backs to the water; their tails pendant in the stream, and serving the purpose of rudders."

11. Mus socialis, social mouse. The social mouse is a native of the Caspian deserts between the Volga and the Yaik, and the country of Hircania. It lives in low sandy situations, in large societies; the ground in many places being covered with the little hillocks formed by the earth cast out in forming the burrows, which are said to be about a span deep, with eight or more passages. The animals are always observed to live in pairs, or with a family; they are fond of tulip-roots, which form a principal article of their food. They appear chiefly in the spring, when they are very numerous, but are rarely seen in autumn, and are supposed either to migrate in autumn or to conceal themselves among the bushes, &c. and in the winter to shelter themselves in hay-ricks. The head in this species is thick, and the nose blunt; the whiskers white; the ears oval and naked; the limbs short and strong, and the tail slender. The upper parts are of a light grey, and the under white.

12. Mus cricetus, hamster rat. Of the pouched rats the hamster is the most remarkable, and indeed is the only European species provided with those peculiar receptacles, which are situated on each side the mouth, and when empty are so far contracted as not to appear externally, but when filled resemble a pair of tumid bladders, having a smooth veiny surface, concealed, however, under the fur or skin of the cheeks, which bulge out extremely in this state. They are so large as to hold the quantity of a quarter of a pint, English measure.

The general size of the hamster is nearly that of a brown or Norway rat, but it is of a much thicker form, and has a short tail. Its colour is a pale reddish brown above, and black beneath. The muzzle is whitish, the cheeks reddish, and on each side the body are three moderately large oval white spots, of which those on the shoulders are the largest; the ears are moderately large and rounded, and the tail almost bare, and about three inches long; on the fore-feet are four toes, with a claw in place of a fifth, and on the hind-feet are five toes. Sometimes the hamster varies in colour, being found either black with a white muzzle, or of a pale yellowish white. The male is always much larger than the female. On each side the lower part of the back is an almost bare spot, covered only with very short down.

The hamster inhabits Siberia and the south of Russia. It is also found in Poland, as well as in many parts of Germany. They are very destructive in some districts, devouring great quantities of grain, which they carry off in their cheek-pouches, and deposit in their holes, in order to devour during the autumn. Their habitations, which they dig to the depth of three or four feet, consist of more or fewer apartments, according to the age of the animal: a young hamster makes them hardly a foot deep; an old one sinks them to the depth of four or five feet, and the whole diameter of the residence, taking in all its habitations, is sometimes eight or ten feet. The principal chamber is lined with dried grass, and serves for a lodging; the others are destined for the preservation of provisions, of which he amasses a great quantity during the autumn. Each hole has two apertures; the one descending obliquely, and the other in a perpendicular direction; and it is through this latter that the animal goes in and out. The holes of the females, who never reside with the males, are somewhat different in their arrangement, and have more numerous passages. The female breeds two or three times a year, producing five or six, and sometimes as many as sixteen or eighteen. The growth of the young is rapid, and they are soon able to provide for themselves.

The hamster feeds on all kinds of herbs and roots, as well as on grain, and even occasionally on the smaller animals. "In harvest-time (says Mr. Allamand) he makes his excursions for provision, and carries every article he can find into his granary. To facilitate the transportation of his food, nature has provided him with two pouches in the inside of each cheek. On the outside these pouches are membranous, smooth, and shining; and in the inside are a great many glands, which continually secrete a certain fluid, to preserve their flexibility, and to enable them to resist any accidents which may be occasioned by the roughness or sharpness of particular grains."

On the approach of winter the hamster retires into his subterraneous abode, the entry of which he shuts up with great care; and thus remaining in a state of tranquillity, feeds on his collected provision till the frost becomes severe; at which period he falls into a profound slumber, which soon grows into a confirmed torpidity, so that the animal continues rolled up, with all its limbs inflexible, its body perfectly cold, and without the least appearance of life. In this state it may even be opened; when the heart is seen alternately contracting and dilating, but with a motion so slow as to be scarce perceptible, not exceeding 15 pulsations in a minute, though in the waking state of the animal it beats 150 pulsations in the same time. It is added that the fat of the creature has the appearance of being coagulated, that its intestines do not exhibit the smallest symptoms of irritability on the application of the strongest stimulants, and the electric shock may be passed through it without effect. This lethargy of the hamster has been generally ascribed to the effect of cold alone; but late observations have proved, that unless at a certain depth beneath the surface, so as to be beyond the access of the external air, the animal does not fall into its state of torpidity, and that the severest cold on the surface does not affect it. On the contrary, when dug up out of its burrow, and exposed to the air, it infallibly awakes in a few hours. The waking of the hamster is a gradual operation: he first loses the rigidity of his limbs; then makes profound inspirations, at long intervals; after this he begins to move his limbs, opens his mouth, and utters a sort of unpleasant rattling sound. After continuing these operations for some time, he at length opens his eyes, and endeavours to rise; but reels about for some time, as if in a state of intoxication, till at length, after resting a small space, he perfectly recovers his usual powers. This transition from torpidity to activity requires more or less time, according to the temperature of the air, and other circumstances. When exposed to a cold air, he is sometimes two hours in waking; but in a warmer air the change is effected in half the time.

The manners of the hamster are generally represented as far from pleasing. No society appears to exist among these animals. They are naturally very fierce, and make a desperate defence when attacked: they also pursue and destroy every animal which they are capable of conquering, not excepting even the weaker individuals of their own species. They are said to be particularly fond of the seeds of liquorice, and to abound in the districts where that plant is cultivated. According to Mr. Sultzer, they abound to such a degree in Gotha, that in one year 11,564, in another 54,429, and in a third 80,139 of their skins were delivered in the Hotel de Ville of that capital, where the hamster is proscribed on account of the devastations it commits among the corn.

13. Mus bursarius, Canada rat. This, which is a species but lately discovered, seems to be the most remarkable of all the pouched rats for the proportional size of the receptacles. It is a native of Canada, and is about the size of a brown or Norway rat, and is of a pale greyish-brown colour, rather lighter beneath; the length to the tail is about nine inches, and that of the tail, which is but slightly covered with hair, about two inches; the legs are short; the fore-feet strong, and well adapted for burrowing in the ground, having five claws, of which the three middle ones are very large and long; the interior much smaller, and the exterior very small, with a large tubercle or elbow beneath it. The claws on the hind-feet are comparatively very small, but the two middle are larger than the rest, and the interior one is scarce visible; the teeth are extremely strong, particularly the lower pair, which are much longer than the upper; the ears are very small. This species is described in the 5th volume of the Transactions of the Linnæan Society; but we must observe that by some oversight in the conduct of the figure there given, the claws on the fore-feet are represented as only three in number, and are somewhat too long, weak, and curved. A more faithful representation

is given in Dr. Shaw's excellent work, which is accompanied by an outline of the head, in its natural size, in order to shew the teeth and cheek-pouches. The manners of this species are at present unknown; but it may be concluded that it lays in a stock of provisions, either for autumnal or winter food. The pouches of the individual specimen above described, when first brought to governor Prescot, were filled with a kind of earthy substance: it is, therefore, not improbable that the Indians who caught the animal might have stuffed it thus, in order to preserve it in its utmost extent.

14. Mus typhlus, blind rat. This is perhaps one of the largest and most remarkable of its tribe, measuring between seven and eight inches in length, and being entirely destitute both of eyes and tail; the defect of the former is a very singular circumstance, and the animal perhaps affords the only instance of a truly blind or eyeless quadruped. In the mole, the eyes, however small and deeply seated, are yet perfect in their kind, and though not calculated for acute vision, still enable the animal to avoid the danger of exposure; but in the quadruped now under consideration, there are merely a pair of subcutaneous rudiments of eyes, smaller than poppy-seeds, and covered with a real skin. It is probable, however, that even these minute organs are sufficient to give an obscure perception of light, and to enable the animal to consult its safety by generally continuing beneath the surface. The external ears are also wanting, and the foramina leading to the internal organs are very small, entirely hid by the fur, and situated at a great distance backward. There is scarce any distinction between the head and neck, and the whole form of the animal, like that of the mole, is calculated for a subterraneous life; the body being cylindric, the limbs very short, and the feet and claws, though small and weak in comparison with those of moles, yet calculated for digging or burrowing in the ground. The colour of the animal is a greyish brown; the fur, which is very thick, soft, and downy, being dusky toward the roots, and greyish toward the tips; the head is lighter and the abdomen darker than the other parts; the lower lip is also whitish, and sometimes a white mark extends along the forehead; the front-teeth are very large, and are naturally bare or exserted; the lower pair being much longer than the upper. This singular species is a native of the southern parts of Russia, where it burrows to a great extent beneath the surface, forming several lateral passages, by which it may pass in quest of roots, &c. It is said to feed in particular on the roots of the chærophyllum bulbosum. In the morning hours it sometimes quits its hold to bask in the sunshine, and if disturbed, instantly takes refuge beneath the surface; burrowing with great agility, and frequently in a perpendicular direction. Its bite is very severe when attacked. It has no voice, but emits a kind of snorting sound, and gnashes its large teeth in a menacing manner, raising its head at the same time. The female is said to produce from two to four young.

15. Mus Capensis, Cape rat. In its general shape, this animal is not unlike the great sand rat first described, and is equally common about the Cape of Good Hope; but it is far inferior in size, measuring about seven inches to the tail, which is very short, nearly white, and flattish. The general colour of this species is a dusky rufous ash-brown, paler or more inclining to whitish beneath; the end or tip of the nose is naked and black, the remainder white, and on each side are several strong white bristles; the chin, lower sides of the cheeks, and spaces round the eyes, are also white, and on the hind part of the head is an oval white spot; the teeth are naturally exserted or naked, and are similar in form to those of the great sand rat. In its manners and way of life, the animal is also similar to that species; and is very destructive to gardens, flinging up hillocks, and eating various kinds of roots.

MUSA, *the plantain tree*, a genus of the monœcia order, in the polyandria class of plants, and in the natural method ranking under the 8th order, scitamineæ. The calyx of the male hermaphrodite is a spatha or sheath; the corolla is dipetalous; the one petal erect and quinquedentate; the other nectariferous, concave, and shorter: there are six species, five of which are perfect; one style; the germen inferior and abortive. The female hermaphrodite has the calyx, corolla, filaments, and pistil, of the male hermaphrodite, with only one filament perfect; the berry is oblong, and three-angled below. There are three species:

1. Musa paradisiaca, is cultivated in all the islands of the West Indies, where the fruit serves the Indians for bread; and some of the white people also prefer it to most other things, especially to the yams and cassada bread. The plant rises with a soft stalk 15 or 20 feet high; the lower part of the stalk is often as large as a man's thigh, diminishing gradually to the top, where the leaves come out on every side: these are often eight feet long, and from two to three broad, with a strong fleshy mid-rib, and a great number of transverse veins running from the mid-rib to the borders. The leaves are thin and tender, so that where they are exposed to the open air, they are generally torn by the wind; for as they are large, the wind has great power against them: these leaves come out from the centre of the stalk, and are rolled up at their first appearance; but when they are advanced above the stalk, they expand and turn backward. As these leaves come up rolled in this manner, their advance upward is so quick, that their growth may almost be discovered by the naked eye: and if a fine line is drawn across level with the top of the leaf, in an hour the leaf will be near an inch above it. When the plant is grown to its full height, the spikes of flowers appear in the centre, which is often near four feet long. The flowers come out in bunches, those in the lower part of the spike being the largest; the others diminish in their size upward. Each of these bunches is covered with a sheath of a fine purple colour, which drops off when the flowers open. The upper part of the spike is made up of male flowers, which are not succeeded by fruit, but fall off with their covers. The fruit or plantain is about a foot long, and an inch and a half or two inches diameter: it is at first green, but when ripe pale-yellow. The skin is tough; and within is a soft pulp of a luscious sweet flavour. The spikes of the fruit are often so large as to weigh upwards of 40lb. The fruit of this sort is generally cut before it is ripe. The green skin is pulled off, and the heart is roasted in a clear fire for a few minutes, and frequently turned: it is then scraped, and served up as bread. Boiled plantains are not so palatable.

This tree is cultivated on a very extensive scale in Jamaica, without the fruit of which, Dr. Wright says, the island would scarce be habitable, as no species of provision could supply their place. Even flour or bread itself would be less agreeable, and less able to support the laborious negro, so as to enable him to do his business, or to keep in health. Plantains also fatten horses, cattle, swine, dogs, fowls, and other domestic animals. The leaves, being smooth and soft, are employed as dressings after blisters. The water from the soft trunk is astringent, and employed by some to check diarrhœas. Every other part of the tree is useful in different parts of rural economy. The leaves are used for napkins and table-cloths, and are food for hogs.

2. Musa sapientum, *the banana tree.* This species differs from the preceding in having its stalks marked with dark-purple stripes and spots. The fruit is shorter, straighter, and rounder; the pulp is softer, and of a more luscious taste. It is never eaten green; but when ripe it is very agreeable, either eaten raw or fried in slices as fritters; and is relished by all ranks of people in the West Indies. Both these plants were carried to the West Indies from the Canary Islands, whither, it is believed, they had been brought from Guinea, where they grow naturally. They are also cultivated in Egypt, and in most other hot countries, where they grow to perfection in about ten months from their first planting to the ripening of their fruit. When their stalks are cut down, several suckers come up from the roots, which in six or eight months produce fruit; so that by cutting down the stalks at different times, there is a constant succession of fruit all the year. In Europe some of these plants are raised by gentlemen who have hot-houses capacious enough for their reception, in many of which they have ripened their fruit very well; but as they grow very tall, and their leaves are large, they require more room in the stove than most people are willing to allow them. They are propagated by suckers, which come from the roots of those plants that have fruited; and many times the younger plants, when stinted in growth, also put out suckers. The fruit of this tree is four or five inches long, of the size and and shape of a middling cucumber, and of a high, grateful flavour: the leaves are two yards long, and a foot broad in the middle; they join to the top of the body of the tree, and often contain in their cavities a great quantity of water which runs out upon a small incision being made into the tree, at the junction of the leaves. Bananas grow in great bunches, that weigh 12 lb. and upwards. The body of the tree is so porous as not to merit the name of wood; the tree is only perennial by its roots, and dies down to the ground every autumn. When the natives of the West Indies (says Labat) undertake a voyage, they make provision of a paste of banana, which, in ease of need, serves them for nourishment and drink: for

this purpose they take ripe bananas, and having squeezed them through a fine sieve, form the solid fruit into small loaves, which are dried in the sun or in hot ashes, after being previously wrapped up in the leaves of Indian flowering-reed.

3. Musa troglodytarum, has a scarlet spathe and scarlet berry, but not eatable.

MUSCA, *fly*, a genus of insects of the order diptera. The generic character is: mouth formed into a fleshy proboscis, with two lateral lips; palpi, none.

The vast extent of the genus musca makes it necessary to divide the whole into different assortments, in order to the more ready investigation of the species. These divisions are instituted from the form of the antennæ, which are either simple (without any lateral hair or plume), or armed (that is, furnished with a lateral hair or plume). These divisions are farther separated into others, according to the more or less downy or hairy appearance of the insects.

The first section of this genus comprehends such flies as have simple antennæ.

The larvæ, in the different tribes of flies, differ far more in habit than the complete insects, some being terrestrial, and others aquatic. Those of the more common kinds are emphatically distinguished by the title of *maggots*, and spring from eggs deposited on various putrid substances. Several of the aquatic kinds are of singularly curious formation, and exhibit wonderful examples of the provision ordained by nature for the preservation of even the meanest and most seemingly contemptible of animals. Several are inhabitants of plants, feeding during this state on other living insects.

The general form of the chrysalis or pupa is that of an oval, differently modified, according to the species, and formed by the external skin of the larva, which hardens round the chrysalis. Some species, however, cast their skin before their change into the pupa state.

In this division one of the most remarkable species is the musca chamæleon, which is a large black fly, with a broad flattish abdomen, having the sides of each segment yellow, forming so many abrupt semibands across that part. It proceeds from an aquatic larva, of very considerable size, measuring two inches and a half in length, of a somewhat flattened shape, and of a brown colour, with a narrow or slender front, the body widening by degrees towards the middle, and from thence gradually tapering to the extremity or tail, which is terminated by a circle of radiating or diverging hairs. This larva is common in stagnant waters during the summer months, and passes into its chrysalis state without casting its skin, which dries over it, so as to preserve the former appearance of the animal in a more contracted state.

In this division also stands the musca vermileo, a middle-sized fly, of a somewhat lengthened form, with a distant resemblance to a tipua. It is of a dull yellow colour, with transparent wings; the thorax marked above by two black lines, and the abdomen by a triple series of black spots. The larva of this species measures above three quarters of an inch in length, and is of a pale yellowish-grey colour, slender or sharpened in front, and growing gradually broader towards the tail. It is found in the southern parts of Europe, and is not uncommon in some districts of France, and is remarkable for practising a method exactly similar to that of the hemerobius formicaleo in order to obtain its prey; excavating a circular pit or cavity in the dry sand, concealing itself beneath the centre, and thus waiting the arrival of any small insect which may happen to fall into it, and after absorbing its juices, throwing out the exhausted remains to a considerable distance from the verge of the cavity. This larva seems to have been first observed and described by Reaumur, in the Memoirs of the French Academy for the year 1752. It assumes the state of a chrysalis by casting its skin, which rolls to the hinder part of the body: the chrysalis is of a dull reddish colour, and is rounded or clubbed at the upper part, suddenly tapering from thence to the extremity, and after lying nine or ten days, gives birth to the included insect.

Of the downy or slightly haired flies with bristled antennæ, one of the most remarkable is the musca tenax, which is about the size of a drone, and of a brown colour, with transparent wings, and the first segment of the abdomen yellowish on each side. It proceeds from a larva of a very singular appearance, being a long-tailed brown maggot, of rather slow motion, measuring about three quarters of an inch in length, exclusive of the tail, which is extensile, and consists of a double tube, the exterior annulated into numerous segments, and the interior slender, and terminated by a circle of hairs, surrounding a spiraculum or air-hole. This maggot is seen in muddy stagnant waters, drains, and other places of the dirtiest description; and notwithstanding its unpleasing appearance, exhibits, when accurately examined, many particulars well worthy of admiration. The feet in particular, which are seven in number on each side, are wonderfully calculated for enabling the animal to ascend walls or other perpendicular places, in order to seek some proper situation in which it may undergo its change into chrysalis, being very broad, and beset on their under surface with numerous small hooked claws, giving it the power of clinging with security during its ascent.

Of this larva a particularity is stated on the authority of Linnæus, which, if true, may indeed well be numbered among the Miracula Insectorum (the title of the paper in the Amœnitates Academicæ, in which it is announced), viz. that being a frequent inhabitant of the turbid pulp used in the operation of paper-making, it is often exposed to the action of the wooden mallets used in the process, as well as squeezed in the strongest presses, and yet survives uninjured these seemingly destructive operations!!!

The above larva commonly changes to a chrysalis about the end of August, the skin contracting and drying round the body, and the tail continuing in a shrivelled state. After thus remaining about the space of a fortnight, it gives birth to the complete insect, which has so much the general appearance of a drone, that it is very frequently mistaken for such. It is extremely common during the month of September.

Musca pendula, which belongs also to this division of the genus, is a moderately large and very beautiful insect. Its colour is black, with four bright yellow stripes down the thorax, and three broad interrupted bars across the abdomen; or, in other words, this fly might be described as of a bright yellow colour, with the thorax marked by four longitudinal black lines, and the abdomen by three transverse ones, connected by a black stripe down the middle. Its larva, which is an inhabitant of stagnant waters, is of a still more remarkable appearance than that of the immediately preceding species, which it resembles in size, but is of a paler colour, and furnished with a tail of greater length, composed of a double tube, the interior of which is very slender, extensile at the pleasure of the animal to a vast length, and terminated by a very small spiracle. The length of this tube is therefore varied according to the greater or smaller depth at which the insect chooses to continue, the tip reaching to the surface, in order to supply the requisite quantity of air. Sometimes great numbers of these maggots are found coiled or twisted together by their tails in such a manner that it is by no means easy to separate any one from the rest. The chrysalis resembles that of the musca tenax, the remains of the tail being visible in a dried and contracted state. The complete insect is frequently seen on flowers during the autumnal season.

Among the hairy or bristly flies with plumed antennæ stands the well-known species called musca carnaria, or the common large blow-fly. This, as every one knows, deposits its eggs on animal flesh, either fresh or putrid. The larvæ or maggots hatch in about the space of a few hours, and when full-grown, which happens in eight or ten days, are of a white or yellowish-white colour with a slight tinge of pale-red, and of a lengthened shape, with a sharpened front, in which the mouth is situated, and from whence the body gradually enlarges in size to the last or terminal segment, which is of a very broad and flattened form, surrounded by several slightly prominent tips, and furnished with a pair of dusky specks resembling eyes; so that an inaccurate spectator might easily mistake this part for the head, and the proper head for the tail. When the animal changes to a chrysalis, the skin dries round it, and the whole assumes a completely oval form, and a reddish colour, soon changing into a reddish-brown. In ten days more the fly itself emerges, which is too well known to require particular description.

Musca vivipara greatly resembles the preceding, and is found in similiar situations, but is viviparous, disclosing small ready-formed larvæ instead of eggs, which in this species are hatched internally. This particularity is not confined to the present species, but has been observed in some others of this genus.

To this as well as the preceding has been applied the observation, *Tres muscæ consumunt cadaver equi æquè citò ac leo;* the number of larvæ proceeding from the flies, and the quick evolution of the successive broods, destroying the same quantity of flesh in a given time as the predacious quadruped, who devours a great quantity at certain intervals only, while the process of destruction continues with unremitted perseverance on the part of one or other of the respective races of flies.

Of the hair-flies with bristled antennæ, the musca grossa, the largest of European flies, affords a good example.

Musca flava, is one of the smallest but most elegant of the European flies; it is of a yellow colour, with bright gold-green eyes.

MUSCI, *Mosses*, one of the seven families or classes into which all vegetables are divided by Linnæus in the Philosophia Botanica, is the 2d order in the cryptogamia class, according to the sexual system.

The more perfect kinds of mosses are found in the shape of small but regular plants, divided into several branches, and clothed with leaves. these are of various forms and structures; some being broad and thin, others slender as hairs; some pellucid, others opaque; some smooth, others hairy. From the alæ of these leaves in some kinds, and from the summit of the stalks in others, there arise heads or capsules of various figure and structure, but all unicapsular; some of these are naked, and others covered with a calyptra- or hood; some stand on long pedicles, and others are placed close to the stalks. These heads are usually called capsulæ, which contain their seeds or farina; and their pedicles setæ, in the mnia, hypna, brya, and polytricha, &c. These capsules in some are covered with a calyptra or hood; in others they are naked. Of the first kind are the splachnum, polytrichum, mnium, bryum, hypnum, fontinalis, and buxbaumia; and of the latter sort, the lycopodium, porella, sphagnum, and phascum.

Some of the mosses, it is evident, approach to the nature of the plants which have their male and female parts in the same flower, and others to those which have them in different ones. After all, this tribe of plants, as well as the mushrooms, ferns, and seaweeds, is still inperfectly known. The characteristics of these plants, however, according to the sexual system, are, 1. Tops without filaments or threads. 2. The male flower, constituted by the presence of the antheræ or tops, placed apart from the female, either on the same or distinct roots. 3. The female roots, flowers deprived of the pistillum or pointal. 4. The seeds devoid of both lobes (cotyledones) and proper coverings, so that they exhibit the naked embryo.

This order is subdivided into 13 genera, from the presence or absence of the calyx, which in these plants is a veil or cover like a monk's cowl, that is placed over the male organs or tops of the stamina, and is denominated calyptra, from the sexes of the plants, which bear male and female flowers, sometimes on the same, sometimes on distinct roots; and from the manner of growth of the female flowers, which are sometimes produced singly, sometimes in bunches or cones.

The manner of seeding of mosses in general, may be more clearly understood from the description of that genus of them which has been traced through all its stages, and to which most of the others, though every genus has its distinct fructification in some respects, yet bear a very general analogy.

The genus already observed, is that called by Dr. Dillenius, the hypnum. The species of this are very numerous and common; but that particular one which was the subject of these observations, is the short-branched silky kinds, common on old walls; and called by that author in his History, hypnum vulgare, sericum, recurvum, capsulis erectis cuspidatis.

The head of this moss appears to the naked eye a small, smooth, brownish-yellow, oblong body, of about a ninth of an inch long; this is covered at its upper end with a membranaceous calyptra or hood, in shape resembling an extinguisher, or a funnel inverted. When this calyptra is taken off, and the head viewed with a microscope, the surface of it is seen to be ridged with longitudinal striæ. The basis of the head is of a deep orange-colour, and more opaque than the rest; and the top is bounded by an orange-coloured ring, swelling out something beyond the surface of the contiguous parts of the head. Good glasses show that in this head there are not wanting the parts essential to the fructification of what are usually called the more perfect plants. This ring is truly a monophyllous undulated calyx, within which arise sixteen pyramidal fimbriated stamina; these are of a pale-greenish colour, and are loaded with a whitish oval farina. The stamina all bend toward each other from their bases, and almost meet in a point at the tops. This is their appearance when the head is nearly ripe; and immediately under the arch formed by these stamina, is a cylindric hollow pistillum, through which the farina makes its way, and is dispersed among the seeds in the head. The fruit is a large capsule, filling every part of the membrane which shows itself on the outside of the head, and in most places is contiguous to it; this capsule is filled with perfect and very beautiful seeds; they are round, transparent when unripe, but afterwards opaque, and of a very beautiful green, which colour they retain even when dried.

When this head is first produced from the plant, the stamina are very slender, and stand erect; the head is scarcely any thicker than the stalk, and the calyptra covers it all over, to shield the tender substance of the farina from external injuries. As the farina afterwards swells in the stamina, the seeds in the head increase also in bulk, and by their increase the head is more extended in thickness; and the stamina are by this means separated farther and farther from each other at their bases, but bend inwards toward their points, so as to form a kind of arched covering over the stigma of the pistillum, which is single, and hence the farina falls as it ripens into the head, and impregnates the seeds.

The 11 principal genera are as follow: lycopodium, polytrichum, bryum, selagines, usneæ, mnium, byssi, sphagnum, hypna, confervæ, and fontinales. These are found growing on the barks of trees as well as on the ground.

Many of the mosses grow on rocks and barren places, and, rotting away, afford the first principles of vegetation to other plants, which could never else have taken root there. Others grow in bogs and marshes, and by continual increase and decay fill up and convert them either into fertile pastures, or into peat-bogs, the source of inexhaustible fuel to the polar regions. They are applicable also to many domestic purposes: the lycopodiums are some of them used in dyeing of yarn, and in medicine; the sphagnum and polytrichum furnish convenient beds for the Laplanders; and the hypnums are used in tiling of houses, stopping crevices in walls, packing up of brittle wares and the roots of plants for distant conveyance, &c.

MUSCICAPA, or FLY-CATCHER, a genus of birds belonging to the order of passeres. The bill is flatted at the base, almost triangular, notched at the upper mandible, and beset with bristles; the toes (generally) divided as far as their origin. There are 97 species; the most remarkable are:

1. The grisola, or spotted fly-catcher, about five inches and three quarters long. The head is large, of a brownish hue, spotted obscurely with black: the back is of a mouse-colour; the wings and tail are dusky; the breast and belly white. It is a bird of passage; appears here in the spring, breeds with us, and departs in September. It builds its nest against any part of a tree that will support it; often in the hollow caused by the decay of some large limb, hole in a wall, &c. also on old posts and beams of barns; and is found to return to the same place season after season. It lays four or five pale eggs marked with reddish. It feeds on insects, and collects them on the wing.

2. The flabellifera, or fan-tailed fly-catcher, is in length six inches and a half: the head is black, which colour descends on the back part lower than the nape, whence it passes forward in a narrow collar to the throat; the chin, throat, and sides of the neck, except where this collar passes, are white, and over the eye is a white streak like an eye-brow; the tail is longer than the body, the two middle feathers black, the others white; the legs are dusky. This species inhabits the southern isle of New Zealand; where it is seen constantly hunting after insects, and flies always with its tail in shape of a fan. It is easily tamed; and will then sit on any person's shoulder, and pick off the flies. See Plate Nat. Hist. fig. 281.

3. The caribonensis, or cat-bird, is somewhat bigger than a lark: length eight inches: bill black; the upper parts of the body and wings are of a deep brown; the under ash-coloured; the crown of the head is black; the tail is blackish; and the legs are brown. This species is found in Virginia in the summer-season, where it frequents shrubs rather than tall trees, and feeds on insects; its cry resembles that of a cat, whence the English name given it by Catesby.

4. The rubicollus, purple-throated fly-catcher, is about the size of a blackbird; the whole plumage is black, except the chin, throat, and fore part of the neck, on which is a large bed of beautiful crimson, inclining to purple; the legs are black. These birds inhabit Cayenne and other parts of South America; where they are found in flocks, and precede in general the toucans in their movements. They feed on fruits and insects; and are lively birds, always in action. They for the most part frequent the woods, like the toucans; and where the first are found, the others are seldom far off. See Plate Nat. Hist. fig. 283.

MUSCLE. See ANATOMY.

MUSCLES, *Insertion and force of the.* The all-wise Author of nature has furnished animals with limbs, moveable about the joints by means of muscular cords, inserted near the joint or centre of motion; the great wisdom of which will appear, from supposing the insertion to be at E (Plate Miscel. fig. 168.) near the wrist B, the muscle D E being either loose and separate from the bone D, A, B, or bound down to it by some ligament or fascia R; in either of which cases the bone A B cannot be turned up quite to the situation A H, unless the muscle D E is contracted or shortened to D M, which would not only be troublesome but even impossible. It would be troublesome, because the breadth and thickness of the arm would be vastly increased, so as to become as big as the belly of an animal. On the other hand, the structure of a muscle being such that it cannot be contracted but a little, seldom above two or three fingers'-breadth; such an insertion as that at E, which requires a contraction of about a foot and a half, would be altogether impossible. Therefore, in fact, we find the muscles inserted near the centre of motion, as at I, fig. 169.

In order to calculate the force of any muscle, we are to consider the bones as levers; and then the power or force of the muscle will be always to the resistance or weight it is capable of raising, as the greater distance of the weight from the centre of motion is to the lesser distance of the power. Hence, it being found by experiments, that a robust young man is able to suspend a weight R, equal to twenty-eight pounds, when the arm is extended in a supine and horizontal situation, we have this proportion, viz. the force of the muscle I D is to the weight R, = 28 ℔, as the distance D C is to the distance I C. But it is found, that D C, the length of the cubit and hand, is more than twenty times greater than I C, the distance of the muscle from the centre of motion. Therefore the force of the muscle I D, must be more than twenty times greater than the weight R, or more than 28 × 20 = 560 ℔.

Again, to find the force which the biceps and brachiæus muscles exert, when the humerus D A, (fig. 170.) is perpendicular to the horizon, we are first to consider what weight a man is capable of sustaining in this posture, viz. R = 35 pounds, and next the quantity of the distances C B, C I, which in this case are as 16 to 1. Therefore the force of these muscles is to the weight R = 35 pounds, as the distance C B = 16 is to the distance I C = 1; or the force is equal to 560, as before.

But what appears most wonderful is, the force of the muscles that move the lower jaw; which, when taken altogether, do not in a man exceed the weight of 1 pound, and yet exert a force equal to 534 pounds, and in mastiff-dogs, wolves, bears, lions, &c. their force is vastly superior, so as to break large bones, as they practise daily in their feeding.

The motions of the far greater part of the muscles are voluntary, or dependant on our will; those of a few others, involuntary. The former are called animal, the other natural motions. Finally, the motions of some of the muscles are of a mixed kind, partly animal and partly natural. Those muscles which perform the voluntary motions, receive nerves from the brain or spinal marrow: those which perform their motions involuntarily, have their nerves from the cerebellum; and those whose motion is partly voluntary, and partly involuntary, have theirs in part from the brain, and in part from the cerebellum. And as a muscle can no longer act when its nerve is either cut asunder or tied up, so the same absolute dependance it has on its artery: for from the experiments of Steno and others on living animals, it appears that in cutting or tying up the artery, the muscle in the same manner loses its whole power of action, as if the nerve had been cut or tied up.

MUSCOVY GLASS. See Mica.

MUSHROOM. See Agaricus.

MUSIC, a science which teaches the properties, dependances, and relations of melodious sounds; or the art of producing harmony and melody by the due combination and arrangement of those sounds. This science, when employed in searching the principles of this combination and succession, and the causes of the pleasure we receive from them, becomes very profound, and demands much patience, sagacity, and depth of thinking. It is generally supposed that the word music is derived from Musa, because it is previously believed that the invention of this art is to be attributed to the muses: but Diodorus derives it from an Egyptian name, intimating that music was first established as a science in Egypt after the Deluge, and that the first idea of musical sound was received from that produced by the reeds growing on the banks of the Nile, by the wind blowing into them. Others again imagine, that the first ideas of music were received from the warbling of birds. However this may really have been, it appears at least equally rational, to attribute its origin to mankind; since musical intonation, in the infancy of language, must often have been the natural result of passionate feeling, and since also we find that wherever there is speech there is song.

The antient writers on this science differ greatly as to its object and extent. In general, they give to it a much wider latitude than that which it obtains with us. Under the name of music they comprehended not only the melodious union of voices and instruments, but also the dance, gesture, poetry, and even all the other sciences. Hermes defines music to be the general knowledge of order; which was also the doctrine of Plato, who taught that every thing in the universe was music.

Music, however, properly so called, only concerns the due order and proportion of sounds; and is divided into two parts, the theoretical and the practical. Theoretical music comprehends the knowledge of harmony and modulation; and the laws of that successive arrangement of sound by which air, or melody, is produced. Practical music is the art of bringing this knowledge and those laws into operation, by actually disposing of the sounds, both in combination and succession, so as to produce the desired effect; and this is the art of composition: but practical music may, in fact, be said to extend still further, and to include not only the production of melodious and harmonious composition, but also its performance; and to such a facility in execution, and nicety of expression, has this department of practical music arrived at the present day, that its professors, generally speaking, hold a truly respectable rank in the various list of modern artists; and are highly, as well as most deservedly, esteemed by all lovers and patrons of musical taste and ingenuity.

MUSSÆNDA, a genus of the pentandria monogynia class and order. The cor. is funnel-form; stigma 2, thickish; berry oblong, inferior; seeds disposed in 4 rows. There are three species, shrubs of China.

MUSK. This substance is secreted into a kind, situated in the umbilical region of the quadruped called moschus moschifer (which see). Its colour is brownish red; its feel unctuous; its taste bitter; and its smell aromatic and intensely strong. It is partially soluble in water, which acquires its smell; and in alcohol, but that liquid does not retain the odour of musk. Nitric and sulphuric acids dissolve it, but destroy the odour. Fixed alkalies develope the odour of ammonia. Oils do not act on it. At a red heat it has the same fetid smell as urine. Its component parts have not been ascertained.

MUSKET, a fire-arm borne on the shoulder, and used in war. The length of a musket is fixed at three feet eight inches from the muzzle to the pan, and it carries a ball of 29 to 2 pounds.

In fortification, the length of the line of defence is limited by the ordinary distance of a musket-shot, which is about 120 fathoms; and the length of almost all military architecture is regulated by this rule. See Gunnery, Gun-smithery, and Rifle.

MUSKETOON, a kind of short thick musket, whose bore is the thirty-eighth part of its length: it carries five ounces of iron, or seven and a half of lead, with an equal quantity of powder. This is the shortest sort of blunderbuss.

MUSLIN, a fine thin sort of cotton cloth, which bears a downy nap on its surface. There are several sorts of muslins brought from the East Indies, and more particularly from Bengal.

MUSTELA, the *otter*, a genus of quadrupeds of the order feræ: the generic character is, foreteeth upper six, erect, acuter, distinct; lower six, obtuser, crowded, placed within; tongue smooth.

M. lutra, common otter. The common otter is found in almost every part of Europe, as well as in the colder regions of Asia; inhabiting the banks of rivers, and feeding principally on fish. It occurs also in the northern parts of America, and particularly in Canada, where it appears to arrive at a larger size than in Europe. In the river Euphrates, on the contrary, it is found to be no larger than a common cat; but it is probable, that this is in reality a different species, viz. the M. lutreola, or smaller otter, hereafter to be described. The length of the otter is nearly two feet from nose to tail, and of the tail about sixteen inches. Its colour is a deep brown, with a small light-coloured patch on each side the nose, and another under the chin. "The otter, (says Mr. Pennant) shews great sagacity in forming its habitation: it burrows under ground on the banks of some river or lake, and always makes the entrance of its hole under water, working upwards to the surface of the earth; and, before it reaches the top, makes several holts or lodges, that in case of high floods it may have a retreat, for no animal affects lying drier; and then makes a minute orifice for the admission of air. It is farther observed, that this animal, the more effectually to conceal its retreat, contrives to make even this little air-hole in the midst of some thick bush." Though the principal food of the otter consists of fish, yet it is said that in hard weather, when this its natural prey fails, it will attack the smaller quadrupeds, as well as poultry, &c. The otter is naturally a very fierce animal; and when hunted with dogs, as is sometimes the practice, will inflict very severe wounds on its antagonists. The female produces four or five young at a birth; this commonly happens early in the spring. The young otters, if taken at a very early age, may be successfully tamed, and taught by degrees to hunt for fish, and bring them to their master.

When the otter, in its natural or uneducated state, has caught a fish, it immediately draws it ashore, and devours the head and upper parts, leaving the remainder; and when in a state of captivity, will eat no fish but what is perfectly fresh, but will prefer bread, milk, &c.

2. M. lutreola, the smaller otter, very much resembles the common otter, but is smaller; the body is of a dusky colour, but with a considerable cast of tawny. In size it falls short of the common otter, measuring about a foot in length. In North America this species is known by the name of minx; and is said sometimes to leave the water, and prey on poultry, &c. in the manner of a polecat, biting off the heads and sucking the blood. It is said also to have a fetid smell. In Europe the smaller otter is chiefly found in Poland and Lithuania, living on fish, frogs, &c. Its fur is very valuable, and next in beauty to that of the sable.

3. M. lutris, the sea otter, is the largest of the otters, measuring about 3 feet from the nose to the tail, and the tail thirteen inches. The colour of this species is a deep, glossy, brownish black, the fur being extremely soft and very fine; on the forehead is generally a cast of greyish or silver-colour. According to Mr. Pennant, it is one of the most local animals we are acquainted with, being entirely confined between lat. 44. and 60. north; and between east long. from London, 126. to 150.; inhabiting, in great abundance, Bering's islands, Kamtschatka, the Aleutian and Fox islands, between Asia and America. They land also in the Kurile islands, but are never seen in the channel between the northeast of Siberia and America. It is supposed that they bring but one at a time. They are most extremely harmless animals, and are singularly affectionate to their young. They bring forth on land, and often carry the young one between their teeth; fondle them; and frequently fling them up, and catch them again in their paws; and before they can swim, the parents take them in their fore feet, and swim about on their backs. The young continues with its parent till it takes a mate.

This animal is killed for its skin, which is one of the most valuable of furs, being sold at the rate of from 14 to 25 pounds sterling each. They are said to be chiefly sold to the Chinese.

The sea otter is sometimes taken with nets, but is more frequently destroyed with clubs and spears.

4. M. fero, ferret, has eyes red and fiery. It inhabits Africa. In Europe it is tamed to catch rabbits, rats, &c. It procreates twice a year, and brings forth from 6 to 8 at a time. See Plate Nat. Hist. fig. 284.

M. erminea, stoat: inhabits Europe, the cold parts of Africa, Asia, and China; lives in heaps of stones, banks of rivers, hollow trees, and forests, especially of beech: preys on squirrels, mice, and small birds. Body about ten inches long; hair short, which in northern climates becomes white, except the outer half of the tail, which remains black. The fur is very valuable. See Plate Nat. Hist. fig. 286. There are 28 species of the mustela.

MUTE. If any person being arraigned on any indictment or appeal for felony, or on any indictment for piracy, shall upon such arraignment stand mute, or will not answer directly to the felony or piracy, he shall be convicted of the offence, and the court shall thereupon award judgment and execution, in the same manner as if he had been convicted by verdict or confession; and by such judgment shall have all the same consequences as a conviction by verdict or confession. 12 G. III. c. 20.

And the law is the same with respect to an arraignment for petit treason or larceny; for before this act, persons standing mute in either of these cases, were to have the like judgment as if they had confessed the indictment. 2 Inst. 177.

MUTILLA, a genus of insects, of the order hymenoptera; the generic character is, antennæ filiform; feelers four; the articulations obconic, seated on the tip of the lip; jaw membranaceous at the tip, lip projecting obconic; wings in most species obconic; body pubescent, thorax retuse behind; sting pungent, concealed. The M. helvola inhabits the Cape of Good Hope. See Plate Nat. Hist. fig. 287. There are 38 species.

MUST. See FERMENTATION.

MUTISIA, a genus of the class and order syngenesia polygamia superflua. The cal. is cylindric, imbricate; cor. of the ray oval, oblong; of the disk, trifid, down-feathered; recept. naked. There is one species, a climber of Peru.

MUTUAL PROMISE, is where one man promises to pay money to another, and he, in consideration thereof, promises to do a certain act, &c. &c. Such promises must be binding, as well on one side as the other; and both made at the same time. 1 Salk. 21.

MUTUS ET SURDUS, a person dumb and deaf, and being a tenant of a manor, the lord shall have the wardship and custody of him. But if a man be dumb and deaf, and have understanding, he may be grantor or grantee of lands, &c. 1 Co. Inst.

A prisoner deaf and dumb from his birth, may be arraigned for a capital offence, if intelligence can be conveyed to him by signs or symbols. Leach's Cr. Law, 97. See EVIDENCE.

MUTULE. See ARCHITECTURE.

MUTUUM, in the civil law, denotes a loan simply so called; or a contract introduced by the law of nations, whereby a thing consisting in weight, as bullion; in number, as money; or in measure, as corn, timber, wine, &c. is given to another upon condition that he shall return another thing of the same quantity, nature, and value, on demand. This, therefore, is a contract without reward; so that where use or interest arises, there must be some particular article in the contract whereon it is founded.

MUTINY, in a military sense, to rise against authority. Any officer or soldier who shall presume to use traiterous or disrespectful words against the sacred person of his majesty, or any of the royal family, is guilty of mutiny.

Any officer or soldier who shall behave himself with contempt or disrespect towards the general or other commander in chief of our forces, or shall speak words tending to their hurt or dishonour, is guilty of mutiny.

Any officer or soldier who shall begin, excite, cause, or join in, any mutiny or sedition in the troop, company, or regiment to which he belongs, or in any other troop, or company, in our service, or on any party, post, detachment, or guard, on any pretence whatsoever, is guilty of mutiny.

Any officer or soldier, who, being present at any mutiny or sedition, does not use his utmost endeavours to suppress the same, or coming to the knowledge of any mutiny, or intended mutiny, does not, without delay, give information to his commanding officer, is guilty of mutiny.

Any officer or soldier, who shall strike his superior officer, or draw, or offer to draw, or shall lift up any weapon, or offer any violence against him, being in the execution of his office, on any pretence whatsoever, or shall disobey any lawful command of his superior officer, is guilty of mutiny. See the articles of war.

MYA, the gaper, in zoology; a genus belonging to the order of vermes testacea, the characters of which are these. It has a bivalve shell gaping at one end; the hinge, for the most part, furnished with a thick, strong, and broad tooth, not inserted into the opposite valve. This animal is an ascidia. The most remarkable species are,

1. The declivis, or sloping mya, which has a brittle half-transparent shell, with a hinge slightly prominent near the opening, and sloping downwards. It inhabits the rivers of Europe. It is frequent about the Hebrides, and the fish is eaten there by the gentry.

2. The mya pictorum, has an oval brittle shell, with a single longitudinal tooth like a lamina in one shell, and two in the other; the breadth is a little above two inches, the length one. It inhabits rivers. The shells are used to put water-colours in, whence the name. Otters feed on this and the other fresh-water shells.

3. The margaritifera, or pearl mya, has a very thick, coarse, opaque shell; often much decorticated; oblong, bending inward on one side, or arcuated; black on the outside; usual breadth from five to six inches, length two and a quarter. It inhabits great rivers, especially those which water the mountainous parts of Great Britain. This shell is noted for producing quantities of pearl. There have been regular fisheries for the sake of this precious article in several of our rivers. Sixteen have been found within one shell. They are the disease of the fish, analogous to the stone in the human body. On being squeezed they will eject the pearl, and often cast it spontaneously in the sand of the stream. The river Conway was noted for them in the days of Camden.

Linnæus made a remarkable discovery relating to the generation of pearls in this fish. It is a fish that will bear removal remarkably well; and it is said, that in some places they form reservoirs for the purpose of keeping it, and taking out the pearl, which, in a certain period of time, will be again renewed. From observations on the growth of their shells, and the number of their annular laminæ or scales, it is supposed the fish will attain a very great age; 50 or 60 years are imagined to be a moderate computation. The discovery turned on a method which Linnæus found, of putting these shell-fish into a state of producing pearls at his pleasure; though the final effect did not take place for several years: he says that in five or six years after the operation, the pearl would have acquired the size of a vetch. We are unacquainted with the means by which he accomplished this extraordinary operation.

MYAGRUM, *Gold of Pleasure*, a genus of the siliculosa order, in the tetradynamia class of plants; and in the natural method ranking under the 39th order, siliquosæ. The silicula is terminated by an oblong style; the cell generally monospermous. There are ten species; but the most remarkable is the sativum, which grows naturally in cornfields in the south of France and Italy, and also in some parts of Britain. It is an annual plant; and is cultivated in Germany for the sake of the expressed oil of the seeds, which the inhabitants use for medicinal, culinary, and economical purposes. The seeds are a favourite food with geese. Horses, goats, sheep, and cows, eat the plant.

MYCTERIA, the JABIRU, a genus of birds belonging to the order of grallæ. The bill is long, bending upwards, and acute; the nostrils are small and linear; there is no tongue; and the feet have four toes. There are two species: 1. The Americana, or American jabiru, is about the size of a turkey. See Plate Nat. Hist. fig. 288. The bill is long, stout, and of a black colour; the whole plumage is white, except the head, and about two-thirds of the neck, which are bare of feathers and of a blackish colour; the remainder is also bare, and of a fine red; on the hind-head are a few greyish feathers; the legs are strong, of a great length, and covered with black scales; wings and tail even at the end. This bird is found in all the savannas of Cayenne, Guiana, and other parts of South America. It is migratory and gregarious. It makes its nest in great trees, which grow on the borders; lays two eggs, and brings up the young in the nest till they can descend to the ground. The colour of the young birds is grey; the second year it changes to rose-colour, and the third to pure white. They are very wild and voracious, and their food is fish, which they devour in great quantities. The flesh of the young birds is said to be good eating, but that of the old is hard and oily. 2. The Asiatica, or Indian jabiru, is of a large size. The bill is dusky, almost straight above, and gibbous near the forehead; the under mandible swelled beneath; and from the base of the bill there passes through and beyond the eye a black streak. The general colour of the plumage is white; the lower half of the back, the prime quills, and tail, are black; the legs a pale red. This species inhabits the East Indies, and feeds on snails.

MYGINDA, a genus of the tetragynia order, in the tetrandria class of plants; and in the natural method ranking with those of which the order is doubtful. The calyx is quadripartite; the petals four; the fruit a globose plum. There are three species, shrubs of the West Indies.

MYOSOTIS, *Scorpion-grass*, a genus of the monogynia order, in the pentandria class of plants; and in the natural method ranking under the 41st order, asperifoliæ. The corolla is salver-shaped, quinquefid, and emarginated; the throat shut up by small arches. There are seven species, of which the most remarkable is the scorpioides, or mouse-ear. This is a weed of Britain, growing naturally in dry fields, and margins of springs and rills. The blossoms vary from a full blue to a very pale one, and sometimes a yellow; and appear in a long spirally twisted spike. When it grows in the water, and its taste and smell are thereby rendered less observable, sheep will sometimes eat it; but it is generally fatal to them. Cows, horses, swine, and goats, refuse it.

MYOSURUS, a genus of the polyginia order, in the pentandria class of plants; and in the natural method ranking under the 26th order, multisiliquæ. The calyx is pentaphyllous, the leaves cohering at the base; there are five subulated nectaria resembling petals; the seeds are numerous. There is one species, a weed.

MYOXUS, *dormouse*, a genus of quadrupeds of the order glires: The generic character is, front-teeth two, the upper cuneated, the lower compressed; grinders four in each jaw; vibrissæ long; tail cylindric, villose, thicker towards the end; legs of equal length, fore-feet tetradactylous.

1. Myoxus glis, fat dormouse; this species, the glis of Pliny and the old naturalists, is a native of France and the South of Europe. It also occurs in Russia, Austria, &c. residing on trees, and leaping from bough to bough in the manner of a squirrel, though with a less degree of agility. It feeds on nuts, acorns, fruit, &c. and during great part of the winter remains torpid in its nest, which is prepared in the hollows of trees, with dried leaves, moss, &c. During its state of torpidity, it is said to grow very fat, contrary to the nature of most of the hybernating or sleeping animals; which are observed, on their first emerging from that state, to be far leaner than before its commencement. It is probable, however, that this animal awakes at intervals, and indulges in the use of its collected stores of provision.

It is but just to observe, that the count de Buffon has very properly exposed the absurdity of the ancient notion; and has observed that the animal occasionally wakess and makes use of its stock of provision. The truth is, that it is at all times fat, and appear, as much so in spring as in autumn. By the ancient Romans it was numbered among the articles of luxury, and was fattened in proper receptacles, called gliraria.

The size of this elegant species is not very far short of that of a squirrel, measuring from nose to tail near six inches, and the tail four and a half. It is an animal of a much thicker form, in proportion, than a squirrel, and is of an elegant ash-colour, white on the under parts and insides of the limbs; the tail is very villose or furry, and of a slightly spreading form, like that of a squirrel; the eyes are large and black; the ears thin, rounded, and very slightly haired. Sometimes the upper parts of the body have a slight dusky, and sometimes a ferruginous tinge. Its general manners resemble those of a squirrel, but it is not easily tamed. The young are produced about the middle of summer, and are four or five in number.

2. Myoxus nitella, garden dormouse. The garden dormouse is a native of the temperate and warmer regions of Europe and Asia, and is commonly found in gardens, feeding on various kinds of fruit, particularly peaches and apricots. It makes its nest, like the rest of this genus, in the hollows of trees, and sometimes in those of walls, or even in the ground about the roots of trees, &c. collecting, for this purpose, dried leaves, grass, mosses, &c. In autumn it collects a quantity of nuts, mast, &c. and deposits it in its hole; and during the greatest part of the winter remains in a state of torpidity, awaking only at distant intervals. Its general length is about four inches and a half, and the tail rather less. It is of an elegant rufous or ferruginous colour above, and yellowish white beneath; the eyes are imbedded in a large black patch or spot, which extends to some distance beyond each ear; the tail is somewhat wider towards the end, and sharpens at the extremity, and is marked on that part by a longitudinal black stripe, having the edges white. These animals produce their young about the middle of summer, which are about five or six in number, and are said to be of a very quick growth.

3. Myoxus muscardinus, common dormouse. The size of this animal is nearly equal to that of a mouse, but it is of a more plump or rounded form, and the nose is more obtuse in proportion; the eyes are large, black, and prominent; the ears broad, thin, and semitransparent; the fore-feet have four toes, and the hind-feet five, but the interior of these latter are destitute of nails; the tail is about two inches and a half long, and is closely covered on all sides with hair, which is rather longer towards the tip than on the other parts; the head, back, sides, belly, and tail, are of a tawny-red colour; the throat white; the fur is remarkably soft, and the whole animal has a considerable degree of elegance in its appearance. It sometimes happens that the colour is rather brown than reddish.

Dormice, says Mr. Pennant, inhabit woods or very thick hedges; forming their nests in the hollows of some low tree, or near the bottom of a close shrub. As they want much of the sprightliness of the squirrel, they never aspire to the tops of trees, or attempt to bound from spray to spray. Like the squirrel, they form little magazines of nuts, &c. for their winter provision, and take their food in the same upright posture. The consumption of their hoard during the rigour of winter is but small, for they sleep most part of the time, retiring into their holes on the approach of winter, and rolling themselves up, lie torpid during the greatest part of the gloomy season. Sometimes they experience a short revival in a warm sunny day; when they take a little food, and then relapse into their former state.

These animals seldom appear far from their retreats, or in any exposed situation; for which reason they seem less common in this country than they really are. They make their nest of grass, moss, and dead leaves. According to the count de Buffon, it consists of interwoven herbs, and is six inches in diameter, open only above, and is situated between the branches of hazel and brushwood. The number of young is generally three or four.

MYRICA, *Gale*, or *Sweet-willow*, a genus of the tetrandria order, in the diœcia class of plants; and in the natural method ranking under the 5th order, amentaceæ. The scale of the male catkin is in the form of a crescent, without any corolla. The scale of the female catkin the same: there is no corolla; but two styles, and a monospermous berry.

1. The gale, Dutch myrtle, or sweet-willow, grows naturally upon bogs in many places both of Scotland and England. It rises about four feet high. The female flowers or catkins are produced from the sides of the branches, growing upon separate plants from the male, which are succeeded by clusters of small berries, each having a small seed. It flowers in July, and ripens in autumn. When transplanted into shrubberies, the moistest parts must be assigned to it.

The leaves, flowers, and seeds of this plant, have a strong fragrant smell, and a bitter taste. They are said to be used among the common people for destroying moths and cutaneous insects, being accounted an enemy to insects of every kind; internally, in infusions, as a stomachic and vermifuge; and as a substitute to hops for preserving malt liquors, which they render more inebriating, and of consequence less salubrious; it is said that this quality is destroyed by boiling.

2. The cerifera, wax-bearing myrica, or candleberry myrtle, is a native of North America. It is a small tree, about 10 or 12 feet high, with crooked stems branching forth near the ground irregularly. The leaves grow irregularly on them all round; sometimes by pairs, sometimes alternately, but generally at unequal distances. The branches of the old plants shed their leaves in the autumn; but the young plants raised from seeds retain them the greatest part of the winter, so as during that season to have the appearance of an evergreen. But this beauty will not be lasting, for they shed their leaves proportionably earlier as the plants get older. There are both male and female trees of this sort: the flowers are small, of a whitish colour, and make no figure; neither does the fruit that succeeds the female (which is a small, dry, blue berry), though produced in clusters, make any shew: so that it is from the leaves this tree receives its beauty and value; for these being bruised, as well as the bark of the young shoots, emit the most refreshing and delightful fragrance, that is exceeded by no myrtle, or any other aromatic shrub. See Plate Nat. Hist. fig. 289.

There is a variety of this species of lower growth, with shorter but broader leaves, and of equal fragrance. This grows commonly in Carolina; where the inhabitants collect from its berries a wax of which they make candles, and which occasions its being called the candleberry tree. It delights in a moistish soil. The wax is procured in the following manner: In November and December, when the berries are ripe, a man with his family will remove from home to some island or sand-bank near the sea, where these trees most abound, taking with them kettles to boil the berries in. He builds a hut with palmetto-leaves for the shelter of himself and family during his residence there, which is commonly four or five weeks. The man cuts down the trees, while the children strip off the berries into a porridge-pot; and having put water to them, they boil them till the oil floats, which is then skimmed off into another vessel. This is repeated till no more oil appears. When cold, this hardens to the consistence of wax, and is of a dirty-green colour. They then boil it again, and clarify it in brass kettles; which gives it a transparent greenness. These candles burn a long time, and yield a grateful smell. They usually add a fourth part of tallow, which makes them burn clearer. There are seven other species.

MYRIOPHYLLUM, a genus of the polyandria order, in the monœcia class of plants; and in the natural method ranking under the 15th order, inundatæ. The male calyx is tetraphyllous; there is no corolla; the stamina are eight in number. The female calyx is tetraphyllous; the pistils four; there is no stile; and four naked seeds. There are two species, aquatics of Europe.

MYRISTICA, the nutmeg-tree; in botany, a genus of plants belonging to the class diœcia, and order syngenesia, and of the natural order lauri. The male calyx is monophyllous, strong, and parted into three laciniæ of an oval shape, and ending in a point: it has no corolla. In the middle of the receptacle rises a column of the height of the calyx; to the upper part of which the antheræ are attached. They vary in number from three to twelve or thirteen. The female calyx and corolla, as in the male, on a distinct tree. The germen of an oval shape; the style short, with a bifid stigma, the laciniæ of which are oval and spreading. The fruit is of that sort called drupa. It is fleshy, roundish, sometimes unilocular, sometimes bivalved, and when ripe bursts at the side. The seed is enveloped with a fleshy and fatty membraneous substance, which divides into filaments: this, in one of the species is the mace of the shops. The seed or nutmeg is round or oval-shaped, unilocular, and contains a small kernel, variegated on the surface by the fibres running in the form of a screw.

There are five species of this genus according to some authors; but several of these being only varieties, may be reduced to three, viz. 1. Myristica fatua, or wild nutmeg; this grows in Tobago, and rises to the height of an apple-tree; has oblong, lanceolated, downy leaves, and hairy fruit; the nutmeg of which is aromatic, but when given inwardly is narcotic, and occasions drunkenness, delirium, and madness for a time. 2. The myristica sebifera, a tree frequent in Guiana, rising to 40 or even to 60 feet high; on wounding the trunk of which, a thick, acrid, red juice runs out. Aublet says nothing of the nutmegs being aromatic; he only observes, that a yellow fat is obtained from them, which serves many economical and medical purposes, and that the natives make candles of it. 3. The mysteria aromatica, or nutmeg, attains the height of 30 feet, producing numerous branches, which rise together in stories, and covered with bark, which of the trunk is a reddish brown, but that of the young branches is of a bright green colour; the leaves are nearly elliptical, pointed, undulated, obliquely nerved, on the upper side of a bright green, on the under whitish, and stand alternately upon footstalks; the flowers are small, and hang upon slender peduncles, proceeding from the axillæ of the leaves: they are both male and female upon separate trees.

The nutmeg has been supposed to be the comacum of Theophrastus, but there seems little foundation for this opinion; nor can it with more probability be thought to be the chrysobalanos of Galen. Our first knowledge of it was evidently derived from the Arabians; by Avicenna it was called jiausiban, or jausiband, which signifies nut of Banda.

There are two kinds of nutmegs, the one male and the other female. The female is that in common use; the male is longer and more cylindric, but it has less of the fine aromatic flavour than the other. This is very subject to be worm-eaten, and by the Dutch it is strictly prohibited from being packed with the others, because it will give occasion to their being worm-eaten too, by the insects getting from one species to the other. An almost exclusive and very lucrative trade in nutmegs from the island of Ceylon was carried on by the Dutch, but it is now transferred to the English, who have become masters of the colony.

The seeds or kernels called nutmegs are well known, as they have been long used both for culinary and medical purposes. Distilled with water, they yield a large quantity of essential oil, resembling in flavour the spice itself; after the distillation, an insipid sebaceous matter is found swimming on the water; the decoction inspissated, gives an extract of an unctuous, very lightly bitterish taste, and with little or no astringency. Rectified spirit extracts the whole virtue of nutmegs by infusion, but elevates very little of it in distillation; hence the spirituous extract possesses the flavour of the spice in an eminent degree.

Nutmegs, when heated, yield to the press a considerable quantity of limpid yellow oil, which on cooling concretes into a sebaceous consistence. In the shops we meet with three sorts of unctuous substances, called oil of mace, though really expressed from the nutmeg. The best is brought from the East Indies in stone jars; this is of a thick consistence, of the colour of mace, and has an agreeable fragrant smell; the second sort, which is paler-coloured, and much inferior in quality, comes from Holland in solid masses, generally flat, and of a square figure: the third, which is the worst of all, and usually called common oil of mace, is an artificial composition of sevum, palm oil, and the like, flavoured with a little genuine oil of nutmeg.

Method of gathering and preparing nutmegs.—When the fruit is ripe, the natives ascend the trees, and gather it by pulling the branches to them with long hooks. Some are employed in opening them immediately, and in taking off the green shell or first rind, which is laid together in a heap in the woods, where in time it putrefies. As soon as the putrefaction has taken place, there spring up a kind of mushrooms, called boleti moschatyni, of a blackish colour, and much valued by the natives, who consider them as delicate eating. When the nuts are stripped of their first rind, they are carried home, and the mace is carefully taken off with a small knife. The mace, which is of a beautiful red, but afterwards assumes a darkish red colour, is laid to dry in the sun for the space of a day, and is then removed to a place less exposed to his rays, where it remains for eight days that it may soften a little. They afterwards moisten it with sea-water, to prevent it from drying too much, or from losing its oil. They are careful, however, not to employ too much water, lest it should become putrid, and be devoured by the worms. It is last of all put into small bags, and squeezed very close.

The nuts, which are still covered with their ligneous shell, are for three days exposed to the sun, and afterwards dried before a fire, till they emit a sound, when they are shaken; they then beat them with small sticks in order to remove their shell, which flies off in pieces. These nuts are distributed into three parcels; the first of which contains the largest and most beautiful, which are destined to be brought to Europe; the second contains such as are reserved for the use of the inhabitants; and the third contains the smallest, which are irregular or unripe. These are burnt; and part of the rest is employed for procuring oil by pressure. A pound of them commonly gives three ounces of oil, which has the consistence of tallow, and has entirely the taste of nutmeg. Both the nut and mace, when distilled, afford an essential, transparent, and volatile oil, of an excellent flavour.

The nutmegs which have been thus selected, would soon corrupt if they were not watered, or rather pickled, with lime-water made from calcined shell-fish, which they dilute with salt water till it attains the consistence of fluid pap. Into this mixture they plunge the nutmegs, contained in small baskets, two or three times, till they are completely covered over with the liquor. They are afterwards laid in a heap, where they heat, and lose their superfluous moisture by evaporation. When they have sweated sufficiently, they are then properly prepared, and fit for a sea-voyage.

The medicinal qualities of nutmeg are supposed to be aromatic, anodyne, stomachic, and astringent; and with a view to the last mentioned effects, it has been much used in diarrhœas and dysenteries. To many people the aromatic flavour of nutmeg is very agreeable; they however should be cautious not to use it in large quantities, as it is apt to affect the head, and even to manifest an hypnotic power in such a degree as to prove extremely dangerous. Bontius speaks of this as a frequent occurrence in India; and Dr. Cullen relates a remarkable instance of this soporific effect of the nutmeg, which fell under his own observation, and hence concludes, that in apoplectic and paralytic cases this spice may be very improper. He observes that a person by mistake took two drams or a little more of powdered nutmeg; he felt it warm in his stomach, without any uneasiness; but in about an hour after he had taken it he was seized with a drowsiness, which gradually increased to a complete stupor and insensibility; and not long after he was found fallen from his chair, lying on the floor of his chamber in the state mentioned. Being laid abed he fell asleep; but waking a little from time to time, he was quite delirious; and he thus continued alternately sleeping and delirious for several hours. By degrees, however, both these symptoms diminished; so that in about six hours from the time of taking the nutmeg he was pretty well recovered from both. Although he still complained of head-ache, and some drowsiness, he slept naturally and quietly the following night, and next day was quite in his ordinary health.

The officinal preparations of nutmeg are, a spirit and essential oil; and the nutmeg in substance roasted, to render it more astringent. Both the spice itself and its essential oil enter several compositions, as the confectio aromatica, spiritus ammoniæ, com.,&c. Mace possesses qualities similar to those of the nutmeg, but is less astringent, and its oil is supposed to be more volatile and acrid.

MYRMECIA, a genus of the class and order tetrandria monogynia; the calyx is tubular, five-toothed; cor. one-petalled; germ five glands at the base; stigma bilamelate; caps. two-valved. There is one species, a shrub of Guiana.

MYRMECOPHAGA, Ant-eater, a genus of quadrupeds of the order bruta. The generic character is, teeth none; tongue cylindric, extensile; mouth lengthened into a somewhat tubular form; body covered with hair. The animals of this genus live entirely on insects, more particularly on the various kinds of ants; in order to obtain which, they extend their tongue, which is of a very great length, and of a roundish or worm-like form, into the nests of those insects; and when, by means of the viscid moisture with which it is covered, a sufficient number are secured, they retract it suddenly into the mouth, and swallow them. A part of the generic character of the myrmecophaga is the total want of teeth, in which particularity it resembles no other animals except those of the genus manis, in which the same circumstance takes place. There are, however, in the ant-eaters, according to the observations of Mons. Broussonet, certain bones or processes not unlike teeth, situated deep at the entrance of the gullet or œsophagus; or rather, according to the celebrated Camper, at the lower end of the jaws. The species of ant-eaters are not numerous.

1. Myrmecophaga jubata, great ant-eater. This is by far the largest of the ant-eaters, being upwards of seven feet in length, from the tip of the nose to the end of the tail; but if measured to the origin of the tail, it is no more than about five feet and a half. It is an animal of an uncouth appearance; the head is small; the snout very long; the eyes small; the ears short and round; the shoulders thick and muscular, from whence the body tapers towards the tail; but the thighs are thick and stout; the colour of the animal is a deep grey, with a very broad band of black running from the neck downwards on each side the body, growing gradually narrower as it passes down; this black band is accompanied on the upper part by a streak of white; the fore legs are of a lighter cast than the hinder; and have a patch or spot of black in front not much above the foot; the tail is black, extremely long and bushy; the hair on the whole body, but especially on the tail, is very harsh and coarse: there are four toes on the fore-feet, and five on the hind: the two middle claws of the fore feet are extremely large and strong; which render this creature, though destitute of teeth, a very formidable adversary; since it has been known to destroy animals of much greater apparent strength than itself; fixing its claws upon them, and exerting such powerful strength as to kill them by continued laceration and pressure. It is a native of Brasil and Guiana; it is chiefly a nocturnal animal, and is said to sleep during the greatest part of the day in retired places. Its pace is somewhat slow, and its manners dull and heavy. It is said to swim with ease; at which time it flings its tail over its back. A living specimen was some years ago brought into Spain, and kept in the royal menagerie at Madrid; in this state of confinement it would readily eat raw meat cut small, and was said to swallow four or five pounds in a day. Its length was six feet, from the nose to the end of the tail, and its height was two feet.

2. Myrmecophaga didactyla, little ant-eater. This is an animal of great elegance. It is not superior in size to a squirrel; measuring little more than seven inches from the nose to the tail, which is longer than the body and head: the head is small; the snout sharpened, and slightly bent downwards; the legs are short; the fore feet have only two claws on each, the exterior one much larger and stronger than the interior; on each of the hind feet are four claws of moderate size; the ears are very small, and hid in the fur; the eyes are also small. The whole animal is covered with a beautiful soft, and somewhat crisped or curled fur, of a pale yellow colour, or rather yellow-brown; the tail, which is very thick at the beginning or base, gradually tapers to the tip; and the lower surface, for about the space of four inches from the tip, is bare; the tail in this species being prehensile, and the animal commonly residing on trees, and preying on ants, by means of its long tongue, in the manner of other species. It is a native of Guiana. See Plate Nat. Hist. fig. 290.

3. Myrmecophaga aculeata, aculeated ant-eater. The aculeated ant-eater is one of those curious animals which have been lately discovered in the vast island, or rather continent, of Australasia or New Holland; and is a striking instance of that beautiful gradation, so frequently observed in the animal kingdom, by which creatures of one tribe or genus approach to those of a very different one. It forms a connecting link between the very distant Linnæan genera of hystrix (porcupine) and myrmecophaga (ant-eater), having the external coating and general appearance of the one, with the mouth and peculiar generic characters of the other. This animal, so far as may be judged from the specimens hitherto imported, is about a foot in length.

In its mode of life this animal resembles the rest of the ant-eaters, being generally found in the midst of some large ant-hill: it burrows with great strength and celerity under ground, when disturbed; its feet and legs being most excessively strong and short, and wonderfully adapted to this purpose. It will even burrow under a pretty strong pavement, removing the stones with its claws; or under the bottom of a wall. During these exertions, its body is strengthened or lengthened to an uncommon degree, and appears very different from the short or plump aspect which it bears in its undisturbed state.

It cannot escape the observation of every scientific naturalist, that, in consequence of the discovery of this curious animal, the Linnæan character of myrmecophaga is, in part, rendered inapplicable. Since, therefore, the genera of manis and myrmecophaga differ only in the external covering (the former being coated with scales, and the latter with hair), it would, perhaps, be not improper to conjoin the two genera, to add this as a new species, and to give as part of the generic character, corpus pilis, squamis, vel aculeis tectum. Or it might even constitute a new genus, which would differ from those of manis and myrmecophaga, in having the body covered with spines.

MYRMELEON, a genus of insects of the order neuroptera: the generic character is, mouth furnished with jaws, teeth two; feelers four, elongated; stemmata none; antennæ clavated, of the length of the thorax; wings deflected; tail of the male furnished with a forceps consisting of two straightish filaments. Of this genus the species whose history is best understood is the myrmeleon formicaleo of Linnæus, whose larva has long been celebrated by naturalists for its wonderful ingenuity, in preparing a kind of pitfal or deceptive cavity for the destruction of such insects as happen unwarily to enter it. The myrmeleon formicaleo, in its complete or fly state, bears no inconsiderable resemblance to a small dragon-fly, from which, however, it may readily be distinguished by its antennæ. It is of a predacious nature, flying chiefly by night, and pursuing the smaller insects in the manner of a libellula. It deposits its eggs in dry sandy situations; and the young larvæ, when hatched, begin separately to exercise their talent of preparing, by turning themselves rapidly round, a very small conical cavity in the sand. Under the centre of the cavity the little animal conceals itself, suddenly rushing forth at intervals in order to seize any small insect which, by approaching the edge of the cavity, has been so unfortunate as to fall in; and after sucking out its juices through its tubular forceps, throws it by a sudden exertion to some distance from the cavity. As the creature increases in size it enlarges the cavity, which at length becomes about two inches or more in diameter. The larva, when full-grown, is more than half an inch long, and is of a flattened figure, broad towards the upper part, and gradually tapering to an obtuse point at the extremity. It is of a brown colour, and beset with numerous tufts of dusky hair, which are particularly conspicuous on each side the annuli of the abdomen; the legs are slender; the head and thorax rather small; the tubular jaws long, curved, serrated internally, and very sharp-pointed. The whole animal is of an unpleasing aspect, and on a cursory view bears a general resemblance to a flat-bodied spider. When magnified, its appearance is highly uncouth.

The ingenious Reaumur and Roësel have given accurate descriptions of this larva and its extraordinary history. It is one of those whose term of life, like that of the libellulæ and ephemeræ, is protracted to a very considerable space, since it survives the first winter in its larva state, taking no nourishment during that time, and in the spring resumes its usual manner of preying. In preparing its pit, it begins by tracing an exterior circle of the intended diameter of the cavity, continuing its motion, in a spiral line, till it gets to the centre, thus marking several volutes in the sand, resembling the impression of a large helix or snail-shell; and after having sufficiently deepened the cavity by a repetition of this motion, it smooths the sides into a regular shape by throwing out the superfluous sand lying on the ridges; this it does by closing its forceps in such a manner, that together with the head, they form a convenient shovel, with which it throws the sand with so strong a motion out of the cavity, that the grains often fall to the distance of near a foot beyond the brink. The depth of the pit is generally equal to the diameter. When full-grown and ready to change into a chrysalis, the animal envelopes itself in a round ball of sand, agglutinated and connected by very fine silk, which it draws from a tubular process at the extremity of the body; with this silk it also lines the internal surface of the ball, which, if opened, appears coated by a fine pearl-coloured silken tissue. It continues in the state of chrysalis about four weeks, and then gives birth to the complete insect.

The myrmeleon barbarus has antennæ as long as the body; thorax spotted with yellow. See Plate Nat. Hist. fig. 291.

MYROBALANS, a kind of medicinal fruit brought from the Indies. See MATERIA MEDICA.

MYRODENDRUM, a genus of the class and order polyandria monogynia. The cor. is five-petalled; stigma, capitate, five-lobed; per. five-celled. There is one species, a tree of Guiana.

MYRODIA, a genus of the monadelphia polyandria class and order; the calyx is single, one-leafed; cor. five-petalled; pist. one column of anthers undivided, drupe dry, two nuts. There are two species, shrubs of the West Indies.

MYROSMA, a genus of the monandria monogynia class and order; the cal. is double, outer three-leaved, inner three-parted; cor. five-parted: caps. three-cornered. There is one species, a shrub of Surinam.

MYROXYLUM, a genus of the monogynia order, in the decandria class of plants. The calyx is campanulated; the superior petal larger than the rest; the germ. is longer than the corolla; the legumen monospermous. There is but one species, the peruiferum, a native of Peru and the warmer parts of Africa. It is this shrub that yields the balsam of Peru, which is said to be extracted from it by coction in water. This balsam, as brought to us, is nearly of the consistence of thin honey, of a reddish brown colour inclining to black, an agreeable aromatic smell, and a very hot biting taste. Distilled with water, it yields a small quantity of a fragrant essential oil of a reddish colour; and in a strong fire, without addition, a yellowish red oil. Balsam of Peru is a very warm aromatic medicine, considerably hotter and more acrid than copaiva. (See BALSAM.) Its principal effects are to warm the habit, to strengthen the nervous system, and attenuate viscid humours. Hence its use in some kinds of asthmas, gonorrhœas, dysenteries, and other disorders proceeding from a debility of the solids, or sluggishness and inactivity of the juices. It is also employed externally, for cleansing and healing wounds and ulcers, and sometimes against palsies and rheumatic pains. There is another sort of balsam of Peru of a white colour, and considerably more fragrant than the former. This is very rarely brought to us. It is said to be the produce of the same plant which yields the common or black balsam; and to exsude from incisions made in the trunk, while the former is obtained by boiling. There is also a third kind, commonly called the red or dry. This is supposed to obtain a different state from the white, merely in consequence of the treatment to which it is subjected after it is got from the tree. It is almost as fragrant as the balsam of Gilead, held in so high esteem among the Eastern nations. It is very rarely in use in Britain, and almost never to be met with in our shops.

MYRRH, a gummy resinous concrete juice. The plant from which this substance is obtained, is not certainly known. According to Bruce, it belongs to the genus mimosa, and grows in Abyssinia and Arabia. It is in the form of tears. Colour reddish-yellow, sometimes transparent, but more frequently opaque. Taste brittle and aromatic. Does not melt when heated, and burns with difficulty. With water it forms a yellow solution. The solution in alcohol becomes opaque when mixed with water. By distillation it yields oil. Its specific gravity is 1.36. It is employed in medicine, and is soluble in alkalies.

The medical effects of this aromatic bitter are, to warm and strengthen the viscera; it frequently occasions a mild diaphoresis, and promotes the fluid secretions in general. Hence it proves serviceable in languid cases, diseases arising from a simple inactivity, cachectic disorders, and where the lungs and thorax are oppressed by viscid phlegm.

Rectified spirit extracts the fine aromatic flavour and bitterness of this drug, and does not elevate any thing of either in evaporation; the gummy substance left by this menstruum has a disagreeable taste, with scarcely any of the peculiar flavour of the myrrh; this part dissolves in water, except some impurities which remain. In distillation with water, a considerable quantity of a ponderous essential oil arises, resembling in flavour the original drug. Myrrh is the basis of an officinal tincture. It enters the pilulæ ex aloe et myrrha, the pilulæ e gummi, the pilulæ stomachicæ, and other formulæ.

MYRSINE, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 18th order, bicornes. The corolla is semiquinquefid and connivent; the germen filling the corolla; the berry quinquelocular and pentaspermous. There are two species, herbs of the Cape.

MYRTLE. See MYRTUS.

MYRTUS, the myrtle; a genus of the monogynia order, in the icosandria class of plants; and in the natural method ranking under the 19th order, hesperidæ. The calyx is quinquefid, superior; there are five petals; the berry is dispermous or trispermous. There are 36 species, of which the most remarkable are:

1. The communis, or common myrtle-tree, of which the most material varieties are: broad-leaved Roman myrtle, with oval, shining, green leaves, an inch and a half long, and one broad; and which is remarkably floriferous. Gold-striped broad-leaved Roman myrtle. Broad-leaved Dutch myrtle, with spear-shaped, sharp-pointed, dark-green leaves, an inch long, and about three quarters of one broad. Double-flowered Dutch myrtle. Broad-leaved Jew's myrtle, having the leaves placed by threes at each joint; by which particular circumstance this species is in universal estimation among the Jews in their religious ceremonies, particularly in decorating their tabernacles; and for which purpose many gardeners about London cultivate this variety with particular care to sell to the above people: for the true sort, having the leaves exactly by threes, is very scarce, and is a curiosity; but by care in its propagation, taking only the perfectly ternate-leaved shoots for cuttings, it may be increased fast enough; and is worth the attention of the curious, and particularly those who raise myrtles for the London markets. Orange-leaved Spanish myrtle, with oval spear-shaped leaves, an inch and a half long or more, and one broad, in clusters round the branches, and resembling the shape and colour of orange-tree leaves. Gold-striped-leaved orange myrtle. Common upright Italian myrtle, with its branches and leaves growing more erect, the leaves oval, lanceolate-shaped, acute-pointed, and near an inch long and half one broad. Silver-striped upright Italian myrtle. White-berried upright Italian myrtle. Portugal acute-leaved myrtle, with spear-shaped, oval, acute-pointed leaves, about an inch long. Box-leaved myrtle, with weak branches, and small, oval, obtuse, lucid-green, closely-placed leaves. Striped box-leaved myrtle. Rosemary-leaved myrtle. Silver-striped rosemary-leaved myrtle. Thyme-leaved myrtle, with very small closely-placed leaves. Nutmeg-myrtle, with erect branches and leaves; the leaves oval, acute-pointed, and finely scented like a nutmeg. Broad-leaved nutmeg-myrtle. Silver-striped-leaved ditto. Cristated or cock's-comb myrtle, frequently called bird's-nest myrtle. These are all beautiful evergreen shrubs, of exceeding fragrance, exotics originally of the southern parts of Europe, and of Asia and Africa, and consequently in this country require a shelter of a greenhouse in winter.

2. The pimenta, pimento, Jamaica pepper, or allspice tree, grows about 30 feet in height and two in circumference; the branches near the top are much divided and thickly beset with leaves, which by their continual verdure always give the tree a beautiful appearance; the bark is very smooth externally, and of a grey colour; the leaves vary in shape and in size, but are commonly about four inches long, veined, pointed, elliptical, and of a deep shining green colour; the flowers are produced in bunches or panicles, and stand upon subdividing or trichotomous stalks, which usually terminate the branches; the calyx is cut into four roundish segments; the petals are also four, white, small, reflex, oval, and placed opposite to each other between the segments of the calyx; the filaments are numerous, longer than the petals, spreading, of a greenish-white colour, and rise from the calyx and upper part of the germen; the antheræ are roundish, and of a pale yellow colour; the style is smooth, simple, and erect; the stigma is obtuse; the germen becomes a round succulent berry, containing two kidney-shaped flattish seeds. This tree is a native of New Spain and the West India islands. In Jamaica it grows very plentifully; and in June, July, and August, puts forth its flowers, which, with every part of the tree, breathe an aromatic fragrance. The berries when ripe are of a dark purple colour, and full of a sweet pulp, which the birds devour greedily. The pimento is a most beautiful odoriferous evergreen, and exhibits a fine variety in the stove at all seasons.

MYTILUS, the *mussel*, a genus of animals belonging to the order of vermes testacei. The animal is an ascidia; the shell bivalve, often affixed to some substance by a beard; the hinge without a tooth, marked by a longitudinal hollow line. Of these animals there are a great many species, some of them inhabiting the seas, others the rivers and ponds. Several of them are remarkable for the beauty of their internal shell, and for the pearls which are sometimes found in them.

1. The edulis, or edible mussel, has a strong shell, slightly incurvated on one side, and angulated on the other. The end near the hinge is pointed, the other rounded. When the epidermis is taken off it is of a deep-blue colour. It is found in immense beds, both in deep water and above low-water mark. This species inhabits the European and Indian seas. Between the tropics it is largest, and smaller within the polar circle. It is said to be hurtful if too often eaten, or in too great quantities.

2. The anatinus, or duck mussel, has a shell more oblong and less convex than the last; is very brittle and semitransparent; the space round the hinges like the last; the length about five inches, breadth two. It is found in Europe in fresh waters. Both it and the cygneus are devoured by swans and ducks, whence their names: crows also feed on these mussels, as well as on different other shell-fish; and it is diverting to observe, that when the shell is too hard for their bills they fly with it to a great height, drop the shell on a rock, and pick out the meat when the shell is fractured by the fall.

3. The violacea, or violet mussel, has the shell longitudinally furrowed, the rim very obtuse, somewhat formed like the mytilus edulis, but considerably larger and more flattened, of a beautiful violet-colour. Inhabits the southern ocean.

4. The margarite ferus produces the true mother-of-pearl, and frequently the most valuable pearls: the outside sometimes sea-green, or chesnut, or bloom-colour with white rays; when the outer coat is removed it has the same lustre as the inside: the younger shells have ears as long as the shell, and resemble scallops.

There are between 50 and 60 other species.

Mussels not only open and shut their shells at pleasure, but they have also a progressive motion; they can fasten themselves where they please; they respire water like the fishes; and some even flutter about on its surface so as to inhale air. If they lie in shallow places a small circular motion is seen above the heel of the shell, and a few moments after they cast out the water by one single stroke at the other end of the shell. The mouth is situated near the sharp angle of the animal; and is furnished with four floating fringes in the shape of mustachios, which may perhaps answer the purpose of lips. The barbs which surround the edge of almost half the mussel, are a wonderful web of hollow fibres which serve as fins or organs of respiration, as vessels for the circulation of the fluids; and probably, as some philosophers suppose, as wedges for opening their shells; for we observe two large muscles or tendons for the purpose of shutting them; but we in vain look for their antagonists, or those which are destined to open them. When the mussel wishes to open itself, it relaxes the two muscles or tendons, and swells the fringes, which act as wedges, and separate the shells. The animal shuts up itself by the contraction of two thick fibrous muscles, which are fixed internally to each end of the shells; and these shells are lined all round with a membrane or epidermis, which unites them so closely together when they are soaked in water, that not the smallest drop can escape from the mussel. When mussels choose to walk they often contrive to raise themselves on the sharp edge of their shells, and put forth a fleshy substance susceptible of extension, which serves them as a leg to drag themselves along, in a kind of groove or furrow which they form in the sand or mud, and which supports the shell on both sides. In ponds these furrows are very observable. From the same member or leg hang the threads by which the animals fasten themselves to rocks, or to one another.

According to the observations of M. Mery, of the Paris academy, and the subsequent experiments of other naturalists, mussels are all androgynous; and, from a peculiar generative organization, each individual is of itself capable of propagating its species, and annually does it without the intercourse of any other. This is altogether singular, and different from what takes place in snails, earthworms, and other androgenous or hermaphroditical animals. In the spring, mussels lay their eggs; there being none found in them but in winter. The minute eggs, or embryos, are by the parent placed in due order, and in a very close arrangement, on the outside of the shell; where, by means of a gluey matter, they adhere very fast, and continually increase in size and strength, till becoming perfect mussels, they fall off and shift for themselves, leaving the holes where they were placed behind them. This abundance the mussel-shells very plainly show, when examined by the microscope, and sometimes the number is 2000 or 3000 on one shell; but it is not certain that these have been all fixed there by the mussel within;

for these fish usually lying in great numbers near one another, the embryos of one are often affixed to the shell of another. The fringed edge of the mussel, which Lewenhoeck calls the beard, has in every the minutest part of it such variety of motions as is inconceivable; for being composed of longish fibres, each fibre has on both sides a vast many moving particles.

The mussel is infested by several enemies in its own element; according to Reaumur it is in particular the prey of a small shell-fish of the trochus kind. This animal attaches itself to the shell of the mussel, pierces it with a round hole, and introduces a sort of tube, five or six lines long, which it turns in a spiral direction, and with which it sucks the substance of the mussel. Mussels are also subject to certain diseases, which have been supposed to be the cause of those bad effects which sometimes happen from the eating of them.

MYXINE, the hag; a genus of insects belonging to the order of vermes intestini. It has a slender body, carinated beneath; mouth at the extremity, cirrated; the two jaws pinnated; an adipose or rayless fin round the tail and under the belly. The only remarkable species is the glutinosa, about eight inches long. It inhabits the ocean; enters the mouths of fish when on the hooks of lines that remain a tide under water; and totally devours the whole, except the skin and bones. The Scarborough fishermen often take it in the robbed fish, on drawing up their lines. Linnæus attributes to it the property of turning water into gube.

N

N, or n, the thirteenth letter of our alphabet; as a numeral stands for 900; and with a dash over it, thus N̄, for 900,000. N, or N°, stands for numero, *i. e.* in number; and N. B. for nota bene, note well, or observe well. Among the antient Romans, N. denotes Nepos, Nonnius, &c. N. C. Nero Cæsar, or Nero Claudius; N. L. Non liquet; N. P. Notarius Publicus; and NBL. stands for nobilis.

NADIR, in astronomy, that point of the heavens which is diametrically opposite to the zenith, or point directly over our heads.

NAIAS: a genus of the monandria order, in the diœcia class of plants; and in the natural method ranking with those of which the order is doubtful. The male calyx is cylindrical and bifid; the corolla quadrifid; there is no filament, nor is there any female calyx or corolla; there is one pistil, and the capsule is ovate and unilocular. There is one species, an aquatic of the South of Europe.

NAIL, *unguis.* See Anatomy, and Horn.

NAILS, in building, &c. small spikes of iron, brass, &c. which being driven into wood, serve to bind several pieces together, or to fasten something upon them. The several sorts of nails are very numerous: as, 1. back and bottom nails, which are made with flat shanks to hold fast, and not open the wood. 2. Clamp-nails, for fastening the clamps in buildings, &c. 3. Clasp-nails, whose heads clasping and sticking into the wood, render the work smooth, so as to admit a plane over it. 4. Clench-nails, used by boat- and barge-builders, and proper for any boarded-buildings that are to be taken down; because they will drive without splitting the wood, and draw without breaking; of this there are many sorts. 5. Clout-nails, used for nailing on clouts to axle-trees. 6. Deck-nails, for fastening of decks in ships, doubling of shipping, and floors laid with planks. 7. Dog-nails, for fastening hinges on doors, &c. 8. Flat-points, much used in shipping, and proper where there is occasion to draw and hold fast, and no conveniency of clenching. 9. Jobent-nails, for nailing thin plates of iron to wood, as small hinges on cupboard-doors, &c. 10. Lead-nails, for nailing lead, leather, and canvas, to hard wood. 11. Port-nails, for nailing hinges to the ports of ships. 12. Pound-nails, which are four square, and are much used in Essex, Norfolk, and Suffolk, and scarcely any where else, except for pailing. 13. Ribbing-nails, principally used in ship-building, for fastening the ribs of ships in their places. 14. Rose-nails, which are drawn four-square in the shank, and commonly in a round tool, as all common twopenny nails are; in some countries all the larger sort of nails are made of this shape. 15. Rother-nails, which have a full head, and are chiefly used in fastening rother-irons to ships. 16. Round-head nails, for fastening on hinges, or for any other use where a neat head is required; these are of several sorts. 17. Scupper-nails, which have a broad head, and are used for fastening leather and canvas to wood. 18. Sharp nails; these have sharp points and flat shanks, and are much used, especially in the West Indies, for nailing soft wood. 19. Sheathing-nails, for fastening sheathing-boards to ships. 20. Square nails, which are used for hard wood, and nailing up wall-fruit. 21. Tacks, the smallest of which serve to fasten paper to wood, the middling for wool-cards, &c. and the larger for upholsterers and pumps.

Nails are said to be toughened when too brittle, by heating them in a fire-shovel, and putting some tallow or grease among them.

Nail, is also a measure of length, containing the sixteenth part of a yard.

NAIS, a genus of the vermes mollusca; the generic character is, body creeping, long, linear, pellucid, depressed; peduncles or feet with small bristles on each side. There are ten species: the digitata is found with single lateral bristles, tail laciniate, in stagnant waters, or the sandy sediment of rivers, with its head attached to the stalk of aquatic plants; it is about 4 lines long.

NAMA, a genus of the digynia order, in the pentandria class of plants: and, in the natural method, ranking under the 13th order, succulentæ. The calyx is pentaphyllous, the corolla quinquepartite, the capsule unilocular and bivalved. There is one species, an annual of Jamaica.

NANDINA, a genus of the class and order hexandria monogynia. The calyx is many-leaved, imbricate; corolla six-petalled. There is one species, a herb of Japan.

NAPÆA, a genus of the polyandria order, in the polyadelphia class of plants; and in the natural method ranking under the 37th order, columniferæ. The calyx is single and cylindric; the arilli coalited and monospermous. There are two species; both of them with perennial roots. Both of them are natives of Virginia and other parts of North America; from the bark of some of the Indian kinds a sort of fine hemp might be procured, capable being woven into very strong cloth. They are easily propagated by seed, which will thrive in any situation.

NAPTHA a name given to the most liquid bitumen; it is light, transparent, and very inflammable. There are several varieties, found chiefly in Italy, and particularly near Modena. Kempfer, however, says, that great quantities are collected in several parts of Persia; naturalists attribute the formation of the liquid bitumens to the decomposition of those that are solid, by the action of the subterraneous fires. Naptha is said to be the lightest, which the fire first disengages: naptha is very volatile, and so combustible, that it catches fire, if any thing burning be brought near it. In Persia, this and the other bitumens are employed for the purpose of giving light in lamps by means of wicks; they may be used also to give heat; for this purpose some naptha is poured on a few handfuls of earth, and kindled with paper, when it burns briskly, but diffuses a thick smoke, which adheres to every thing, and leaves a disagreeable smell. In India, the flame produced by it is worshipped, and the heat it emits is used for dressing victuals; and in some cases it has been successfully employed in paralytic diseases. See Bitumen.

NARCISSUS, a genus of the monogynia order, in the hexandria class of plants; and in the natural method ranking under the 9th order, spathaceæ. There are six petals; the nectarium is funnel-shaped and monophyllous; the stamina are within the nectarium. There are 15 species; the most remarkable are:

1. The bastard narcissus, or common yellow English daffodil, grows wild in great plenty in many of our woods and coppices, and under hedges, in several parts of England. Its commonness renders it of but

little esteem with many; considered, however, as an early and elegant flower, of exceeding hardiness and easy culture, it merits a place in every garden, especially the double.

2. The bicolor, or two-coloured incomparable narcissus; the varieties are, common single-flowered, semi-double-flowered, with the interior petals some white, and some yellow, with sulphur-coloured flowers.

3. The poeticus, poetic daffodil, or common white narcissus, is well known. Of this there are varieties with purple-cupped flowers, yellow-cupped flowers, double-flowered; all of them with entire white petals. It is the antient celebrated narcissus of the Greek and Roman poets, which they so greatly extol for its extreme beauty and fragrance.

4. The bulbocodium. From the large spreading nectarium of this species, which is three or four times longer than the petals, narrow at bottom, and widening gradually to the brim, so as to resemble the shape of some old-fashioned hoop petticoats, it obtained the name hoop-petticoat narcissus.

5. The serotinus, or late-flowering small autumnal narcissus.

6. The tazetta, or multiflorous daffodil, commonly called polyanthus narcissus. The varieties of this are very numerous, consisting of about eight or nine principal sorts; each of which has many intermediate varieties, amounting in the whole to greatly above a hundred in the Dutch florists' catalogues, each variety distinguished by a name according to the fancy of the first raiser of it. They are all very pretty flowers, and make a charming appearance in the flower-borders, &c.; they are also finely adapted for blowing in glasses of water, or in pots, to ornament rooms in winter.

7. The jonquila, or jonquil, sometimes called rush-leaved daffodil. The varieties are, jonquil minor with single flowers; jonquil major with single flowers, starry-flowered, yellow and white flowered, white-flowered, semi-double-flowered, double-flowered, and large double inodorous jonquil; all of them multiflorous, the single in particular; but sometimes the doubles produce only two or three flowers from a spatha, and the singles commonly six or eight. All the sorts have so fine a shape, so soft a colour, and so sweet a scent, that they are among the most agreeable spring-flowers.

8. The calathinus, or multiflorous yellow narcissus.

9. The odorus, odoriferous, or sweet-scented starry-yellow narcissus.

10. The triandrus, or triandrous rush-leaved white narcissus.

11. The trilobus, or trilobate yellow narcissus.

12. The minor, or yellow winter daffodil.

NARCOTICS, in medicine, soporiferous medicines, which excite a stupefaction. See the next article.

NARCOTIC Principle. It has been long known that the milky juices which exude from certain plants, as the poppy, lettuce, &c. and the infusions of others, as of the leaves of the digitalis purpurea, have the property of exciting sleep, or, if taken in doses large enough, of inducing a state resembling apoplexy, and terminating in death. How far these plants owe these properties to certain common principles which they possess, is not known, though it is exceedingly probable that they do. But as a peculiar substance has been detected in opium, the most noted of the narcotic preparations, which possesses narcotic properties in perfection, we are warranted, till further experiments elucidate the subject, to consider it as the narcotic principle, or at least as one species of the substances belonging to this genus.

Opium is obtained from the papaver album, or white poppy, a plant which is cultivated in great abundance in India and the East. The poppies are planted in a fertile soil, and well watered. After the flowering is over, and the seed-capsules have attained nearly their full size, a longitudinal incision is made in them about sun-set for three or four evenings in succession. From these incisions there flows a milky juice, which soon concretes, and is scraped off the plant and wrought into cakes. In this state it is brought to Europe.

Opium thus prepared is a tough brown substance, has a peculiar smell, and a nauseous bitter acrid taste. It becomes softer when held in the warm hand, and burns very readily and strongly. It is a very compound substance, containing sulphat of lime, sulphat of potass, an oil, a resinous body, an extractive matter, gluten, mucilage, &c. besides the peculiar narcotic principle to which probably it owes its virtues as a narcotic.

When water is digested upon opium, a considerable portion of it is dissolved, the water taking up several of its constituents. When this solution is evaporated to the consistence of a syrup, a gritty precipitate begins to appear, which is considerably increased by diluting the liquid with water. It consists chiefly of three ingredients; namely, resin, oxygenized attractive, and the peculiar narcotic principle which is crystallized. When alcohol is digested on this precipitate, the resin and narcotic substances are taken up, while the oxygenised extractive remains behind. The narcotic principle falls down in crystals as the solution cools, still however coloured with resin. But it may be obtained tolerably pure by repeated solutions and crystallizations.

Water is incapable of dissolving the whole of opium. What remains behind still contains a considerable portion of narcotic principle. When alcohol is digested on this residuum, it acquires a deep red colour; and deposits, on cooling, crystals of narcotic principle, coloured by resin, which may be purified by repeated crystallizations. The narcotic principle obtained by either of these methods possesses the following properties:

Its colour is white. It crystallizes in rectangular prisms with rhomboidal bases. It has neither taste nor smell.

It is insoluble in cold water, soluble in about 400 parts of boiling water, but precipitates again as the solution cools. The solution in boiling water does not affect vegetable blues.

It is soluble in 24 parts of boiling alcohol and 100 parts of cold alcohol. When water is mixed with the solution, the narcotic principle precipitates in the state of a white powder.

Hot ether dissolves it, but lets it fall on cooling.

When heated in a spoon it melts like wax. When distilled it froths, and emits white vapours, which condense into a yellow oil. Some water and carbonat of ammonia pass into the receiver; and at last carbonic acid gas, ammonia, and carbureted hydrogen gas, are disengaged. There remains a bulky coal, which yields traces of potass. The oil obtained by this process is viscid, and has a peculiar aromatic smell and an acrid taste.

It is very soluble in all acids. Alkalies throw it down from these solutions in the state of a white powder.

Alkalies render it rather more soluble in water. When they are saturated with acids, the narcotic principle falls down in the state of a white powder, which is redissolved by adding an excess of acid.

Volatile oils, while hot, dissolve it; but, on cooling, they let it fall in an oleaginous state at first, but it gradually crystallizes.

When treated with nitric acid, it becomes red and dissolves; much oxalic acid is formed, and a bitter substance remains behind.

When potass is added to the aqueous solution of opium, the narcotic principle is thrown down; but it retains a portion of the potass.

Its solubility in water and alcohol, when immediately extracted from opium, seems to be owing to the presence of resin and extractive matter, both of which render it soluble.

It possesses the properties of opium in perfection. Derosne tried it upon several dogs, and found it more powerful than opium. Its bad effects were counteracted by causing the animals to swallow vinegar. This substance is known to be of equal service in counteracting the effects of opium. Derosne supposes that the efficacy of vinegar may be owing to the readiness with which it dissolves the narcotic principle.

Many other substances beside opium possess narcotic virtues; but hitherto they have not been examined by chemists with much attention. The most remarkable are the following:

1. The lactuca virosa, and the sativa or garden-lettuce, and indeed all the lactucas, yield a milky juice, which, when inspissated, has very much the appearance of opium, and possesses the same properties. Indeed, Dr. Coxe of Philadelphia affirms, that as good opium may be obtained from the garden-lettuce as from the poppy. The milky juice is obtained by incisions at the time when the lettuce is running to seed. The resemblance between the inspissated juice of the lactuca virosa and opium is striking.

2. The leaves of the atropa belladonna, or deadly nightshade, and indeed the whole plant, are remarkably narcotic; and when taken in too great doses produce blindness, convulsions, coma, and death.

3. The leaves of the digitalis purpurea, or fox-glove, are still more powerful if possible. They lower the pulse in a remarkable degree, and, like several other very poisonous narcotics, promote the discharge of urine.

4. Hyoscyamus, niger or henbane.

5. Conium maculatum, or hemlock.

6. Datura stramonium.

7. Ledum palustre.

To these may perhaps be added the prunus laurocerasus, and the leaves of nicotiana tabacum or tobacco. The list, indeed, might be easily increased; almost all the plants belonging to the natural order of luridæ possessing narcotic properties; but as we are completely ignorant of the chemical properties of these plants, it is unnecessary to be more particular.

Narcotic salt. See Boracic acid.

NARDUS, a genus of the monogynia order, in the triandria class of plants; and in the natural method ranking under the 4th order, gramina. There is no calyx; the corolla is bivalved. There are three species. This plant was highly valued by the antients both as an article of luxury and medicine. The unguentum nardinum was used at baths and feasts as a favourite perfume. Its value is evident from that passage of scripture, where our Saviour's head was anointed with a box of it, with which Judas found fault. From a passage in Horace it appears that this ointment was so valuable among the Romans, that as much as could be contained in a small box of precious stone was considered as a sort of equivalent for a large vessel of wine, and a proper quota for a guest to contribute at an entertainment. The plant had a great character among the antients as a medicine, both internally taken and externally applied. Its sensible qualities, indeed, promise it to be of considerable efficacy in some cases, as it has a pungency of taste superior to contrayerva, and little inferior to serpentaria.

NATIONAL DEBT, the sum which is owing by a government to individuals who have advanced money for public purposes, either in anticipation of the produce of particular branches of the revenue, or on credit of the general power which the government possesses of levying the sums necessary to pay interest for the money borrowed, or to repay the principal. The practice of borrowing money on account of the state has been found so convenient, that almost every nation of modern Europe is encumbered with a considerable debt: the different manner of conducting hostilities in antient and modern times has perhaps rendered this practice absolutely necessary, as the vast expences with which wars are now attended could not possibly be defrayed during the time of their continuance, without producing the greatest distress, or perhaps absolute ruin, to the countries engaged in them. In antient times wars were not only shorter in their duration, but were conducted on principles which rendered great pecuniary supplies less necessary than at present; the whole contest was a scene of plunder and devastation, the persons and property of the enemy were at the entire disposal of the conqueror, and the greater part of the plunder was accounted for to the public. The arms made use of were much less expensive than those of modern warfare, and the extent of naval operations, the great source of national expenditure in modern times, was comparatively trifling. Sir J. Sinclair has justly observed, that had the rage of equipping numerous fleets, and building ships of great magnitude and dimensions, never existed, hardly any state in Europe would have been at this time in debt.

The principal advantages arising from national debts, and the system of credit on which they are founded, are, 1. The resource they afford in great emergencies, which gives a greater permanency to states, which in former times, for want of such occasional resources, were more liable to internal derangements and to foreign subjugation. 2. The equalization of taxes. If the supplies were raised within the year, and the expences of war were considerable, every individual would be obliged, in consequence of the additional weight of his contributions, greatly to curtail his expences; and the employment of the poor, and the consumption of the rich, would be considerably diminished; whereas, when taxes are nearly equal, in time of peace and war, the value of every species of property, of industry, and the circulation of wealth, are maintained on as regular, steady, and uniform a footing, as the uncertainty and instability of human affairs will admit. 3. They retain money in the country, which would otherwise be sent out of it; public debts have more influence in this respect than all the laws against the exportation of specie that ever were made. 4. They promote circulation. The taxes which they occasion on the property of the rich, and the encouragement they hold out to the avaricious, prevent the accumulation of private hoards, and bring the whole money and personal property of a country into employment. 5. They attach the people to the government; for every individual creditor is led by his own interest to support the authority on the prosperity and existence of which the security of his property depends. The extent of this influence is so well understood, that it is not probable the government of any country where a public debt has once existed, will ever permit it to be wholly paid off. 6. They encourage industry and the acquirement of property, by the facility with which individuals can lay out the surplus of their profits, without the risk of commercial bankruptcies, or the unavoidable expences and small advantage which landed estates yield, and receive interest on their capital with certainty and regularity.

The disadvantages attending the system of incurring national debts, are, 1. The facility of carrying on war being much increased: while large sums can be easily borrowed, it may frequently cause wars to be protracted, which would have been much sooner brought to a termination, had the governments engaged in them experienced the difficulty of defraying the whole expence by taxation. 2. The value of the property of those who have lent their money to the state, depending on the public tranquillity, inclines them to support indiscriminately the measures of the government, whatever may be their tendency: they are interested both to preach and practice apathy under every invasion of the constitution of their country. 3. The increase of taxes to pay the interest of the debt, produces an increase in the price of all the necessaries of life, and renders it difficult for the manufacturers of a state in which this system has been carried to a great height, to maintain a successful competition with the subjects of other powers, who may be in a less embarrassed situation. 4. When a nation is encumbered with debts, a pernicious spirit of gambling is encouraged: stock-jobbing, with all its train of evil consequences, necessarily arises; and a moneyed interest is erected, the sole employment of which is that of drawing every possible advantage from the wants of individuals, or the necessities of the public. 5. Public debts have a very material influence on the distribution of property. Every new loan must be procured from persons already possessing considerable wealth, and such persons will not lend their money without the expectation of making a profit by it; the increase of the debt is, therefore, to them a source of increasing wealth, to which their share of the additional taxes attendant upon it bears but a small proportion; and if the government possesses no revenue but what is drawn from the people, whatever it pays to one description of men must be drawn principally from others: thus the additional income acquired by moneyed men, by taking advantage of the necessities of the state, is, in fact, a portion of the income of their less affluent fellow-citizens, which is transferred to them through the medium of the government, and which, in a much greater proportion than it increases their wealth, must render those poorer from whom it is drawn.

The practice of incurring national debts on extraordinary occasions had been resorted to in other countries long before it was adopted in England. The Italian republics seem to have begun it; Genoa and Venice had both considerable debts. Spain was deeply in debt before the end of the 16th century, about a hundred years before England owed a shilling. In France the funding system was introduced about the year 1678; and previously to the revolution, the debt of that country was 142 millions sterling; two-fifths of which consisted of life-annuities, which in this estimate are taken at eleven years purchase.

The national debt of Great Britain commenced in the reign of William III. The war which began in 1689 being very expensive, and the grants of parliament not supplying money so fast as it was wanted, the expedient of mortgaging part of the public revenue was adopted. At first the produce of particular taxes was assigned for repayment of the principal and interest of the money borrowed; large sums were also raised on life-annuities, and annuities for terms of years; and the funds established for payment of these debts being generally inadequate to the charge upon them, occasioned great deficiencies, which, at the conclusion of the war, amounted to 5,160,459*l.* 14*s.* $9\frac{1}{4}$*d.* and were charged on the continuation of various duties which had been granted for short terms. The total amount of the funded and unfunded debts in the year 1697, was 19,950,945*l.* 19*s.* $8\frac{3}{4}$*d.* The frequent anticipation of the different funds, and their general deficiency from the diminution of the revenue, in consequence of which the interest due upon money lent to government was often long in arrear, reduced public credit at this period to a very low ebb, and rendered persons who had money very reluctant in advancing it to the government, though paid what would now be called an exorbitant interest: the accumulation of the public debts caused serious apprehensions among people of property of all descriptions.

The great expence of the war during the reign of queen Anne was chiefly defrayed by the sale of annuities for different terms, but mostly for 99 years; and money was not only borrowed to pay the interest of loans, but often to pay the interest of that interest; or, what is much the same thing, the arrears of interest were converted into principal, by which means, and from great mismanagement of the public finances, the debt rapidly increased, and on the 31st December 1716, amounted to 48,364,501*l.* 8*s.* 4*d.* This amount was considered, in the language of the king and parliament, as an "insupportable weight;" and the house of commons expressed their determination to apply themselves, with all possible diligence and attention, to the great and necessary work of reducing by degrees this heavy burthen, as the most effectual means of preserving to the public funds a real and certain security.

The current rate of interest having lowered considerably, a plan was adopted for reducing the rate of interest payable on such part of the public debts as carried 6 per cent. interest, which causing a surplus in the funds appropriated to the payment of the interest, the overplus remaining, after satisfying the charges upon the respective funds, was formed into a separate fund, under the title of the sinking fund, for the express purpose of discharging such national debts as were incurred before December 1716, and "for no other use, intent, or purpose, whatsoever." This arrangement was well calculated for effecting a gradual reduction of the amount of the debt, and gave a new confidence to the public creditors, from a persuasion that the provisions made would prevent the inconveniences which had formerly arisen from the interest of particular debts being frequently long in arrear; and that instead of the depression of the current value of their securities, which generally attends the increase of public debts, this value would increase in proportion to the progress of redemption. The public had also a distant hope at least of being relieved from some of the many taxes which it had been necessary to impose for paying the interest of the debt, the pernicious effects of which, both on the foreign trade and the internal state of the country, began to be sensibly felt.

The expectations entertained from the sinking fund were, however, soon disappointed; as the period of its strict application to the purpose for which it was established did not exceed 10 or 11 years. The famous South Sea scheme was likewise to have furnished a considerable sum to be employed in the reduction of the public debts; instead of which it increased their amount by an addition to the capital of 3,034,769*l.* 11*s.* 11*d.*, while the annual charge was rather augmented than diminished by the allowance for management on the increased capital: a further reduction of a part of the interest was however secured by this transaction.

In 1727 the interest payable on 29,962,979*l.* 12*s.* 9¼*d.* South Sea stock and annuities, and on 7,775,027*l.* 17*s.* 10½*d.* due to the Bank, was reduced from 5 to 4 per cent. which produced such an important augmentation of the sinking fund, that had it been faithfully applied to the purpose for which it was intended, and received no other increase than what would have arisen from a judicious application of it, the national debt would at this time have been wholly annihilated. During the reign of George I. the fund continued to be appropriated to the purposes for which it was formed: little progress, however, was made in discharging the public debts; for at the same instant that old incumbrances were thus paid off, new debts were contracted; so that at the end of the year 1727, the total of the funded debt amounted to 51,258,939*l.* 4*s.* 2¾*d.*, of which it must be remembered that upwards of three millions arose from the additional capital created by the South Sea company's subscription.

The whole sum paid off by the sinking fund from its establishment to the year 1739, was only 8,328,354*l.* 17*s.* 11*d.*; and the total amount of the debt at this period 46,954,623*l.* 3*s.* 4*d.*½.

The war with Spain and France, which began in this year, increased the debt to 78,293,313*l.* 1*s.* 10*d*¾., the interest on which amounted to 3,061,004*l.* 11*s.* 1¼*d.* per ann.

The interest of money, which had risen during the war to upwards of 4 per cent. fell, when the cessation of hostilities terminated the loans of government, to 3 per cent.; and the administration seized the moment of increased prosperity to propose another important reduction of interest. Towards the end of 1749, 3 per cent. stock had been for some months above par: an act was therefore passed by which the interest was reduced on all the public debts redeemable by law, which then carried 4 per cent. interest, forming together a capital of 57,703,475*l.* 6*s.* 4½*d.* The proprietors, on signifying their consent to the reduction, were to have 4 per cent. interest to the 25th December following, thence 3½ per cent. till 25 December, 1757, and afterwards 3 per cent. per annum. Upwards of three millions remained unsubscribed, which was therefore paid off, by money borrowed at 3 per cent., and thus a saving of 612,735*l.* per annum was effected, which ought to have contributed materially to the reduction of the debt. Little progress, however, was made in diminishing the capital of the debt; and at the commencement of the war in 1755 it amounted to 74,980,886*l.* 8*s.* 2¼*d.*

The great expences of the war rendered the loans of greater magnitude than had ever before been raised, and the debts incurred were somewhat increased by the practice of entitling the persons lending the money to a greater capital than the sum actually advanced; so that at the end of the war, including the loan of 1763, they amounted to 141,691,313*l.* 13*s.* 4*d.*, and the annual interest to 4,706,734*l.* 11*d.*

During the succeeding 12 years of peace, little was done in reality towards diminishing the amount of the debt; for although in each year from 1765 to 1775, some small portion of the funded debt was paid off, the whole amounted to only 11,983,553*l.* being a less amount than had sometimes been borrowed in one year of war; and the debt was far from being diminished even this amount, as during the same period a new debt of 5,052,500*l.* was contracted, by borrowing money on 3 per cent. stock, in order to redeem 4 per cents.

The American war was entered into with a funded debt of 132,343,051*l.*, including an estimated value of the long annuities and exchequer annuities, and an unfunded debt of about 3,600,000*l.*, making together 135,943,051*l.* the interest on which amounted to 4,476,821*l.* per annum. The expences of this war greatly exceeded those which had preceded it; and the increase of the debt was much greater than had ever been incurred by any country in the same space of time. The following statements will shew the extent of the sums borrowed, and the additions thus made to the annual burthens of the country:

	Money bor.	Debt created.	Interest.
1776	2,000,000	2,150,000	64,500
1777	5,000,000	5,000,000	225,000
1778	6,000,000	6,000,000	330,000
1779	7,000,000	7,000,000	472,500
1780	12,000,000	12,000,000	697,500
1781	12,000,000	21,000,000	660,000
1782	13,500,000	20,250,000	793,125
1783	12,000,000	15,000,000	560,000
1784	6,000,000	9 000,000	316,500
	£75,500,000	97,400,000	4,119,125

From which it appears that a nominal capital of 21,900,000*l.* was added to the sum of 75,500,000*l.* actually borrowed, and that the interest on the whole amounted to 5*l.* 9*s.* 1*d.* per cent., on which the perpetual interest was equal to 4*l.* 6*s.* per cent. on the whole sum. In addition to the above sums, a very considerable amount of navy debt was funded after the conclusion of the war, which being properly part of the expences of it, the total debt incurred by the American war may be stated as follows:

	Debt created.	Interest.
In 3 per cents.	64,648,000	1,939,440
4 per cents.	32,750,000	1,310,000
5 per cents.	17,869,992	893,499
Terminable annuities		869,623
	£115,267,992	5,012,562

The whole amount of the funded and unfunded debts, including a valuation of the terminable annuities, was on the 5th Jan. 1786, 268,100,379*l.* 18*s.* 8*d.*, and the amount of the annual interest 9,512,232*l.* 7*s.* 9*d.*

The magnitude of the public debt, and the consequent low price of the funds, appear at this period to have engaged the serious attention of the government; in consequence of which some new taxes were imposed, in order to raise a surplus of revenue, as the foundation of a plan for establishing a new sinking fund. In order to ascertain what portion of the revenue might be appropriated to this purpose, a select committee of the house of commons was appointed to examine and state the accounts presented to the house relating to the public income and expenditure, and to report what might be expected to be the annual amount of the income and expenditure in future. On the 21st March, 1786, the committee made their report; and conceiving that the circumstances of the times rendered any average drawn from the amount of the revenue in former periods in a great degree inapplicable to the situation of the country, they formed an account of the public receipt and expenditure to Michaelmas 1785, and to January 1786, from which it appeared, that at the former period there was a surplus of 901,001*l.*, and at the latter a surplus of 919,299*l.* As it was evident that a fund of less than one million per annum would be very inadequate to the purpose for which it was designed, new taxes were imposed for raising the surplus revenue to this sum; and, in order the more effectually to prevent ministers from diverting it to any other purpose, the mode was adopted which had been frequently suggested, of vesting the annual sums in the hands of commissioners: some other judicious regulations were also established by the act passed for this purpose. See Sinking Fund.

In the year 1789, it was found necessary to borrow 1,002,140*l.* on a tontine scheme, and 187,000*l.* to replace the like sum which had been issued out of the civil list revenue, as a loan to the prince of Orange: the latter was raised on annuities for 18¾ years. The total amount of the public debt in the year 1792, being the year previous to the war with the French republic, was, according to the official account, 238,231,248*l.*; but including the value of the terminable annuities, and the amount of the unfunded debt, the total was 268,267,272*l.* 1*s.* 7*d.*, the annual interest and charges of management on which amounted to 9,752,673*l.* 14*s.* 8*d.* From this amount, however, a deduction is to be made of the stock which had been redeemed by the operation of the sinking fund. With this formidable burthen on the property and industry of the country, a war was entered into, which from the enormous expenditure attending it, increased the amount of the national debt in a degree beyond all former precedent or conjecture. The loan of the year 1793 was raised wholly on 3 per cent. stock, and those of the subsequent years being also raised chiefly on this description of stock, an unnecessary addition has been made to the capital of the debt, and the charge for management has been considerably augmented, as the allowance to the bank on this account is computed on the capital created. In the third year of the war the amount of the loan was considerably greater than had ever before been borrowed in one year; but still larger sums were raised in some of the succeeding years. The natural consequence of such a rapid accumulation of debt was a great depreciation of the current prices of the public funds, so that the government was obliged to allow a very high interest for the money borrowed; and towards the end of the year 1797, many persons seemed to entertain an apprehension that the funding system had been extended nearly to its limits; in consequence of this opinion, various expedients were successively tried for raising a considerable part of the war expenditure within the year; none of these projects fully succeeded, but they certainly rendered the sums which it was necessary to borrow, somewhat less in amount than they must otherwise have been; still, however, they were of unprecedented magnitude: and in 1802, after the conclusion of the war, it was still found necessary to borrow twenty-five millions more, to make good expences of the war remaining unprovided for. The total amount of the national debt at Midsummer 1802, including the stock created by the imperial loans, and estimating the unfunded debt at 15,500,000*l.* was 619,303,027*l.* 9*s.* 6*d.*, the annual charge of which for interest and management amounted to 21,557,728*l.* 15*s.* 6*d.* From this amount is to be deducted the stock bought up by the commissioners, and transferred to them for redemption of land-tax.

PROGRESS OF THE NATIONAL DEBT, FROM ITS COMMENCEMENT TO MIDSUMMER 1802.

	Capital.	Interest.
National Debt at the Revolution, 1688	£. 664,263	39,855
Increase during the reign of William IIId.	15,730,439	1,271,087
Amount at the accession of Queen Anne	16,394,702	1,310,942
Increase during the reign of Queen Anne	31,969,799	1,841,582
Amount at establishment of Sinking Fund, 1716	48,364,501	3,152,524
Increase during the reign of Geo. I.	4,654,654	
Decrease of annual charge	- - -	941,958
Amount at the accession of Geo. IId.	53,019,155	2,210,566
Decrease during the Peace	6,064,532	246,541
Amount at commencement of the War, 1739	46,954,623	1,964,025
Increase during the War	31,338,689	1,096,979
Amount at the end of the War in 1748	78,293,312	3,061,004
Decrease during the Peace	3,312,426	389,364
Amount at the commencement of the War, 1755	74,980,886	2,671,640
Increase during the War	66,710,427	2,035,094
Amount at the end of the War, 1762	141,691,313	4,706,734
Decrease during the Peace	5,748,262	229,913
Amount at commencement of the American War	135,943,051	4,476,821
Increase during the War	132,157,328	5,035,411
Amount at the conclusion of the American War	268,100,379	9,512,232
Increase in the year 1789	1,189,140	56,863
Amount in 1789	269,289,519	9,569,095
Redeemed during the Peace	9,441,850	283,255
Amount at the commencement of the War, 1793	259,847,669	9,285,840
Increase during the War	350,013,508	11,988,633
	609,861,177	21,274,473
Redeemed during the War	69,243,336	2,089,220
Amount at conclusion of the War in 1802	540,617,841	19,185,253

Since the period at which the above statement terminates, another war has been entered into, which has already added many millions to the public debt; but as the sum to which it may be increased is beyond the reach even of probable estimate, we can only give the following statement of the total amount of the Debt on the 5th January, 1806, which will also shew the different descriptions of Stock and Annuities of which it consists:

NATIONAL DEBT OF GREAT BRITAIN.

	Capital.			Interest and Management.		
5 per Cent. Consolidated Annuities	£. 41,389,136	8	4	£. 2,088,081	18	7
5 per Cent. Annuities, 1797 and 1802	9,088,902	16	3	458,535	2	10
4 per Cent. Consolidated Annuities	49,725,084	17	2	2,011,379	13	7
3 per Cent. Reduced Annuities	137,246,269	3	7	4,179,148	17	2
3 per Cent. Consolidated Annuities	376,707,982	2	0¼	11,470,758	0	3
3 per Cent. Deferred Annuities	1,740,625	0	0	——		
3 per Cent. Annuities, 1726	1,000,000	0	0	30,450	0	0
Bank Stock	11,686,800	0	0	356,502	3	5
South Sea Stock	3,662,784	8	6	}		
Old South Sea Annuities	11,907,470	2	7	} 735,974	13	11
New South Sea Annuities	8,494,830	2	10	}		
South Sea Annuities, 1751	1,919,600	0	0	58,325	15	6
Imperial 3 per Cent. Annuities	7,502,633	6	8	228,455	3	8
Value of the Long Annuities	19,969,799	12	6	1,075,669	4	11
Do. of the Short Annuities	786,599	5	1	423,039	5	9
Do. of Imperial Annuities	2,184,694	7	9	232,587	10	0
Do. of the Life Annuities	403,779	9	6	67,296	11	7
Annuities on Lives, with Survivorship, 1765	18,000	0	0	540	0	0
Tontine Annuities, 1789	280,452	18	0	20,032	7	0
Value of Exchequer Annuities	23,668	0	0	23,668	0	0
	685,739,112	0	9¼	23,460,444	8	2
Redeemed by Sinking Fund	104,701,999	0	0	3,170,073	19	4
	581,037,113	0	9¼	20,290,370	8	10
Transferred for Land Tax redeemed	22,000,000	0	0	660,000	0	0
Total Funded Debt	559,037,113	0	9¼	19,630,370	8	10
Navy, Victualling, and Transport Debt	5,500,000	0	0	}		
Army, Barracks, Ordnance, &c.	3,000,000	0	0	} 681,000	0	0
Treasury Bills, &c.	1,200,000	0	0	}		
Exchequer Bills	13,000,000	0	0	}		
Total of the Nat. Debt and the ann. interest thereon,	581,737,113	0	9¼	20,311,370	8	10

For the comparative value of the different funds, and the mode of transacting business therein, see Public Funds.

NATRUM. See Soda.

NATIVITY, in old law-books, signifies villainage or servitude.

NATURAL HISTORY. The object of this branch of science may be divided into two heads; the first teaches us the characteristics, or distinctive marks, of each individual object, whether animal, vegetable, or mineral; the second makes us acquainted with all its peculiarities, as to its habits, its qualities, and its uses. To assist in attaining the first, it is necessary to adopt some system of classification, in which individuals that agree in particular points may be arranged together. In this work we have adopted the Linnæan system, as the most simple and perfect that has been presented to the public.

A knowledge of the second head is only gained by a patient investigation of each particular object; for this we refer the reader to the several genera described in these volumes, under which we have endeavoured to give a brief account of all the interesting and material facts.

The study of natural history consists in the collection, arrangement, and exhibition, of the various productions of the earth. These are divided into the three grand kingdoms of nature, the boundaries of which meet together in the zoophytes. See Zoophytes.

Minerals inhabit the interior parts of the earth, in rude and shapeless masses. They are bodies concrete without life and sensation. See Mineralogy.

Vegetables clothe the surface with verdure, imbibe nourishment through bibulous roots, breathe by leaves, and continue their kind by the dispersion of seed within prescribed limits. They are organized bodies, and have life and not sensation. See Botany.

Animals adorn the exterior parts of the earth, respire and generate eggs; are impelled to action by hunger, affections, and pain; and by preying on other animals and vegetables, restrain within proper bounds and proportions the numbers of both. They have organized bodies, and have life, sensation, and the power of locomotion.

Man, the governor and subjugator of all other beings, is, by his wisdom alone, able to form just conclusions from such things as present themselves to his senses, which consist of natural bodies. Hence the first step of wisdom is to know these bodies; and to be able, by marks imprinted on them by the God of nature, to distinguish them from each other, and to affix to every object its proper name. These are the elements of this science; this is the great alphabet of nature: for if the name is lost, the knowledge of the object is lost also.

The method adopted in natural history, indicates that every body may, by inspection, be known by its peculiar name, and this points out whatever the industry of man has been able to discover concerning it; so that, amidst the greatest apparent confusion, the greatest order is visible.

The Linnæan system is divided into five branches, each subordinate to the other: these are, class, order, genus, species, and variety, with their names and characters. In this arrangement, the classes and orders are arbitrary, the genera and species are natural.

Of the three grand divisions above referred to, the animal kingdom ranks highest in comparative estimation, the next the vegetable, and last is the mineral kingdom.

To the vegetable and mineral kingdoms, we have already referred under the distinct heads Botany and Mineralogy: with regard to the animal kingdom, we observe that,

Animals enjoy sensation by means of a living organization, animated by a medullary substance; perception by nerves; and motion by the exertion of the will. They have members for the different purposes of life; organs for their different senses; and faculties or powers for the application of their different perceptions. They all originate from an egg. Their external and internal structure, habits, instincts, and various relations to each other, will be found under the different genera. See also Comparative Anatomy.

The division of animals is into six classes, formed from their internal structure.

1. Mammalia	Heart with 2 auricles & 2 ventricles: blood warm and red.	viviparous
2 Birds		oviparous
3. Amphibia	Heart with 1 auricle & 1 ventricle: blood cold and red.	lungs voluntary
4. Fishes		
5. Insects	Heart with 1 auricle, ventricle 0; sanies cold and white.	have antennæ
6. Vermes		tentacula.

The following is an abstract of Linnæus's Systema Naturæ, by Gmelin.

Class I. Mammalia.

Order.	Genera.	Species.
Primates	4	88
Bruta	7	25
Feræ	10	186
Glires	10	129
Pecora	8	90
Belluæ	4	25
Cete	4	14
7	47	557

Class II. Aves.

Order.	Genera.	Species.
Accipitres	4	271
Picæ	26	663
Anseres	13	314
Grallæ	20	326
Gallinæ	10	129
Passeres	17	983
6	87	2686

Class III. Amphibia.

Order.	Genera.	Species.
Reptilia	4	147
Serpentes	6	219
2	10	366

Class IV. Pisces.

Order.	Genera.	Species.
Apodes	10	37
Jugulares	6	52
Thoracici	19	452
Abdominales	16	202
Branchiostegi	10	81
Chondropterygii	5	65
6	66	889

Class V. Insectæ.

Order.	Genera.	Species.
Coleoptera	55	4048
Hemiptera	14	1464
Lepidoptera	3	2600
Neuroptera	7	174
Hymenoptera	25	1239
Diptera	12	692
Aptera	15	679
7	121	10896

Class VI. Vermes.

Order.	Genera.	Species.
Intestina	21	384
Mollusca	31	538
Testacea	36	2525
Zoophita	15	498
Infusoria	15	191
5	118	4036.

Natural philosophy, that which considers the powers and properties of natural bodies, and their actions on one another.

Our knowlege of nature being now found to result entirely from well-conducted experiments, the term natural philosophy has been latterly compounded with that of experimental philosophy, and indeed they seem nearly to mean the same thing. See Experimental Philosophy. Natural philosophy is, however, obviously rather a system or aggregate of several branches of knowledge, than a simple and uniform science. These branches, therefore, it was necessary to treat of under separate articles, to which we must content ourselves with referring upon this occasion, arranging them in the order in which we think they may be studied with most advantage, viz. Attraction, Gravitation, and Gravity, Magnetism, Motion, Mechanics, Pneumatics, Hydrostatics, Hydraulics, Electricity, Galvanism, Optics, Astonomy; to which we may add Chemistry and Mineralogy.

NATURALIZATION, is when an alien-born is made the king's natural subject.

Hereby an alien is put in the same state as if he had been born in the king's liegeance, except only that he is incapable of being a member of the privy council or parliament, and of holding any office or grant. No bill for a naturalization can be received in either house of parliament, without such disabling clause in it; nor without a clause disabling the person from obtaining any immunity in trade thereby, in any foreign country, unless he shall have resided in Britain seven years after the commencement of the session in which he is naturalized. Neither can any person be naturalized, or restored in blood, unless he has received the sacrament within one month before bringing in of the bill, and unless he also takes the oaths of allegiance and supremacy in the presence of the parliament. 1 Black. 374. See Alien.

NAVAL stores comprehend all those particulars made use of, not only in the royal navy, but in every other kind of navigation; as timber for shipping, pitch, tar, hemp, cordage, sail-cloth, gunpowder, ordnance and fire-arms of every sort, ship-chandlery wares, &c.

NAUCLÆA, a genus of the pentandria monogynia class and order. The corolla is funnel-form; seed one, inferior, two-celled; receptacle, common globular. There are four species, trees of the East Indies, &c.

NAVIGATION, the art of conducting a ship from one port to another. The main end of all practical navigation is, to conduct the ship in safety to her destined port; and for this purpose it is of the utmost consequence to know in what particular part of the surface of the globe she is at any particular time. This can only be done by having an accurate map of the sea-coasts of all the countries of the world, and, by tracing out the ship's progress along the map, to know at what time she approaches the desired haven, or how she is to direct her course in order to reach it. It is therefore a matter of great importance for navigators to be furnished with maps, or charts, as they are called, not only very accurate in themselves, but such as are capable of having the ship's course easily traced upon them, without the trouble of laborious calculations, which are apt to create mistakes. The navigator should have a perfect knowledge of the figure and motion of the earth; the various real and imaginary lines upon it, so as to be able to ascertain the distance and situation of places with respect to one another. He should also be acquainted with the several instruments employed in measuring the ship's way; such as the log, half-minute glass; quadrant to take the altitude of the sun and stars; compass to represent the sensible horizon; and azimuth compass to take the azimuth and amplitude of the sun, in order to know the variation of the magnetic needle. He should have an accurate knowledge of maps and charts of the lands and seas, together with the depth of water, the times and setting in of the tides upon the coasts that he may have occasion to visit; also the currents; of the mould and trim of the ship, and the sail she bears, that so a due allowance may be made for lee-way. By the help of these, he may at all times know the place the ship is in, which way he must steer, and how far he has to run to gain his intended port.

The names of the two great divisions of navigation are taken merely from the kind of charts made use of. Plane sailing is that in which the plane chart is made use of; and Mercator's sailing, or globular sailing, is that in which Mercator's chart is used. In both these methods, it is easy to find the ship's place with as great exactness as the chart will allow, either by the solution of a case in plane trigonometry, or by geometrical construction.

Of Plane sailing. As a necessary preliminary to our understanding this method of navigation, we shall here give the construction of the plane chart.

1. This chart supposes the earth to be a plane, and the meridians parallel to one another; and likewise the parallels of latitude at equal distances from one another, as they really are upon the globe. Though this method is in itself evidently false; yet, in a short run, and especially near the equator, an account of the ship's way may be kept by it tolerably well.

Having determined the limits of the chart, that is, how many degrees of latitude and longitude, or meridional distance (they being in this chart the same), it is to contain: suppose from the lat. of 20° N. to the lat. of 71° N., and from the longitude of London in 0 deg. to the long. of 50° W.; then choose a scale of equal parts, by which the chart may be contained within the size of a sheet of paper on which it is intended to be drawn.

Make a parallelogram ABCD (Plate Navigation. fig. 1), the length of which AB from north to south shall contain 51 degrees, the difference of latitude between the limits of 20° and 71°; and the breadth AD from east to west shall contain the proposed 50 degrees of longitude, the degrees being taken from the said scale, and this parallelogram will be the boundaries of the chart.

About the boundaries of the chart make scales containing the degrees, halves, and quarters of degrees (if the scale is large enough); drawing lines across the chart through every 5 or 10 degrees; let the degrees of latitude and longitude have their respective numbers annexed, and the sheet is then fitted to receive the places intended to be delineated thereon.

On a straight slip of pasteboard, or stiff paper, let the scale of the degrees and parts of degrees of longitude, in the line AD, be laid close to the edge; and the divisions numbered from the right hand towards the left, being all west longitude.

Seek in a geographical table for the latitudes and longitudes of the places contained within the proposed limits; and let them be written out in the order in which they increase in latitude.

Then, to lay down any place, lay the edge of the pasteboard scale to the divisions on each side the chart, shewing the latitude of the place; so that the beginning of its divisions falls on the right-hand border AB; and against the division shewing the longitude of the given place make a point, and this gives the position of the place proposed; and in like manner are all the other places to be laid down.

Draw waving lines from one point to the other, where the coast is contiguous, and thus the representation of the lands within the proposed limits will be delineated.

Write the names to the respective parts, and in some convenient place insert a compass, and the chart will be completed.

2. The angle formed by the meridian and rhumb that a ship sails upon, is called, as we have said, the ship's course. Thus, if a ship sails on the N.N.E. rhumb, then her course will be 22° 30′; and so of others, as is manifest from the following table of the angles which every point of the compass makes with the meridian.

North.	South.	Points.	D. M.	North.	South.
		$\frac{1}{4}$	2.49		
		$\frac{1}{2}$	5.37		
		$\frac{3}{4}$	8.26		
N. by E.	S. by E.	1	11.15	N. by W.	S. by W.
		1 $\frac{1}{4}$	14. 4		
		1 $\frac{1}{2}$	16 52		
		1 $\frac{3}{4}$	19.41		
N. N. E.	S. S. E.	2	22.30	N. N. W.	S. S. W.
		2 $\frac{1}{4}$	25.19		
		2 $\frac{1}{2}$	28. 7		
		2 $\frac{3}{4}$	30.56		
N E. by N.	S. E. by S.	3	33.45	N. W. by N.	S. W. by S.
		3 $\frac{1}{4}$	36.34		
		3 $\frac{1}{2}$	39.22		
		3 $\frac{3}{4}$	42.11		
N. E.	S. E.	4	45. 0	N. W.	S. W.
		4 $\frac{1}{4}$	47.49		
		4 $\frac{1}{2}$	50.37		
		4 $\frac{3}{4}$	53.26		
N. E. by E.	S. E. by E.	5	56.15	N. W. by W.	S. W. by W.
		5 $\frac{1}{4}$	59. 4		
		5 $\frac{1}{2}$	61.52		
		5 $\frac{3}{4}$	64.42		
E. N. E.	E. S. E.	6	67.30	W. N. W,	W. S. W.
		6 $\frac{1}{4}$	70.19		
		6 $\frac{1}{2}$	73. 7		
		6 $\frac{3}{4}$	75.56		
E. by N.	E. by S.	7	78.45	W. by N.	W. by S.
		7 $\frac{1}{4}$	81.34		
		7 $\frac{1}{2}$	84.22		
		7 $\frac{3}{4}$	87.11		
	East.	8	90. 0	West.	

3. The distance between two places lying on the same parallel counted in miles of the equator, or the distance of one place from the meridian of another counted as above on the parallel passing over that place, is called meridional distance; which, in plane sailing, goes under the name of departure.

4. Let A (fig. 2), denote a certain point on the earth's surface, AC its meridian, and AD the parallel of latitude passing through it; and suppose a ship to sail from A on the N. N.E. rhumb till she arrives at B; and through B draw the meridian BD, (which, according to the principles of plane sailing, must be parallel to CA,) and the parallel of latitude BC; then the length of AB, viz. how far the ship has sailed upon the N. N.E. rhumb, is called her distance; AC or BD will be her difference of latitude, or northing: CB will be her departure, or easting; and the angle CAB will be the course. Hence it is plain, that the distance sailed will always be greater than either the difference of latitude or departure; it being the hypothenuse of a right-angled triangle, whereof the other two are the legs; except the ship sails either on a meridian or a parallel of latitude: for if the ship sails on a meridian, then it is plain, that her distance will be just equal to her difference of latitude, and she will have no departure; but if she sails on a parallel, then her distance will be the same with her departure, and she will have no difference of latitude. It is evident also from the figure, that if the course is less than 4 points, or 45 degrees, its complement, viz. the other oblique angle, will be greater than 45 degrees, and so the difference of latitude will be greater than the departure; but if the course is greater than 4 points, then the difference of latitude

will be less than the departure; and lastly, if the course is just 4 points, the difference of latitude will be equal to the departure.

5. Since the distance, difference of latitude, and departure, form a right-angled triangle, in which the oblique angle opposite to the departure is the course, and the other its complement; therefore, having any two of these given, we can (by plane trigonometry) find the rest; and hence arise the cases of plane-sailing, which are as follow:

Case I. Course and distance given, to find the difference of latitude and departure.

Example. Suppose a ship sails from the latitude of 30° 25′ north, N. NE. 32 miles (fig. 3). Required the difference of latitude and departure, and the latitude come to. Then (by right-angled trigonometry) we have the following analogy for finding the departure, viz.

As radius - - - - - -		10.00000
to the distance AC -	32.	1.50515
so is the sine of the course A	22° 30′	9.58284
to the departure BC -	12.25	1.08799

so the ship has made 12.25 miles of departure easterly, or has got so far to the eastward of her meridian. Then for the difference of latitude or northing the ship has made, we have (by rectangular trigonometry) the following analogy, viz.

As radius - - - - - -		10.00000
is the distance AC -	32	1.50515
so is the co-sine of course A	22° 30′	9.58284
to the difference of lat. AB	29.57	1.47077

so the ship has differed her latitude, or made of northing, 29.57 minutes.

And since her former latitude was north, and her difference of latitude also north; therefore,

To the latitude sailed from -	30°, 25′ N
add the difference of latitude	00°, 29.57
and the sum is the latitude come to	30°, 54.57′N.

By this case are calculated the tables of difference of latitude, and departure, to every degree, point, and quarter-point, of the compass.

Case II. Course and difference of latitude given, to find distance and departure.

Example. Suppose a ship in the latitude of 45° 25′ north, sails NEbN½ easterly (Plate Navigation, fig. 4), till she comes to the latitude of 46° 55′ north: required the distance and departure made good upon that course.

Since both latitudes are northerly, and the course also northerly; therefore,

From the latitude come to -	46°, 55′
subtract the latitude sailed from	45°, 25′
and there remains - - -	01°, 30′
the difference of latitude, equal to	90 miles.

And (by rectangular trigonometry) we have the following analogy for finding the departure BD, viz.

As radius - - - - - -		10.00000
is to the diff. of latitude AB	90	1.95424
so is the tangent of course A	39°, 22′	9.91404
to the departure BD -	73.84	1.86828

so the ship has got 73.84 miles to the eastward of her former meridian.

Again, for the distance AD, we have (by rectangular trigonometry) the following proportion, viz.

As radius - - - - -		10.00000
is to the secant of the course	39°, 22′	10.11176
so is the diff. of latitude AB	90	1.95424
to the distance AD -	116.4	2.06600

Case III. Difference of latitude and distance given, to find course and departure.

Example. Suppose a ship sails from the latitude of 56° 50′ north, on a rhumb between south and west, 126 miles, and she is then found by observation to be in the latitude of 55°, 40′ north: required the course she sailed on, and her departure from the meridian. (Fig. 5.)

Since the latitudes are both north, and the ship sailing towards the equator; therefore,

From the latitude sailed from -	56°, 50′
subtract the observed latitude -	55°, 10′
and the remainder - - -	01°, 40′

equal to 70 miles, is the difference of latitude.

By rectangular trigonometry we have the following proportion for finding the angle of the course F, viz.

As the distance sailed DF	126	2.10037
is to radius - - - -		10.00000
so is the diff. of latitude FD	70	1.84510
to the co-sine of the course F	56°, 15′	9.74473

which, because she sails between south and west, will be south 56° 15′ west, or SWbW. Then, for the departure, we have (by rectangular trigonometry) the following proportion, viz.

As radius - - - - - -		10.00000
is to the distance sailed DF	126	2.10037
so is the sine of the course F	56°, 15′	9.91985
to the departure DE -	104.8	2.02022

consequently she has made 104.8 miles of departure westerly.

Case IV. Difference of latitude and departure given, to find course and distance.

Example. Suppose a ship sails from the latitude of 44° 50′ north, between south and east, till she has made 64 miles of easting, and is then found by observation to be in the latitude of 42° 56′ north: required the course and distance made good.

Since the latitudes are both north, and the ship sailing towards the equator; therefore,

From the latitude sailed from -	44°, 50′ N
take the latitude come to -	42°, 56′
and there remains - - - -	01°, 54′

equal to 114 miles, the difference of latitude or southing.

In this case (by rectangular trigonometry) we have the following proportion to find the course KGL (fig. 6), viz.

As the diff. of latitude GK	114	2.05690
is to radius - - - -		10.00000
so is the departure KL	64	1.80618
to the tangent of course G	29°, 19′	9.74928

which, because the ship is sailing between south and east, will be south 29° 19′ east, or SSE½ east nearly.

Then for the distance, we shall have (by rectangular trigonometry) the following analogy, viz.

As radius - - - - - -		10.00000
is to the diff. of latitude GK	114	2.05690
so is the secant of the course	29°, 19′	10.05952
to the distance GL -	130.8	2.11642

consequently the ship has sailed on a SSE½ east course 130.8 miles.

Case V. Distance and departure given, to find course and difference of latitude.

Example. Suppose a ship at sea sails from the latitude of 34° 24′ north, between north and west, 124 miles, and is found to have made of westing 86 miles: required the course steered, and the difference of latitude or northing made good.

In this case (by rectangular trigonometry) we have the following proportion for finding the course ADB, (fig. 7), viz.

As the distance AD -	124	2.09342
is to radius - - - -		10.00000
so is the departure AB	86	1.93450
to the sine of the course D	43° 54′	9.84108

so the ship's course is north 33° 45′ west, or NWbN ¼ west nearly.

Then for the difference of latitude, we have (by rectangular trigonometry) the following analogy, viz.

As radius - - - - -		10.00000
is to the distance AD	124	2.09342
so is the co-sine of the course	43°, 54′	9.85766
to the diff. of latitude BD	89.35	1.95108

which is equal to 1 degree and 29 min. nearly.

Hence, to find the latitude the ship is in, since both latitudes are north and the ship sailing from the equator; therefore

To the latitude sailed from -	34°, 24′
add the difference of latitude -	1°, 29′
the sum is - - - -	35°, 53′

the latitude the ship is in north.

Case VI. Course and departure given, to find distance and difference of latitude.

Example. Suppose a ship at sea, in the latitude of 24° 30′ south, sails SEbS, till she has made of easting 96 miles: required the distance and difference of latitude made good on that course.

In this case (by rectangular trigonometry and by case 2,) we have the following proportion for finding the distance (fig. 8), viz.

As the sine of the course G	33°, 45′	9.74474
is to the departure HM	96	1.98227
so is radius - - - -		10.00000
to the distance GM -	172.8	2.23753

Then, for the difference of latitude, we have (by rectangular trigonomety) the following analogy, viz.

As the tangent of course	33°, 45′	9.82489
is to the departure HM	96 -	1.98227
so is radius - - - -		10.00000
to the difference of lat. GH	143.7	2.15738

equal to 2°, 24′ nearly. Consequently, since the latitude the ship sailed from was south, and she sailing still towards the south,

To the latitude sailed from -	24°, 30′
add the difference of latitude -	2°, 25′
and the sum - - -	26°, 55′

is the latitude she is come to south.

6. When a ship sails on several courses in 24 hours, the reducing all these into one, and thereby finding the course and distance made good upon the whole, is commonly called the resolving of a traverse.

7. At sea they commonly begin each day's reckoning from the noon of that day, and from that time they set down all the different courses and distances sailed by the ship till noon next day upon the log-board; then from these several courses and distances, they compute the difference of latitude and departure for each course (by Case I. of Plane Sailing); and these, together with the courses and distances, are set down in a table, called the Traverse Table, which consists of five columns: in the first of which are placed the courses and distances; in the two next, the differences of latitude belonging to these courses, according as they are north or south; and in the two last are placed the departures belonging to these courses, according as they are east or west. Then they sum up all the northings and all the southings; and taking the difference of these, they know the difference of latitude made good by the ship in the last 24 hours, which will be north or south, according as the sum of the northings or southings is greatest: the same way, by taking the sum of all the eastings, and likewise of all the westings, and subtracting the lesser of these from the greater, the difference will be the departure made good by the ship last 24 hours, which will be east or west according as the sum of the eastings is greater or less than the sum of the westings; then from the difference of latitude and departure made good by the ship last 24 hours, found as above, they find the true course and distance made good upon the whole (by Case 4 of Plane Sailing) as also the course and distance to the intended port

Example. Suppose a ship at sea, in the latitude of 48° 24′ north, at noon any day, is bound to a port in the latitude of 43° 40′ north, whose departure from the ship is 144 miles east; consequently the direct course and distance of the ship is SSE. ¼ east 315 miles; but by reason of the shifting of the winds she is obliged to steer the following courses till noon next day, viz. SEbS 56 miles, SSE 64 miles, NWbW 48 miles, SbW $\frac{1}{2}$ west 54 miles, and SEbS $\frac{1}{2}$ east 74 miles: required the course and distance made good the last 24 hours, and the bearing and distance of the ship from the intended port.

The solution of this traverse depends entirely on the 1st and 4th Cases of Plane Sailing; and first we must (by Case 1.) find the difference of latitude and departure for each course. Thus,

1. Course SEbS distance 56 miles.

For departure.

As radius - - -		10 00000
is to the distance -	56	1.74819
so is the sine of the course	33°, 45′	9.74474
to the departure -	31.11	1.49293

For difference of latitude.

As radius - - -		10.00000
is to the distance -	56	1.74819
so is the co-sine of the course	33°, 45′	9.91985
to the diff of latitude	46.57	1.66804

2. Course SSE and distance 64 miles.

For departure.

As radius - - -		10.00000
is to the distance -	64	1.80618
so is the sine of the course	22°, 30′	2.58284
to the departure -	24.5	1.38902

For difference of latitude.

As radius - - -		10 00000
is to the distance -	64	1.80618
so is the co-sine of the course	22°, 30′	9.96562
to the difference of latitude	59.13	1.77180

3. Course NWbW and distance 48 miles.

For departure.

As radius - - -		10.00000
is to the distance -	48	1.68124
so is the sine of the course	56°, 15′	9.91985
to the departure -	39.91	1.60109

For difference of latitude.

As radius - - -		10.00000
is to the distance -	48	1.68124
so is the co-sine of the course	56°, 15′	9.74474
to the difference of latitude	26.67	1.42598

4. Course SbW $\frac{1}{2}$ west and distance 54 miles.

For departure.

As radius - - -		10.00000
is to the distance -	54	1.73239
so is the sine of the course	16°, 52′	9.46262
to the departure -	15.67	8.19501

For difference of latitude.

As radius - - -		10.00000
is to the distance -	54	1.73239
so is the co-sine of the course	16°, 52′	9.98090
to the difference of latitude	51.67	1.71329

5. Course SEbS $\frac{1}{2}$ east and distance 74 miles.

For departure.

As radius - - -		10.00000
is to the distance -	74	1.86923
so is the sine of the course	39°, 22′	9.80228
to the departure -	46.94	1.67151

For difference of latitude.

As radius - - -		10.00000
is to the distance -	74	1.80923
so is the co-sine of the course	39°, 22′	9.88824
to the difference of latitude	57.21	1.75747

Now these several courses and distances, together with the differences of latitude and departures deduced from them, being set down in the proper columns in the traverse table, will stand as follow:

THE TRAVERSE TABLE.

Courses.		*Distances.*	*Diff. of Lat.*		*Departure.*	
			N.	S.	E.	W.
SE b S	—	56	—	46.57	31.11	—
S SE	—	64	—	59.13	24.5	—
NW b W	—	48	26.67	—	—	39.91
SbW $\frac{1}{2}$W	—	54	—	51.67	—	15.67
SEbS $\frac{1}{2}$E	—	94	—	57.21	46.94	—
			26.67	214. 2	108.55	55 58
				26.67	55.58	
		Diff. of Lat.		187.91	46.97	Dep.

From the above table it is plain, since the sum of the northings is 26.67, and of the southings 214.58, the difference between these, viz. 187.91, will be the southing made good by the ship the last 24 hours; also the sum of the eastings being 102.55, and of the westings 55.58, the difference 46.97 will be the easting or departure made good by the ship's last 24 hours; consequently, to find the true course and distance made good by the ship in that time, it will be (by Case 4. of Plane Sailing),

As the difference of latitude	187.91	2.27393
is to the radius - -		10.00000
so is the departure -	46.97	1.67182
to the tangent of the course	14°, 03′	9.39789

which is SbE $\frac{1}{4}$ east nearly. Then for the distance, it will be,

As radius - - - - -		10.00000
is to the difference of latitude	187.91	2.27393
so is the secant of the course	14°, 03′	10.01319
to the distance -	193.7	2.28712

consequently the ship has made good the last 24 hours, on a SbE $\frac{1}{4}$ east course, 193.7 miles: and since the ship is sailing towards the equator; therefore,

From the latitude sailed from -	48°, 24′ N
take the diff. of latitude made good	3 , 08 S
there remains - -	45 , 16 N

the latitude the ship is in north. And because the port the ship is bound for lies in the latitude of 43° 40′ N. and consequently south of the ship; therefore,

From the latitude the ship is in	44°, 16′ N
take the latitude she is bound for	43 , 40 N
and there remains - - -	1 , 36

or 96 miles, the difference of latitude or southing the ship has to make. Again, the whole easting the ship had to make being 144 miles, and she having already made 46.97, or 47 miles of easting; therefore the departure or easting she still has to make will be 97 miles: consequently, to find the direct course and distance between the ship and the intended port, it will be (by Case 4. of Plane Sailing),

As the difference of latitude	96	1.98227
is to radius - - -		10.00000
so is the departure -	97	1.98677
to the tangent of the course	45°, 19′	10.00450

And

As radius - - -		10.00000
is to the difference of latitude	96	1.98227
so is the secant of the course	45°, 19′	10.15293
to the distance - -	136.5	2.13620

whence the true bearing and distance of the intended port is, SE 136.5 miles.

Of Parallel Sailing. Since the parallels of latitude do always decrease the nearer they approach the pole, it is plain a degree on any of them must be less than a degree upon the equator. Now in order to know the length of a degree on any of them, let PB (fig. 9) represent half the earth's axis, PA a quadrant of a meridian, and consequently A a point on the equator, C a point on the meridian, and CD a perpendicular from that point upon the axis, which plainly will be the sine of CP the distance of that point from the pole, or the co-sine of CA its distance from the equator; and CD will be to AB, as the sine of CP, or co-sine of CA, is to the radius. Again, if the quadrant PAB is turned round upon the axis PB, it is plain the point A will describe the circumference of the equator whose radius is AB, and any other point C upon the meridian will describe the circumference of a parallel whose radius is CD.

Cor. 1. Hence (because the circumference of circles are as their radii) it follows, that the circumference of any parallel is to the circumference of the equator, as the co-sine of its latitude is to radius.

Cor. 2. And since the wholes are as their similar parts, it will be, As the length of a degree on any parallel, is to the length of a degree upon the equator, so is the co-sine of the latitude of that parallel, to radius.

Cor. 3. Hence, As radius, is to the co-sine of any latitude, so are the minutes of difference of longitude between two meridians, or their distance in miles upon the equator, to the distance of these two meridians on the parallel in miles.

Cor. 4. And, As the co-sine of any parallel, is to radius, so is the length of any arch on that parallel (intercepted between two meridians) in miles, to the length of a similar arch on the equator, or minutes of difference of longitude.

Cor. 5. Also, As the co-sine of any one parallel, is to the co-sine of any other parallel, so is the length of any arch on the first in miles, to the length of the same arch on the other in miles.

From what has been said, arises the solution of the several cases of parallel sailing, which are as follow:

CASE I. Given the difference of longitude between two places, both lying on the same parallel; to find the distance between those places.

Example 1. Suppose a ship in the latitude of 54° 20′ north, sails directly west on that parallel till she has differed her longitude 12° 45′; required the distance sailed on that parallel.

First, The difference of longitude reduced into minutes, or nautical miles, is 765′, which is the distance between the meridian sailed from, and the meridian come to, upon the equator; then to find the distance between these meridians on the parallel of 54° 20′, or the distance sailed, it will be, by Cor. 3. of the last article,

As radius - - -		10.00000
is to the co-sine of the lat.	54° 20′	9.76572
so are the minutes of diff. lon.	765	2.18366
to the distance on the parallel	446.1	2.64938

Example 2. A degree on the equator being 60 minutes or nautical miles; required the length of a degree on the parallel of 51° 32′.

By Cor. 3. of the last article, it will be

As radius - - -		10.00000
is to the co-sine of the latitude	51°, 32′	9.79383
so are the min. in 1° on the equa.	60	1.77815
to - - -	37.32	1.57198

the miles answering to a degree on the parallel of 51° 32′.

By this problem a table is constructed, shewing the geographic miles answering to a degree on any parallel of latitude; in which you may observe, that the columns marked at the top with D. L. contain the degrees of latitude belonging to each parallel: and the adjacent columns marked at the top Miles, contain the geographic miles answering to a degree upon these parallels. See the table in the article MAP.

Though the table does only shew the miles answering to a degree of any parallel, whose latitude consists of a whole number of degrees; yet it may be made to serve for any parallel whose latitude is some number of degrees and minutes, by making the following proportion, viz.

As 1 degree, or 60 minutes, is to the difference between the miles answering to a degree in the next greater and next less tabular latitude than that proposed; so is the excess of the proposed latitude above the next tabular latitude, to a proportional part; which, subtracted from the miles answering to a degree of longitude in the next less tabular latitude, will give the miles answering to a degree in the proposed latitude.

Example. Required to find the miles answering to a degree on the parallel of 56° 44′.

First, The next less parallel of latitude in the table than that proposed, is that of 56°, a degree of which (by the table) is equal to 35.55 miles; and the next greater parallel of latitude in the table, than that proposed, is that of 57°, a degree of which is (by the table) equal to 32.68 miles; the difference of these is 87, and the distance between these parallels is 1 degree, or 60 minutes; also the distance between the parallel of 56°, and the proposed parallel of 56° 44′, is 44 minutes: then, by the preceding proportion, it will be, As 60 is to 87, so is 44 to 638, the difference between a degree on the parallel of 56° and a degree on the parallel of 56° 44′; which, therefore, taken from 33.55, the miles answering to a degree on the parallel of 56°, leaves 32 912, the miles answering to a degree on the parallel of 56° 44′, as was required.

Case II. The distance sailed in any parallel of latitude, or the distance between any two places on that parallel, being given; to find the difference of longitude.

Example. Suppose a ship in the latitude of 55° 36′ north, sails directly east 685,6 miles: required how much she has differed her longitude.

By Cor. 4. Art. 1. of this section, it will be

As the co-sine of the lat.	55° 36′	9.75202
is to radius - - -		10.00000
so is the distance sailed	685.6	2.83607
to minute of difference of lon.	1213	3.08405

which reduced into degrees, by dividing by 60, makes 20° 13′, the difference of longitude the ship has made.

This also may be solved by help of the preceding table, viz. by finding from it the miles answering to a degree on the proposed parallel, and dividing with this the given number of miles, the quotient will be the degrees and minutes of difference of longitude required.

Thus in the last example, we find, from the foregoing table, that a degree on the parallel of 55° 36′ is equal to 33.89 miles; by this we divide the proposed number of miles 685.6, and the quotient is 20.13 degrees, *i. e.* 20° 13′, the difference of longitude required.

Case III. The difference of longitude between two places on the same parallel, and the distance between them, being given; to find the latitude of that parallel.

Example. Suppose a ship sails on a certain parallel directly west 624 miles, and then has differed her longitude 18° 46′, or 1126 miles: required the latitude of the parallel she sailed upon; it will be by Cor. 3. before

As the min. of diff. long. 1.	126	3.05154
is to the distance sailed	624	2.79518
so is radius - - -		10.00000
to the co-sine of the lat.	56°, 21′	9.74364

consequently the latitude of the ship, or parallel she sailed upon, was 56° 21′.

From what has been said, may be solved the following problems:

Prob. I. Suppose two ships in the latitude of 46° 30′ north, distant asunder 654 miles, sail both directly north 256 miles, and consequently are come to the latitude of 50° 46′ north: required their distance on that parallel.

By Cor. 5. Art. 1. of this section, it will be,

As the co-sine of	46°, 30′	9 83781
is to the co-sine of	50°, 46′	9.80105
so is - -	654 -	2.81558
to - -	601 -	2.77882

the distance between the ships when on the parallel of 50° 46′.

Prob. II. Suppose two ships in the latitude of 45° 48′ north, distant 846 miles, sail directly north till the distance between them is 624 miles: required the latitude come to, and the distance sailed.

By Cor. 5. Art. 1. of this section, it will be,

As their first distance	846	2.92737
is to their second distance	624	2.79518
so is the co-sine of -	45°, 48′	9.84334
to the co-sine - -	59°, 04′	9.71115

the latitude of the parallel the ships are come to.

Consequently, to find their distance sailed,

From the latitude come to -	59°, 04′
subtract the latitude sailed from	45 , 48
and there remains - -	13 , 16

equal to 796 miles, the difference of latitude or distance sailed.

Of Middle-latitude Sailing. 1. When two places lie both on the same parallel, we have shewn how, from the difference of longitude given, to find the miles of easting or westing between them, *et è contra*. But when two places lie not on the same parallel, then their difference of longitude cannot be reduced to miles of easting or westing on the parallel of either place: for if counted on the parallel of that place that has the greatest latitude, it would be too small; and if on the parallel of that place having the least latitude, it would be too great. Hence the common way of reducing the difference of longitude between two places, lying on different parallels, to miles of easting or westing, *et è contra*, is by counting it on the middle parallel between the places, which is found by adding the latitudes of the two places together, and taking half the sum, which will be the latitude of the middle parallel required. And hence arises the solution of the following cases:

Case I. The latitudes of two places, and their difference of longitude, given; to find the direct course and distance.

Example. Required the direct course and distance between the Lizard in the latitude of 50° 0′ north, and longitude of 5° 14′ west, and St. Vincent in the latitude of 17° 10′ N. and longitude of 24° 20′ W.

First, To the latitude of the Lizard	50° 00′	N
add the latitude of St. Vincent	17 10	
The sum is - - - -	67 10	
Half the sum or latitude of the middle parallel is - -	33 35	N
Also the difference of latitude is	33 50	

equal to 1970 miles of southing. Again,

From the longitude of St. Vincent	24 20	W
take the longitude of the Lizard	05 14	
there remains - - - -	16 06	

equal to 1146 min. of diff. of lon. west.

Then for the miles of westing, or departure, it will be (by Case 1. of Parallel Sailing),

As radius - - -		10.00000
is to the co-sine of the middle parallel	33°, 35′	9.92069
so is min. diff. of lon. -	1146	3.05918
to the miles of westing	954.7	2.97987

And for the course it will be (by Case 4. of Plane Sailing),

As the diff. of lat. -	1970	3.29447
is to radius - - - -		10.00000
so is the departure -	954.7	2.97987
to the tang. of the course	25°, 51′	9.68540

which, because it is between south and west, will be SSW $\frac{1}{4}$ west nearly.

For the distance, it will be, by the same case,

As radius - - - -		10.00000
is to the diff. of lat. -	1970	3.29447
so is the secant of the course	25°, 51′	10.04579
to the distance - -	2189	3.34026

whence the direct course and distance from the Lizard to St. Vincent are SSW $\frac{1}{4}$ 2189 W. miles.

Case II. One latitude, course, and distance sailed, being given; to find the other latitude, and difference of longitude.

Example. Suppose a ship in the latitude of 50° 00′ north, sails south 50° 06′ west, 150 miles; required the latitude the ship has come to, and how much she has differed her longitude.

First, For the difference of latitude, it will be, (by Case 1. of Plane Sailing,)

As radius - - -		10.00000
is to the distance -	150	2 17609
so is the co-sine of the course	50°, 06′	9.80716
to the diff. of latitude -	96.22	1.98325

equal to 1°, 36′. And since the ship is sailing towards the equator: therefore,

From the latitude she was in -	50°, 00′
take the difference of latitude -	1 , 36
and there remains - -	48 , 24

the latitude she has come to north. Consequently the latitude of the middle parallel will be 49° 12′.

Then for departure or westing it will be, by the same Case,

As radius - - - - -		10.00000
is to the distance -	150	2.17609
so is the sine of the course	50°, 06′	9.88489
to the departure -	115.1	2.06098

As for the difference of longitude, it will be, (by Case 2. of Plane Sailing,)

As the co-s. of the middle par.	49° 12′	9.81519
is to radius - - - -		10.00000
so is the departure -	115.1	2.06098
to the min. diff. of longitude	176.1	2.24579

equal to 2° 56′, which is the difference of longitude the ship has made westerly.

Case III. Course and difference of latitude given; to find the distance sailed, and difference of longitude.

Example. Suppose a ship in the latitude of 53° 34′ north, sails SE*b*S, till by observation she is found to be in the latitude of 51° 12′, and consequently has differed her latitude 2° 22′, or 142 miles: required the distance sailed, and the difference of longitude.

First, for the departure, it will be, (by Case 2. of Plane Sailing,)

As radius - - -		10 00000
is to the diff. of latitude	142	2.15229
so is the tang. of course	33°, 45′	9.82489
to the departure -	94.88	1.97718

And for the distance it will be, (by the same Case,)

As radius - -		10.00000
is to the diff. of latitude	142	2.15229
so is the secant of the course	33°, 45′	10.08015
to the distance -	170,8	2.23244

Then, since the latitude sailed from was 53° 34′ north, and the latitude come to 51° 12′ north; therefore the middle parallel will be 52° 23′; and consequently, for the difference of longitude, it will be, (by Case 2. of Parallel Sailing,)

As the co-sine of the mid. par.	52°, 23′	9.78560
is to the departure -	94.88	1.97718
so is radius - -		10.00000
to min. of diff. of longitude	155.5	2.19158

equal to 2° 35′, the difference of longitude easterly.

Case IV. Difference of latitude and distance sailed, given; to find the course and difference of longitude.

Example. Suppose a ship in the latitude of 43° 26′ north, sails between south and east, 246 miles, and then is found by observation to be in the latitude of 41° 06′ north: required the direct course and difference of longitude.

First, for the course, it will be, (by Case 3. of Plane Sailing,)

As the distance -	246	2.39094
is to radius - -		10.00000
so is the diff. of latitude	140	2.14613
to the co-sine of the course	55°, 19′	9.75519

which, because the ship sails between south and east, will be south 55° 19′ east, or SE*b*E nearly.

Then, for departure, it will be, by the same Case,

As radius - - -		10.00000
is to the distance -	246	2.39094
so is the sine of the course	55°, 19′	9.91504
to the departure -	202.3	2.30598

Lastly, For the difference of longitude, it will be, (by Case 2. of Parallel Sailing,)

As the co-sine of the mid. par.	42°, 16′	9.86924
is to the departure -	203.8	2.30598
so is radius - -		10 00000
to min. of diff. of longitude	273.3	2.43674

equal to 4° $33'$, the difference of longitude easterly.

CASE V. Course and departure given; to find difference of latitude, difference of longitude, and distance sailed.

Example. Suppose a ship in the latitude of 48° $23'$ north, sails SW*b*S, till she has made of westing 123 miles: required the latitude come to, the difference of longitude, and the distance sailed.

First, For the distance, it will be, (by Case 6. of Plane Sailing,)

As the sine of the course	33°, $45'$	6.74474
is to the departure -	123	2.08991
so is radius - - -		10.00000
to the distance -	221.4	2.34517

And for the difference of latitude, it will be, by the same Case,

As the tang. of course	33°, $45'$	9.82489
is to the departure -	123	2.08991
so is radius - - -		10.00000
to the diff. of latitude	184	2.26502

equal to 3° $04'$; and since the ship is sailing towards the equator, the latitude come to will be 45° $19'$ north; and consequently the middle parallel will be 46° $51'$.

Then, to find the difference of longitude, it will be, (Case 2. of Parallel Sailing,)

As the co-sine of middle par.	46°, $51'$	9.83500
is to the departure -	123	2.08991
so is radius - - -		10.00000
to min. of diff. of longitude	180	2.25491

which is equal to 3° $00'$, the difference of longitude westerly.

CASE VI. Difference of latitude and departure given; to find course, distance, and difference of longitude.

Example. Suppose a ship in the latitude of 46° $37'$ north, sails between south and east, till she has made of easting 146 miles, and is then found by observation to be in the latitude of 43° $24'$ north: required the course, distance, and difference of longitude.

First, by Case 4. of Plane Sailing, it will be for the course,

As the diff. of latitude	193	2.28556
is to the departure -	146	2.16137
so is radius - -		10.00000
to the tang. of the course	36°, $55'$	9.87581

which, because the ship is sailing between south and east, will be south 36° $55'$ east, or SE*b*S $\frac{1}{4}$ east nearly.

For the distance, it will be, by the same Case,

As radius - -		10.00000
is to the diff. of latitude	193	2.28556
so is the secant of the course	36°, $55'$	10.09718
to the distance -	241.4	2.38274

Then, for the difference of longitude, it will be, by Case 2. of Parallel Sailing,

As the co-sine of the mid. par.	45°, $00'$	9.84949
is to the departure -	146	2.16137
so is radius - -		10.00000
to min. of diff. of longitude	205	2.31188

equal to 3° $25'$, the difference of longitude easterly.

CASE VII. Distance and departure given; to find difference of latitude, course, and difference of longitude.

Example. Suppose a ship in the latitude of 33° $40'$ north, sails between south and east 165 miles, and has then made of easting 112.5 miles: required the difference of latitude, course, and difference of longitude.

First, for the course, it will be, by Case 5. of Plane Sailing,

As the distance -	165	2.21748
is to radius - -		10.00000
so is the departure -	102.5	2.05115
to the sine of the course	42°, $59'$	9.83367

which, because the ship sails between south and east, will be south 42° $59'$ east, or SE*b*E $\frac{3}{4}$ east nearly.

And for the difference of latitude, it will be, by the same Case,

As radius - -		10.00000
is to the distance -	165	2.21748
so is the co-sine of the course	42° $59'$	9.86436
to the difference of latitude	120.7	2.08184

equal to 2° $00'$; consequently the latitude come to will be 31° $40'$ north, and the latitude of the middle parallel will be 32° $40'$. Hence, to find the difference of longitude, it will be, by Case 2. of Parallel Sailing,

As the co-sine of the mid. par.	32°, $40'$	9.92522
is to the departure -	112.5	2.05115
so is radius - - -		10.00000
to min. of diff. of long.	133.6	2.12593

equal to 2° $13'$ nearly, the difference of longitude easterly.

CASE VIII. Difference of longitude and departure given: to find difference of latitude, course, and distance sailed.

Example. Suppose a ship in the latitude of 50° $46'$ north, sails between south and west, till her difference of longitude is 3° $12'$, and is then found to have departed from her former meridian 126 miles: required the difference of latitude, course, and distance sailed.

First, for the latitude she has come to, it will be, by Case 3. of Parallel Sailing,

As min. of diff. of long.	192	2.28330
is to the departure -	126	2.10037
so is radius - -		10.00000
to the co-sine of mid. par.	48°, $59'$	9.81707

Now, since the middle latitude is equal to half the sum of the two latitudes (by art. 1. of this sect.) and so the sum of the two latitudes equal to double the middle latitude; it follows, that if from double the middle latitude we subtract any one of the latitudes, the remainder will be the other. Hence from twice 48° $59'$, viz. 97° $58'$, taking 50° $46'$ the latitude sailed from, there remains 47° $12'$ the latitude come to; consequently the difference of latitude is 3° $34'$, or 214 minutes.

Then, for the course, it will be, by Case 4. of Plane Sailing,

As difference of latitude	214	2.33041
is to radius - - -		10.00000
so is the departure -	126	2.10037
to the tang. of the course	30° $29'$	9.76996

which, because it is between south and west, will be south 30° $29'$ west, or SSW $\frac{3}{4}$ west nearly.

And for the distance, it will be, by the same Case,

As radius - - -		10.00000
is to the difference of lat.	214	2.33041
so is the secant of the course	30°, $29'$	10.06461
to the distance - -	248.4	2.39502

2. From what has been said, it will be easy to solve a traverse by the rules of Middle-latitude Sailing.

Example. Suppose a ship in the latitude of 43° $25'$ north, sails upon the following courses, viz. SW*b*S 63 miles, SSW $\frac{1}{2}$ west 45 miles, S*b*E 54 miles, and SW*b*W 74 miles: required the latitude the ship has come to, and how far she has differed her longitude.

First, By Case 2. of this sect. find the difference of latitude and difference of longitude belonging to each course and distance, and they will stand as in the following table:

Courses.	*Distances.*	*Diff. of Lat.* North.	*Diff. of Lat.* South.	*Diff. of Long.* East.	*Diff. of Long.* West.
SW*b*S	- 63	—	52.4	—	47.85
SSW$\frac{1}{2}$W	- 45	—	39.7	—	28.62
S*b*E	- 54	—	53.0	14.75	—
SW*b*W	- 74	—	41.1	—	81.08
					157.55
		Diff. of Lat.	186.2		13.75
				Diff. of Long.	143.80

Hence it is plain the ship has differed her latitude 186.2 minutes, or 3° $6'$, and so has come to the latitude of 40° $19'$ north, and has made of difference of longitude 143.8 minutes, or 2° $23'$ $48''$, westerly.

3. This method of sailing, though it is not strictly true, yet comes very near the truth, as will be evident by comparing an example wrought by this method with the same wrought by the method delivered in the next section, which is strictly true; and it serves, without any considerable error, in runnings of 450 miles between the equator and parallel of 30 degrees, of 300 miles between that and the parallel of 60 degrees, and of 150 miles as far as there is any occasion, and consequently must be sufficiently exact for 24 hours run.

Of Mercator's sailing. Though the meridians do all meet at the pole, and the parallels to the equator do continually decrease, and that in proportion to the co-sines of their latitudes; yet in old sea-charts the meridians were drawn parallel to one another, and consequently the parallels of latitude made equal to the equator, and so a degree of longitude on any parallel as large as a degree on the equator; also in these charts the degrees of latitude were still represented (as they are in themselves) equal to each other, and to those of the equator. By these means the degrees of longitude being increased beyond their just proportion, and the more so the nearer they approach the pole, the degrees of latitude at the same time remaining the same, it is evident places must be very erroneously marked down upon these charts with respect to their latitude and longitude, and consequently their bearing from one another very false.

To remedy this inconvenience, so as still to keep the meridians parallel, it is plain we must protract, or lengthen, the degrees of latitude in the same proportion as those of longitude are, that so the proportion in easting and westing may be the same with that of southing and northing, and consequently the bearings of places from one another are the same upon the chart as upon the globe itself.

Let ABD (fig. 10.) be a quadrant of a meridian, A the pole, D a point on the equator, AC half the axis, B any point upon the meridian, from which draw BF perpendicular to AC, and BG perpendicular to CD: then BG will be the sine, and BF or CG the co-sine, of BD the latitude of the point B; draw DE the tangent and CE the secant of the arch CD. It has been demonstrated, that any arch of a parallel is to the like arch of the equator, as the co-sine of the latitude of that parallel is to radius. Thus any arch, as a minute on the parallel described by the point B, will be to a minute on the equator, as BF or CG is to CD; but since the triangles CGB, CDE, are similar, therefore CG will be to CD as CB is to CE, *i. e.* the co-sine of any parallel is to radius as radius is to the secant of the latitude of that parallel. But it has been just now shown, that the co-sine of any parallel is to radius, as the length of any arch (as a minute) on that parallel is to the length of the like arch on the equator; therefore the length of any arch (as a minute) on any parallel, is to the length of the like arch on the equator, as radius is to the secant of the latitude of that parallel; and so the length of any arch (as a minute) on the equator, is longer than the like arch of any parallel, in the same proportion as the secant of the latitude of that parallel is to radius. But since in this projection the meridians are parallel, and consequently each parallel of latitude equal to the equator, it is plain the length of any arch (as a minute) on any parallel, is increased beyond its just proportion, at such rate as the secant of the latitude of that parallel is greater than radius; and therefore, to keep up the proportion of northing and southing to that of easting and westing, upon this chart, as it is upon the globe itself, the length of a minute upon the meridian at any parallel must also be increased beyond its just proportion at the same rate, *i. e.* as the secant of the latitude of that parallel is greater than radius. Thus to find the length of a minute upon the meridian at the latitude of 75 degrees, since a minute of a meridian is every where equal on the globe, and also equal to a minute upon the equator, let it be represented by unity; then making it as radius to the secant of 75 degrees, so is unity to a fourth number, which is 3.864 nearly; and consequently, by whatever line you represent one minute on the equator of this chart, the length of one minute on the enlarged meridian at the latitude of 75 degrees, or the distance between the parallel of 75° 00′ and the parallel of 75° 01′, will be equal to 3 of these lines, and $\frac{804}{1000}$ of one of them. By making the same proportion, it will be found that the length of a minute on the meridian of this chart at the parallel of 60°, or the distance between the parallel of 60° 00 and that of 60° 01′, is equal to two of these lines. After the same manner, the length of a minute on the enlarged meridian may be found at any latitude; and consequently beginning at the equator, and computing the length of every intermediate minute between that and any parallel, the sum of all these shall be the length of a meridian intercepted between the equator and that parallel; and the distance of each degree and minute of latitude from the equator upon the meridian of this chart, computed in minutes of the equator, forms what is commonly called a table of meridional parts.

If the arch BD (fig. 10.) represents the latitude of any point B, then (CD being radius) CE will be the secant of that latitude; but it has been shown above, that radius is to secant of any latitude, as the length of a minute upon the equator is to the length of a minute on the meridian of this chart at that latitude; therefore CD is to CE, as the length of a minute on the equator is to the length of a minute upon the meridian at the latitude of the point B. Consequently, if the radius CD is taken equal to the length of a minute upon the equator, CE, or the secant of the latitude, will be equal to the length of a minute upon the meridian at that latitude. Therefore, in general, if the length of a minute upon the equator is made radius, the length of a minute upon the enlarged meridian will be every where equal to the secant of the arch contained between it and the equator.

Hence it follows, since the length of every intermediate minute between the equator and any parallel is equal to the secant of the latitude, (the radius being equal to a minute upon the equator), the sum of all these lengths, or the distance of that parallel on the enlarged meridian from the equator, will be equal to the sum of all the secants to every minute contained between it and the equator.

Consequently, the distance between any two parallels on the same side of the equator, is equal to the difference of the sums of all the secants contained between the equator and each parallel; and the distance between any two parallels on contrary sides of the equator, is equal to the sum of the sums of all the secants contained between the equator and each parallel.

By the tables of meridional parts given by all the writers on this subject, may be constructed the nautical chart, commonly called Mercator's chart. See Maps.

In fig. 11, let A and E represent two places upon Mercator's chart, AC the meridian of A, and CE the parallel of latitude passing through E; draw AE, and set off upon AC the length AB equal to the number of minutes contained in the difference of latitude between the two places, and taken from the same scale of equal parts the chart was made by, or from the equator, or any graduated parallel of the chart, and through B draw BD parallel to CE meeting AE in D. Then AC will be the enlarged difference of latitude, AB the proper difference of latitude, CE the difference of longitude, BD the departure, AE the enlarged distance, and AD the proper distance, between the two places A and E; also the angle BAD will be the course, and AE the rhumb-line between them.

Now, since in the triangle ACE, BD is parallel to one of its sides CE; it is plain the triangles ACE, ABD, will be similar, and consequently the sides proportional. Hence arise the solutions of the several cases in this sailing, which are as follow:

Case I. The latitudes of two places given, to find the meridional or enlarged difference of latitude between them.

Of this case there are three varieties, viz. either one of the places lies on the equator: or both on the same side of it; or lastly, on different sides.

1. If one of the proposed places lies on the equator, then the meridional difference of latitude is the same with the latitude of the other place, taken from the table of meridional parts.

Example. Required the meridional difference of latitude between St. Thomas, lying on the equator, and St. Antonio, in the latitude of 17° 20′ north. We look in the tables for the meridional part answering to 17° 20′, and find it to be 1056.2, the enlarged difference of latitude required.

2. If the two proposed places are on the same side of the equator, then the meridional difference of latitude is found by subtracting the meridional parts answering to the least latitude from those answering to the greatest, and the difference is that required.

Example. Required the meridional difference of latitude between the Lizard in the latitude of 50° 00′ north, and Antigua in the latitude of 17° 30′ north.

From the meridional parts of	50°, 00′	3474.5
subtract the merid. parts of	17 30	1066.7
there remains - -		2407.8

the meridional difference of latitude required.

3. If the places lie on different sides of the equator, then the meridional difference of latitude is found by adding together the meridional parts answering to each latitude, and the sum is that required.

Example. Required the meridional difference of latitude between Antigua in the latitude of 17° 30′ north, and Lima in Peru in the latitude of 12° 30′ south.

To the merid. parts answering to	17° 30′	1066.7
add these answering to -	12 30	756.1
the sum is - - - -		1822.8

the meridional difference of latitude required.

Case II. The latitudes and longitudes of two places given; to find the direct course and distance between them.

Example. Required to find the direct course and distance between the Lizard in the latitude of 50° 00′ north, and Port Royal in Jamaica, in the latitude of 17° 40′; differing in longitude 70° 46′, Port Royal lying so far to the westward of the Lizard.

Preparation.

From the latitude of the Lizard -	50° 00′
subtract the latitude of Port Royal	17 40
and there remains - - - -	32 20

equal to 1940 minutes, the proper difference of latitude.

Then from the merid. parts of	50° 00′	3474.5
subtract those of -	17 40	1057.2
and there remains - - -		2397.3

the meridional or enlarged difference of longitude.

Geometrically. Draw the line AC, fig. 12, representing the meridian of the Lizard at A; and set off from A, upon that line, AE equal to 1940 (from any scale of equal parts) the proper difference of latitude, also AC equal to 2397.3 (from the same scale) the meridional or enlarged difference of latitude. Upon the point C raise CB perpendicular to AC, and make CB equal to 4246, the minutes of difference of longitude.

Join AB, and through E draw ED parallel to BC: so the case is constructed; and AD applied to the same scale of equal parts the other legs were taken from, will give the direct distance, and the angle DAD measured by the line of chords will give the course.

By Calculation.

For the angle of the course EAD, it will be, (by rectangular trigonometry,)

AC : CB :: R : T, BAC,

i. e. As the merid. diff. of lat.	2397.3	3.37970
is to the difference of long.	4246.0	3.62798
so is radius - -		10.00000
to the tang. of the direct course	60° 33′	10.34828

which, because Port Royal is southward of the Lizard, and the difference of longitude westerly, will be south 60° 33′ west, or SW*b*W ½ west nearly.

Then for the distance AD, it will be (by rectangular trigonometry),

R : AE :: Sec. A : AD,

i. e. As the radius - -		10.00000
is the proper diff. of lat.	1940	3.28780
so is the secant of the course	60° 33′	10.30833
to the distance -	3945.6	3.59613

consequently the direct course and distance between the Lizard and Port Royal in Jamaica, is south 60° 33′ 3945.6 miles.

Case III. Course and distance sailed, given; to find difference of latitude, and difference of longitude.

Example. Suppose a ship from the Lizard in the latitude of 50° 00′ north, sails south 35° 40′ west 156 miles: required the latitude come to, and how much she has altered her longitude.

Geometrically. 1. Draw the line BK (fig. 13), representing the meridian of the Lizard at B; from B draw the line BM, making with BK an angle equal to 35° 40′ and upon this line set off BM equal to 56 the given distance, and from M let fall the perpendicular MK upon BK.

Then for BK the proper difference of latitude, it will be, (by rectangular trigonometry,)

R : MB :: S. BMK : BK,

i. e. As radius - -		10.00000
is to the distance -	156	2.19312
so is the co-sine of the course	35° 40′	9.90978
to the proper diff. of lat.	127	2.10290

equal to 2° 07′; and since the ship is sailing from a north latitude towards the south, therefore the latitude come to will be 47° 53′ north. Hence the meridional difference of latitude will be 193.4.

2. Produce BK to D, till BD is equal to 193.4; through D draw DL parallel to MK, meeting DM produced in L; then DL will be the difference of longitude: to find which by calculation, it will be, (by rectangular trigonometry,)

R : BD :: T. LBD : DL,

i. e. As radius - -		10.00000
is to the meridional diff. of lat.	193.4	2.28646
so is the tang. of the course	35° 40′	9.85594
to minutes of diff. of long.	138.8	2.14240

equal to 2° 18′ 48″, the difference of longitude the ship has made westerly.

Case IV. Given course and both latitudes, viz. the latitude sailed from, and the latitude come to; to find the distance sailed, and the difference of longitude.

Example. Suppose a ship in the latitude of 50° 20′ north, sails south 33° 45′ east, until by observation she is found to be in the latitude of 51° 45′ north: required the distance sailed, and the difference of longitude.

Geometrically. Draw AB (fig. 14), to represent the meridian of the ship in the first latitude; and set off from A to B 155 the minutes of the proper difference of latitude, also AG equal to 257.9 the minutes of the enlarged difference of latitude. Through B and G, draw the lines BC and GK perpendicular to AG; also draw AK, making with AG an angle of 33° 45′, which will meet the two former lines in the points C and K; so the case is constructed, and AC and GK may be found from the line of equal parts: to find which,

By Calculation;

First, For the difference of longitude, it will be, (by rectangular trigonometry,)

R : AG :: T. GAK : GK,

i. e. As radius - -		10.00000
is to the enlarged diff. of lat.	257.2	2.41145
so is the tang. of the course	33° 45′	9.84289
to min. of diff. of longitude	172.3	2.23634

equal to 2° 52′ 18″, the difference of longitude the ship has made easterly.

This might also have been found, by first finding the departure BC (by Case 2. of Plane Sailing), and then it would be AB : BC :: AG : GK, the difference of longitude required.

Then, for the direct distance AC, it will be, (by rectangular trigonometry,)

R : AB :: Sec. A : AC,

i. e. As radius - -		10.00000
is to the proper diff. of lat.	155	2.19033
so is the secant of the course	33° 45′	10.08015
to the direct distance	186.4	2.27048

consequently the ship has sailed south 33° 45′ east 186.4 miles, and has differed her longitude 2° 52′ 18″ easterly.

Case V. Both latitudes and distances sailed, given; to find the direct course, and difference of longitude.

Example. Suppose a ship from the latitude of 45° 26′ north, sails between north and east 195 miles, and then by observation she is found to be in the latitude of 48° 6′ north: required the direct course, and difference of longitude.

Geometrically. Draw AB (fig. 15), equal to 160, the proper difference of latitude, and from the point B raise the perpendicular BD; then take 195 in your compasses, and setting one foot of them in A, with the other cross the line BD in D. Produce AB, till AC is equal to 233.6 the enlarged difference of latitude. Through C draw CK parallel to BD, meeting AD produced in K: so the case is constructed; and the angle A may be measured by the line of chords, and CK by the line of equal parts: to find which,

By Calculation;

First, For the angle of the course BAD, it will be, (by rectangular trigonometry,)

AB : R :: AD : Sec. A.

i. e. As the proper diff. of lat.	160	2.20412
is to radius - -		10.00000
so is the distance -	195	2.29003
to the secant of the course	34° 52′	10.08591

which, because the ship is sailing between north and east, will be north 34° 52′ east, or NE*b*N 1° 7′ easterly.

Then, for the difference of longitude, it will be, (by rectangular trigonometry,)

R : AC :: T. A : CK,

i. e. As radius - -		10.00000
is to the merid. diff. of lat.	233.6	2.36847
so is the tang. of the course	34° 52′	9.84307
to min. of diff. of longitude	162.8	2.21154

equal to 2° 42′ 48″, the difference of longitude easterly.

Case VI. One latitude, course, and difference of longitude, given; to find the other latitude and distance sailed.

Example. Suppose a ship from the latitude of 48° 50′ north, sails south 34° 40′ west, till her difference of longitude is 2° 42′: required the latitude come to, and the distance sailed.

Geometrically. 1. Draw AE (fig. 16), to represent the meridian of the ship in the first latitude, and make the angle EAC equal to 34° 40′, the angle of the course; then draw FC parallel to AE, at the distance of 164 the minutes of difference of longitude, which will meet AC in the point C. From C let fall upon AE the perpendicular CE; then AE will be the enlarged difference of latitude. To find which, by calculation, it will be, (by rectangular trigonometry,)

T. A : R :: CE : AE,

i. e. As the tang. of the course	34° 40′	9.83984
is to the radius - -		10.00000
so is min. of diff. longitude	164	2.21484
to the enlarged diff. of latitude	237.2	2.37500

and because the ship is sailing from a north latitude southerly, therefore

From the merid. parts of the latitude sailed from	48° 50′	3366.9
take the merid. difference of latitude		237.2
and there remains - - -		3129.7

the meridional parts of the latitude come to, viz. 46° 09′.

Hence, for the proper difference of latitude,

From the latitude sailed from -	48° 50′ N
take the latitude come to - -	46 09 N
and there remains - -	2 41

equal to 161, the minutes of difference of latitude.

2. Set off upon AE the length AD equal to 161 the proper difference of latitude, and through D draw DB parallel to CE: then AB will be the direct distance. To find which, by calculation, it will be, (by rectangular trigonometry,)

R : AD :: Sec. A : AB.

i. e. As radius - -		10.00000
is to the proper diff. of lat.	161	2.20683
so is the secant of the course	34° 40′	10.08488
to the direct distance -	195.8	2.29171

Case VII. One latitude, course, and departure, given; to find the other latitude, distance sailed, and difference of longitude.

Example. Suppose a ship sails from the latitude of 54° 36′ north, south 42° 33′ east, until she has made of departure 116 miles: required the latitude she is in, her direct distance sailed, and how much she has altered her longitude.

Geometrically. 1. Having drawn the meridian AB (fig. 17), make the angle BAD equal to 42° 33′. Draw FD parallel to AB at the distance of 116, which will meet AD in D. Let fall upon AB the perpendicular DB. Then AB will be the proper difference of latitude, and AD the direct distance: to find which by calculation, first, for the distance AD it will be, (by rectangular trigonometry,)

S. A : BD :: R : AD.

i. e. As the sine of the course	42° 33′	9.83010
is to the departure -	116	2.06446
so is radius - -		10.00000
to the direct distance -	171.5	2.23436

Then, for the proper difference of latitude, it will be, (by rectangular trigonometry,)

T. A : BD :: R : AB.

i. e. As the tang. of the course	42° 33′	9.96281
is to the departure -	116	2.06446
so is radius - -		10.00000
to the proper diff. of latitude	126.4	2.10165

equal to 2° 6′: consequently the ship has come to the latitude of 52° 30′ north; and so the meridional difference of latitude will be 212.2.

2. Produce AB to E, till AE be equal to 212.2; and through E draw EC parallel to BD, meeting AD produced in C; then EC will be the difference of longitude; to find which by calculation, it will be, (by rectangular trigonometry,)

R : AE :: T. A : EC.

i. e. As radius - -		10.00000
is to the merid. diff. of lat.	212.2	2.32675
so is the tang. of the course	42° 33′	9.96281
to the min. of diff. of long.	194.8	2.28956

equal to 3° 14′ 48″, the difference of longitude easterly.

This might have been found otherwise, thus: Because the triangles ACE, ADB, are similar; therefore it will be,

AB : BD :: AE : EC.

i. e. As the proper diff. of lat.	126.4	2.10165
is to the departure -	116	2.06446
so is the enlarged diff. of lat.	212.2	2.32675
to min. of diff. of longitude	194.8	2.28956

Case VIII. Both latitudes and departure given; to find course, distance, and difference of longitude.

Example. Suppose a ship from the latitude of 46° 20′ N. sails between south and west, till she has made of departure 126.4 miles; and is then found by observation to be in the latitude of 43° 35′ north: required the course and distance sailed, and difference of longitude.

Geometrically. Draw AK (fig. 18), to represent the meridian of the ship in her first latitude; set off upon it AC, equal to 165, the proper difference of latitude. Draw BC perpendicular to AC, equal to 126.4 the departure, and join AB. Set off from A, AK equal to 233.3, the enlarged difference of latitude; and through K draw KD parallel to BC, meeting AB produced in D; so the case is constructed, and DK will be the difference of longitude, AB the distance, and the angle A the course; to find which,

By Calculation;

First, For DC the difference of longitude, it will be,

AC : CB :: AK : KD.

i. e. As the proper diff. of lat.	165	2.21748
is to the departure -	126.4	2.10175
so is the enlarged diff. of lat.	233.3	2.36791
to min. of diff. of longitude	178.7	2.25218

equal to 2° 58′ 42″, the difference of longitude westerly.

Then, for the course it will be, (by rectangular trigonometry,)

AC : BC :: R : T. A.

i. e. As the proper diff. of lat.	165	2.21748
is to the departure -	446.1	2.10175
so is radius - -		10.00000
to the tang. of the course	37° 27′	9.88427

which, because the ship sails between south and west, will be south 37° 27′ west, or SW*b*S 6° 33′ westerly.

Lastly, For the distance AB, it will be, (by rectangular trigonometry,)

S, A : BC :: R : AB.

i. e. As the sine of the course	37° 27′	9.78395
is to the departure -	126.4	2.10175
so is radius -	-	10.00000
to the direct distance -	207.9	2.31780

Case IX. One latitude, distance sailed, and departure, given; to find the other latitude, difference of longitude, and course.

Example. Suppose a ship in the latitude of 48° 33′ north, sails between south and east 138 miles, and has then made of departure 112.6: required the latitude come to, the direct course, and difference of longitude.

Geometrically. 1. Draw BD (fig. 19) for the meridian of the ship at B; and parallel to it draw FE, at the distance of 112.6, the departure. Take 138, the distance, in your compasses, and fixing one point of them in B, with the other cross the line FE in the point E; then join B and E, and from E let fall upon BD the perpendicular ED; so BD will be the proper difference of latitude, and the angle B will be the course; to find which by calculation,

First, For the course it will be, (by rectangular trigonometry,)

BE : R :: DE : S. B.

i. e. As the distance -	138	2.13988
is to radius - - - -		10.00000
so is the departure -	112.6,	2.05154
to the sine of the course	54° 41′	9.91166

which, because the ship sails between south and east, will be south 54° 41′ east, or SE 0° 41′ easterly.

Then, for the difference of latitude, it will be, (by rectangular trigonometry,)

R : BE :: Co. S. B : BD.

i. e. As radius - - - -		10.00000
is to the distance -	138	2.13988
so is the co-sine of the course	54° 41′	9.76200
to the difference of latitude	79.8	1.90188

equal to 1° 19′. Consequently the ship has come to the latitude of 47° 13′. Hence the meridional difference of latitude will be 117.7.

2dly. Produce B to A, till BA is equal to 117.7; and through A draw AC parallel to DE, meeting BE produced in C; then AC will be the difference of longitude; to find which by calculation, it will be,

BD : DE :: BA : AC.

i. e. As the proper diff. of lat.	79.8	1.90180
is to the departure -	112.6	2.05154
so is the enlarged diff. of lat.	117.7	2.07078
to the diff. of longitude -	166.1	2.22014

equal to 2° 46′ 06″, the difference of longitude easterly.

Having shewn under the article Maps how to construct a Mercator's chart, we shall now proceed to point out its several uses.

Prob. I. Let it be required to lay down a place upon the chart, its latitude, and the difference of longitude between it and some known place upon the chart being given.

Example. Let the known place be the Lizard, lying on the parallel of 50° 00′ north, and the place to be laid down St. Katherine's on the east coast of America, differing in longitude from the Lizard 42° 36′, lying so much to the westward of it.

Let L represent the Lizard on the chart, (fig. 20,) lying on the parallel of 50° 00′ north, its meridian. Set off AE from E upon the equator EQ 42° 36′, towards Q, which will reach from E to F. Through F draw the meridian FG, and this will be the meridian of St. Katharine's then set off from Q to H upon the graduated meridian QB, 28 degrees; and through H draw the parallel of latitude HM, which will meet the former meridian in K, the place upon the chart required.

Prob. II. Given two places upon the chart, to find their difference of latitude and difference of longitude.

Through the two places draw parallels of latitude; then the distance between these parallels, numbered in degrees and minutes upon the graduated meridian, will be the difference of latitude required; and through the two places drawing meridians, the distance between these, counted in degrees and minutes on the equator, or any graduated parallel, will be the difference of longitude required.

Prob. III. To find the bearing of one place from another, upon the chart.

Example. Required the bearing of St. Katherine's at K, from the Lizard at L.

Draw the meridian of the Lizard AE, and join K and L with the right line KL; then, by the line of chords, measuring the angle KLE, and with that entering the tables, we shall have the thing required.

This may also be done, by having compasses drawn on the chart (suppose at two of its corners); then lay the edge of a ruler over the two places, and let fall a perpendicular, or take the nearest distance from the centre of the compass next the first place, to the ruler's edge; then, with this distance in your compasses, slide them along by the ruler's edge, keeping one foot of them close to the ruler, and the other as near as you can judge perpendicular to it, which will describe the rhumb required.

Prob. IV. To find the distance between two given places upon the chart.

This problem admits of four cases, according to the situation of the two places with respect to one another.

Case I. When the given places lie both upon the equator.

In this case their distance is found by converting the degrees of difference of longitude intercepted between them into minutes.

Case II. When the two places lie both on the same meridian.

Draw the parallels of those places; and the degrees upon the graduated meridian, intercepted between those parallels, reduced to minutes, give the distance required.

Case III. When the two places lie on the same parallel.

Example. Required to find the distance between the points K and N, both lying on the parallel of 28° 00′ north. Take from your scale the chord of 60°, or radius, in your compasses, and with that extent on KN as a base make the isosceles triangle KPN: then take from the line of sines the co-sine of the latitude, or sine of 72°, and set that off from P to S and T. Join S and T with the right line ST, and that applied to the graduated equator will give the degrees and minutes upon it equal to the distance; which, converted into minutes, will be the distance required.

The reason of this is evident from the method of Parallel Sailing; for it has been there demonstrated, that radius is to the co-sine of any parallel, as the length of any arch on the equator, to the length of the same arch on that parallel. Now, in this chart KN is the distance of the meridians of the two places K and N upon the equator; and since, in the triangle PNK, ST is the parallel to KN, therefore PN : PT :: NK : TS. Consequently TS will be the distance of the two places K and N upon the parallel of 28°.

If the parallel the two places lie on is not far from the equator, and they not far asunder; then their distance may be found thus: Take the distance between them in your compasses and apply that to the graduated meridian, so that one foot may be as many minutes above as the other is below the given parallel; and the degrees and minutes intercepted, reduced to minutes, will give the distance.

Or it may also be found thus: Take the length of a degree on the meridian at the given parallel, and turn that over on the parallel from the one place to the other, as oft as you can; then, as often as that extent is contained between the places, so many times 60 miles will be contained in the distance between them.

Case IV. When the places differ both in longitude and latitude.

Example. Suppose it was required to find the distance between the two places *a* and *e* upon the chart. By Prob. II. find the difference of latitude between them; and take that in your compasses from the graduated equator, which set off on the meridian of *a*, from *a* to *b*; then through *b* draw *bc* parallel to *de*; and taking *ac* in your compasses, apply it to the graduated equator, and it will shew the degrees and minutes contained in the distance required, which multiplied by 60 will give the miles of distance.

The reason of this is evident; for it is plain *ad* is the enlarged difference of latitude, and *ab* the proper; consequently *ae* is the enlarged distance, and *ac* the proper.

Prob. V. To lay down a place upon the chart, its latitude and bearing from some known place upon the chart being known; or (which is the same) having the course and difference of latitude that a ship has made, to lay down the running of the ship, and find her place upon the chart.

Example. A ship from the Lizard in the latitude of 50° 00′ north, sails SSW till she has differed her latitude 36° 40′: required her place upon the chart.

Count from the Lizard at L, on the graduated meridian downwards (because the course is southerly) 36° 40′ to *g*; through which draw a parallel of latitude, which will be the parallel the ship is in; then from L draw a SSW line L*f*, cutting the former parallel in *f*, and this will be the ship's place upon the chart.

Prob. VI. One latitude, course, and distance sailed, given; to lay down the running of the ship, and find her place upon the chart.

Example. Suppose a ship at *a* in the latitude of 20° 00′ north, sails north 37° 20′, east 191 miles: required the ship's place upon the chart.

Having drawn the meridian and parallel of the place *a*, set off the rhumb-line *ae*, making with *ab* an angle of 37° 20′; and upon it set off 191 from *a* to *c*; through *c* draw the parallel *cb*; and taking *ab* in your compasses, apply it to the graduated equator, and observe the number of degrees it contains; then count the same number of degrees on the graduated meridian from C to *b*, and through *b* draw the parallel *be*, which will cut *ac* produced in the point *e*, the ship's place required.

Prob. VII. Both latitudes and distance sailed given; to find the ship's place upon the chart.

Example. Suppose a ship sails from *a*, in the latitude of 20° 00′ north, between north and east 191 miles, and is then in the latitude of 45° 00′ north: required the ship's place upon the chart.

Draw *de* the parallel of 45°, and set off upon the meridian of *a* upwards, *ab* equal to the proper difference of latitude taken from the equator or graduated parallel. Through *b* draw *bc* parallel to *de*; then, with 191 in your compasses, fixing one foot of them in *a*, with the other cross *bc* in *c*. Join *a* in *c* with the right line *ac*; which produced will meet *de* in *e*, the ship's place required.

Prob. VIII. One latitude, course, and difference of longitude, given; to find the ship's place upon the chart.

Example. Suppose a ship from the Lizard in the latitude of 50° 00′ north, sails SW*b*W, till her difference of longitude is 42° 36′: required the ship's place upon the chart.

Having drawn AE the meridian of the Lizard at L, count from E to F upon the equator 42° 36′; and through F draw the meridian EG; then from L draw the SW*b*W line LK, and where this meets FG, as at K, will be the ship's place required.

Prob. IX. One latitude, course, and departure, given; to find the ship's place upon the chart.

Example. Suppose a ship at *a* in the latitude of 20° 00′ north, sails north 37° 20′ east, till she has made of departure 116 miles: required the ship's place upon the chart.

Having drawn the meridian of *a*, at the distance of 116 draw parallel to it the meridian *kl*. Draw the rhumb-line *ac*, which will meet *kl* in some point *c*; then through *c* draw the parallel *cb*, and *ab* will be the proper difference of latitude, and *bc* the departure. Take *ab* in your compasses, and apply it to the equator or graduated parallel; then observe the number of degrees it contains, and count so many on the graduated meridian from C upwards to *b*. Through *b* draw the parallel *be*, which will meet *ac* produced in some point as *e*, which is the ship's place upon the chart.

Prob. X. One latitude, distance, and departure, given; to find the ship's place upon the chart.

Example. Suppose a ship at *a* in the latitude of 20° 00′ north, sails 191 miles between north and east, and then is found to have made of departure 116 miles: required the ship's place upon the chart.

Having drawn the meridian and parallel of the place *a*, set off upon the parallel *am* equal to 116, and through *m* draw the meridian *kl*. Take the given distance 191 in your compasses; setting one foot of them in *a*, with the other cross *kl* in *c*. Join *ac*, and through *c* draw the parallel *cb*; so *cb* will be the departure, and *ab* the proper difference of latitude; then proceeding with this as in the foregoing problem, you will find the ship's place to be *c*.

Prob. XI. The latitude sailed from, difference of latitude, and departure, given; to find the ship's place upon the chart.

Example. Suppose a ship from *a* in the latitude of 20° 00′ north, sails between north and east, till she is in the latitude of 45° 00′ north, and is then found to have made of departure 116 miles: required the ship's place upon the chart.

Having drawn the meridian of *a*, set off upon it, from *a* to *b*, 25 degrees, (taken from the equator or graduated parallel) the proper difference of latitude; then through *b* draw the parallel *bc*, and make *bc* equal to 116 the departure, and join *ac*. Count from the parallel of *a* on the graduated meridian upwards to *d* 25 degrees, and through *d* draw the parallel *de*, which will meet *ac* produced in some point *e*, and this will be the place of the ship required.

In the article of Plane Sailing, it is evident that the terms meridional distance, departure, and difference of longitude, were synonimous, constantly signifying the same thing; which evidently followed from the supposition of the earth's surface being projected on a plane in which the meridians were made parallel, and the degrees of latitude equal to one another and to those of the equator. But since it has been demonstrated, that if, in the projection of the earth's surface upon a plane, the meridians are made parallel, the degrees of latitude must be unequal, still increasing the nearer they come to the pole; it follows, that these terms must denote lines really different from one another.

Of Oblique Sailing. The questions that may be proposed on this head being innumerable, we shall only give one as a specimen.

Coasting along the shore, I saw a cape bear from me NNE: then I stood away NW*b*W 20 miles, and I observed the same cape to bear from me NE*b*E: required the distance of the ship from the cape at each station.

Geometrically. Draw the circle NWSE (figure 21,) to represent the compass, NS the meridian, and WE the east and west line, and let C be the place of the ship in her first station; then from C set off upon the NW*b*W line, CA 20 miles, and A will be the place of the ship in her second station.

From C draw the NNE line CB, and from A draw AB parallel to the NE*b*E line CD, which will meet CB in B, the place of the cape, and CB will be the distance of it from the ship in its first station, and AB the distance in the second: to find which,

By Calculation;

In the triangle ABC are given AC, equal to 20 miles; the angle ACB, equal to 78° 45′, the distance between the NNE and NW*b*W lines; also the angle ABC, equal to BCD, equal to 33° 45′, the distance between the NNE and NE*b*E lines; and consequently the angle A, equal to 67° 30′.

Hence, for CB, the distance of the cape from the ship in her first station, it will be, (by oblique trigonometry,)

S. ABC : AC :: S. BAC : CB.

i. e. As the sine of the angle B	33° 45′	9.74473
is to the distance run AC	20 —	1.30163
so is the sine of BAC	67 30	9.96562
to CB - - - -	33.26	1.52191

the distance of the cape from the ship at the first station. Then for AB, it will be, (by oblique trigonometry,)

S. ABC : AC :: S. ACB : AB.

i. e. As the sine of B -	33° 45′	9.74474
is to AC - - -	20 —	1 30103
so is the sine of C -	78 45	9.99157
to AB - - -	35.31	1.54786

the distance of the ship from the cape at her second station.

Of the Log-line and Compass. The method commonly made use of for measuring a ship's way at sea, or how far she runs in a given space of time, is by the log-line and half-minute glass. See the article Log.

The log is generally about a quarter of an inch thick, and five or six inches from the angular point to the circumference. It is balanced by a thin plate of lead, nailed upon the arch, so as to swim perpendicularly in the water, with about $\frac{2}{3}$ impressed under the surface. The line is fastened to the log by means of two legs, one of which passes through a hole at the corner and is knotted on the opposite side; while the other leg is attached to the arch by a pin fixed in another hole, so as to draw out occasionally. By these legs the log is hung in equilibrio; and the line which is united to it, is divided into certain spaces, which are in proportion to an equal number of geographical miles, as a half-minute or quarter-minute is to an hour of time.

These spaces are called knots, because at the end of each of them there is a piece of twine with knots in it, inreeved between the strands of the line, which shews how many of these spaces or knots are run out during the half-minute. They commonly begin to be counted at the distance of about 10 fathoms or 60 feet from the log, so that the log when it is hove overboard may be out of the eddy of the ship's wake before they begin to count; and for the more ready discovery of this point of commencement, there is commonly fastened at it a piece of red rag.

The log being thus prepared, and hove overboard from the poop, and the line veered out by help of a reel that turns easily, and about which it is wound as fast as the log will carry it away, or rather as the ship sails from it, will shew, according to the time of veering, how far the ship has run in a given time, and consequently her rate of sailing.

A degree of a meridian according to the exactest measures contains about 69.545 English miles; and each mile by the statute being 5280 feet, therefore a degree of the meridian will be about 7200 feet; whence the $\frac{1}{60}$ of that, viz. a minute or nautical mile, must contain 6120 standard feet; consequently, since $\frac{1}{2}$ is the $\frac{1}{120}$ part of an hour, and each knot is the same part of a nautical mile, it follows, that each knot will contain the $\frac{1}{120}$ of 6120 feet viz. 51 feet.

Hence it is evident, that whatever number of knots the ship runs in half a minute, the same number of miles she will run in one hour, supposing her to run with the same degree of velocity during that time; and therefore it is the general way to heave the log every hour, to know her rate of sailing: but if the force or direction of the wind varies, and not continues the same during the whole hour; or if there has been more sail set, or any sail handed, so that the ship has run swifter or slower in any part of the hour than she did at the time of heaving the log; then there must be an allowance made accordingly for it, and this must be according to the discretion of the artist.

Sometimes, when the ship is before the wind, and there is a great sea setting after her, it will bring home the log, and consequently the ship will sail faster than is given by the log. In this case it is usual, if there is a very great sea, to allow one mile in ten; and less in proportion, if the sea is not so great. But for the generality, the ship's way is really greater than that given by the log; and therefore, in order to have the reckoning rather before than behind the ship (which is the safest way), it will be proper to make the space on the log-line between knot and knot to consist of 50 feet instead of 51.

If the space between knot and knot on the log-line should happen to be too great in proportion to the half-minute glass, viz. greater than 50 feet, then the distance given by the log will be too short; and if that space is too small, then the distance run (given by the log) will be too great: therefore, to find the true distance in either case, having measured the distance between knot and knot, we have the following proportion, viz.

As the true distance, 50 feet, is to the measured distance; so are the miles of distance given by the log, to the true distance in miles that the ship has run.

Example I. Suppose a ship runs at the rate of $6\frac{1}{4}$ knots in half a minute; but measuring the space between knot and knot, I find it to be 56 feet: required the true distance in miles.

Making it, As 50 feet, are to 56 feet, so are 6.25 knots, to seven knots; I find that the true rate of sailing is 7 miles in the hour.

Example II. Suppose a ship runs at the rate of $6\frac{1}{2}$ knots in half a minute; but meaduring the space between knot and knot, I find it to be only 44 feet: required the true rate the ship is sailing.

Making it, As 50 feet are to 44 feet, so are 6.5 knots to 5.72 knots, I find that the true rate of sailing is 5.72 miles in the hour.

Again, supposing the distance between knot and knot on the log-line to be exactly 50 feet, but that the glass is not 30 seconds; then, if the glass requires longer time than 30 seconds, the distance given will be too great, if estimated by allowing one mile for every knot run in the time the glass runs; and, on the contrary, if the glass requires less time to run than 30 seconds, it will give the distance sailed too small. Consequently, to find the true distance in either case, we must measure the time the glass requires to run out (by the method in the following article); then we have the following proportion, viz.

As the number of seconds the glass runs, is to half a minute, or 30 seconds; so is the distance given by the log, to the true distance.

Example I. Suppose a ship runs at the rate of $7\frac{1}{2}$ knots in the time the glass runs; but measuring the glass, I find it runs 34 seconds; required the true distance sailed.

Making it, As 34 seconds are to 30 seconds, so are 7.5 to 6.6; I find that the ship sails at the rate of 6.6 miles an hour.

Example II. Suppose a ship runs at the rate of $6\frac{1}{2}$ knots; but measuring the glass, I find it runs only 25 seconds; required the true rate of sailing.

Make it, As 25 seconds are to 30 seconds, so are 6.5 knots to 7.8 knots; I find that the true rate of sailing is 7.8 miles an hour.

In order to know how many seconds the glass runs, you may try it by a watch or clock that vibrates seconds; but if neither of these is at hand, then take a line, and to the one end fastening a plummet, hang the other upon a nail or peg so that the distance from the peg to the centre of the plummet is $39\frac{1}{6}$ inches: then this put into motion will vibrate seconds; *i. e.* every time it passes the perpendicular, you are to count one second; consequently, by observing the number of vibrations that it makes during the time the glass is running, we know how many seconds the glass runs.

If there is an error both in the log-line and half-minute glass, viz. if the distance between knot and knot and the log-line is either greater or less than 50 feet, and the glass runs either more or less than 30 seconds; then the finding out the ship's true distance will be somewhat more complicate, and admit of three cases, viz.

Case I. If the glass runs more than 30 seconds, and the distance between knot and knot is less than 50 feet, then the distance given by the log-line, viz. by allowing 1 mile for each knot the ship sails while the glass is running, will always be greater than the true distance, since either of these errors gives the distance too great. Consequently, to find the true rate of sailing in this case, we must first find the distance on the supposition that the log-line only is wrong, and then with this we shall find the true distance.

Example. Suppose a ship is found to run at the rate of 6 knots; but examining the glass, I find it runs 35 seconds; and measuring the log-line, I find the distance between knot and knot to be but 46 feet: required the true distance run.

First, we have the following proportion, viz. As 50 feet : 46 : : 6 knots : 5.52 knots. Then, As 35 seconds : 30 seconds : : 5.52 knots : 4.73 knots. Consequently the true rate of sailing is 4.73 miles an hour.

Case II. If the glass is less than 30 seconds, and the space between knot and knot is more than 50 feet; then the distance given by the log will always be less than the true distance, since either of these errors lessens that true distance.

Example. Suppose a ship is found to run at the rate of 7 knots; but examining the glass, I find it runs only 25 seconds; and measuring the space between knot and knot on the log-line, I find it is 54 feet: required the true rate of sailing.

First, As 25 seconds : 30 seconds : : 7 knots : 8 knots. Then, As 50 feet : 54 feet : : 8, 4 knots: 9.072 knots. Consequently the true rate of sailing is 9.072 miles an hour.

Case III. If the glass runs more than 30 seconds, and the space between knot and knot is greater than 50 feet; or if the glass runs less than 30 seconds, and the space between knot and knot is greater than 50 feet: then, since in either of these two cases the effects of the errors are contrary, it is plain the distance will sometimes be too great, and sometimes too little, according as the greater quantity of the error lies; as will be evident from the following examples:

Example I. Suppose a ship is found to run at the rate of $9\frac{1}{2}$ knots per glass; but examining the glass, it is found to run 36 seconds; and by measuring the space between knot and knot, it is found to be 58 feet; required the true rate of sailing.

First, As 50 feet : 58 feet : : 9.5 knots : 11.20 knots. Then, As 38 seconds : 30 seconds : : 11.02 knots : 8.7 knots. Consequently the ship's true rate of sailing is 8.7 miles an hour.

Example II. Suppose a ship runs at the rate of 6 knots per glass; but examining the glass, it is found to run only 20 seconds; and by measuring the log-line, the distance between knot and knot is found to be but 38 feet: required the true rate of sailing.

First, As 50 feet : 38 feet : : 6 knots : 4.56 knots. Then, As 20 seconds : 30 seconds : : 4.56 knots : 6.84 knots. Consequently the true rate of sailing is 6.83 miles an hour.

But if in this case it happens, that the time the glass takes to run, is to the distance between knot and knot, as 30, the seconds in half a minute, is to 50, the true distance between knot and knot; then it is plain, that whatever number of seconds the glass consists of, and whatever number of feet is contained between knot and knot, yet the distance given by the log-line will be the true distance in miles.

The meridian and prime vertical of any place cuts the horizon in four points, at 90 degrees distance from one another, viz. North South, East, and West: that part of the meridian which extends itself from the place to the north point of the horizon is called the north line; that which tends to the south point of the horizon is called the south line; and that part of the prime vertical which extends towards the right hand of the observer when his face is turned to the north, is called the east-line; and lastly, that part of the prime vertical which tends towards the left hand is called the west line; the four points in which these lines meet the horizon are called the cardinal points.

In order to determine the course of the wind and to discover the various alterations or shiftings, each quadrant of the horizon, intercepted between the meridian and prime vertical, is usually divided into eight equal parts, and consequently the whole horizon into thirty-two; and the lines drawn from the place on which the observer stands, to the points of division in his horizon, are called rhumb-lines; the four principal of which are those described in the preceding paragraph, each of them having its name from the cardinal point in the horizon towards which it tends: the rest of the rhumb-lines have their names compounded of the principal lines on each side of them, as in the figure; and over whichsoever of these lines the course of the wind is directed, that wind takes its name accordingly. See MAGNETISM.

Hence it follows, that all rhumbs, except the four cardinals, must be curves or hemispherical lines, always tending towards the pole, and approaching it by infinite gyrations or turnings, but never falling into it. Thus let P, Plate Miscel. fig. 172, be the pole, EQ an arch of the equator, PE, PA, &c. meridians, and EFGHKL any rhumb: then because the angles PEF, PFG, &c. are by the nature of the rhumb-line equal, it is evident that it will form a curve-line on the surface of the globe always approaching the pole P, but never falling into it; for if it were possible for it to fall into the pole, then it would follow, that the same line could cut an infinite number of other lines at equal angles, in the same point; which is absurd.

Because there are 32 rhumbs or points in the compass equally distant from one another, therefore the angle contained between any two of them adjacent will be 11° 15′, viz. $\frac{1}{32}$ part of 360°; and so the angle contained between the meridian and the N*b*E will be 11° 15′, and between the meridian and the NNE will 22° 30′; and so of the rest. See Table of the angles &c. at the beginning of the article.

Concerning currents, and how to make proper allowances. 1. Currents are certain settings of the stream, by which all bodies (as ships, &c.) moving therein, are compelled to alter their course or velocity, or both; and submit to the motion impressed upon them by the current.

Case I. If the current sets just the course of the ship, *i. e.* moves on the same rhumb with it; then the motion of the ship is increased, by as much as is the drift or velocity of the current.

Example. Suppose a ship sails SE*b*S at the rate of 6 miles an hour, in a current that sets SE*b*S 2 miles an hour: required her true true rate of sailing.

Here it is evident that the ship's true rate of sailing will be 8 miles an hour.

Case II. If the current sets directly against the ship's course, then the motion of the ship is lessened by as much as is the velocity of the current.

Example. Suppose a ship sails SSW at the rate of 10 miles an hour, in a current that sets NNE 6 miles an hour, required the ship's true rate of sailing.

Here it is evident, that the ship's true rate of sailing will be 4 miles an hour. Hence it is plain,

1. If the velocity of the current is less than the velocity of the ship, then the ship will get so much ahead as is the difference of these velocities.

2. If the velocity of the current is greater than that of the ship, then the ship will fall so much astern as is the difference of these velocities.

3. Lastly, if the velocity of the current is equal to that of the ship, then the ship will stand still, the one velocity destroying the other.

Case III. If the current thwarts the course of the ship, then it not only lessens or augments her velocity, but gives her a new direction, compounded of the course she steers and the setting of the current.

The method of keeping a journal at sea, and how to correct it; by making proper allowance for the lee-way, variation, &c. 1. Lee-way is the angle that the rhumb-line, upon which the ship endeavours to sail, makes with the rhumb she really sails upon. This is occasioned by the force of the wind or surge of the sea, when she lies to the windward, or is close hauled, which causes her to fall off and glide sideways from the point of the compass she capes at. Thus let NESW (fig. 22,) represent the compass; and suppose a ship at C capes at, or endeavours to sail upon, the rhumb C*a*; but by the force of the wind, and surge of the sea, she is obliged to fall off, and make her way good upon the rhumb C*b*; then the angle *a*C*b* is the lee-way; and if that angle is equal to one point, the ship is said to make one point lee-way; and if equal to two points, the ship is said to make two points lee-way, &c.

2. The quantity of this angle is very uncertain, because some ships, with the same quantity of sail, and with the same gale, will make more lee-way than others; it depending much upon the mould and trim of the ship, and the quantity of water that she draws. The common allowances that are generally made for the lee-way, are as follow:

(1.) If a ship is close hauled, has all her sails set, the water smooth, and a moderate gale of wind, she is then supposed to make little or no lee-way. (2.) If it blows so fresh as to cause the small sails to be handed, it is usual to allow one point. (3.) If it blows so hard that the top-sails must be close-reefed, then the common allowance is two points for lee-way. (4.) If one top-sail must be handed, then the ship is supposed to make between two and three points lee-way. (5.) When both top-sails must be handed, then the allowance is about four points for lee-way. (6.) If it blows so hard as to occasion the fore-course to be handed, the allowance is between $5\frac{1}{2}$ and 6 points. (7.) When both main and fore-courses must be handed, then 6 or $6\frac{1}{2}$ points are commonly allowed for lee-way. (8.) When the mizen is handed, and the ship is trying ahull, she is then commonly allowed about 7 points for lee-way.

3. Though these rules are such as are generally made use of, yet since the lee-way depends much upon the mould and trim of the ship, it is evident that they cannot exactly serve to every ship; and therefore the best way is to find it by observation. Thus, let the ship's wake be set by a compass in the poop, and the opposite rhumb is the true course made good by the ship; then the difference between this and the course given by the compass in the binacle, is the lee-way required. If the ship is within sight of land, then the lee-way may be exactly found by observing a point on the land which continues to bear the same way; and the distance between the point of the compass it lies upon, and the point the ship capes at, will be the lee-way. Thus, suppose a ship at C is lying up N*b*W (fig. 23) towards A; but instead of keeping that course, she is carried on the NNE line CB, and consequently the point B continues to bear the same way from the ship; here it is evident that the angle ACB (or the distance between the N*b*W line that the ship capes at, and the NNE line that the ship really sails upon) will be the lee-way.

4. Having the course steered and the lee-way given, we may from thence find the true course by the following method, viz. Let your face be turned directly to the windward; and if the ship has her larboard tacks on board, count the lee-way from the course steered towards the right hand; but if the starboard tacks are on board, then count it from the course steered towards the left hand. Thus, suppose the wind at north, and the ship lies up within six points of the wind, with her larboard tacks on board, making one point lee-way; here it is plain that the course steered is ENE, and the true course E*b*N: also suppose the wind is at NNW, and the ship lies up within $6\frac{1}{2}$ points of the wind, with her starboard tack on board, making $1\frac{1}{2}$ point lee-way; it is evident that the true course, in this case, is WSW.

5. We have this general rule for finding the ship's true course, having the course steered and the variation given, viz. Let your face be turned towards the point of the compass upon which the ship is steered; and if the variation is easterly, count the quantity of it from the course steered towards the right hand, but if westerly towards the left hand; and the course thus found is the true course steered. Thus, suppose the course steered is N*b*E, and the variation one point easterly, then the true course steered will be NNE; also suppose the course steered is NE*b*E, and the variation one point westerly, then in this case the true course will be NE: and so of others.

Hence, by knowing the lee-way, variation, and course steered, we may from thence find the ship's true course; but if there is a current under foot, then that must be tried, and proper allowances made for it, as has been shown in the section concerning currents, from thence to find the true course.

6. After making all the proper allowances for finding the ship's true course, and making as just an estimate of the distance as we can; yet by reason of the many accidents that attend a ship in a day's running, such as different rates of sailing between the times of heaving the log, the want of due care at the helm by not keeping her steady but suffering her to yaw and fall off, sudden storms when no account can be kept, &c. the latitude by account frequently differs from the latitude by observation; and when that happens, it is evident there must be some error in the reckoning: to discover which, and where it lies, and also how to correct the reckoning, you may observe the following rules:

1st. If the ship sails near the meridian, or within 2 or $2\frac{1}{2}$ points thereof, then if the latitude by account disagrees with the latitude by observation, it is most likely that the error lies in the distance run; for it is plain, that in this case it will require a very sensible error in the course to make any considerable error in the difference of latitude, which cannot well happen if due care is taken at the helm, and proper allowances are made for the lee-way, variation, and currents. Consequently, if the course is pretty near the truth, and the error in the distance runs regularly through the whole, we may, from the latitude obtained by observation, correct the distance and departure by account, by the following analogies, viz.

As the difference of latitude by account
is to the true difference of latitude,
So is the departure by account
to the true departure,
And so is the direct distance by account
to the true direct distance.

The reason of this is plain; for let AB, fig. 24, denote the meridian of the ship at A; and suppose the ship sails upon the rhumb AE near the meridian, till by account she is found in C, and consequently her difference of latitude by account is AB; but by observation she is found in the parallel ED, and so her true difference of latitude is AD, her true distance AE, and her true departure DE; then, since the triangles ABC, ADE, are similar, it will be AB : AD :: BC : DE, and AB : AD :: AC : AE.

Example. Suppose a ship from the latitude of 45° 20′ north, after having sailed upon several courses near the meridian for 24 hours, her difference of latitude is computed to be upon the whole 95 miles southerly, and her departure 34 miles easterly; but by observation she is found to be in the latitude of 43° 10′ north, and consequently her true difference of latitude is 130 miles southerly; then for the true departure, it will be, As the difference of latitude by account 95, is to the true difference of latitude 130, so is the departure by account 34, to the true departure 46.52, and so is the distance by account 100.9, to the true distance 138.

2dly, If the courses are for the most part near the parallel of east and west, and the direct course is within $5\frac{1}{2}$ or 6 points of the meridian; then if the latitude by account differs from the observed latitude, it is most probable that the error lies in the course or distance, or perhaps both; for in this case it is evident, the departure by account will be very nearly true; and thence by the help of this, and the true difference of latitude, may the true course and direct distance be readily found by case 4. of plane sailing.

The form of the log-book and journal, together with an example of a day's work, are here subjoined.

To express the days of the week, we commonly use the characters by which the sun and planets are expressed, viz. ☉ denotes Sunday, ☽ Monday, ♂ Tuesday, ☿ Wednesday, ♃ Thursday, ♀ Friday, ♄ Saturday.

The Form of the Log-Book, with the Manner of working Days' Works at Sea.

THE LOG-BOOK.

H	K.	½K.	Courses.	Winds	Observations and Accidents. ☾— Day of ——
1					Fair weather: at four this afternoon I took my departure from the Lizard, in the latitude of 5° 00′ north, it bearing N N E. distance 5 leagues.
2				North	
3					
4					
5	7		S W *b* S	N *b* E	
6	7				
7	7	1			
8	7	1			
9	6				
10	6				
11	6		S S W	E *b* S	The gale increasing and being under all our sails.
12	6	1			
1	6	1			After three this morning, frequent showers with thick weather till near noon.
2	6	1	SW *b* W	N N E	
3	6	1			
4	7				
5		1			
6					
7	8				
8	8		S W	E N E	The variation I reckon to be one point westerly
9	8	1			
10	9				
11	8	1	SW ½ W	NE *b* E	
12	8				

THE LOG-BOOK.

Courses Correct.	Dist.	Diff. Lat.		Diff. Long.	
		N.	S.	E.	W.
S SW	50		46.2		29.4
S *b* W	19		18.6		5.5
S W	49		29.7		45.5
S W*b*S	24.5		20.2		20.0
S W½S	25.5		19.5		19.5
			144.2		125.0

Hence the ship, by account, has come to the latitude of 47° 46′ north, and has differed her longitude 2° 5′ westerly; so this day I have made my way good S. 31° 31′ W. distance 157.4 miles.

At noon the Lizard bore from me N. 31° 31′ E. distance 157.4 miles; and having observed the latitude, I found it agreed with the latitude by account.

We have under the article LONGITUDE shewn the method of finding the longitude at sea by means of timekeepers. For the method of doing the same by lunar observations, we refer to the Nautical Almanac, and the tables that accompany it.

NAUTILUS, in zoology, a genus belonging to the order of vermes testaceæ. The shell consists of one spiral valve, divided into several apartments by partitions. There are 17 species, chiefly distinguished by particularities in their shells.

The most remarkable division of the nautili is into the thin and thick-shelled kinds. The first is called nautilus papyraceus; and its shell is indeed no thicker than a piece of paper when out of the water. This species is not at all fastened to its shell; but there is an opinion, as old as the days of Pliny, that this creature creeps out of its shell, and goes on shore to feed. When this species is to sail, it expands two of its arms on high, and between these supports a membrane which it throws out on this occasion; this serves for its sail: and the two other arms it hangs out of its shell, to serve occasionally either as oars or as a steerage; but this last office is generally served by the tail. When the sea is calm, it is common to see numbers of these creatures diverting themselves in this manner; but as soon as a storm rises, or any thing gives them disturbance, they draw in their legs, and take in as much water as makes them specifically heavier than that in which they float; and they sink to the bottom. When they rise again, they void this water by a number of holes, of which their legs are full. The other nautilus, whose shell is thick, never quits that habitation. This shell is divided into 40 or more partitions, which grow smaller and smaller as they approach the extremity or centre of the shell; between every one of these cells and the adjoining ones, there is a communication by means of a hole in the centre of every one of the partitions. Through this hole there runs a pipe of the whole length of the shell. It is supposed by many, that by means of this pipe the fish occasionally passes from one cell to another; but this seems by no means probable, as the fish must undoubtedly be crushed to death by passing through it. It is much more likely that the fish always occupies the largest chamber in its shell; that is, that it lives in the cavity between the mouth and the first partition, and that it never removes out of this; but that all the apparatus of cells and a pipe of communication, which we so much admire, serves only to admit occasionally air or water into the shell, in such proportion as may serve the creature in its intentions of swimming.

Some authors call this shell the concha margaritifera; but this can be only on account of the fine colour on its inside, which is more beautiful than any other mother-of-pearl; for it has not been observed that this species of fish ever produced pearls. It must be observed, that the polypus is by no means to be confounded with the paper-shelled nautilus, notwithstanding the great resemblance in the arms and body of the inclosed fish; nor is the cornu ammonis, so frequently found fossil, to be confounded with the thick-shelled nautilus, though the concamerations and general structure of the shell are alike in both; for there are great and essential differences between all these genera.

NAZARITES, among the Jews, persons who either of themselves, or by their parents, were dedicated to the observation of Nazariteship. They were of two sorts, namely, such as were bound to this observance for only a short time, as a week or month; and those who were bound to it all their lives. All that we find peculiar in the latter's way of life is, that they were to abstain from wine and all intoxicating liquors, and never to shave or cut off the hairs of their heads. The first sort of Nazarites were moreover to avoid all defilement; and if they chanced to contract any pollution before the term was expired, they were obliged to begin afresh. Women as well as men might bind themselves to this vow.

NE ADMITTAS, in law, a writ directed to the bishop, at the suit of one that is patron of a church, where, on a quare impedit, &c. depending, he is doubtful that the bishop will collate his clerk, or admit the other's clerk, during the suit between them.

NEAT, or NET-WEIGHT, the weight of a commodity alone, clear of the cask, bag, case, or even filth.

NEBULOUS, *cloudy*, in astronomy, a term applied to certain of the fixed stars, which shew a dim hazy light, being less than those of the sixth magnitude, and therefore scarce visible to the naked eye.

NECESSITY. The law charges no man with default where the act is compulsory, and not voluntary, and where there are not a consent and election; and therefore if either there is an impossibility for a man to do otherwise, or so great a perturbation of the judgment and reason as in presumption of law man's nature cannot overcome, such necessity carries a privilege in itself.

Necessity is of three sorts; necessity of conservation of life, necessity of obedience, and necessity of the act of God, or of a stranger.

And first, of conservation of life; if a man steals viands to satisfy his present hunger, this is no felony nor larceny.

The second necessity is of obedience; and therefore where baron and feme commit a felony, the feme can neither be principal nor accessary, because the law intends her to have no will in regard of the subjection and obedience she owes her husband.

The third necessity is of the act of God, or of a stranger; as if a man is particular tenant for years of a house, and it should be overthrown by thunder, lightning, and tempest, in this case, he is excused of waste. Bac. Elem. 25, 26, 27.

NECK. See ANATOMY.

NECKERIA, a genus of the class and order cryptogamia musci, but little known.

NECTARIUM. See BOTANY, vol. i. p. 254.

NECTRIS, a genus of the hexandria digynia class and order: the calyx is one-leafed, six-parted, coloured; corolla none; styles permanent; caps. two; superior ovate, one-celled, many-seeded; there is one species, a native of Guiana.

NECYDALIS, a genus of insects belonging to the order of coleoptera. The feelers are setaceous; the elytra are shorter and narrower than the wings; the tail is simple. There are 11 species, chiefly distinguished by the size and figure of the elytra.

NEEDLE, a very common small instrument or utensil, made of steel, pointed at one end, and pierced at the other, used in sewing, embroidery, tapestry, &c. Needles make a very considerable article in commerce, though there is scarcely any commodity cheaper, the consumption of them being almost incredible. The sizes are from N° 1. the largest, to N° 25. the smallest. In the manufacture of needles, German and Hungarian steel are of most repute. In the making of them, the first thing is to pass the steel through a coal-fire, and under a hammer, to bring it out of its square figure into a cylindrical one. This done, it is drawn through a large hole of a wiredrawing-iron, and returned into the fire, and drawn through a second hole of the iron, smaller than the first, and thus successively, from hole to hole, till it has acquired the degree of fineness required for that species of needles, observing every time it is to be drawn that it is greased over with lard, to render it more manageable. The steel thus reduced to a fine wire, is cut in pieces of the length of the needles intended. These pieces are flatted at one end on the anvil, in order to form the head and eye; they are then put into the fire to soften them farther, and thence taken out and pierced at each extreme of the flat part on the anvil, by force of a puncheon of well-tempered steel; and laid on a leaden block to bring out, with another puncheon, the little piece of steel remaining in the eye. The corners are then filed off the square of the heads, and a little cavity filed on each side of the flat of the head; this done, the point is formed with a file, and the whole filed over; they are then laid to heat red-hot on a long flat narrow iron, crooked at one end, in a charcoal-fire, and when taken out, are thrown into a bason of cold water to harden. On this operation a good deal depends; too much heat burns them, and too little leaves them soft: the medium is learned by experience. When they are thus hardened, they are laid in an iron shovel on a fire, more or less brisk in proportion to the thickness of the needles; taking care to move them from time to time. This serves to temper them, and take off their brittleness: great care here too must be taken of the degree of heat. They are then straightened one after another with the hammer, the coldness of the water used in hardening them having twisted the greatest part of them. The next process is the polishing them. To do this they take twelve or fifteen thousand needles, and range them in little heaps against each other in a piece of new buckram sprinkled with emery-dust. The needles thus disposed, emery dust is thrown over them, which is again sprinkled with oil of olives: at last the whole is made up into a roll, well bound at both ends. This roll is then laid on a polishing-table; and over it a thick plank loaden with stones, which two men work backwards and forwards a day and a half, or two days, successively; by which means the roll being continually agitated by the weight and motion of the plank over it, the needles withinside being rubbed against each other with oil and emery, are insensibly polished. After polishing they are taken out, and the filth washed off them with hot water and soap; they are then wiped in hot bran, a little moistened, placed with the needles in a round box, and suspended in the air by a cord, which is kept stirring till the bran and needles are dry. The needles thus wiped in two or three different brans are taken out and put in wooden vessels, to have the good separated from those whose points or eyes have been broken, either in polishing or wiping; the points are then all turned the same way, and smoothed with an emery-stone turned with a wheel. This operation finishes them, and there remains nothing but to make them into packets of two hundred and fifty each.

NE EXEAT REGNO, is a writ to restrain a person from going out of the kingdom without the king's licence.

Within the realm, the king may command the attendance and service of all his liegemen; but he cannot send any man out of the realm, or even upon the public service, except seamen and soldiers, the nature of whose employment necessarily implies an exception. 1 Black. 138.

This writ is now mostly used where a suit is commenced in the court of chancery against a man, and he intending to defeat the other of his just demand, or to avoid the justice and equity of the court, is about to go beyond sea, or however, that the duty will be endangered if he goes.

If the writ is granted on behalf of a subject, and the party is taken, he either gives security by bond in such sum as is demanded, or he satisfies the court by answering (where the answer is not already in) or by affidavit, that he intends not to go out of the realm, and gives such reasonable security as the court directs, and then he is discharged. P. R. C. 252.

NEGLIGENCE, is where a person neglects or omits to do a thing which he is obliged by law to do. Thus where one has goods of another to keep till such a time, and he has a certain recompence or reward for the keeping, he shall stand charged for injury by negligence, &c.

NEPA, a genus of insects of the order hemeptera; the generic character is, snout inflected; wings four, cross-complicate, coriaceous on the upper part; fore-feet cheliform, the rest formed for walking. This genus is aquatic, inhabiting stagnant waters, and preying on the smaller water-insects, &c. The largest species yet known, and which very far surpasses in size all the European animals of the genus, is the nepa grandis, which is a native of Surinam and other parts of South America, often measuring more than three inches in length. Its colour is a dull yellowish-brown, with a few darker shades or variegations; the under wings are of a semitransparent white colour, and the abdomen is terminated by a short tubular process.

Nepa cinerea, or the common water-scorpion, is a very frequent inhabitant of stagnant waters in our own country, measuring about an inch in length, and appearing, when the wings are closed, entirely of a dull brown colour; but when the wings are expanded, the body appears of a bright red colour above, with a black longitudinal band down the middle; and the lower wings, which are of a fine transparent white, are decorated with red veins: from the tail proceeds a tubular bifid process or style, nearly of the length of the body, and which appears single on a general view, the two valves of which it consists being generally applied close to each other throughout their whole length. The animal is of slow motion, and is often found creeping about the shallow parts of ponds, &c. In the month of May it deposits its eggs on the soft surface of the mud at the bottom of the water; they are of a singular shape, resembling some of the crowned seeds, having an oval body, and an upper part surrounded by seven radiating processes or curved spines; the young, when first hatched, are not more than the eighth of an inch in length. The water-scorpion flies only by night, when it wanders about the fields in the neighbourhood of its native waters. The larvæ and pupæ differ in appearance from the complete insect, in having only the rudiments of wings, and being of a paler or yellower colour. See Plate Nat. Hist. fig. 292.

Nepa cimicoides of Linnæus differs materially from the preceding species, and has at first view more the aspect of a notonecta than a nepa, the hind legs being formed for swimming briskly, and furnished with an edging of hairs on the inner side. This insect is less common than the preceding, but is found in similar situations.

Nepa linearis is an insect of a highly singular aspect, bearing a distant resemblance to some of the smaller insects of the genera mantis and phasma. It measures about an inch and a half from the tip of the snout to the beginning of the abdominal style or process, which is itself of equal length to the former part, and the whole animal is extremely slender in proportion to its length; the legs also are long and slender, and the chelæ or fore-legs much longer in proportion than those of the second species or nepa cinerea; the colour of the animal is dull yellowish-brown; the back, when the wings are expanded, appearing of a brownish-red, and the under wings white and transparent. It inhabits the larger kind of stagnant waters, frequenting the shallower parts during the middle of the day, when it may be observed to prey on the smaller water-insects, &c. Its motions are singular, often striking out all its legs in a kind of starting manner at intervals, and continuing this exercise for a considerable time. The eggs are smaller than those of the nepa cinerea, of an oval shape, and furnished with two processes or bristles divaricating from the top of each. See Plate Nat. Hist. fig. 293.

There are 14 species.

NEPENTHES, a genus of the tetrandria order, in the gynandria class of plants, and in the natural method ranking among those of which the order is doubtful. The calyx is quadripartite; there is no corolla; the capsule is quadrilocular. There is one species, a plant of Ceylon.

NEPER's RODS, or Bones, an instrument invented by J. Neper, baron of Merchiston, in Scotland, whereby the multiplication and division of large numbers are much facilitated.

Neper's rod, *the construction of.* Suppose the common table of multiplication to be made upon a plate of metal, ivory, or pasteboard, and then conceive the several columns (standing downwards from the digits on the head) to be cut asunder; and these are what we call Neper's rods for multiplication. But then there must be a good number of each; for as many times as any figure is in the multiplicand, so many rods of that species (*i. e.* with that figure on the top of it) must we have; though six rods of each species will be sufficient for any example in common affairs; there must be also as many rods of 0's.

But before we explain the way of using these rods, there is another thing to be known, viz. that the figures on every rod are written in an order different from that in the table. Thus, the little square space or division in which the several products of every column are written, is divided into two parts by a line across from the upper angle on the right to the lower on the left; and if the product is a digit, it is set in the lower division; if it has two places, the first is set in the lower, and the second in the upper division; but the spaces on the top are not divided. Also there is a rod of digits, not divided, which is called the index-rod; and of this we need but one single rod. See the figure of all the different rods, and the index, separate from one another, in plate Miscel. fig. 174.

Neper's rod, *multiplication by*. First lay down the index-rod; then on the right of it set the rod whose top is the figure in the highest place of the multiplicand; next to this again set the rod whose top is next the figure of the multiplicand; and so on in order to the first figure. Then is your multiplicand tabulated for all the nine digits; for in the same line of squares standing against every figure of the index-rod, you have the product of that figure, and therefore you have no more to do than to transfer the products and sum them. But in taking out these products from the rods, the order in which the figures stand obliges you to a very easy and small addition; thus, begin to take out the figure in the lower part, or unit's place, of the square of the first rod on the right; add the figure in the upper part of this rod to that in the lower part of the next, and so on, which may be done as fast as you can look on them. To make this practice as clear as possible, take the following example.

Example: To multiply 4768 by 385. Having set the rods together for the number 4768, against 5 in the index I find this number, by adding according to the rule - 23840
Against 8 this number - - 38144
Against 3 this number - - 14304
Total product 1835680

To make the use of the rods yet more regular and easy, they are kept in a flat square box, whose breadth is that of ten rods, and the length that of one rod, as thick as to hold six (or as many as you please); the capacity of the box being divided into ten cells, for the different species of rods. When the rods are put up in the box (each species in its own cell distinguished by the first figure of the rod set before it on the face of the box near the top), as much of every rod stands without the box as shews the first figure of that rod; also upon one of the flat sides without and near the edge, upon the left hand the index-rod is fixed; and along the foot there is a small ledge, so that the rods when applied are laid upon this side, and supported by the ledge, which makes the practice very easy; but in case the multiplicand should have more than 9 places, the upper face of the box may be made broader. Some make the rods with four different faces and figures on each for different purposes.

Neper's rods, *division by*. First tabulate your divisor; then you have it multiplied by all the digits, out of which you may choose such convenient divisors as will be next less to the figures in the dividend, and write the index answering in the quotient, and so continually till the work is done. Thus 2179788 divided by 6123, gives in the quotient 356.

Having tabulated the divisor, 6123, you see that 6123 cannot be had in 2179; therefore take five places, and on the rods find a number that is equal, or next less, to 21797, which is 18369; that is 3 times the divisor, wherefore set 3 in the quotient, and subtract 18369 from the figures above, and there will remain 3428; to which add 8, the next figure of the dividend, and seek again on the rods for it, or the next less, which you will find to be five times; therefore set 5 in the quotient, and subtract 30615 from 34288, and there will remain 3673; to which add 8, the last figure in the dividend, and finding it to be just 6 times the divisor, set 6 in the quotient.

NEPETA, Catmint, or Nep, a genus of the gymnospermia order, in the didynamia class of plants; and in the natural method ranking under the 42d order, verticillatæ. The under lip of the corolla has a small middle segment crenated; the margin of the throat is reflexed; the stamina approach one another. There are 20 species; the most remarkable is the cataria, common nep, or catmint. This is a native of many parts of Britain, growing about hedges and in waste places. The plant has a bitter taste, and strong smell, not unlike pennyroyal. An infusion of this plant is reckoned a good cephalic and emmenagogue; being found very efficacious in chlorotic cases. Two ounces of the expressed juice may be given for a dose. It is called catmint, because cats are very fond of it, especially when it is withered; for then they will roll themselves on it, and tear it to pieces, chewing it in their mouths with great pleasure.

NEPHELIUM, a genus of the pentandria order, in the monœcia class of plants. The male calyx is quinquedentate; there is no corolla: the female calyx is quadrifid; there is no corolla. There are two germens and two styles on each: the fruit are two dry plumbs, muricated, and monospermous. There is one species, a herb of the East Indies.

NEPHRITIC WOOD, lignum nephriticum, a wood of a very dense and compact texture, and of a fine grain, brought us from New Spain, in small blocks, in its natural state, and covered with its bark. It is to be chosen of a pale colour, sound and firm, and such as has not lost its acrid taste; but the surest test of it is the infusing it in water; for a piece of it infused only half an hour in cold water, gives it a changeable colour, which is blue or yellow, as variously held to the light. If the phial it is in is held between the eye and the light, the tincture appears yellow; but if the eye is placed between the light and the phial, it appears blue.

This wood is a very good diuretic, and is said to be of great use with the Indians in all diseases of the kidneys and bladder, and in suppressions of urine from whatever cause. It is also commended in fevers and obstructions of the viscera. The way of taking it, among the Indians, is only an infusion in cold water.

NEPHRITIS. See Medicine.

NEREIS, in zoology, a genus of animals belonging to the order of vermes mollusca. The body is oblong, linear, and fitted for creeping; it is furnished with lateral pencilled tentacula. There are 11 species, of which the most remarkable are the five following: 1. The noctiluca, or noctilucous nereis, which inhabits almost every sea, and is one of the causes of the luminousness of the water. These creatures shine like glow-worms, but with a brighter splendour, so as at night to make the element appear as if on fire all around. Their bodies are so minute as to elude examination by the naked eye.

It is sometimes called nereis phosphorans; and is thus described by Griseline. The head is roundish and flat, and the mouth acuminated. The two horns or feelers are short and subulated. The eyes are prominent, and placed on each side of the head. The body is composed of about twenty-three segments or joints, which are much less nearer the tail than at the head. These segments on both sides the animal all end in a short conical apex, out of which proceeds a little bundle of hairs; from under these bundles the feet grow in the form of small flexile subulated figments destitute of any thing like claws. It is scarcely two lines long, and is quite pellucid, and its colour is that of water, green. They are found upon all kinds of marine plants; but they often leave them, and are found upon the surface of the water: they are frequent at all seasons, but especially in summer before stormy weather, when they are more agitated and more luminous. Their numbers, and wonderful agility, added to their pellucid and shining quality, do not a little contribute to their illuminating the sea, for myriads of those animalculæ may be contained in the portion of a small cup of seawater. Innumerable quantities of them lodge in the cavities of the scales of fishes, and to them probably do the fishes owe their noctilucous qualitity.

2. Nereis lacustris, or bog nereis (fig. 2.) The body of the size of a hog's short bristle, transparent, articulated, and on either side at every articulation provided with a short setaceous foot; interiorly it seems to consist in a manner of oval-shaped articulations, and a back formed by two lines bent backwards. It inhabits marshes abounding in clay, where it remains under ground, pushing out its other extremity by reason of its continual motion. When taken out it twists itself up. Is frequent in Sweden.

3. Nereis cirrosa, or waving nereis. The body is red, lumbriciform, with sixty-five notches, furnished on both sides with two rows of bristles. At each side of the head ten filaments, at the sides of the mouth many, twice as long as the former. It dwells in Norway, on rocks at the bottom of the sea. It vomits a red liquor, with which it tinges the water. See Plate Nat. Hist. fig. 294.

4. Nereis cærulea, or blue nereis. It inhabits the ocean, where it destroys the serpulæ and teredines. fig. 295.

5. Nereis gigantæa, or giant nereis, is a peculiar species of those large worms that make their way into decayed piles driven down into the sea, which they bore through and feed upon, whence they are called sea-worms, or nereis. From head to tail they are beset on either side with small tufts terminating in three points, which are like the fine hair-pencils used by painters, and composed of shining bristles of various colours. The upper part of the body in this worm is all over covered with small hairs. The rings of which it is formed are closely pressed together, and yield to the touch. The three rows of small tufts we have been describing, serve this nereis instead of feet, which it uses to go forwards as fishes do their fins. Fig. 296.

NERITA, a genus of vermes testacea: the generic character is; animal a limax; shell univalve, spiral, gibbous, flattish at bottom; aperture semiorbicular or semilunar; pillar-lip transversely truncate, flattish. There are about 80 species of this genus.

NERIUM, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 30th order, contortæ. There are two erect follicles; the seeds plumy; the tube of the corolla terminated by a lacerated crown. There are nine species, all of them natives of the warmer climates; the most remarkable of which are, 1. The oleander, South Sea rose; this is a beautiful shrub, cultivated in gardens on account of its flowers, which are of a fine red, and in clusters, but of an indifferent smell; the whole plant is poisonous, and especially the bark of the roots. The double variety is beautiful, but it should be kept in a stove. 2. The antidysintericum, a native of Ceylon; the bark of which is an article of the materia medica, under the name of conessi. 3. The tinctorium, a new species, with beautiful blue flowers, discovered by Dr. Roxburgh at Madras. A decoction of the leaves, with an addition of lime-water, makes an indigo of fine quality. The whole plant in all the neriums is of a poisonous quality, in that respect resembling apocynum.

NERTERIA, a genus of the class and order tetrandria digynia: the corolla is funnel-shaped, four cleft; superior berry two-celled; seeds solitary. There is one species, an annual of New Zealand.

NERVES. See Anatomy.

NESTORIANS, a christian sect, the followers of Nestorius, bishop and patriarch of Constantinople; who, about the year 429, taught that there were two persons in Jesus Christ, the divine and the human, which are united, not hypostatically or substantially, but in a mystical manner: whence he concluded, that Mary was the mother of Christ, and not the mother of God. For this opinion Nestorius was condemned and deposed by the council of Ephesus; and the decree of this council was confirmed by the emperor Theodosius, who banished the bishop to a monastery.

NETTINGS, in a ship, a sort of grates made of small ropes, seized together with rope-yarn or twine, and fixed on the quarters and in the tops; they are sometimes stretched upon the ledges from the waste-trees to the roof-trees, from the top of the forecastle to the poop; and sometimes are laid in the waste of a ship to serve instead of gratings.

NETTLE. See Urtica.

Nettle, *dead*. See Lamium.

NEURADA, a genus of the decagynia order, in the decandria class of plants, and in the natural method ranking under the 13th order, succulentæ. The calyx is quinquepartite; there are five petals; the capsule inferior, decemlocular, decaspermous, and aculeated. There is only one species, the procumbens. The whole plant is white and woolly; and is a native of the warm climates, and found on dry parched grounds.

NEUTRAL SALTS, among chemists, a sort of salts neither acid nor alkaline, but partaking of the nature of both. See Acid, Alkali, Chemistry, &c.

NEUTRALIZATION. When two or more substances mutually destroy each other's properties, they are said to neutralize one another. Thus, in a proper combination of acid and alkaline substances, the acid and alkaline properties are destroyed.

NEWEL. See Architecture.

NEWT. See Lacerta.

NEWTONIAN PHILOSOPHY, the doctrine of the universe, or the properties, laws, affections, actions, forces, motions, &c. of bodies, both celestial and terrestrial, as delivered by Newton.

The chief parts of the Newtonian philosophy, as delivered by the author, except his Optical Discoveries, &c. are contained in his Principia, or Mathematical Principles of Natural Philosophy. He founds his system on the following definitions.

1. Quantity of matter is the measure of the same, arising from its density and bulk conjointly. Thus, air of a double density, in the same space, is double in quantity; in a double space, is quadruple in quantity; in a triple space, is sextuple in quantity, &c.

2. Quantity of motion is the measure of the same, arising from the velocity and quantity of matter conjunctly. This is evident, because the motion of the whole is the motion of all its parts; and therefore in a body double in quantity, with equal velocity, the motion is double, &c.

3. The vis insita, vis inertiæ, or innate force of matter, is a power of resisting, by which every body, as much as in it lies, endeavours to persevere in its present state, whether it is of rest, or moving uniformly forward in a right line. This definition is proved to be just, by experience, from observing the difficulty with which any body is moved out of its place, upwards or obliquely; or even downwards, when acted on by a body endeavouring to urge it quicker than the velocity given it by gravity, and any how to change its state of motion or rest. And therefore this force is the same, whether the body has gravity or not; and a cannon-ball, void of gravity, if it could be, being discharged horizontally, will go the same distance in that direction, in the same time, as if it were endued with gravity.

4. An impressed force is an action exerted upon a body, in order to change its state, whether of rest or motion. This force consists in the action only; and remains no longer in the body when the action is over. For a body maintains every new state it acquires, by its vis inertiæ only.

5. A centripetal force is that by which bodies are drawn, impelled, or any way tend, towards a point, as to a centre. This may be considered of three kinds, absolute, accelerative, and motive.

6. The absolute quantity of a centripetal force is a measure of the same, proportional to the efficacy of the cause that urges it to the centre.

7. The accelerative quantity of a centripetal force, is the measure of the same proportional to the velocity which it generates in a given time.

8. The motive quantity of a centripetal force, is a measure of the same, proportional to the motion which it generates in a given time. This is always known by the quantity of force equal and contrary to it, that is just sufficient to hinder the descent of the body.

After these definitions, follow certain scholia, treating of the nature and distinctions of time, space, place, and motion, absolute, relative, apparent, true, real, &c. After which, the author proposes to shew how we are to collect the true motions from their causes, effects, and apparent differences; and vice versâ, how, from the motions, either true or apparent, we may come to the knowledge of their causes and effects. In order to this, he lays down the following axioms or laws of motion.

1st law. Every body perseveres in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impressed upon it. Thus, "projectiles persevere in their motions, so far as they are not retarded by the resistance of the air, or impelled downwards by the force of gravity. A top, whose parts, by their cohesion, are perpetually drawn aside from rectilinear motions, does not cease its rotation otherwise than as it is retarded by the air. The greater bodies of the planets and comets, meeting with less resistance in more free spaces, preserve their motions, both progressive and circular, for a much longer time."

2d law. The alteration of motion is always proportional to the motive force impressed, and is made in the direction of the right line in which that force is impressed. Thus, if any force generates a certain quantity of motion, a double force will generate a double quantity, whether that force is impressed all at once or in successive moments.

3d law. To every action there is always opposed an equal re-action; or the mutual actions of two bodies upon each other, are always equal, and directed to contrary parts. Thus, whatever draws or presses another, is as much drawn or pressed by that other. If you press a stone with your finger, the finger is also pressed by the stone, &c.

From this axiom, or law, Newton deduces the following corollaries:

1. A body by two forces conjoined will describe the diagonal of a parallelogram, in the same time that it would describe the sides by those forces apart.

2. Hence is explained the composition of any one direct force out of any two oblique ones, viz. by making the two oblique forces the sides of a parallelogram, and the diagonal the direct one.

3. The quantity of motion, which is collected by taking the sum of the motions directed towards the same parts, and the difference of those that are directed to contrary parts, suffers no change from the action of bodies among themselves; because the motion which one body loses is communicated to another.

4. The common centre of gravity of two or more bodies does not alter its state of motion or rest by the actions of the bodies among themselves; and therefore the common centre of gravity of all bodies, acting upon each other, (excluding external actions and impediments) is either at rest, or moves uniformly in a right line.

5. The motions of bodies included in a given space are the same among themselves, whether that space is at rest, or moves uniformly forward in a right line without any circular motion. The truth of this is evident from the experiment of a ship; where all motions are just the same, whether the ship is at rest, or proceeds uniformly forward in a straight line.

6. If bodies, any how moved among themselves, are urged in the direction of parallel lines by equal accelerative forces, they will all continue to move among themselves, after the same manner as if they had not been urged by such forces.

The mathematical part of the Newtonian Philosophy depends chiefly on the following lemmas, especially the first, containing the doctrine of prime and ultimate ratios.

Lem. 1. Quantities, and the ratios of quantities, which in any finite time converge continually to equality, and before the end of that time approach nearer the one to the other than by any given difference, become ultimately equal.

Lem. 2. shews, that in a space bounded by two right lines and a curve, if an infinite number of parallelograms are inscribed, all of equal breadth; then the ultimate ratio of the curve space, and the sum of the parallelograms, will be a ratio of equality.

Lem. 3. shews, that the same thing is true when the breadths of the parallelograms are unequal.

In the succeeding lemmas it is shewn, in like manner, that the ultimate ratios of the sine, chord, and tangent, of arcs infinitely diminished, are ratios of equality; and therefore that in all our reasonings about these, we may safely use the one for the other: that the ultimate form of evanscent triangles, made by the arc, chord, or tangent, is that of similitude, and their ultimate ratio is that of equality; and hence, in reasonings about ultimate ratios, these triangles may safely be used one for another, whether they are made with the sine, the arc, or the tangent. He then demonstrates some properties of the ordinates of curvilinear figures; and shews that the spaces which a body describes by any finite force urging it, whether that force is determined and immutable, or continually varied, are to each other, in the very beginning of the motion, in the duplicate ratio of the forces; and lastly, having added some demonstrations concerning the evanescence of angles of contact, he proceeds to lay down the mathematical part of his system, which depends on the following theorems.

Theor. 1. The areas which revolving bodies describe by radii drawn to an immoveable centre of force, lie in the same immoveable planes, and are proportional to the times in which they are described. To this proposition are annexed several corollaries, respecting the velocities of bodies revolving by centripetal forces, the directions and proportions of those forces, &c. such as, that the velocity of such a revolving body is reciprocally as the perpendicular let fall from the centre of force upon the line touching the orbit in the place of the body, &c.

Theor. 2. Every body that moves in any curve line described in a plane, and by a radius drawn to a point either immoveable or moving forward with an uniform rectilinear motion, describes about that point areas proportional to the times, is urged by a centripetal force directed to that point. With corollaries relating to such motions in resisting mediums, and to the direction of the forces when the areas are not proportional to the times.

Theor. 3. Every body that, by a radius drawn to the centre of another body, any how moved, describes areas about that centre proportional to the times, is urged by a force compounded of the centripetal forces tending to that other body, and of the whole accelerative force by which that other body is impelled. With several corollaries.

Theor. 4. The centripetal forces of bodies which by equal motions describe different circles, tend to the centres of the same circles; and are one to the other as the squares of the arcs described in equal times, applied to the radii of the circles. With many corollaries relating to the velocities, times, periodic forces, &c. And, in a scholium, the author farther adds, moreover, by means of the foregoing proposition and its corollaries, we may discover the proportion of a centripetal force to any other known force, such as that of gravity. For if a body, by means of its gravity, revolves in a circle concentric to the earth, this gravity is the centripetal force of that body. But from the descent of heavy bodies, the time of one entire revolution, as well as the arc described in any given time, is given by a corollary to this proposition.

On these and such-like principles depends the Newtonian mathematical philosophy. The author farther shews how to find the centre to which the forces impelling any body are directed, having the velocity of the body given; and finds that the centrifugal force is always as the versed sine of the nascent arc directly, and as the square of the time inversely; or directly as the square of the velocity, and inversely as the chord of the nascent arc. From these premises, he deduces the method of finding the centripetal force directed to any given point when the body revolves in a circle; and this, whether the central point is near hand, or at immense distance; so that all the lines drawn from it may be taken for parallels. And he shews the same thing with regard to bodies revolving in spirals, ellipses, hyperbolas, or parabolas. He shews also, having the figures of the orbits given, how to find the velocities and moving powers; and indeed resolves the most difficult problems relating to the celestial bodies with a surprising degree of mathematical skill. These problems and demonstrations are all contained in the first book of the Principia; but an account of them here would neither be generally understood, nor easily comprised in the limits of this work.

In the second book, Newton treats of the properties and motion of fluids, and their powers of resistance, with the motion of bodies through such resisting mediums, those resistances being in the ratio of any powers of the velocities; and the motions being either made in right lines or curves, or vibrating like pendulums.

On entering upon the third book of the Principia, Newton briefly recapitulates the contents of the two former books in these words: " In the preceding books I have laid down the principles of philosophy, principles not philosophical, but mathematical; such, to wit, as we may build our reasonings upon in philosophical enquiries. These principles are, the laws and conditions of certain motions, and powers or forces, which chiefly have respect to philosophy. But lest they should have appeared of themselves dry and barren, I have illustrated them here and there with some philosophical scholiums, giving an account of such things as are of a more general nature, and which philosophy seems chiefly to be founded on; such as the density and the resistance of bodies, spaces void of all matter, and the motion of light and sounds. It remains, he adds, that from the same principles I now demonstrate the frame of the system of the world. Upon this subject I had indeed composed the third book in a popular method, that it might be read by many. But afterwards considering that such as had not sufficiently entered into the principles could not easily discern the strength of the consequences, nor lay aside the prejudices to which they had been many years accustomed; therefore to prevent the disputes which might be raised upon such accounts, I chose to reduce the substance of that book into the form of propositions, in the mathematical way, which should be read by those only who had first made themselves masters of the principles established in the preceding books."

As a necessary preliminary to this third part, Newton lays down rules for reasoning in natural philosophy.

The phenomena first considered are, 1. That the satellites of Jupiter, by radii drawn to his centre, describe areas proportional to the times of description; and that their periodic times, the fixed stars being at rest, are in the sesquiplicate ratio of their distances from that centre. 2. The same thing is likewise observed of the phenomena of Saturn. 3. The five primary planets, Mercury, Venus, Mars, Jupiter, Saturn, with their several orbits, encompass the sun. 4. The fixed stars being supposed at rest, the periodic times of the said five primary planets, and of the earth, about the sun, are in the sesquiplicate proportion of their mean distances from the sun. 5. The primary planets, by radii drawn to the earth, describe areas no ways proportional to the times; but the areas which they describe by radii drawn to the sun are proportional to the times of description. 6. The moon, by a radius drawn to the centre of the earth, describes an area proportional to the time of description. All which phenomena are clearly evinced by astronomical observations. The mathematical demonstrations are next applied by Newton in the following propositions.

Prop. 1. The forces by which the satellites of Jupiter are continually drawn off from rectilinear motions, and retained in their proper orbits, tend to the centre of that planet, and are reciprocally as the squares of the distances of those satellites from that centre.

Prop. 2. The same thing is true of the primary planets, with respect to the sun's centre.

Prop. 3. The same thing is also true of the moon, in respect of the earth's centre.

Prop. 4. The moon gravitates towards the earth; and by the force of gravity is continually drawn off from a rectilinear motion, and retained in her orbit.

Prop. 5. The same thing is true of all the other planets, both primary and secondary, each with respect to the centre of its motion.

Prop. 6. All bodies gravitate towards every planet; and the weights of bodies towards any one and the same planet, at equal distances from its centre, are proportional to the quantities of matter they contain.

Prop. 7. There is a power of gravity tending to all bodies, proportional to the several quantities of matter which they contain.

Prop. 8. In two spheres mutually gravitating each towards the other, if the matter in places on all sides, round about and equidistant from the centres, is similar, the weight of either sphere towards the other, will be reciprocally as the square of the distance between their centres. Hence are compared together the weights of bodies towards different planets; hence also are discovered the quantities of matter in the several planets; and hence likewise are found the densities from those planets.

Prop. 9. The force of gravity, in parts downwards from the surface of the planets towards their centres, decreases nearly in the proportion of the distances from those centres.

These, and many other propositions and corollaries, are proved or illustrated by a great variety of experiments, in all the great points of physical astronomy. See GRAVITY, GRAVITATION, &c.

NICANDRA, a genus of the monogynia order in the decandria class of plants, and in the natural method ranking under the 13th order, contortæ. The calyx is monophyllous and quadripartite; the corolla is monopetalous, tubulated, and parted into ten laciniæ; the fruit is an oval berry, which is grooved longitudinally, and contains many small angular seeds. Of this there is only one species, the amara, a native of Guiana. The leaves and stalks are bitter, and used by the natives as an emetic and purge.

NICHE. See ARCHITECTURE.

NICKEL, in mineralogy. There is found in different parts of Germany a heavy mineral of a reddish-brown colour, not unlike copper. When exposed to the air, it gradually loses its lustre, becomes at first brownish, and is at last covered with green spots. It was at first taken for an ore of copper; but as none of that metal can be extracted from it, the German miners give it the name of kupfernickel, or false copper. Hierne, who may be considered as the father of the Swedish chemists, is the first person who mentions this mineral. He gives a description of it in a book published by him in 1694 on the art of detecting metals. It was generally considered by mineralogists as an ore of copper, till it was examined by the celebrated Cronstedt. He concluded from his experiments, which were published in the Stockholm Transactions for 1751 and 1754, that it contained a new metal, to which he gave the name of nickel.

This opinion was embraced by all the Swedes, and indeed by the greater number of chemical philosophers. Some, however, particularly Sage and Monnet, affirmed, that it contained no new metal, but merely a compound of various known metals, which could be separated from each other by the usual processes. These assertions induced Bergman to undertake a very laborious course of experiments, in order, if possible, to obtain nickel in a state of purity; for Cronstedt had not been able to separate a quantity of arsenic, cobalt, and iron, which adhered to it with much obstinacy. These experiments, which were published in 1775, fully confirmed the conclusions of Cronstedt.

Nickel, when perfectly pure, is of a fine white colour, resembling silver; and like that metal it leaves a white trace when rubbed upon the polished surface of a hard stone. It is rather softer than iron. Its specific gravity is 9. Its malleability, while cold, is rather greater than that of iron, but it cannot be heated without being oxidated, and in consequence rendered brittle. It is attracted by the magnet as strongly as iron. Like that metal, it may be converted into a magnet; and in that state points to the north when freely suspended, precisely as a common magnetic needle. It requires for fusion a temperature at least equal to 150° Wedgewood. It has not hitherto been crystallized.

When heated in an open vessel, it combines with oxygen, and assumes a green colour; and if the heat is continued, acquires a tinge of purple. The oxide of nickel, according to Klaproth, is composed of 77 parts of nickel and 23 of oxygen.

Nickel has not been combined with carbon nor hydrogen, but it combines readily with sulphur and phosphorus. Cronstedt found that sulphuret of nickel may be easily formed by fusion. The sulphuret which he obtained was yellow and hard, with small sparkling facets; but the nickel which he employed was impure.

Phosphuret of nickel may be formed either by fusing nickel along with phosphoric glass, or by dropping phosphorus into it while red-hot. It is of a white colour, and when broke, it exhibits the appearance of very slender prisms collected together. When heated, the phosphorus burns, and the metal is oxidated. It is composed of 83 parts of nickel and 17 of phosphorus. The nickel however on which this experiment was made, was not pure.

Nickel is not acted upon by azote, nor does it combine with muriatic acid.

The alloys of this metal are but very imperfectly known. With gold it forms a white and brittle alloy; with copper a white, hard, brittle alloy, easily oxidized when exposed to the air; with iron it combines very readily, and forms an alloy whose properties have not been sufficiently examined; with tin it forms a white, hard, brittle mass, which swells up when heated; with lead it does not combine without difficulty; with silver and mercury it refuses to unite; its combination with platinum has not been tried.

The affinities of nickel, and its oxides, are, according to Bergman, as follows:

NICKEL.	OXIDE OF NICKEL.
Iron,	Oxalic acid,
Cobalt,	Muriatic,
Arsenic,	Sulphuric,
Copper,	Tartaric,
Gold,	Nitric,
Tin,	Phosphoric,
Antimony,	Fluoric,
Platinum,	Saclactic,
Bismuth,	Succinic,
Lead,	Citric,
Silver,	Lactic,
Zinc,	Acetic,
Sulphur,	Arsenic,
Phosphorus.	Boracic,
	Prussic,
	Carbonic.

NICKEL, *ores of.* Hitherto nickel has been found in too small quantities to be applied to any use; of course there are no mines of nickel. It usually occurs in secondary mountains, and commonly accompanies cobalt. It has been found in different parts of Germany, in Sweden, Siberia, Spain, France, and Britain.

NICOLAITANS, in church history, christian heretics who assumed this name from Nicolas of Antioch; who, being a gentile by birth, first embraced judaism, and then christianity; when his zeal and devotion recommended him to the church of Jerusalem, by whom he was chosen one of the first deacons.

NICOTIANA, *tobacco*, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 28th order, luridæ. The corolla is funnel-shaped, with a plaited limb; the stamina inclined; the capsule bivalved and bilocular. There are seven species, of which the most remarkable is the tabacum (see Plate Nat. Hist. fig. 297), or common tobacco-plant. This was first discovered in America by the Spaniards about the year 1560, and by them imported into Europe. It had been used by the inhabitants of America long before; and was called by those of the islands yoli, and pætun by the inhabitants of the continent. It was sent into Spain from Tabaco, a province of Yucatan, where it was first discovered, and whence it takes its common name.

There are two varieties of that species of nicotiana which is cultivated for common use; and which are distinguished by the names of Oronokoe, and sweet-scented tobacco. They differ from each other in the figure of their leaves; those of the former being longer and narrower than the latter. They are tall herbaceous plants, growing erect with fine foliage, and rising with a strong stem from six to nine feet high. The stalk, near the root, is upward of an inch diameter, and surrounded with a kind of hairy or velvet clammy substance, of a yellowish-green colour. The leaves are rather of a deeper green, and grow alternately at the distance of two or three inches from each other. They are oblong, of a spear-shaped oval, and simple; the largest about twenty inches long, but decreasing in size as they ascend, till they come to be only ten inches long, and about half as broad. The face of the leaves is much corrugated, like those of spinach when full-ripe. Before they come to maturity, when they are about five or six inches long, the leaves are generally of a full green, and rather smooth; but as they increase in size, they become rougher, and acquire a yellowish cast. The stem and branches are terminated by large bunches of flowers collected into clusters, of a delicate red; the edges, when full-blown, inclining to a pale purple. They continue in succession till the end of the summer; when they are succeeded by seeds of a brown colour, and kidney-shaped. These are very small, each capsule containing about 1000; and the whole produce of a single plant is reckoned at about 350,000. The seeds ripen in the month of September.

Mr. Carver informs us, that the Oronokoe, or, as it is called, the long Virginian tobacco, is the kind best suited for bearing the rigour of a northern climate; the strength, as well as the scent, of the leaves, being greater than that of the other. The sweet-scented sort flourishes most in a sandy soil, and in a warm climate, where it greatly exceeds the former in the celerity of its growth; and is likewise, as its name intimates, much more mild and pleasant.

Culture.—Tobacco thrives best in a warm, kindly, rich soil, that is not subject to be overrun by weeds. In Virginia the soil in which it thrives best is warm, light, and inclining to be sandy; and therefore if the plant is to be cultivated in Britain, it ought to be planted in a soil as nearly of the same kind as possible. Other kinds of soil might probably be brought to suit it, by a mixture of proper manure; but we must remember, that whatever manure is made use of must be thoroughly incorporated with the soil. The best situation for a tobacco-plantation is the southern declivity of a hill rather gradual than abrupt, or a spot that is sheltered from the north winds: but at the same time it is necessary that the plants enjoy a free air; for without that they will not prosper.

Having sown the seed, on the least apprehension of a frost after the plants appear, it will be necessary to spread mats over the beds, a little elevated from the ground by poles laid across, that they may not be crushed. When the tobacco has risen to the height of more than two feet, it commonly begins to put forth the branches on which the flowers and seeds are produced; but as this expansion, if suffered to take place, would drain the nutriment from the leaves, which are the most valuable part, and thereby lessen their size and efficacy, it becomes needful at this stage to nip off the extremity of the stalk to prevent its growing higher. In some climates the top is commonly cut off when the plant has 15 leaves: but if the tobacco is intended to be a little stronger than usual, this is done when it has only 13.

The apparent signs of maturity are these: the leaves, as they approach a state of ripeness, become more corrugated or rough; and when fully ripe appear mottled, with yellowish spots on the raised parts; whilst the cavities retain their usual green colour.

Tobacco is subject to be destroyed by a worm; and without proper care to exterminate this enemy, a whole field of plants may soon be lost. This animal is of the horned species, and appears to be peculiar to the tobacco-plant; so that in many parts of America it is distinguished by the name of the tobacco-worm. In what manner it is first produced, or how propagated, is unknown: but it is not discernible till the plants have attained about half their height; and then appears to be nearly as large as a gnat. Soon after this it lengthens into a worm; and by degrees increases in magnitude to the bigness of a man's finger. In shape it is regular from its head to its tail, without any diminution at either extremity. The colour of its skin is, in general, green, interspersed with several spots of a yellowish white; and the whole covered with a short hair scarcely to be discerned. These worms are found the most predominant during the end of July and the beginning of August; at which time the plants must be particularly attended to, and every leaf carefully searched. As soon as a wound is discovered (and it will not be long before it is perceptible), care must be taken to destroy the cause of it, which will be found near it, and from its unsubstantial texture may easily be crushed.

When the tobacco is fit for being gathered, on the first morning that promises a fair day, before the sun is risen, take an axe or a long knife, and holding the stalk near the top with one hand, sever it from its root with the other, as low as possible. Lay it gently on the ground, taking care not to break off the leaves, and there let it remain exposed to the rays of the sun throughout the day, or until the leaves, according to the American expression, are entirely wilted; that is, till they become limber, and will bend any way without breaking. But if the weather should prove rainy without any intervals of sunshine, and the plants appear to be fully ripe, they must be housed immediately. This must be done, however, with great care that the leaves, which are in this state very brittle, may not be broken. They are next to be placed under proper shelter, either in a barn or covered hovel, where they cannot be affected by rain or too much air, thinly scattered on the floor; and if the sun does not appear for several days, they must be left to wilt in that manner; but in this case the quality of the tobacco will not be quite so good.

When the leaves have acquired the abovementioned flexibility, the plants must be laid in heaps, or rather in one heap if the quantity is not too great, and in about 24 hours they will be found to sweat. But during this time, when they have lain for a little while, and begin to ferment, it will be necessary to turn them; bringing those which are in the middle to the surface, and placing those which are at the surface in the middle. The longer they lie in this situation, the darker-coloured is the tobacco. After they have lain for three or four days, for a longer continuance might make the plants turn mouldy, they may be fastened together in pairs with cords or wooden pegs, near the bottom of the stalk, and hung across a pole, with the leaves suspended in the same covered place, a proper interval being left between each pair. In about a month the leaves will be thoroughly dried, and of a proper temperature to be taken down. This state may be ascertained by their appearing of the same colour with those imported from America. But this can be done only in wet weather. The tobacco is exceedingly apt to attract the humidity of the atmosphere, which gives it a pliability that is absolutely necessary for its preservation; for if the plants are removed in a very dry season, the external parts of the leaves will crumble into dust, and a considerable waste will ensue.

Cure.—As soon as the plants are taken down, they must again be laid in a heap, and pressed with heavy logs of wood for about a week; but this climate may possibly require a longer time. While they remain in this state it will be necessary to introduce your hand frequently into the heap, to discover whether the heat is not too intense; for in large quantities this will sometimes be the case, and considerable damage will be occasioned by it. When they are found to heat too much, that is, when the heat exceeds a moderate glowing warmth, part of the weight by which they are pressed must be taken away; and the cause being removed, the effect will cease. This is called the second, or last sweating; and, when completed, which it generally will be about the time just mentioned, the leaves may be stripped from the stalks for use. Many, however, omit this last sweating.

When the leaves are stripped from the stalks, they are to be tied up in bunches or hands, and kept in a cellar or other damp place; though if not handled in dry weather, but only during a rainy season, it is of little consequence in what part of the house or barn they are laid up. At this period the tobacco is thoroughly cured, and as proper for manufacturing as that imported from the colonies.

Tobacco is made up into rolls by the inhabitants of the interior parts of America, by means of a machine called a tobacco-wheel. With this machine they spin the leaves after they are cured, into a twist of any size they think fit; and having folded it into rolls of about 20 pounds each, they lay it by for use. In this state it will keep for several years, and be continually improving, as it always grows milder. The Illinois usually form it into carrots; which is done by laying a number of leaves, when cured, on each other after the ribs have been taken out, and rolling them round with packthread till they become cemented together. These rolls commonly measure about 18 or 20 inches in length, and nine round in the middle part.

NICTITATING Membrane. See Comparative Anatomy.

NIGELLA, *fennel flower*, or *devil in a bush*, a genus of the pentagynia order, belonging to the pentandria class of plants. There is no calyx; the petals are five, and five trifid nectaria within the corolla; there are five connected capsules. There are five species, all of them annuals, and natives of the warm parts of Europe; and rising from a foot to a foot and a half high, adorned with blue or white flowers. They are propagated by seeds, which in a dry and warm situation will thrive very well; and the plants ripen seeds in this country.

NIGHT-MARE. See Medicine.

NIGRINA, in botany, a genus of the monogynia order, belonging to the pentandria class of plants. The corolla is funnel-shaped; the calyx inflated; the stigma obtuse; the capsule bilocular.

NIGRINE. This ore has hitherto been found only near Passau in Bavaria, and at Arendaal in Norway, and near St. Gothard. It was discovered by professor Hunger. It is sometimes disseminated, but more commonly crystallized, in four-sided prisms, not longer than one-fourth of an inch. Primitive form a rhomboidal prism.

Colour reddish, yellowish, or blackish-brown; sometimes whitish-grey. Powder whitish-grey. Lustre waxy, or nearly metallic. Texture foliated. Brittle. Specific gravity 3.510. Muriatic acid, by repeated digestion, dissolves one-third of it. Ammonia precipitates from this solution a clammy yellowish substance. Infusible by the blowpipe, and also in a clay crucible; but in charcoal is converted into a black, opaque, porous slag.

According to the analysis of Klaproth it is composed of

33	oxide of titanium
35	silica
33	lime
101.	

The mineral called sphene by Hauy belongs to this species. According to the analysis of Cordier it is composed of

33.3	oxide of titanium
28.0	silica
32.2	lime.
93.5	

NIHIL DICIT, a failure in the defendant to put in an answer to the plaintiff's declaration, &c. by the day assigned for that purpose, by which omission judgment of course is had against him.

NIMBUS, in antiquity, a circle observed on certain medals, or round the head of some emperors, answering to the circles of light drawn around the images of saints. The nimbus is seen on the medals of Maurice, Phocas, and others, even of the upper empire. See also METEOROLOGY.

NIPA, a genus of the natural order of palms. The male has a spathe; the corolla is six-petalled. The female has a spathe; corolla none; drupes angular.

There is one species, a native of the E. Indies. The leaves are used in making mats.

NIPPERS, in a ship, are small ropes about a fathom or two long, with a little truck at one end, and sometimes only a wale-knot. Their use is to help holding off the cable from the main or jeer-capstan, where the cable is so slimy, so wet, and so great, that they cannot strain it, to hold it off with their bare hands.

NISI PRIUS, in law, a commission directed to the judges of assize, empowering them to try all questions of fact issuing out of the courts at Westminster that are then ready for trial by jury. The original of which name is this: all causes commenced in the courts of Westminster-hall are, by course of the courts, appointed to be tried on a day fixed in some Easter or Michaelmas term, by a jury returned from the county wherein the cause of action arises; but with this proviso, nisi prius justiciarii ad assisas capiendas venerint: that is, unless before the day prefixed the judges of assize come into the county in question, which they always do in the vacation preceding each Easter and Michaelmas term, and there try the cause. And then, upon the return of the verdict given by the jury to the court above, the judges there give judgment for the party to whom the verdict is found. 3 Black. 59. See ASSIZES.

NISSOLIA, a genus of the decandria order, in the diadelphia class of plants, and in the natural method ranking under the 32d order, papilionaceæ. The calyx is quinquedentate; the capsule monospermous, and terminated by a ligulated wing. There are two species, trees of Carthagena.

NITIDULA, a genus of insects of the coleoptera order. The generic character is, antennæ clavate, the club solid; shells margined; head prominent; thorax a little flattened, margined. There are upwards of 30 species of this genus.

NITRARIA, a genus of the monogynia order, in the dodecandria class of plants, and in the natural method ranking with those of which the order is doubtful. The corolla is pentapetalous, with the petals arched at the top; the calyx quinquefid; the stamina 15; the fruit a monospermous plum. There is one species, a shrub of Siberia.

NITRATS, salts formed by the nitric acid. The most important of the nitrats have been long known; and in consequence of the singular properties which they possess, no class of bodies has excited greater attention, or been examined with more unwearied industry. See NITRE. They may be distinguished by the following properties:

1. Soluble in water, and capable of crystallizing by cooling. 2. When heated to redness, along with combustible bodies, a violent combustion and detonation are produced. 3. Sulphuric acid disengages from them fumes, which have the odour of nitric acid. 4. When heated along with muriatic acid, oxymuriatic acid is exhaled. 5. Decomposed by heat, and yield at first oxygen gas. The nitrats at present known are 12 in number. Few of them combine with an excess of acid or of base, so that there are hardly any supernitrats, or subnitrats.

NITRE, or *nitrat of potass*. As this salt, known also by the name of saltpetre, is produced naturally in considerable quantities, particularly in Egypt, it is highly probable that the antients were acquainted with it; but scarcely any thing certain can be collected from their writings. If Pliny mentions it at all, he confounds it with soda, which was known by the names of nitron and nitrum. It is certain, however, that it has been known in the East from time immemorial. Roger Bacon mentions this salt in the 13th century under the name of nitre.

No phenomenon has excited the attention of chemical philosophers more than the continual reproduction of nitre in certain places after it had been extracted from them. Prodigious quantities of this salt are necessary for the purposes of war; and as nature has not laid up great magazines of it, as she has of some other salts, this annual reproduction is the only source from which it can be procured. It became therefore of the utmost consequence, if possible, to discover the means which nature employed in forming it, in order to enable us to imitate her processes by art, or at least to accelerate and facilitate them at pleasure. Numerous attempts accordingly have been made to explain and to imitate these processes.

Lemery the younger advanced, that all the nitre obtained exists previously in animals and vegetables; and that it is formed in these substances by the processes of vegetation and animalization. But it was soon discovered that nitre exists, and is actually formed, in many places where no animal nor vegetable substance had been decomposed; and consequently this theory was as untenable as the former. So far indeed is it from being true that nitre is formed by these processes alone, that the quantity of nitre in plants has been found to depend entirely on the soil in which they grow.

At last, by the numerous experiments of several French philosophers, particularly by those of Thouvenel, it was discovered that nothing else is necessary for the production of nitre than a basis of lime, heat, and an open but not too free communication with dry atmospheric air. When these circumstances combine the acid is first formed, and afterwards the alkali makes its appearance. How the air furnishes materials for this production is easily explained, now that the component parts of the nitric acid are known to be oxygen and azote: but how lime contributes to their union it is not so easy to see. The appearance of the potass is equally extraordinary. If any thing can give countenance to the hypothesis that potass is composed of lime and azote, it is this singular fact.

Nitre is found abundantly on the surface of the earth in India, South America, and even in some parts of Spain. In Germany and France it is obtained by means of artificial nitre-beds. These consist of the refuse of animal and vegetable bodies undergoing putrefaction, mixed with calcareous and other earths. It has been ascertained that if oxygen gas is presented to azote at the instant of its disengagement, nitric acid is formed. This seems to explain the origin of the acid in these beds. The azote disengaged from these putrefying animal substances combines with the oxygen of the air. The potass is probably furnished, partly at least, by the vegetables and the soil.

The nitre is extracted from these beds by lixiviating the earthy matters with water. This water, when sufficiently impregnated, is evaporated, and a brown-coloured salt obtained, known by the name of crude nitre. It consists of nitre, common salt, nitrat of lime, and various other salts. The foreign salts are either separated by repeated crystallizations, or by washing the salt repeatedly with small quantities of water; for the foreign salts being more soluble are taken up first.

Nitre, when slowly evaporated, is obtained in six-sided prisms, terminated by six-sided pyramids; but for most purposes it is preferred in an irregular mass, because in that state it contains less water. The primitive form of its crystals, according to Hauy, is a rectangular octahedron, composed of two four-sided pyramids applied base to base; two of the sides are inclined to the other pyramid at an angle of 120°; the other two at an angle of 111°. The form of its integrant particles is the tetrahedron. The six-sided prism is the most common form which it assumes. Sometimes, instead of six-sided pyramids, these prisms are terminated by 18 facets, disposed in three ranges of six, as if three truncated pyramids were piled on each other; sometimes it crystallizes in tables.

The specific gravity of nitre is 1.9369. Its taste is sharp, bitterish, and cooling. It is very brittle. It is soluble in seven times its weight of water at the temperature of 60°, and in nearly its own weight of boiling water. It is not altered by exposure to the air.

When the solution of nitre is exposed to a boiling heat, part of the salt is evaporated along with the water, as Wallerius, Kirwan, and Lavoisier, observed successively. When exposed to a strong heat it melts, and congeals by cooling into an opaque mass, which has been called mineral crystal. Whenever it melts it begins to disengage oxygen; and by keeping it in a red heat about the third of its weight of that gas may be obtained: towards the end of the process azotic gas is disengaged. If the heat is continued long enough the salt is completely decomposed, and pure potass remains behind.

It detonates more violently with combustible bodies than any of the other nitrats. When mixed with one-third part of its weight of charcoal, and thrown into a red-hot crucible, or when charcoal is thrown into red-hot nitre, detonation takes place, and one of the most brilliant combustions that can be exhibited. The residuum is carbonat of potass. It was formerly called nitre fixed by charcoal. A still more violent detonation is produced by using phosphorus instead of charcoal. When a mixture of nitre and phosphorus is struck smartly with a hot hammer a very violent detonation is produced.

Nitre oxidizes all the metals at a red heat, even gold and platinum.

Nitre, according to Bergman, is composed of

31	acid
61	potass
8	water.
100	

According to the latest experiments of Kirwan, after being dried in the temperature of 70°, it is composed of

44.0	acid
51.8	potass
4.2	water.
100.0	

Nitre is decomposed by the following salts:

1. Sulphats of soda, ammonia, magnesia, alumina.
2. Muriat and acetat of barytes.

One of the most important compounds formed by means of nitre is gunpowder, which has completely changed the modern art of war. See GUNPOWDER.

NITRIC ACID seems to have been first obtained in a separate state by Raymond Lully, who was born at Majorca in 1235. He procured it by distilling a mixture of nitre and clay. It was afterwards denominated aquafortis, and spirit of nitre. The name nitric acid was first given it in 1787 by the French chemists; it was immediately before called nitrous acid.

1. It is generally obtained in large manufactories by distilling a mixture of nitre and clay; but the acid procured by this process is weak and impure. Chemists generally prepare it by distilling three parts of nitre and one of sulphuric acid in a glass retort. The neck of the retort must be luted into a receiver, from which there passes a glass tube into a bottle with two mouths, containing a little water, and furnished with a tube of safety; which is a tube open at its upper end, and having its lower end plunged in water. The water prevents any communication between the external air and the inside of the apparatus. If a vacuum happens to be formed within the vessels, the external air reaches down through the tube, and prevents any injury to the vessels. On the other hand, if air is generated in the vessels it forces the water up the tube, the height of which becomes thus the measure of the elasticity of the air in the vessels. By this contrivance the apparatus is in no danger of being broken, which otherwise might happen. From the other mouth of this bottle there passes a tube into a pneumatic apparatus, to collect the gas which is evolved during the process. The retort is to be heated gradually almost to redness. The nitric acid comes over, and is condensed in the receiver; while the common air of the vessels, and a quantity of oxygen gas which is evolved, especially towards the end of the process, passes into the pneumatic apparatus, and the water in the bottles is impregnated with some acid which is not condensed in the receiver.

The acid thus obtained is of a yellow colour, and almost always contains muriatic and sometimes sulphurous acid. These may be removed by distilling it over again with a moderate heat, and changing the receiver after the first portion, which contains all the foreign acids, has passed. It still contains a quantity of nitrous gas, to which it owes its colour and the red fumes which it exhales. This gas may also be expelled by the application of heat. Pure nitric acid remains behind, transparent and colourless, like water.

When newly prepared in this manner it is a liquid as transparent and colourless as water; but the affinity between its component parts is so weak, that the action of light is sufficient to drive off a part of its oxygen in the form of gas; and thus, by converting it partly into nitrous gas, to make it assume a yellow colour. Its taste is exceedingly acid and peculiar. It is very corrosive, and tinges the skin of a yellow colour, which does not disappear till the epidermis comes off. It is constantly emitting white fumes which have an acrid disagreeable odour.

It has a strong affinity for water, and has never yet been obtained except mixed with that liquid. When concentrated it attracts moisture from the atmosphere, but not so powerfully as sulphuric acid. It also produces heat when mixed with water, owing evidently to the concentration of the water.

The specific gravity of the strongest nitric acid that can be procured is 1.583; but at the temperature of 60°, Mr. Kirwan could not procure it stronger than 1.5543.

As this liquid acid is a compound of two ingredients, namely, pure nitric acid and water, it becomes an object of the greatest consequence to ascertain the proportion of each of these parts. This problem has lately occupied the attention of Mr. Kirwan, who has endeavoured to solve it in the following manner:

He dried a quantity of crystallized carbonat of soda in a red heat, and dissolved it in water, in such a proportion that 367 grains of the solution contained 50.05 of alkali. He saturated 367 grains of this solution with 147 grains of nitric acid, the specific gravity of which was 1.2754; and which he ascertained to contain 45.7 per cent. of acid, of the specific gravity 1.5543, chosen by him as a standard. The carbonic acid driven off amounted to 14 grains. On adding 939 grains of water the specific gravity of the solution, at the temperature of 58.5°, was 1.0401. By comparing this with a solution of nitrat of soda, of the same density, he found that the salt contained in it amounted to $\frac{1}{16.901}$ of the whole. There was an excess of acid of about two grains. The weight of the whole was 1439 grains: the quantity of salt consequently was $\frac{1439}{16.901} = 85.142$ grains. The quantity of alkali was $50.05 - 14 = 36.05$. The quantity of standard acid employed was 66.7. The whole therefore amounted to 102.75 grains; but as only 85.142 grains entered into the composition of the salt, the remaining 17.608 must have been pure water mixed with the nitric acid. But if 66.7 of standard acid contain 17.608 of water, 100 parts of the same acid must contain 26.38. One hundred parts of standard nitric acid, therefore, are composed of 73.62 parts of pure nitric acid and 26.38 of water.

Mr. Davy considers as pure acid the permanently elastic vapour or gas formed by saturating nitrous gas with oxygen gas. This gas is of a pale-yellow colour, and a specific gravity 2.44 times that of air. It is not pure acid, containing undoubtedly a portion of nitrous gas. The following table exhibits the proportion of this acid contained in nitric acid of different densities, according to the experiments of that ingenious chemist:

100 Parts Nitric Acid, of Sp. Gr.	True Acid.	Water.
1.5040	91.55	8.45
1.4475	80.39	19.61
1.4285	71.65	28.35
1.3906	62.96	37.04
1.3551	56.88	43.12
1.3186	52.03	47.97
1.3042	49.04	50.96
1.2831	46.03	53.97
1.2090	45.27	54.73

When nitric acid is exposed to the action of heat it boils at the temperature of 248, and evaporates completely without alteration; but when made to pass through a red-hot porcelain tube it is decomposed, and converted into oxygen and azotic gas. When cooled down to —66 it begins to congeal; and when agitated it is converted into a mass of the consistence of butter.

Oxygen gas has no action whatever on nitric acid; but all the simple combustibles decompose it, unless we are to except the diamond. When poured upon sulphur or phosphorus at a high temperature it sets them on fire; but at a moderate temperature it converts them slowly into acids, while nitrous gas is exhaled. It inflames charcoal also at a high temperature; and even at the common temperature, provided the charcoal is perfectly dry and minutely divided. Hydrogen gas produces no change on it at the temperature of the atmosphere; but when passed along with it through a red-hot porcelain tube it detonates with great violence; water is formed, and azotic gas evolved.

When this acid is poured upon oils it sets them on fire. This is occasioned by a decomposition both of the acid and oil. The oxygen of the acid combines with the carbon and with the hydrogen of the oils, and at the same time lets go a quantity of caloric. Hence we see that the oxygen which enters into the composition of the nitric acid still contains a great deal of caloric; a fact which is confirmed by a great number of other phenomena. The combustion of oils by this acid was first taken notice of by Borrichius and Slare; but it is probable that Homberg communicated it to Slare. In order to set fire to the fixed oils it must be mixed with some sulphuric acid; the reason of which seems to be, that these oils contain water, which must be previously removed. The sulphuric acid combines with this water, and allows the nitric acid, or rather the oil and nitric acid together, to act. The drying oils do not require any sulphuric acid: they have been boiled, and consequently deprived of all moisture.

Azote has no action on nitric acid; but muriatic acid decomposes it by combining with a portion of its oxygen nitrous gas and oxymuriatic gas being evolved.

It is capable of oxidizing all the metals, except gold, platinum, and titanium. It appears, from the experiments of Scheffer, Bergman, Sage, and Tillet, that nitric acid is capable of dissolving (and consequently of oxidizing) a very minute quantity even of gold.

It even sets fire to zinc, bismuth, and tin, if it is poured on them in fusion, and to filings of iron if they are perfectly dry.

Nitric acid combines with alkalies, earths, and the oxides of metals, and forms compounds, which are called nitrats.

The order of its affinities is as follows:

Barytes,
Potass,
Soda,
Strontian,
Lime,
Magnesia,
Ammonia,
Glucina,
Alumina,
Zirconia.

Nitric acid is one of the most important instruments of analysis which the chemist possesses; nor is it of inferior consequence when considered in a political or commercial view, as it forms one of the most essential ingredients of gunpowder. Its nature and composition accordingly have long occupied the attention of philosophers; and from their experiments it appears, that nitric acid is composed of azote and oxygen; consequently nitrous gas is also composed of the same ingredients. And as nitrous gas absorbs oxygen, even from common air, and forms with it nitric acid, it is evident that nitric acid contains more oxygen than nitrous gas. But it is exceedingly difficult to ascertain the exact proportions of the component parts of this acid. Lavoisier concluded, from his experiments on the decomposition of nitre by charcoal, that nitric acid is composed of one part of azote and four parts of oxygen. But Davy has shewn that this decomposition is more complicated than had been supposed; and that Lavoisier's experiments by no means warrant the conclusion which he drew from them. Cavendish, on the other hand, concluded, from his experiments, that the acid which he formed, by combining together azote and oxygen by means of electricity, is composed of one part of azote and 2.346 of oxygen. With this result the late experiments of Mr. Davy corresponded very nearly. He formed his standard acid by combining together known quantities of nitrous gas and oxygen. According to him 100 parts of pure nitric acid are composed of

29.5 azote
70.5 oxygen

100.0;

or 1 part of azote, and 2.39 of oxygen.

Nitric acid is seldom in a state of absolute purity, holding usually a certain portion of nitrous gas in solution. In this state it is distinguished by the name of nitrous acid; a compound of considerable importance. See Nitrous Acid.

NITRITES, are salts formed from nitrats, saturated with nitrous gas. See Nitrats.

The existence of these salts was first pointed out by Bergman and Scheele; the two philosophers to whom we are indebted for the first precise notions concerning the difference between nitric and nitrous acids. They cannot be formed by combining directly nitrous acid with the different earthy and alkaline bases; nor have any experiments made to combine nitrous gas with the nitrats been attended with success.

The only method of obtaining these salts at present known, is that which was long ago pointed out by Bergman and Scheele. It consists in exposing a nitrat to a pretty strong heat till a quantity of oxygen gas is disengaged from it. What remains in the retort after this process is a nitrite; but the length of time necessary for producing this change has not yet been ascertained with any degree of precision. If the heat is applied too long the nitrat will be totally decomposed, and nothing but the base will remain, as happened to some of the French chemists on attempting to repeat the process of Bergman and Scheele.

Nitrite of potass is the only salt formed by this process, of which an account has been given. Scheele's process for obtaining it is as follows: Fill a small retort with nitre, and keep it red-hot for half an hour. When it is allowed to cool it is found in the state of a nitrite. It deliquesces when exposed to the air; and red vapours of nitrous acid are exhaled when any other acid is poured upon it.

As the nitrites have never been examined by chemists, and as it has not even been determined whether any considerable number of the nitrats can be converted into these salts, it would be in vain, in the present state of our knowledge, to attempt a particular description of them. It may, however, be considered as exceedingly probable that no such salts as the nitrites of ammonia, glucina, yttria, alumina, and zirconia, exist or can be formed, at least by the process of Scheele and Bergman; for the nitrats with these bases are decomposed completely by the action of a heat too moderate to hope for the previous emission of oxygen gas.

From the few observations that have been made, it may be concluded that the nitrites are in general deliquescent, very soluble in water, decomposible by heat as well as nitrats; that their taste is cooling like that of the nitrats, but more acrid and nitrous: that by exposure to the air they are gradually converted into nitrats by absorbing oxygen; but this change takes place exceedingly slowly.

NITRO-MURIATIC acid. When muriatic acid is mixed with nitric acid, the mixture is nitro-muriatic acid, which was formerly known by the name of aqua-regia.

NITROUS ACID. The liquid at present called nitrous acid by chemists, may be formed by causing nitrous gas to pass through nitric acid. The gas is absorbed, and the acid assumes a yellow colour; and its specific gravity is diminished. It is then denominated nitrous acid. It is always in this state that it is obtained by distilling a mixture of sulphuric acid and nitre. The acid of commerce is always nitrous acid. The nitric and nitrous acids were first distinguished with accuracy by Scheele.

The nature of nitrous acid was first investigated by Dr. Priestley, who demonstrated, by very decisive experiments, that it is a compound of nitric acid and nitrous gas. This opinion was embraced, or rather it was first fully developed, by Morveau. But the theory of Lavoisier, which supposed the difference between nitric and nitrous acids to depend merely on the first containing a greater proportion of oxygen than the second, for some time drew the attention of chemists from the real nature of nitrous acid. Raymond published a dissertation in 1796, to demonstrate the truth of the theory of Priestley and Morveau; and the same thing has been done still more lately by Messrs. Thomson and Davy. At present it is allowed by every one, that nitrous acid is merely nitric acid more or less impregnated with nitrous gas.

This being the case, and nitric acid being capable of absorbing very different proportions of nitrous gas, it is evident that there must be a great variety of nitrous acids, differing from each other in the proportion of nitrous gas which they contain; unless we choose to confine the term nitrous acid to the compound formed by saturating nitric acid completely with nitrous gas.

When nitrous gas is placed in contact with nitric acid, the acid absorbs it slowly, and acquires first a pale-yellow colour, then a bright yellow. When a considerable portion more of nitrous gas is absorbed, the acid becomes dark orange, then olive, which increases in intensity with the gas absorbed; then it becomes of a bright green; and, lastly, when fully saturated, it becomes blue-green. Its volume and its volatility also increase with the quantity of gas absorbed; and when fully saturated it assumes the form of a dense vapour, of an exceedingly suffocating odour, and difficultly condensible by water. In this state of saturation it is distinguished by Dr. Priestley by the name of nitrous acid vapour. It is of a dark-red colour, and passes through water partly without being absorbed. The quantity of nitrous gas absorbed by nitric acid is very great. Dr. Priestley found, that a quantity of acid, equal in bulk to four pennyweights of water, absorbed 130 ounce-measures of gas without being saturated. The component parts of nitrous acid, of different colours and densities, may be seen in the following table, drawn up by Mr. Davy, from experiments made by him on purpose, with much precision:

100 Parts.	Sp. Grav.	Component Parts.		
		Nitric Acid.	Water.	Nitrous Gas.
Solid nitric acid	1.504	91.55	8.45	—
Yellow nitrous	1.502	90.5	8.3	2
Bright yellow	1.500	88.94	8.10	2.96
Dark orange	1.480	86.84	7.6	5.56
Light olive	1.479	86.00	7.55	6.45
Dark olive	1.478	85.4	7.5	7.1
Bright green	1.476	84.8	7.44	7.76
Blue green	1.475	84.6	7.4	8.00

The colour of nitrous acid depends, in some measure, also on the proportion of water which it contains. When to yellow nitrous acid concentrated, a fourth part by weight of water is added, the colour is changed to a fine green; and when equal parts of water are added, it becomes blue. Dr.

Priestley observed, that water impregnated with this acid in the state of vapour, became first blue, then green, and lastly yellow. A green nitrous acid became orange-coloured while hot, and retained a yellow tinge when cold. A blue acid became yellow on being heated in a tube hermetically sealed. An orange-coloured acid, by long keeping, became green, and afterwards of a deep blue; and when exposed to air resumed its original colour. When nitrous acid is exposed to heat the nitrous gas is expelled, and nitric acid remains behind. The gas, however, carries along with it a quantity of acid, especially if the acid is concentrated. But nitrous acid vapour is not altered in the least by exposure to heat.

It is not altered by oxygen gas, common air, nor by azotic gas.

The simple combustibles and metals act upon it precisely as on nitric acid. It answers much better than nitric acid for inflaming oils and other similar bodies.

It converts sulphurous and phosphorous acids into sulphuric and phosphoric.

Nitrous acid vapour is absorbed by sulphuric acid, but seemingly without producing any change; for when water is poured into the mixture, the heat produced expels it in the usual form of red fumes. The only singular circumstance attending this impregnation is, that it disposes the sulphuric acid to crystallize.

NOBILITY, a quality that ennobles, and raises a person possessed of it above the rank of a commoner.

The civil state of England consists of the nobility and commonalty. The nobility are all those who are above the degree of knight, under which term is included that of a baronet; namely, dukes, marquises, earls, viscounts, and barons. 1 Black. 396.

NOCTURNAL, Nocturlabium, an instrument chiefly used at sea, to take the altitude or depression of some stars about the pole, in order to find the latitude, and hour of the night.

Some nocturnals are hemispheres, or planispheres, on the plane of the equinoctial. Those commonly in use among seamen are two; the one adapted to the polar star, and the first of the guards of the little bear; the other to the pole-star, and the pointers of the great bear.

This instrument consists of two circular plates (see Plate Miscel. figure 173), applied to each other. The greater, which has a handle to hold the instrument, is about two inches and a half in diameter, and is divided into twelve parts, agreeing to the twelve months, and each month subdivided into every fifth day; and so that the middle of the handle corresponds to that day of the year wherein the star here regarded has the same right ascension with the sun. If the instrument is fitted for two stars, the handle is made moveable. The upper left circle is divided into twenty-four equal parts for the twenty-four hours of the day, and each hour subdivided into quarters. These twenty-four hours are noted by twenty-four teeth, to be told in the night. Those at the hours 12 are distinguished by their length. In the centre of the two circular plates is adjusted a long index, A, moveable upon the upper plate; and the three pieces, viz. the two circles and index, are joined by a rivet which is pierced through the centre with a hole, through which the star is to be observed.

To use the nocturnal.—Turn the upper plate till the long tooth, marked 12, is against the day of the month on the under plate: then, bringing the instrument near the eye, suspend it by the handle with the plane nearly parallel to the equinoctial; and viewing the pole-star through the hole of the centre, turn the index about till, by the edge coming from the centre, you see the bright star, or guard, of the little bear (if the instrument is fitted to that star): then that tooth of the upper circle, under the edge of the index, is at the hour of the night on the edge of the hour-circle: which may be known without a light, by counting the teeth from the longest, which is for the hour 12.

NODE. See Surgery.

NODES. See Astronomy.

NOETIANS, in church history, christian heretics in the 3d century, followers of Noetius, a philosopher of Ephesus, who it is said pretended that he was another Moses, sent by God, and that his brother was a new Aaron; his doctrine consisted in affirming that there was but one person in the Godhead, and that the Word and the Holy Spirit were but external denominations given to God in consequence of different operations; that as creator he is called Father; as incarnate, Son; and as descending on the apostles, Holy Ghost.

NOLANA, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 41st order, asperifoliæ. The corolla is campanulated; the style situated betwixt the germens; the seeds are bilocular, and resemble berries. There is one species, an annual of Peru.

NOLLE PROSEQUI, is used where the plaintiff proceeds no farther in his action, and may be as well before as after a verdict, and is stronger against a plaintiff than a nonsuit, which is only a default in appearance; but this is a voluntary acknowledgment that he has no cause of action. Impey's B. R.

NOMBRIL POINT, in heraldry, is the next below the fess-point, or the very centre of the escutcheon.

NOME, or Name, in algebra, denotes any quantity with a sign prefixed or added to it, whereby it is connected with some other quantity, upon which the whole becomes a binomial, trinomial, or the like: thus $a+b$ is a binomial, $a+b+c$ is a trinomial, whose respective names or nomes are a and b for the first, and a, b, and c, for the second. See Algebra.

NOMINATIVE, in grammar, the first case in nouns which are declinable.

NON-APPEARANCE, a default in not appearing in a court of judicature. Attorneys subscribing warrants for appearing in court are liable to attachment and fine for non-appearance. If a defendant does not appear and find bail upon a scire facias and rule given, jugment may be had against him.

Non compos mentis, in law, is used to denote a person's not being of sound memory and understanding. Of these persons there are four different kinds, an ideot, a madman, a lunatic who has lucid intervals, and a drunkard who deprives himself of reason by his own act and deed. In all these cases except the last, one that is non compos mentis shall not lose his life for felony or murder; but the drunkard can have no indulgence on account of the loss of his reason, for, in the eye of the law, his drunkenness does not extenuate but aggravate his offence.

Non est inventus, is a sheriff's return to a writ, that the defendant is not to be found.

Non-naturals, in medicine, so called because by their abuse they become the causes of diseases. See Medicine. The old physicians have divided the non-naturals into 6 classes, viz. the air, meats and drinks, sleep and watching, motion and rest, the passions of the mind, the retentions, and excretions.

Non-pros. If the plaintiff neglects to deliver a declaration for two terms after the defendant appears, or is guilty of other delays or defaults against the rules of law in any subsequent stage of the action, he is adjudged not to pursue his remedy as he ought; and thereupon a nonsuit or non prosequitur is entered, and he is then said to be non-pros'd. 3 Black. 395.

Non-residence. See Residence.

NONAGESIMAL, or *nonagesimal degree*, called also the midheaven, is the highest point, or 90th degree, of the ecliptic, reckoned from its intersection with the horizon at any time; and its altitude is equal to the angle that the ecliptic makes with the horizon at their intersection, or equal to the distance of the zenith from the pole of the ecliptic. It is much used in the calculation of solar eclipses.

NONAGON, a figure having nine sides and angles. In a regular nonagon, or that whose angles and sides are all equal, if each side is 1, its area will be $6.1818242 + \frac{9}{4}$ of $70°$, to the radius 1.

NONIUS. See Vernier.

NONSUIT, in law, is where a person has commenced an action, and at the trial fails in his evidence to support it, or has brought a wrong action. There is this advantage attending a nonsuit, that the plaintiff, though he pays costs, may afterwards bring another action for the same cause, which he cannot do after a verdict against him. Tidd's K. B. Practice.

NONES, *nonæ*, in the Roman calendar, the fifth day of the months January, February, April, June, August, September, November, and December; and the seventh of March, July, and October. March, May, July, and October, had six days in their nones; because these alone, in the antient constitution of the year by Numa, had 31 days apiece, the rest having only 29, and February 30: but when Cæsar reformed the year, and made other months containing 31 days, he did not allot them six days of nones.

NORROY, the title of the third of the three kings at arms. See Heraldry.

NORMAL, a perpendicular forming with another line a right angle.

NORWAY RAT. See Mus.

NOSE. See Anatomy.

NOTARIAL ACTS, are those acts, in the civil law, which require to be done under the seal of a notary, and which are admitted as evidence in foreign courts.

NOTARY, is a person duly appointed to attest deeds and writings; he also protests and notes foreign and inland bills of exchange and promissory notes, translates languages and attests the same, enters and extends ship's protests, &c.

NOTATION, in arithmetic and algebra, the method of expressing numbers or quantities by signs or characters appropriated for that purpose. See ALGEBRA, ARITHMETIC, CHARACTER, &c.

NOTATION, in music, the manner of expressing, or representing by characters, all the different sounds used in music. The antient notation was very different from that of the moderns. The Greeks employed for this purpose the letters of their alphabet, sometimes placing them erect, and sometimes inverting, mutilating, and compounding them in various manners, so as to represent by them all the different tones or chords used in their system. By a treatise of Alypius, professedly written to explain the Greek characters, we find that they amounted to no less a number than 1240. These were, however, rejected afterwards by the Latins, who introduced letters from their own alphabet, A, B, C, D, E, F, G, H, I, K, L, M, N, O, P, fifteen in number, and by which they expressed the sounds contained in the bisdiapason. For the great improvement upon this notation, which at length took place, and which is in part adopted at the present day, we are indebted to St. Gregory, the first pope of that name; who reflecting that in the bisdiapason, the sounds after Lichanos Meson, or the middle tone, were but a repetition of those which preceded, and that every septenary in progression was precisely the same, reduced the number of letters to seven, viz. A, B, C, D, E, F, G: but to distinguish the second septenary from the first, the second was denoted by the small, and not the capital, Roman letters; and when it became necessary to extend the system farther, the small letters were doubled thus, aa, bb, cc, dd, ee, ff, gg. The stave, consisting of a variable number of parallel lines, the application of which some attribute to Guido, was afterwards introduced; and this was again meant to be improved upon by the adoption of small points, commas, accents, and certain little oblique strokes, occasionally interspersed in the stave, while also two colours, yellow and red, were used; a yellow line signifying the letter or note C, and a red line denoting that of F. Two methods of notation were long after employed for the viol and other stringed instruments, which were distinguished by the terms lyra-way and gamut-way; with this exception, that the literal notation for the lute is constantly called the tablature; concerning which, as also the notation by letters in general, it may be observed that they are a very inartificial practice, as was also the old method of notation for the flute and flageolet by dots.

NOTE is a minute, or short writing, containing some article of business; in which sense we say, promissory note, note of hand, bank note. See BILLS of EXCHANGE.

NOTES, in music, characters which by their various forms and situations on the staves, indicate the duration as well as the gravity or acuteness of the several sounds of a composition.

NOTICE, in law, is the making something known that a man was or might be ignorant of before, and it produces divers effects; for by it the party that gives the same shall have some benefit, which otherwise he should not have had: and by this means the party to whom the notice is given is made subject to some action or charge, that otherwise he would not have been liable to, and his estate in danger of prejudice. Co. Lit. 309.

The plaintiff and defendant are both bound at their peril to take notice of the general rules of the practice of the court; but if there is a special particular rule of court made for the plaintiff, or for the defendant, he for whom the rule is made ought to give notice of this rule to the other; or else he is not bound generally to take notice of it, nor shall be in contempt of the court although he does not obey it. 2 L. P. R. 204.

NOTONECTA, a genus of insects of the order hemiptera. The generic character is, snout inflected; antennæ shorter than thorax; wings coriaceous on the upper part, and crossed over each other; hind feet edged with hairs, and formed for swimming. The principal species of this are,

1. The notonecta glauca, a very common aquatic insect, inhabiting stagnant waters; and generally measuring about three parts of an inch in length. Its colour is grey-brown, and the upper wings are marked along the edges by a row of minute black specks. This insect is usually seen swimming on its back, in which situation it bears a most striking resemblance to a boat in miniature, the hind legs acting like a pair of oars, and impelling the animal at intervals through the water. It preys on the smaller inhabitants of the water, and flies only by night.

2. Notonecta striata, is much smaller than the preceding, not measuring more than a quarter of an inch in length, and is of a yellowish-grey colour, with numerous transverse undulated black lines or streaks: it is found in stagnant waters.

3. Notonecta minutissima, is an extremely small species, with grey wings, marked by longitudinal dusky spots: like the two former it is an inhabitant of stagnant waters, but is far less frequently observed than the rest, on account of its very small size. There are 17 species.

NOTOXUS, a genus of insects of the coleoptera order. The generic character is, antennæ filiform; feelers four, hatchet-shaped; jaw one-toothed; thorax a little narrowed behind. There are 13 species, found in Europe and Asia.

NOVATIANS, a christian sect which sprang up in the third century, so called from Novatian, a priest of Rome, or Novatus, an African bishop, who separated from the communion of pope Cornelius, whom Novatian charged with a criminal lenity towards those who had apostatised during the persecution of Decius. He denied the church's power of remitting mortal sins.

NOVEL, in the civil law, a term used for the constitutions of several emperors, as of Justin, Tiberius, Leo, and more particularly for those of Justinian. The constitutions of Justinian were called novels, either from their producing a great alteration in the face of the antient law, or because they were made on new cases, and after the revisal of the antient code, compiled by the order of that emperor. Thus the constitutions of the emperors Theodosius, Valentinian, Marcian, &c. were also called novels, on account of their being published after the Theodosian code.

NOUN, in grammar, a part of speech, which signifies things without any relation to time; as a man, a house, sweet, bitter, &c.

NUCLEUS, in general, denotes the kernel of a nut, or even any seed inclosed within a husk. The term nucleus is also used for the body of a comet, otherwise called its head.

NUDE CONTRACT, a bare promise, without any consideration, and therefore void.

NUISANCE, signifies generally any thing that works hurt, inconvenience, or damage, to the property or person of another. Nuisances are of two kinds, public or private nuisance, and either affect the public or the individual. The remedy for a nuisance is by action on the case for damages. Every continuance of a nuisance is a fresh nuisance, and a fresh action will lie.

NUMBER, *kinds and distinctions of.* Mathematicians, considering number under a great many relations, have established the following distinctions. Broken numbers are the same with fractions. Cardinal numbers are those which express the quantity of units, as 1, 2, 3, &c. whereas ordinal numbers are those which express order, as 1st, 2d, 3d, &c. Compound number, one divisable by some other number besides unity; as 12, which is divisible by 2, 3, 4, and 6. Numbers, as 12 and 15, which have some common measure besides unity, are said to be compound numbers among themselves.

Cubic number is the product of a square number by its root: such as 27, as being the product of the square number 9, by its root 3. All cubic numbers whose root is less than 6, being divided by 6, the remainder is the root itself: thus $27 \div 6$ leaves the remainder 3, its root; 216, the cube of 6, being divided by 6, leaves no remainder; 343, the cube of 7, leaves a remainder 1, which added to 6, is the cube root; and 512, the cube of 8, divided by 6, leaves a remainder 2, which added to 6, is the cube root. Hence the remainders of the divisions of the cubes above 216, divided by 6, being added to 6, always gives the root of the cube so divided, till that remainder is 5, and consequently 11 the cube-root of the number divided. But the cube number above this being divided by 6, there remains nothing, the cube-root being 12. Thus the remainders of the higher cubes are to be added to 12, and not to 6, till you come to 18, when the remainder of the division must be added to 18; and so on ad infinitum.

Determinate number, is that referred to some given unit, as a ternary or three: whereas an indeterminate one, is that referred to unity in general, and is called quantity.

Homogeneal numbers, are those referred to the same unit; as those referred to different units are termed heterogeneal.

Whole numbers, are otherwise called integers. See INTEGER.

Rational number, is one commensurable with unity; as a number incommensurable with unity, is termed irrational or a surd. See SURD.

In the same manner a rational whole number, is that whereof unity is an aliquot part; a rational broken number, that equal to some aliquot part of unity; and a rational mixed number, that consisting of a whole number and a broken one.

Even number, that which may be divided into two equal parts without any fraction, as 6, 12, &c. The sum, difference, and product, of any number of even numbers, is always an even number.

An evenly even number, is that which may be measured, or divided, without any remainder, by another even number, as 4 by 2.

An unevenly even number, when a number may be equally divided by an uneven number, as 20 by 5.

Uneven number, that which exceeds an even number, at least by unity, or which cannot be divided into two equal parts, as 3, 5, &c.

The sum or difference of two uneven numbers makes an even number; but the factum of two uneven ones makes an uneven number.

If an even number is added to an uneven one, or if the one is substracted from the other, in the former case the sum, in the latter the difference, is an uneven number; but the factum of an even and uneven number is even.

The sum of any even number of uneven numbers is an even number; and the sum of any uneven number of uneven numbers is an uneven number.

Primitive or prime numbers, are those only divisible by unity, as 5, 7, &c. And prime numbers among themselves, are those which have no common measure besides unity, as 12 and 19.

Perfect number, that whose aliquot parts, added together, make the whole number, as 6, 28; the aliquot parts of 6 being 3, 2, and 1 = 6; and those of 28, being 14, 7, 4, 2, 1, = 28.

Imperfect numbers, those whose aliquot parts, added together, make either more or less than the whole. And these are distinguished into abundant and defective; an instance in the former case is 12, whose aliquot parts 6, 4, 3, 2, 1 make sixteen; and in the latter case 16, whose aliquot parts 8, 4, 2, and 1, make but 15.

Plain number, that arising from the multiplication of two numbers, as 6, which is the product of 3 by 2; and these numbers are called the sides of the plane.

Square number, is the product of any number multiplied by itself; thus 4, which is the factum of 2 by 2, is a square number.

Every square number added to its root makes an even number.

Polygonal, or polygonous numbers, the sums of arithmetical progressions beginning with unity; these, where the common difference is 1, are called triangular numbers; where 2, square numbers; where 3, pentagonal numbers; where 4, hexagonal numbers; where 5, heptagonal numbers, &c. See POLYGONAL.

Pyramidal numbers: the sums of polygonous numbers, collected after the same manner as the polygons themselves, and not gathered out of arithmetical progressions, are called first pyramidal numbers; the sums of the first pyramidals are called second pyramidals, &c.

If they arise out of triangular numbers, they are called triangular pyramidal numbers; if out of pentagons, first pentagonal pyramidals.

From the manner of summing up polygonal numbers, it is easy to conceive how the prime pyramidal numbers are found, viz. $\frac{(a-2)\,n^3 + 3\,n^2 - (a-5)\,n}{6}$ expresses all the prime pyramidals.

NUMBER, in grammar, a modification of nouns, verbs, &c. to accommodate them to the varieties in their objects, considered with regard to number.

NUMERAL LETTERS, those letters of the alphabet which are generally used for figures as I, V, X, L, C, D, M. See ARITHMETIC, CHARACTER, &c.

NUMERALS, in grammar, those words which express numbers; as six, eight, ten, &c.

NUMERATION. See ARITHMETIC, CHARACTER, &c.

NUMIDA, in ornithology, a genus belonging to the order of gallinæ. On each side of the head there is a kind of coloured fleshy horn; and the beak is furnished with cere near the nostrils. The species called meleagris, or Guinea hen, is a native of Africa. See Plate Nat. Hist. fig. 298. It is larger than a common hen. Its body is sloped like that of a partridge; and its colour is all over a dark grey, very beautifully spotted with small white specks; there is a black ring round the neck; its head is reddish, and it is blue under the eyes. They naturally herd together in large numbers, and breed up their young in common; the females taking care of the broods of others, as well as of their own. Barbut informs us, that in Guinea they go in flocks of 200 or 300, perch on trees, and feed on worms and grasshoppers; that they are run down and taken by dogs; and that their flesh is tender and sweet, generally white, though sometimes black. They breed very well with us.

The white-breasted one is a mere variety, of which there are many; it is mostly found in Jamaica. The mitred, or numida mitrata, is a different and not a common species; it inhabits Madagascar and Guinea. The third species which Mr. Latham mentions is the crested, or numida cristata. This species likewise inhabits Africa. Buffon, who describes it at great length, calls it la peintade. Linnæus and Gmelin call it Numida meleagris, &c. Ray and Willughby call it gallus and gallina Guineensis, &c. Mr. Pennant contends, and seems to prove, that the pintados had been early introduced into Britain, at least prior to the year 1277. But they seem to have been much neglected on account of the difficulty of rearing them; for they occur not in our antient bills of fare. They have a double caruncle at the chaps, and no fold at the throat.

NUNCIO, or *Nuntio*, an ambassador from the pope to some catholic prince or state; or a person who attends on the pope's behalf at a congress, or an assembly of several ambassadors. The nuncio has a jurisdiction and may delegate judges in all the states where he resides, except in France, where he has no authority but that of a simple ambassador. See AMBASSADOR.

NUNCUPATIVE WILL, denotes a last will or testament, only made verbally, and not put in writing. See WILL and TESTAMENT.

NURSERY, in gardening, is a piece of land set apart for raising and propagating all sorts of trees and plants, to supply the garden and other plantations.

In a nursery for fruit-trees, the following rules are to be observed: 1. That the soil should not be better than that in which the trees are to be planted out for good. 2. That it ought to be fresh, and not such as has been already worn out by trees, or other large growing plants. 3. It ought neither to be too wet, nor too dry, but rather of a middling nature; though, of the two extremes, dry is to be preferred; because, though trees in such a soil do not make so great a progress, yet they are generally sounder, and more disposed to fruitfulness. 4. It must be inclosed in such a manner that neither cattle nor vermin may come in; and so as particularly to exclude hares and rabbits, which, when the ground is covered with snow, are great destroyers of young trees. 5. The ground being inclosed should be carefully trenched about two feet deep; this this should be done in August, that it may be ready for receiving young stocks at the season for planting, which is commonly about the beginning of October: in trenching the ground, you must be careful to cleanse it from the roots of all noxious weeds. 6. The season being come for planting, level down the trenches as equal as possible; and then lay out the ground into quarters, which may be laid out in beds for a seminary, in which you may sow the seeds or stones of fruit. 7. And having provided yourself with stocks, the next year proceed to transplant them, in the following manner: draw a line across the ground intended to be planted, and open a number of trenches exactly straight; then take the stocks out of the seed-beds; in doing which, you should raise the ground with a spade, in order to preserve the roots as entire as possible; prune off the very small fibres, and if there are any that have a tendency to root directly downwards, such roots should be shortened. Then plant them in the trenches, if they are designed for standards, in rows three feet and a half, or four feet, from each other, and a foot and a half distant in the rows; but if for dwarfs, three feet row from row, and one foot in the row, will be a sufficient distance. These plants should by no means be headed, or pruned at top, which will weaken them, and cause them to produce lateral branches. If the winter should prove very cold, lay some mulch on the surface of the ground near their roots, taking care not to let it lie too thick near the stems of the plants, and to remove it as soon as the frost is over. In the summer season destroy the weeds, and dig up the ground every spring between the rows. The second year after planting, such of the stocks as are designed for dwarfs will be fit to bud; but those that are designed for standards should be suffered to grow five or six feet high before they are budded or grafted; for the manner of doing which, see GRAFTING.

As to timber trees, Mr. Miller advises those gentlemen who would have plantations in parks, woods, &c. to make nurseries upon the ground intended for planting, where a sufficient number of the trees may be left standing, after the others have been drawn out to plant in other places.

The ground intended for the flower-nursery should be well situated to the sun; and defended from strong winds by plantations of trees, or by buildings. The soil also should be light and dry, especially for bulbous-rooted flowers; for in this nursery the offsets of all bulbous-rooted flowers should be planted, and remain there till they become blowing roots, when they should be removed into the pleasure-garden, and planted either in beds or borders, according to the goodness of the flowers. These flowers may also be raised in the nursery from seed. The seedling auriculas, polyanthuses, ranunculuses, anemonies, carnations, &c. should be raised in this nursery, where they should be preserved till they have flowered, when all those should be marked that are worthy of being transplanted into the flower-garden: this should be done in their proper seasons; for all these seedling flowers ought not indiscriminately to be exposed to public view in the pleasure-garden, because it always happens, that there are great numbers of ordinary flowers produced among them, which will there make but an indifferent appearance.

NUT. See Corylus.

Nut-galls. See Gallic Acid.

NUTATION, in astronomy, a kind of tremulous motion of the axis of the earth, whereby, in each annual revolution, it is twice inclined to the ecliptic, and as often returns to its former position. Sir Isaac Newton observes, that the moon has the like motion, only very small, and scarcely sensible.

NUTMEG. See Myristica.

NUTRITION. See Digestion, Materia Medica, and Physiology.

NUX VOMICA, a flat, compressed, round fruit, about the breadth of a shilling, brought from India. See Strychnus.

NYCTANTHES, *Arabian Jasmine*, a genus of the monogynia order, in the diandria class of plants; and in the natural method ranking with the 44th order, sepiariæ. The corolla and calyx are octofid: the perianthium dicoccous. There are seven species, the most remarkable of which are: 1. The arbor tristis, or sorrowful tree. This tree, or shrub, the pariaticu of the Bramins, grows naturally in sandy places in India, particularly in the islands of Ceylon and Java, where it is procured in great abundance, and attains the height of 18 or 20 feet. It rises with a four-cornered stem, bearing leaves that are oval, and taper to a point. The flowers, which are white and highly odoriferous, having a sweet delectable smell emulating the best honey, consist of one petal deeply divided into eight parts, which are narrower towards the stalk, and dilated towards the summit. The fruit is dry, capsular, membranaceous, and compressed.

It is generally asserted of this plant, that the flowers open in the evening, and fall off the succeeding day. Fabricius and Paludanus, however, restrict the assertion, by affirming, from actual observation, that this effect is found to take place only in such flowers as are immediately under the influence of the solar rays. Grimmius remarks in his Laboratorium Ceylonicum, that the flowers of this tree afford a fragrant water, which is cordial, refreshing, and frequently employed with success in inflammations of the eyes. The tube of the flower, when dried, has the smell of saffron; and being pounded and mixed with sanders-wood, is used by the natives of the Malabar coast for imparting a grateful fragrancy to their bodies, which they rub or anoint with the mixture.

2. The angustifolia, of which the flowers are white, inexpressibly fragrant, and generally appear in the warm summer-months. Strong loam is its proper soil.

NYMPH, among naturalists, that state of winged insects between their living in the form of a worm, and their appearing in the winged or most perfect state. See Entomology.

NYMPHÆA. See Anatomy.

Nymphæ, the *water-lily*, a genus of the monogynia order, in the polyandria class of plants; and in the natural method ranking under the 54th order, miscellanea. The corolla is polypetalous; the calyx tetraphyllous or pentaphyllous; the berry multilocular and truncated. There are six species, of which the most remarkable are: 1. and 2. The lutea and alba, or yellow and white water-lilies; both of which are natives of Britain, growing in lakes and ditches. Linnæus tells us, that swine are fond of the leaves and roots of the former; and that the smoke of it will drive away crickets and blattæ, or cock-roaches, out of houses. The root of the second has an astringent and bitter taste, like those of most aquatic plants that run deep into the mud. 3. The lotus, with heart-shaped toothed leaves, a plant thought to be peculiar to Egypt, is mentioned by Herodotus. M. Savary mentions it as growing in the rivulets and on the sides of the lakes; and that there are two sorts or varieties of the plant, the one with a white, the other with a blueish flower. "The calyx (he says) blows like a large tulip, and diffuses a sweet smell, resembling that of the lily. The first species produces a round root like that of a potatoe; and the inhabitants of the banks of the lake Menzall feed upon it. The rivulets in the environs of Damietta are covered with this majestic flower, which rises upwards of two feet above the water. 4. In the East and West Indies grows a species of this plant, named nelumbo by the inhabitants of Ceylon. The flowers are large, flesh-coloured, and consist of numerous petals, disposed as in the other species of water-lily, in two or more rows. The seed-vessel is shaped like a top, being broad and circular above, narrow and almost pointed below. It is divided into several distinct cells, which form so many large round holes upon the surface of the fruit, each containing a single seed. With the flower of this plant, which is sacred among the heathens, they adorn the altars of their temples. The stalks, which are used as a pot-herb, are of a wonderful length. The root is very long, extends itself transversely, is of the size of a man's arm, jointed and fibrous, with long intervals between the joints. The fibres surround the joints in verticilli or whorls.

NYSSA, a genus of the order of diœcia, in the polygamia class of plants; and in the natural method ranking under the 12th order, holoraceæ. The hermaphrodite calyx is quinquepartite; there is no corolla; the stamina are five; there is one pistil; the fruit a plum inferior. The male calyx is quinquepartite, no corolla, and ten stamina. There are two species: 1. The integrifolia, entire-leaved; and, 2. The denticulata, or serrated-leaved tupelo.

The entire-leaved tupelo-tree, in its native soil and climate, grows to near 20 feet high; in this country its size varies according to the nature of the soil or situation. In a moist rich earth, well sheltered, it comes to near 20 feet; in others, that are less so, it makes slower progress, and in the end is proportionally lower. The branches are not very numerous; and it rises with a regular trunk, at the top of which they generally grow. In England they seldom produce fruit.

The serrated-leaved tupelo-tree grows usually nearly 30 feet in height; and divides into branches near the top like the other. The leaves are oblong, pointed, of a light-green colour, and come out without order on long footstalks. The flowers come out from the wings of the leaves on long footstalks. They are small, of a greenish-colour; and are succeeded by oval drupes, containing sharp-pointed nuts, about the size of a French olive.

O.

O, the fourteenth letter of our alphabet. As a numeral, it is sometimes used for eleven; and with a dash over it thus $\bar{O}$ for eleven thousand. In the notes of the antients, O. CON. is read opus conductum; O. C. Q. opere consilioque; O. D. M. opera, donum, munus; and O. L. O. opus locatum.

In music, the O, or rather a circle, or double CO, is a note of time called by us a semi-breve; and by the Italians circolo. The O is also used as a mark of triple time, as being the most perfect of all figures.

OAK. See QUERCUS.

OAKAM, old ropes untwisted, and pulled out into loose hemp, in order to be used in caulking the seams, tree-nails, and bends of a ship, for stopping or preventing leaks.

OAR, in navigation, a long piece of wood, for moving a vessel by rowing. Oars for ships are generally cut out of fir-timber, those for barges are made out of New England or Dantzic-rafters, and those for boats, either out of English ash, or fir rafters from Norway.

OAT. See AVENA.

OATH, an affirmation or denial of any thing before one or more persons, who have the authority to administer the same, for the discovery and advancement of truth and right. See AFFIDAVIT.

OBELISK, a truncated, quadrangular, and slender pyramid, raised as an ornament, and frequently charged either with inscriptions or hieroglyphics.

Obelisks appear to be of very great antiquity, and to be first raised to transmit to posterity precepts of philosophy, which were cut in hieroglyphical characters: afterwards they were used to immortalize the great actions of heroes, and the memory of persons beloved. The first obelisk mentioned in history was that of Rameses king of Egypt, in the time of the Trojan war, which was forty cubits high. Phius, another king of Egypt, raised one of forty-five cubits; and Ptolemy Philadelphus, another of eighty-eight cubits, in memory of Arsinoe. Augustus erected one at Rome in the Campus Martius, which served to mark the hours on an horizontal dial, drawn on the pavement. They were called by the Egyptian priests the fingers of the sun, because they were made in Egypt also, to serve as styles or gnomons to mark the hours on the ground. The Arabs still call them Pharoah's needles, whence the Italians call them aguglia, and the French aiguilles.

The proportions in the height and thickness are nearly the same in all obelisks; their height being nine or nine and a half, and sometimes ten times, their thickness; and their diameter at the top never less than half, and never greater than three-fourths, of that at the bottom.

OBLATE, flatted, or shortened; as an oblate spheroid, having its axis shorter than its middle diameter, being formed by the rotation of an ellipse about the shorter axis.

OBLATENESS. See EARTH, figure of.

OBLIGATION, a bond containing a penalty, with a condition annexed, either for payment of money, performance of covenants, or the like. This security is called a specialty. Co. Lit. 172. See BOND, and DEED.

OBLIQUE, in geometry, something aslant, or that deviates from the perpendicular. Thus, an oblique angle, is either an acute or obtuse one; that is, any angle except a right one.

OBLIQUE PLANES. See DIALLING.

OBLONGATA MEDULLA. See ANATOMY.

OBOLUS, in antiquity, an antient Athenian coin, worth a penny farthing. Among antient physicians; obolus likewise denoted a weight, equal to ten grains.

OBOLARIA, a genus of the angiospermia order, in the didynamia class of plants; and in the natural method ranking under the 40th order, personatæ. The calyx is bifid; the corolla campanulated and quadrifid; the capsule unilocular, bivalved, and polyspermous; the stamina rising from the divisions of the corolla. There is one species, a herb of Virginia.

OBSERVATORY, a place destined for observing the heavenly bodies; being generally a building erected on some eminence, covered with a terrace for making astronomical observations.

The principal instruments for a fixed observatory are, a large fixed quadrant, or a circular divided instrument, chiefly for measuring vertical angles; a transit instrument; an equatorial instrument; a chronometer, or regulator; one or more powerful telescopes; a fixed zenith telescope, and a night telescope.

The quadrant, or quarter of a circle, divided into 90°, and each degree subdivided into minutes or smaller parts, has been made of various sizes; some of them having a radius even of eight or nine or more feet in length. When those quadrants do not exceed one or two, or at most three feet, in radius, they are generally fixed upon their particular stands, which are furnished with various mechanical contrivances, that are nesessary to place the plane of the quadrant perpendicular to the horizon, and for all the other necessary adjustments. But large quadrants are fixed upon a strong wall by means of proper clamps; hence they have been commonly called mural quadrants, and are situated in the plane of the meridian of the observatory. In either of those quadrants an index, which reaches from the centre to the edge of the arch, moves round that centre, or round a short axis which passes through that centre so as to be moveable with its extremity all round that arc, and thus point out on the divisions of the arch, the angle which it forms with the horizon, or with the vertical line, in any given situation. This index carries a telescope, through which the observer looks at any particular object, whose altitude he wishes to determine.

Plate Observatory, &c. fig. 1. represents a simple construction of a small moveable quadrant, and fig. 2. represents a mural quadrant. Of the quadrant fig. 1. CEB is the arch divided into 90°, and generally subdivided into smaller divisions, such as half degrees, or third parts of each degree, &c. The centre of the arch is at A, and the whole is connected together by means of strong metallic bars, as is shewn between the letters ABC in the figure: in the centre A, a short axis is fixed perpendicular to the plane of the instrument, and to the upper part of this axis is fastened the index AD, which carries the telescope. This index generally has a small lateral projection, as at E, upon which the nonius or vernier is marked, by which means the minutes or smaller parts of each degree may be discerned. (See VERNIER.) The screw P, commonly called the tangent screw, with a nut that may be fastened to any part of the arch BC, screws likewise into the extremity of the index, and is useful for moving the index gently, or more accurately than by the immediate application of the hand to the index itself.

Since the index is suspended at one end, viz. at A, if the other end D happens to be disengaged from the screw P, the lower end D of the index will naturally come down to C, on account of its own weight, and that of the telescope. Now, in order to avoid this tendency downwards, an arm Y of brass or iron, is frequently affixed to the upper part of the index, which carries the leaden weight Z, sufficient to balance the weight of the index and telescope; so that by this means, even when disengaged from the screw P, the index will remain in any situation in which it may be left. The whole frame ABC is supported upon a strong vertical axis FS, the lower part of which turns into the pedestal OKm, and carries an index SX, which moves upon the divided horizontal circle O, fixed to the pedestal. This serves to fix the plane of the quadrant in any azimuth that may be required. The lower part of the pedestal has three claws, with a screw m in each; by which means the axis FS may be set truly perpendicular. The plummet AO, suspended at A, serves to shew when the edge AC of the instrument is truly perpendicular, or when the first division of the arch at C is exactly in the vertical which passes through the centre A of the quadrantal arc BC. The weight of the plummet generally moves in a glass of water, which is fixed upon the arm GR; the object of which is to check the vibrations of the pendulum; which otherwise would be easily moved by every breath of air, and would continue to move for a considerable time after. We do not mention the lenses or microscopes that are applied to read off the divisions at E and at X, or to see the coincidence of the plummet-line with a dot marked upon the arc at C, as matters that need no particular description.

In the eye-tube of the telescope AD, there are certain slender wires, placed in the focus of the eye-lens, and perpendicular to the axis of the telescope, which enable the observer to distinguish more accurately when an object, that is seen through the telescope, reaches the axis of the telescope, or, as it is more commonly called, the line of collimation, &c. Now when the stars or planets are observed at night, those wires in the eye-tube cannot be seen; therefore, to render them visible, an arm or wire is fixed occasionally at the end of the telescope, which arm holds a small piece of ivory or card c, set aslant to the axis of the telescope; for when a lighted candle or lantern is situated at a little distance, and is directed so as to shine upon the above-mentioned ivory or card, the reflection of the light from it into the tube of the telescope will enable the observer to distinguish the wires at the same time that he beholds the celestial object.

The mural quadrant, fig. 2, is a larger instrument like the above, excepting that it has no stand; and its index is prevented from bending on account of its great length, by means of metallic bars, *d, f, b. c.* This instrument is firmly fixed upon a wall exactly in the plane of the meridian of the observatory, for which purpose it has clamps, screws, and other adjustments. It has likewise a plummet.

This undoubtedly is the principal instrument of an observatory; for by observing the times by the clock, of the arrival of any celestial object to the meridian, the right ascension of that object is had immediately; and its declination is shewn at the same time by the index of the quadrant upon the divided arch; deducting the inclination of the equator, which is given by the latitude once ascertained of the observatory. It is by this means that exact catalogues of the places of the fixed stars have been made.

The transit instrument consists of a telescope of any convenient length, fixed at right angles to a horizontal axis, which axis is supported at its two extremities; and the instrument is generally situated so that the line of collimation of the telescope may move in the plane of the meridian. The use of this instrument is to observe the precise time of the celestial bodies' passage across the meridian of the observatory.

Fig. 3. exhibits a transit instrument. N M is the telescope; in the eye-tube of which a system of parallel wires, is situated in the focus of the eye-lens. FE is the horizontal axis, in the middle of which the telescope is steadily fixed: so that by moving the telescope, the axis is forced to turn round its two extremities E and F, which rest in the notches of two thick pieces, T, S, of bell-metal, such as are delineated separately and magnified at X and Z. Those pieces are generally fixed upon two pillars, either of cast iron, or which is better, of stone, as are shewn in the figure; and they are constructed so as to be susceptible of a small motion by means of slides and screws, viz. the piece T backwards and forwards, and the piece S upwards and downwards; by which means the axis EF of the instrument may be set exactly horizontal, and caused to move perpendicular to the plane of the meridian. In order to verify the first of those requisites, viz. to see whether the axis is truly horizontal, the long spirit-level P Q is suspended upon it by means of the metallic branches PO and QR; and the situation of the bubble in it will immediately shew whether the axis is truly horizontal, or which way it inclines, and of course where it must be raised or depressed. The other requisite, viz. whether the axis is perpendicular to the plane of the meridian, or not, may be verified by various means, the best of which is by observations on those circumpolar stars which never go below the horizon of the observatory. Thus, observe the times by the clock, when a circumpolar star, seen through the telescope NM, crosses the meridian both above and below the pole; and if the times of describing the eastern and western parts of its circuit are equal, the telescope is then in the plane of the meridian, consequently the axis EF is perpendicular to that plane; otherwise the notched pieces T and S, which support the extremities E, F, of the axis, must be moved accordingly, or until upon observation it is found that the above-mentioned times of the stars' semi-revolutions are equal.

When the instrument has been once so adjusted, a mark may be made upon a house, or rock, or post, at some distance from the observatory, so that when viewed through the telescope, this mark may appear to be in the direction of the axis of the telescope; by which means the correct situation of the instrument may afterwards be readily verified.

The cylindric extremity F is perforated, and the perforation passes through the half of the axis, and reaches the inside of the telescope; that side of the telescope tube which is exactly facing F, being also perforated. Within the said tube, and directly opposite to the perforation of the end F, a plane reflector, or a flat piece of ivory, is fixed, making an angle of 45° with the axis of the telescope, and having a hole through it large enough to admit all the rays passing from the object-glass to the eye-glass of the telescope.

When stars or other celestial objects are to be observed in the night-time, a small lantern Y is set upon a stand just before the perforation of the extremity F, so as to throw the light within the axis, and upon the slant reflector within the tube of the telescope, whence it is reflected upon the wires in the eye-tube M, and renders them visible. By placing the lantern nearer to, or farther from, the extremity F, the observer may illuminate the wires sufficiently for the purpose, and not too much.

To the other extremity E of the axis, a divided circle, or sometimes a semicircle, is fixed, which turns with the axis; the index being fixed to the pillar which supports the axis. Sometimes the situation of those parts is reversed, viz. the circle is fastened to the pillar, or to the brass piece which supports the axis, and the index is fastened to the extremity E of the axis. The use of this circle, is to place the telescope in the direction of any particular celestial body, when that body crosses the meridian; which inclination is equal to the collatitude of the place, more or less the declination of the celestial body, according as that declination is north or south.

To adjust the clock by the sun's transit over the meridian.—Note the times by the clock when the preceding and following edges of the sun's limb touch the cross wires. The difference between the middle time and 12 hours, shews how much the mean, or time by the clock, is faster or slower than the apparent, or solar time, for that day; to which the equation of time being applied, will show the time of mean noon for that day, by which the clock may be adjusted.

Astronomical or equatorial sector, an instrument for finding the difference in right ascension and declination between two objects, the distance of which is too great to be observed by the micrometer, was invented by Graham. Let AB (fig. 4.) represent an arch of a circle, containing 10 or 12 degrees well divided, having a strong plate CD for its radius, fixed to the middle of the arch at D: let this radius be applied to the side of an axis HFI, and be moveable about a joint fixed to it at F, so that the plane of the sector may be always parallel to the axis HI; which being parallel to the axis of the earth, the plane of the sector will always be parallel to the plane of some hour-circle. Let a telescope CE be moveable about the centre C of the arch AB, from one end of it to the other, by turning a screw at G; and let the line of sight be parallel to the plane of the sector. Now, by turning the whole instrument about the axis HI, till the plane of it is successively directed, first to one of the stars and then to another, it is easy to move the sector about the joint F, into such a position, that the arch AB, when fixed, shall take in both the stars in their passage, by the plane of it, provided the difference of their declinations does not exceed the arch AB. Then, having fixed the plane of the sector a little to the westward of both the stars, move the telescope CE by the screw G; and observe by a clock the time of each transit over the cross hairs, and also the degrees and minutes upon the arch AB cut by the index at each transit; then in the difference of the arches, the difference of the declinations, and by the difference of the times, we have the difference of the right ascensions of the stars.

The dimensions of this instrument are these: The length of the telescope, or the radius of the sector, is $2\frac{1}{2}$ feet; the breadth of the radius, near the end C, is $1\frac{1}{4}$ inch; and at the end D two inches. The breadth of the limb AB is $1\frac{1}{2}$ inch; and its length six inches, containing ten degrees divided into quarters, and numbered from each end to the other. The telescope carries a nonius or subdividing plate, whose length, being equal to sixteen quarters of a degree, is divided into fifteen equal parts; which, in effect, divides the limb into minutes, and, by estimation, into smaller parts. The length of the square axis HFI is eighteen inches, and its thickness is about a quarter of an inch: the diameters of the circles are each 5 inches; the thickness of the plates, and the other measures, may be taken at the direction of a workman.

This instrument may be rectified, for making observations, in this manner: By placing the intersection of the cross hairs at the same distance from the plane of the sector, as the centre of the object-glass, the plane described by the line of sight during the circular motion of the telescope upon the limb will be sufficiently true, or free from conical curvity: which may be examined by suspending a long plumb-line at a convenient distance from the instrument; and by fixing the plane of the sector in a vertical position, and then by observing, while the telescope is moved by the screw along the limb, whether the cross hairs appear to move along the plumb-line.

The axis *h f o* (see figure below) may be elevated nearly parellel to the axis of the earth, by means of a small common quadrant; and its error may be corrected by making the line of sight follow the circular motion of any of the circumpolar stars, while the whole instrument is moved about its axis *hfo*, the telescope being fixed to the limb: for this purpose, let the telescope *k l* be directed to the star *a*, when it passes over the highest point of its diurnal circle, and let the division cut by the nonius be then noted: then after twelve hours, when the star comes to the lowest point of its circle, having turned the instrument half-round its axis to bring the telescope into the position *m n*; if the cross hairs cover the same star supposed at *b*, the elevation of the axis *hfo* is exactly right; but if it is necessary to move the telescope into the position *u v*, in order to point to this star at *c*, the arch *m u*, which measures the angle *mfu* or *bfc*, will be known; and then the axis *hfo* must be depressed half the quantity of this given angle if the star passed below *b*, or must be raised so much higher if above it; and thus the trial must be repeated till the true elevation of the axis is obtained. By making the like observations upon the same star on each side the pole, in the six o'clock hour-circle, the error of the axis, towards the east or west, may also be found and corrected, till the cross-hairs follow the star quite round the pole: for supposing *a o p b c* to be an arch of the meridian, make the angle *a f p* equal to half the angle *a f c*, and the line *fp* will point to the pole; and the angle *ofp*, which is the error of the axis, will be equal to half the angle *bfc*, or *mfu*, found by the observation; because the difference of the two angles *afb*, *afc*, is double the difference of their halves *afo* and *afp*. Unless the star is very near the pole, allowance must be made for refractions.

Equatorial or portable observatory: an instrument designed to answer a number of useful purposes in practical astronomy, independantly of any particular observatory; it may be made use of in any steady room or and performs most of the useful problems in the science.

The principal parts of this instrument (fig. 5.) are, 1. The azimuth or horizontal circle A, which represents the horizon of the place, and moves on an axis B, called the vertical axis. 2. The equatorial or hour circle C, representing the equator, placed at right angles to the polar axis D, or the axis of the earth, upon which it moves. 3. The semicircle of declination E, on which the telescope is placed, and moving on the axis of declination, or the axis of motion of the line of collimation F. These circles are measured and divided as in the following table:

Measures of the several circles, and divisions on them.	Radius in dec.	Limb divided to	Nonius of 30 gives seconds.	Divided on limb into parts of inc.	Divided by nonius into parts of inc.
Azimuth, or horizontal circle -	5 1	15′	30″	45th	1350th
Equatorial, or hour circle -	5 1	15′ } 1′ in time }	30″ } 2″ }	45th	1350th
Vertical semi-circle, for declination or latitude -	5 5	15′	30″.	45th	1260th

4. The telescope in this equatorial may be brought parallel to the polar axis, as in the figure, so as to point to the pole-star in any part of its diurnal revolution; and thus it has been observed near noon, when the sun has shone very bright. 5. The apparatus for correcting the error in altitude occasioned by refraction, which is applied to the eye-end of the telescope, and consists of a slide G moving in a groove or dovetail, and carrying the several eye-tubes of the telescope, on which slide there is an index corresponding to 5 small divisions engraved on the dovetail; a small circle called the refraction circle, H, moveable by a finger-screw at the extremity of the eye-end of the telescope; which circle is divided into half-minutes, one entire revolution of it being equal to 3′ 18″, and by its motion raises the centre of the cross hairs on a circle of altitude; and likewise a quadrant I of an inch and a half radius, with divisions on each side, one expressing the degree of altitude of the object viewed, and the other expressing the minutes and seconds of error occasioned by refraction, corresponding to that degree of altitude: to this quadrant is joined a small round level K, which is adjusted partly by the pinion that turns the whole of this apparatus, and partly by the index of the quadrant; for which purpose the refraction-circle is set to the same minute, &c. which the index points to on the limb of the quadrant; and if the minute, &c. given by the quadrant exceeds the 3′ 18″ contained in one entire revolution of the refraction-circle, this must be set to the excess above one or more of its entire revolutions; then the centre of the cross hairs will appear to be raised on a circle of altitude to the additional height which the error of refraction will occasion at that altitude.

The principal adjustment in this instrument is that of making the line of collimation to describe a portion of an hour-circle in the heavens; in order to which, the azimuth-circle must be truly level; the line of collimation, or some corresponding line represented by the small brass rod M parallel to it, must be perpendicular to the axis of its own proper motion; and this last axis must be perpendicular to the polar axis. On the brass rod M there is occasionally placed a hanging level N, the use of which will appear in the following adjustments.

The azimuth-circle may be made level by turning the instrument till one of the levels is parallel to an imaginary line joining two of the feet-screws; then adjust that level with these two feet-screws; turn the circle half round, that is, 180°; and if the bubble is not then right, correct half the error by the screw belonging to the level, and the other half error by the two feet-screws; repeat this till the bubble comes right; then turn the circle 90° from the two former positions, and set the bubble right, if it is wrong, by the foot-screw at the end of the level; when this is done, adjust the other level by its own screw, and the azimuth-circle will be truly level. The hanging level must then be fixed to the brass rod by two hooks of equal length, and made truly parallel to it: for this purpose make the polar axis perpendicular or nearly perpendicular to the horizon; then adjust the level by the pinion of the declination-semicircle, reverse the level, and if it is wrong, correct half the error by a small steel screw that lies under one end of the level, and the other half error by the pinion of the declination-semicircle; repeat this till the bubble is right in both positions. In order to make the brass rod on which the level is suspended, at right angles to the axis of motion of the telescope or line of collimation, make the polar axis horizontal, or nearly so; set the declination-semicircle to 0°, turn the hour-circle till the bubble comes right; then turn the declination-circle to 90°; adjust the bubble by raising or depressing the polar axis (first by hand till it is nearly right, afterwards tighten with an ivory-key the socket which runs on the arch with the polar axis, and then apply the same ivory key to the adjusting screw at the end of the said arch till the bubble comes quite right); then turn the declination-circle to the opposite 90°; if the level is not then right, correct half the error by the aforesaid adjusting screw at the end of the arch, and the other half error by the 2 screws which raise or depress the end of the brass rod. The polar axis remaining nearly horizontal as before, and the declination-semicircle at 0°, adjust the bubble by the hour-circle; then turn the declination-semicircle to 90°, and adjust the bubble by raising or depressing the polar axis; then turn the hour-circle 12 hours; and if the bubble is wrong, correct half the error by the polar axis, and the other half-error by the two pair of capstan-screws at the feet of the two supports on one side of the axis of motion of the telescope; and thus this axis will be at right angles to the polar axis. The next adjustment is to make the centre of cross hairs remain on the same object, while you turn the eye-tube quite round by the pinion of the refraction apparatus: for this adjustment, set the index on the slide to the first division of the dovetail; and set the division marked 18″ on the refraction-circle to its index; then look through the telescope, and with the pinion turn the eye-tube quite round; and if the centre of the hairs does not remain on the same spot during that revolution, it must be corrected by the four small screws, two and two at a time (which you will find upon unscrewing the nearest end of the eye-tube that contains the first eye-glass); repeat this correction till the centre of the hairs remains on the spot you are looking at during an entire revolution. In order to make the line of collimation parallel to the brass rod on which the level hangs, set the polar axis horizontal, and the declination-circle to 90°; adjust the level by the polar axis; look through the telescope on some distant horizontal object, covered by the centre of the cross hairs; then invert the telescope, which is done by turning the hour circle half-round; and if the centre of the cross hairs does not cover the same object as before, correct half the error by the uppermost and lowermost of the four small screws at the eye-end of the large tube of the telescope: this correction will give a second object now covered by the centre of the hairs, which must be adopted instead of the first object: then invert the telescope as before; and if the second object is not covered by the centre of the hairs, correct half the error by the same two screws which were used before: this correction will give a third object, now covered by the centre of the hairs, which must be adopted instead of the second object; repeat this operation till no error remains; then set the hour-circle exactly to 12 hours (the declination-circle remaining at 90° degrees as before); and if the centre of the cross hairs does not cover the last object fixed on, set it to that object by the two remaining small screws at the eye-end of the large tube, and then the line of collimation will be parallel to the brass rod. For rectifying the nonius of the declination and equatorial circles, lower the telescope as many degrees, minutes, and seconds, below 0° or Æ on the declination-semicircle, as are equal to the complement of the latitude; then elevate the polar axis till the bubble is horizontal, and thus the equatorial circle will be elevated to the co-latitude of the place; set this circle to 6 hours; adjust the level by the pinion of the declination-circle; then turn the equatorial circle exactly 12 hours from the last position; and if the level is not right, correct one half of the error by the equatorial circle, and the other half by the declination-circle; then turn the equatorial circle back again exactly 12 hours from the last position; and if the level is still wrong, repeat the correction as before till it is right when turned to either position; that being done, set the nonius of the equatorial circle exactly to 6 hours, and the nonius of the declination circle exactly to 0°.

The principal uses of this equatorial are,

1. To find the meridian by one observation only: for this purpose elevate the equatorial circle to the co-latitude of the place, and set the declination-semicircle to the sun's declination for the day and hour of the day required; then move the azimuth and hour circles both at the same time, either in the same or contrary directions, till you bring the centre of the cross hairs in the telescope exactly to cover the centre of the sun; when that is done, the index of the hour-circle will give the apparent or solar time at the instant of observation; and thus the time is gained, though the sun is at a distance from the meridian; then turn the hour-circle till the index points precisely at 12 o'clock, and lower the telescope to the horizon, in order to observe some point there in the centre of your glass, and that point is your meridian mark found by one observation only; the best time for this operation is three hours before or three hours after 12 at noon.

2. To point the telescope on a star, though not on the meridian, in full day-light. Having elevated the equatorial circle to the co-latitude of the place, and set the declination-semicircle to the star's declination, move the index of the hour-circle till it shall point to the precise time at which the star is then distant from the meridian, found in tables of the right ascension of the stars, and the star will then appear in the glass. Besides these uses peculiar to this instrument, it is also applicable to all the purposes to which the principal astronomical instruments, viz. a transit, a quadrant, and an equal-altitude instrument, are applied.

Of all the different sorts of chronometers or timekeepers, a pendulum-clock, when properly constructed, is undoubtedly capable of the greatest accuracy, it being liable to fewer causes of obstruction or irregularity; therefore such machines are most recommendable for an observatory. The situation of this clock must be near the quadrant, and near the transit instrument; so that the observer, whilst looking through the telescope of any of those instruments, may hear the beats of the clock and count the seconds.

We need hardly observe with respect to telescopes, that they are of very great use in an observatory. Indeed a telescope for the same can never be too good or too large; and it should be furnished with micrometers, with different eye-pieces, &c.; but as a large instrument of that sort is not easily managed, nor is always required, so there should be two or three telescopes of different sizes and different powers in every observatory. One at least ought to be fixed upon an axis which may move parallel to the axis of the earth; for in this construction the celestial bodies may, with the telescope, be easily followed in their movements; as the hand of the observer is, in that case, obliged to move the telescope in one direction only.

A pretty good telescope placed truly vertical in an observatory, is likewise a very useful instrument; as the aberration of the stars, latitude of the place, &c. may be observed and determined by the use of such an instrument, with great ease and accuracy.

The night telescope is a short telescope, which magnifies very little; but it collects a considerable quantity of light, and has a very great field of view; it therefore renders visible several dim objects, which cannot be discovered with telescopes of considerably greater magnifying powers; and hence it is very useful for finding out nebulæ, or small comets, or to see the arrangement of a great number of stars in one view.

The principal instruments that are at present used for marine astronomy, or for the purposes of navigation, are that incomparably useful instrument called Hadley's sextant, or quadrant, or octant; a portable chronometer; and a pretty good telescope. With these few instruments, the latitudes, longitudes, hours of the day or night, and several other problems useful to navigators, may be accurately solved. See OPTICS, and QUADRANT.

OBSIDIAN, in mineralogy, called also the Iceland agate, is found either in detached masses, or forming a part of rocks. It has the appearance of black glass. It is usually invested with a grey or opaque crust. Its fracture is conchoidal. Specific gravity 2.35 nearly. Colour black, or greyish-black; when in very thin pieces green. Very brittle. It melts into an opaque grey mass. It is composed of

69	silica
22	alumina
9	iron
100.	

OBTURATOR. See ANATOMY.

OCCIPITALES. See ANATOMY.

OCCULT, in geometry, is used for a line that is scarcely perceptible, drawn with the point of the compasses, or a leaden pencil. These lines are used in several operations, as the raising of plans, designs of buildings, pieces of perspective, &c. They are to be effaced when the work is finished.

OCCULTATION, *circle of perpetual*, is a parallel in an oblique sphere, as far distant from the depressed pole, as the elevated pole is from the horizon. All the stars between this parallel and the depressed pole, never rise, but lie constantly hid under the horizon of the place.

OCCUPATION, or OCCUPANCY. The law of occupancy is founded upon the law of nature, and is simply the taking possession of those things, which before belonged to nobody; and this is the true ground and foundation of all property. In the civil law it denotes the possession of such things as at present properly belong to no private person, but are capable of being made so; as by seizing or taking of spoils in war, by catching things wild by nature, as birds and beasts of game, &c. or by finding things before undiscovered, or lost by their proper owners.

OCCUPIERS *of walling*, a term in the salt-works for the persons who are the sworn officers that allot, in particular places, what quantity of salt is to be made, that the markets may not be overstocked, and see that all is carried fairly and equally between the lord and the tenant.

OCEAN, in geography, that vast collection of salt and navigable waters, in which the two continents, the first including Europe, Asia, and Africa, and the last America, are inclosed like islands. The ocean is distinguished into three grand divisions: 1. The Atlantic ocean, which divides Europe and Africa from America, which is generally about three thousand miles wide; 2. The Pacific ocean, or South-sea, which divides America from Asia, and is generally about ten thousand miles over; and, 3. The Indian ocean, which separates the East Indies from Africa, which is three thousand miles over. The other seas which are called oceans, are only parts or branches of these, and usually receive their names from the countries they border upon.

OCHNA, a genus of the monogynia order, in the polyandria class of plants; and in the natural method ranking with those of which the order is doubtful. The corolla is pentapetalous; the calyx pentaphyllous; the berries monospermous, and affixed to a large roundish receptacle. There are three species, trees of the East Indies and South America.

OCHRE, in natural history, a genus of earths, slightly coherent, and composed of fine, smooth, soft, argillaceous particles, rough to the touch, and readily diffusible in water. It is a combination of alumina and red oxide of iron. Ochres are of various colours, as red, blue, yellow, brown, green, &c.

OCHROMA, a genus of the pentandria order, in the monadelphia class of plants; and in the natural method ranking under the 37th order, columniferæ. The corolla consists of six petals, three of which are external, and the other three internal; the antheræ unite, and form a spiral pillar round the style; the capsule is long, and has five loculaments, which contain a number of black round seeds. Of this there is only one species, viz. the ochroma lagopus, the down-tree, or cork-wood. This tree is frequent in Jamaica, is of speedy growth, and rises to about 25 or 30 feet. The flowers are large and yellow. The capsules are about five inches long, rounded, and covered with a thin skin; which when dry falls off in five longitudinal segments, and leaves the fruit greatly resembling a hare's foot. The down is short, soft, and silky; it is used sometimes to stuff beds and pillows; but, like other vegetable downs, is apt to get into clots: an insipid clear gum exudes from the tree when wounded. The bark is tough, and its fibres are in a reticulated form; it might be made into ropes. The dried wood is so very light and buoyant, as to be used by the fishermen in Jamaica for their nets instead of pieces of cork.

OCHROXYLUM, a genus of the class and order pentandria trigynia. The calyx is five-cleft; petals five; nect. angular, three-lobed, gland.; capsules three, approximately, one-celled, two-seeded.

OCIMUM, or Ocymum, basil, a genus of the didynamia gymnospermia class of plants, with a bilabiated cup; its flower is monopetalous and ringent; and its seeds, which are four in number, are contained in the cup, which closes for that purpose. There are 25 species. Both the herbs and seed of basil are used in medicine, and are said to be good in disorders of the lungs, and to promote the menses.

OCTAGON, or Octogon, in geometry, is a figure of eight sides and angles; and this, when all the sides and angles are equal, is called a regular octagon, or one which may be inscribed in a circle. If the radius of a circle circumscribing a regular octagon is $= r$, and the side of the octagon $= y$; then $y = \sqrt{2r^2 - r\sqrt{2r^2}}$.

Octagon, in fortification, denotes a place that has eight bastions.

OCTAHEDRON, or Octaedron, in geometry, one of the five regular bodies, consisting of eight equal and equilateral triangles. The square of the side of the octahedron is to the square of the diameter of the circumscribing sphere, as 1 to 2. If the diameter of the sphere is 2, the solidity of the octahedron inscribed in it will be 1,33333 nearly. The octahedron is two pyramids put together at their bases; therefore its solidity may be found by multiplying the quadrangular base of either of them, by one third of the perpendicular height of one of them, and then doubling the product.

OCTANDRIA, the eighth class in Linnæus's sexual system; consisting of plants with hermaphrodite flowers, which are furnished with eight stamina, or male organs of generation. See Botany.

OCTANT, or Octile, in astronomy, that aspect of two planets, wherein they are distant an eighth part of a circle, or 45°, from each other.

OCTAVE, in music, an interval containing seven degrees, or twelve semitones, and which is the first of the consonances in the order of generation. The most simple perception that we can have of two sounds is that of unisons, which, resulting from equal vibrations, are as one to one; the next to this in simplicity is the octave, which is in double computation as one to two. The harmonies of these sounds have a perfect agreement, which distinguishes them from any other interval, and contributes to give them that unisonous effect which induces the common ear to confound them, and take them indifferently one for the other. This interval is called an octave, because moving diatonically from one term to the other, we produce eight different sounds. The octave comprehends all the primitive and original sounds; so that having established a system, or series of sounds, in the extent of an octave, we can only prolong that series by repeating the same order in a second octave, and again in a third, and so on, in all which we shall not find any sound that is not the replicate of some sound in the adjoining octave.

The complete and rigorous system of the octave requires three major tones, two minor, and two major semitones. The temperated system is of five equal tones, and two semitones, forming together seven diatonic degrees.

ODE. See Poetry.

ODONTOGNATHUS, a genus of fishes of the order apodes. The generic character is, mouth furnished with a strong moveable lamina or process on each side the upper jaw; gill-membrane five-rayed.

Aculeated odontognathus. The genus odontognathus consists of a single species, of which the following is the description. The head, body, and tail, are very compressed; the lower jaw, which is longer than the upper, is very much elevated towards the other when the mouth is closed, insomuch as to appear almost vertical; and is lowered somewhat in the manner of a drawbridge when the mouth is opened, when it appears like a small scaly boat, very transparent, furrowed beneath, and finely denticulated on the margins; this lower jaw, in the act of depression, draws forwards two flat, irregular laminæ, of a scaly substance, a little bent at their posterior end, and larger at their origin than at their tips, denticulated on their anterior margin, and attached, one on one side and the other on the opposite, to the most prominent part of the upper jaw; when the mouth is closed again, these pieces apply themselves on each side to one of the opercula, of which they represent the exterior denticulated border; in the middle of these jaws is placed the tongue, which is pointed and free in its movements; the gill-covers, which are composed of several pieces, are very transparent at the hind part, but scaly and of a bright silver-colour in front; the gill-membrane is also silvery, and has five rays; the breast is terminated below by a sharp carina furnished with eight crooked spines; the carina of the belly is also furnished with twenty-eight spines, disposed in two longitudinal ranges; the anal fin is very long, and extends almost as far as the base of the tail-fin, which is of a forked shape; the dorsal fin is placed on the tail, properly speaking, at about three quarters of the whole length of the animal, but it is extremely small. The general length of this fish is three decimetres, and its colour, so far as may be conjectured from specimens preserved for some time in spirits, is a bright silver. It is a native of the American seas, and is common about the coasts of Cayenne, where it ranks in the number of edible fishes.

OECONOMY, *animal*, comprehends the various operations of nature, in the generation, nutrition, and preservation of animals. See Anatomy, Physiology, Comparative Anatomy, Digestion, &c.

OEDEMA. See Surgery.

OEDERA, a genus of the syngenesia polygamia-segregata class and order; the calyx many-flowered; corollets tubular, hermaphrodite, with one or two female ligulate florets: recep. chaffy, down of several chaffs. There are two species, herbs of the Cape.

OENANTHE, water (or hemlock) dropwort: a genus of the digynia order, in the pentandria class of plants; and in the natural method ranking under the 45th order, umbellatæ. The florets are difform; those of the disc sessile and barren; the fruit crowned with the calyx. There are 11 species, of which the most remarkable is the crocata, or hemlock dropwort, growing frequently on the banks of ditches, rivers, and lakes, in many parts of Britain. The root and leaves of this plant are a strong poison; several persons have perished by eating it through mistake, either for water-parsnips or for celery, which last it much resembles in its leaves. So exceedingly deleterious is this plant, that Mr. Lightfoot tells us he has heard the late Mr. Christopher d'Ehret, the celebrated botanic painter say, that while he was drawing it, the smell or effluvia rendered him so giddy, that he was several times obliged to quit the room, and walk out in the fresh air to recover himself; but recollecting at last what might be the probable cause of his repeated illness, he opened the door and windows of the room, and the free air then enabled him to finish his work without any more returns of the giddiness. Mr. Lightfoot informs us, that he has given a spoonful of the juice of this plant to a dog, but without any other effect than that of making him very sick and stupid. In about an hour he recovered; and our author has seen a goat eat it with impunity. To such of the human species as have unfortunately eaten any part of this plant, a vomit is the best remedy.

Lobel, Ray, and others, call this vegetable œnanthe aquatica cicutæ facie. It grows in great plenty all over Pembrokeshire, and is called by the inhabitants five-fingered root; it is much used by them in cataplasms for the felon or worst kind of whitlow. They eat some parts of it, but carefully avoid the roots or stalk. These indeed are of a most pernicious nature, and never fail to prove instantly fatal unless a proper remedy is applied.

OENOTHERA, TREE-PRIMROSE: a genus of the monogynia order, in the octandria class of plants; and in the natural method ranking under the 17th order, calycanthemæ. The calyx is quadrifid; the petals four; the capsule cylindric beneath; the seeds naked. There are 11 species; the most remarkable of which are: 1. The biennis, or common biennial tree-primrose, with large bright-yellow flowers. 2. Octovalvis, or octovalved, smooth, biennial tree-primrose, with large bright-yellow flowers. 3. The fruticosa, or shrubby narrow-leaved perennial tree-primrose, with clusters of yellow flowers, succeeded by pedicellated, acute-angled capsules. 4. The pumila, or low perennial tree-primrose, with bright-yellow flowers, succeeded by acute-angled capsules.

These plants are exotics from America; but are all very hardy, prosper in any common soil and situation, and have been long in the English gardens, especially the three first sorts; but the oenothera biennis is the most commonly known.

OESOPHAGUS. See ANATOMY.

OESTRUS, a genus of insects of the order diptera: the generic character is, antennæ triarticulate, very short, sunk; face broad, depressed, vesicular; mouth, a simple orifice; feelers two, biarticulate, sunk; tail inflected. The genus oestrus or gad-fly is remarkable, like that of ichneumon, for the singular residence of its larvæ; viz. beneath the skin, or in different parts of the bodies of quadrupeds.

The principal European species is the oestrus bovis, or ox-gadfly. This is about the size of a common bee, and is of a pale yellowish-brown colour, with the thorax marked by four longitudinal dusky streaks, and the abdomen by a black bar across the middle, the tip being covered with tawny or orange-coloured hairs; the wings are pale brown, and unspotted.

The female of this species, when ready to deposit her eggs, fastens on the back of a heifer or cow, and piercing the skin with the tube situated at the tip of the abdomen, deposits an egg in the puncture; she then proceeds to another spot at some distance from the former, repeating the same operation at intervals on many parts of the animal's back. This operation is not performed without severe pain to the animal on which it is practised; and it is for this reason that cattle are observed to be seized with such violent horror when apprehensive of the approaches of the female oestrus; flying with uncontrolable rapidity, and endeavouring to escape their tormentor by taking refuge in the nearest pond; it being observed that this insect rarely attacks cattle when standing in water.

In the punctures of the skin thus formed by the gadfly, the several eggs hatch; and the larvæ, by their motion and suction, cause so many small swellings or abscesses beneath the skin, which growing gradually larger, become externally visible, exhibiting so many tubercles an inch or more in diameter, with an opening at the top of each, through which may be observed the larva, imbedded in a purulent fluid; its appearance is that of an oval maggot of a yellowish-white colour while young, but growing gradually darker as it advances in age, till at the time of its full growth it is entirely brown. It is chiefly in the months of August and September that the eggs are laid, and the larvæ remain through the ensuing winter, and till the latter part of the next June, before they are ready to undergo their change into chrysalis. At this period they force themselves out from their respective cells, and falling to the ground, each creeps beneath the first convenient shelter, and lying in an inert state becomes contracted into an oval form, but without casting the larva skin, which dries and hardens round it. When the included insect is ready for exclusion, it forces open the top of the pupa or chrysalis coat, and emerges in its perfect form, having remained within the chrysalis somewhat more than a month.

Though the history of this insect in its larva state has long ago been detailed with sufficient accuracy by Vallisneri, Reaumur, and others, yet the fly itself appears to have been very generally confounded, and that even by Linnæus himself, with a very different species, resembling it in size, but which is bred in the stomach and intestines of horses, the larvæ being no other than the whitish rough maggots which farriers call by the title of bots. This insect is the oestrus equi; it is a trifle smaller than the oestrus bovis, and is of a yellowish-brown colour, with a dusky band across the thorax, and the tip of the abdomen of similar colour; the wings are whitish, with a pale dusky bar across the middle of each, and two dusky spots at the tip.

The manner in which the young larvæ or bots are introduced into the stomach and bowels of the animal they infest is singularly curious. When the female has been impregnated, and the eggs are sufficiently matured, she seeks among the horses a subject for her purpose, and approaching it on the wing, she holds her body nearly upright in the air, and her tail, which is lengthened for the purpose, curved inwards and upwards; in this way she approaches the part where she designs to deposit her egg; and suspending herself for a few seconds before it, suddenly darts upon it, and leaves her egg adhering to the hair; she hardly appears to settle, but merely touches the hair with the egg held out on the projected point of the abdomen. The egg is made to adhere by means of a glutinous liquor secreted with it. She then leaves the horse at a small distance, and prepares a second egg, and, poising herself before the part, deposits it in the same way. The liquor dries, and the egg becomes firmly glued to the hair; this is repeated by various flies till four or five hundred eggs are sometimes placed on one horse. The horses, when they become used to this fly, and find that it does them no injury (as the tabani and conopes, by sucking their blood), hardly regard it, and do not appear at all aware of its insidious object. The skin of the horse is always thrown into a tremulous motion on the touch of this insect; which merely arises from the very great irritability of the skin and cutaneous muscles at this season of the year, occasioned by the continual teasing of the flies, till at length these muscles act involuntarily on the slightest touch of any body whatever. The inside of the knee is the part on which these flies are most fond of depositing their eggs, and next to this on the side and back part of the shoulder, and less frequently on the extreme ends of the mane. But it is a fact worthy of attention, that the fly does not place them promiscuously about the body, but constantly on those parts which are most liable to be licked with the tongue: and the ova therefore are always scrupulously placed within its reach; for, when they have remained on the hairs four or five days, they become ripe, after which time the slightest application of warmth and moisture is sufficient to bring forth in an instant the latent larva. At this time, if the tongue of the horse touches the egg, its operculum is thrown open, and a small active worm is produced, which readily adheres to the moist surface of the tongue, and is thence conveyed with the food to the stomach.

These larvæ attach themselves to every part of the stomach, but are generally most numerous about the pylorus, and are sometimes, though much less frequently, found in the intestines. Their numbers in the stomach are very various, often not more than half a dozen, at other times more than a hundred, and if some accounts might be relied on, even a much greater number than this. They hang most commonly in clusters, being fixed by the small end to the inner membrane of the stomach, which they adhere to by means of two small hooks or tentacula. When they are removed from the stomach they will attach themselves to any loose membrane, and even to the skin of the hand.

The body of the larva is composed of eleven segments, all of which, except the two last, are surrounded with a double row of horny bristles directed towards the truncated end, and are of a reddish colour, except the points, which are black. These larvæ evidently receive their food at the small end, by a longitudinal aperture, which is situated between two hooks or tentacula. Their food is probably the chyle, which, being nearly pure aliment, may go wholly to the composition of their bodies without any excrementitious residue; though on dissection the intestine is found to contain a yellow or greenish matter, which is derived from the colour of the food, and shews that the chyle, as they receive it, is not perfectly pure.

They attain their full growth about the latter end of May, and are coming from the horse from this time to the latter end of June, or sometimes later. On dropping to the ground they find out some convenient retreat, and change to the chrysalis; and in about six or seven weeks the fly appears.

Oestrus ovis, or the sheep-gadfly, is so named from its larva inhabiting the nostrils and frontal sinuses of sheep in particular, though it is also found in similar situations in deer and some other quadrupeds. It is a smaller species than either of the two preceding, and is of a whitish-grey colour, with the thorax marked by four longitudinal black streaks, and the abdomen speckled with black. The larvæ are nearly as large as those of the oestrus equi, and, according to the observations of Mr. Clark, are of a delicate white colour, flat on the under side, and convex on the upper; having no spines at the divisions of the segments, though they are provided with tentacula at the small end. The other is truncated, with a prominent ring or margin. When young these larvæ are perfectly white and transparent; but as they increase in size the upper side becomes marked with two transverse brown lines on each segment, and some spots are seen on the sides. They move with considerable quickness, holding with their tentacula as a fixed point, and drawing up the body towards them. When full-grown they fall through the nostrils, and change to the pupa or chrysalis state, lying on the ground, or adhering to some blade of grass. The fly proceeds from the chrysalis in the space of about two months.

The other British oestri are the oestrus hæmorrhoidalis of Linnæus, whose larva, like that of the oestrus equi, resides in the stomachs of horses; and the oestrus veterinus of Mr. Clark, the larva of which is also found in similar situations. The oestrus hæmorrhoidalis is about the size of a common window-fly, with pale dusky wings, brown thorax, abdomen white at the base, black in the middle, and red at the tip. The oestrus veterinus is nearly of similar size with the oestrus equi, and is entirely of a ferruginous colour, with the abdomen more dusky towards the tip. The oestrus tarandi inhabits Lapland, and deposits its eggs on the back of the rein-deer, and is often fatal to them. See Plate Nat. Hist. fig. 299.

The other exotic oestri are probably numerous, but are at present very little known.

Whether the formidable African fly, described by Mr. Bruce under the name of zimb or tsaltsalya, may be referred to this genus or not, we shall not pretend to determine; there are however some particulars in its history which would lead one to suppose it an oestrus.

"This insect," says Mr. Bruce, "is a proof how fallacious it is to judge by appearances. If we consider its small size, its weakness, want of variety or beauty, nothing in the creation is more contemptible and insignificant. Yet passing from these to his history, and to the account of his powers, we must confess the very great injustice we do him from want of consideration. We are obliged, with the greatest surprise, to acknowledge, that those huge animals the elephant, the rhinoceros, the lion, and the tiger, inhabiting the same woods, are still vastly his inferiors; and that the appearance of this small insect, nay, his very sound, though he is not seen, occasions more trepidation, movement, and disorder, both in the human and brute creation, than would whole herds of these monstrous animals collected together, though their number was in a tenfold proportion greater than it really is.

"This insect is called zimb; it has not been described by any naturalist. It is in size very little larger than a bee, and his wings, which are broader than those of a bee, placed separate, like those of a fly. As soon as this plague appears, and their buzzing is heard, all the cattle forsake their food, and run wildly about the plain, till they die, worn out with fatigue, fright, and hunger. No remedy remains for the residents on such spots but to leave the black earth, and hasten down to the sands of Atbara, and there they remain while the rains last, this cruel enemy never daring to pursue them farther.

"What enables the shepherd to perform the long and toilsome journeys across Africa is the camel, emphatically called the ship of the desert. Though his size is immense, as is his strength, and his body covered with a thick skin, defended with strong hair, yet still he is not capable to sustain the violent punctures the fly makes with his proboscis. He must lose no time in removing to the sands of Atbara; for when once attacked by this fly, his body, head, and legs, break out into large bosses, which swell, break, and putrify, to the certain destruction of the creature. Even the elephant and rhinoceros, who, by reason of their enormous bulk, and the vast quantity of food and water they daily need, cannot shift to desert and dry places as the season may require, are obliged to roll themselves in mud and mire, which, when dry, coats them over like armour, and enables them to stand their ground against this winged assassin; yet I have found some of these tubercles upon almost every elephant and rhinoceros that I have seen, and attribute them to this cause." There are twelve species of this insect.

OFFENCE, is any act committed against any law. Offences are either capital or not capital. Capital offences are those for which an offender shall lose his life; not capital, where the offender may lose his lands and goods, be fined, or suffer corporal punishment, or both, but not loss of life. High treason, petit treason, and felony, constitute capital offences; other offences, not capital, include the remaining part of criminal offences or pleas of the crown, and come under the denomination of misdemeanors.

OFFERINGS. Oblations and offerings partake of the nature of tithes; and all persons which, by the laws of this realm, ought to pay their offerings, shall yearly pay to the parson, vicar, proprietary, or their deputies, or farmers of the parishes where they dwell, at such four offering days as heretofore within the space of four years last past have been accustomed; and in default thereof, shall pay for the said offerings at Easter following. 2 and 3 Ed. VI. c. 13.

OFFICE, is that function, by virtue whereof a person has some employment in the affairs of another. An office is a right to exercise any public or private employment, and to take the fees and emoluments thereunto belonging, whether public as those of magistrates, or private as of bailiffs, receivers, &c.

The statute 5 and 6 Edward VI. c. 16, declares all securities given for the sale of offices unlawful. And if any person shall bargain or sell, or take any reward, or promise of reward, for any office, or the deputation of any office, concerning the revenue, or the keepers of the king's castles, or the administration and execution of justice, unless it is such an office as had been usually granted by the justices of the king's bench or common pleas, or by justices of assize, every such person shall not only forfeit his right to such office, or to the nomination thereof, but the person giving such reward, &c. shall be disabled to hold such office. But it has been decided, that where an office is within the statute, and the salary certain, if the principal makes a deputy, reserving by bond a less sum out of the salary, it is good; or, if the profits are uncertain, reserving a part as half the profits, it is good; for the fees still belong to the principal, in whose name they must be sued for. Salk. 466. But where a person so appointed, gives a bond to the principal to pay him a sum certain, without reference to the profits; this is void under the statute. Salk. 465.

To offer money to any officer of state, to procure the reversion of an office in the gift of the crown, is a misdemeanor at common law, and punishable by information; and even the attempt to induce him under the influence of a bribe, is criminal, though never carried into execution. Any contract to procure the nomination to an office, not within the stat. 6 Ed. VI. is defective on the ground of public policy, and the money agreed to be given is not recoverable.

Office, in the canon-law, is used for a benefice that has no jurisdiction annexed to it. It is also used for divine service celebrated in public; and in the Romish church it is applied to a particular prayer preferred in honour of some saint; thus, when any saint is canonized, a particular office is at the same time assigned him, out of the common office of the confessors, the Virgin, &c. We say the office of the Holy Spirit, of the Virgin, of the passion, of the holy sacrament, of the dead, &c.

OFFICER, a person possessed of a post or office. See the preceding article. The great officers of the crown, or state, are the lord high steward, the lord high chancellor, the lord high treasurer, the lord president of the council, the lord privy seal, the lord chamberlain, the lord high constable, the earl marshal; each of which see under its proper article.

Officers, *commission*, are those appointed by the king's commission; such are all from the general to the cornet inclusive, who are thus denominated in contradistinction to warrant-officers, who are appointed by the colonel's or captain's warrant, as quarter-masters, serjeants, corporals, and even chaplains and surgeons.

Officers, *general*, are those whose command is not limited to a single company, troop, or regiment; but extends to a body of forces, composed of several regiments; such are the general, lieutenant general, major-generals, and brigadiers.

Officers, *staff*, are such as, in the king's presence, bear a white staff or wand; and at other times, on their going abroad, have it carried before them by a footman bare-headed; such are the lord steward, lord chamberlain, lord treasurer, &c.

The white staff is taken for a commission, and at the king's death each of these officers breaks his staff over the hearse made for the king's body, and by this means lays down his commission, and discharges all his inferior officers.

Officers, *subaltern*, are all who administer justice in the name of subjects; as those who act under the earl marshal, admiral, &c. In the army, the subaltern officers are the lieutenants, cornets, ensigns, serjeants, and corporals.

OFFICIAL, in the canon law, an ecclesiastical judge, apointed by a bishop, chapter, abbot, &c. with charge of the spiritual jurisdiction of the diocese. Of these there are two kinds; the one is in a manner the vicar-general of the diocese, and is called by the canonists officialis principalis, and in our statute-law, the bishop's chancellor. There is no appeal from his court to the bishop, his being esteemed the bishop's court. The other called officialis foraneus, and is appointed by the bishop when the diocese is very large; he has but a limited jurisdiction, and has a certain extent of territory assigned him, wherein he resides.

OFFING, or Offin, in the sea-language, that part of the sea a good distance from shore, where there is deep water, and no need of a pilot to conduct the ship; thus, if a ship from shore is seen sailing out to seaward, they say, she stands for the offing; and if a ship, having the shore near her, has another a good way without her, or towards the sea, they say, that ship is in the offing.

OIL, which is of such extensive utility in the arts, was known at a very remote period. It is mentioned in Genesis, and during the time of Abraham was even used in lamps. The olive was very early cultivated, and oil extracted from it in Egypt. Cecrops brought it from Sais, a town in Lower Egypt, where it had been cultivated from time immemorial, and taught the Athenians to extract oil from it. In this manner the use of oil became known in Europe. But the Greeks seem to have been ignorant of the method of procuring light by means of lamps till after the siege of Troy; at least Homer never mentions them, and constantly describes his heroes as lighted by torches of wood. There are two classes of oils exceedingly different from each other; namely, fixed oils and volatile oils.

Fixed oils are distinguished by the following characters:

1. Liquid, or easily becoming so when exposed to a gentle heat. 2. An unctuous feel. 3. Very combustible. 4. A mild taste. 5. Boiling point not under 600°. 6. Insoluble in water and alcohol. 7. Leave a greasy stain upon paper.

These oils which are called also fat or expressed oils, are numerous; and are obtained, partly from animals and partly from vegetables, by simple expression. As instances may be mentioned, whale-oil or train-oil obtained from the blubber of the whale; olive-oil, obtained from the fruit of the olive; linseed-oil and almond-oil, obtained from linseed and almond-kernels. Fixed oils may also be extracted from poppy-seeds, hempseeds, beech-mast, and many other vegetable substances.

It deserves attention, that the only part of vegetables in which fixed oils are found is the seeds of bicotyledinous plants. In animals they are most usually deposited in the liver, though they are found also in the eggs of fowls.

All these oils differ from each other in several particulars, but they also possess many particulars in common. Whether the oily principle in all the fixed oils is the same, and whether they owe their differences to accidental ingredients, is not yet completely ascertained, as no proper analysis has hitherto been made; but it is not improbable, as all the oils hitherto tried have been found to yield the same products. In the present state of our knowledge, it would be useless to give a particular description of all the fixed oils, as even the differences between them have not been accurately ascertained.

Fixed oils are considered at present as composed of hydrogen and carbon. Lavoisier analysed olive-oil by burning a given portion of it in oxygen gas, by means of a particular apparatus. During the combustion there was consumed

Of oil -	15.79 grains troy
Of oxygen gas	50.86
Total	66.65

The products were carbonic acid and water. The carbonic acid obtained amounted to 44.50 grains; the weight of the water could not be accurately ascertained; but as the whole of the substances consumed were converted into carbonic acid gas and water, it is evident, that if the weight of the carbonic acid is subtracted from the weight of these substances, there must remain precisely the weight of the water. Mr. Lavoisier accordingly concluded, by calculation, that the weight of the water was 22.15 grains. Now the quantity of oxygen in 44.50 grains of carbonic acid gas is 32.04 grains, and the oxygen in 22.15 grains of water is 18.82 grains; both of which taken together amount to 50.86 grains, precisely the weight of the oxygen gas employed.

The quantity of charcoal in 44.50 grains of carbonic acid gas is 12.47 grains; and the quantity of hydrogen in 22.15 grains of water is 3.32 grains; both of which, when taken together, amount to 15.79 grains, which is the weight of the oil consumed.

It follows, therefore, from this analysis, that 15.79 grains of olive oil are composed of

12.47 carbon
3.32 hydrogen.

Olive-oil therefore is composed of about

79 carbon
21 hydrogen

100.

This however can only be considered as a very imperfect approximation towards the truth.

Fixed oil is usually a liquid with a certain degree of viscidity, adhering to the sides of the glass vessels in which it is contained, and forming streaks. It is never perfectly transparent, having always a certain degree of colour; most usually it is yellowish or greenish. Its taste is sweet, or nearly insipid. When fresh, it has little or no smell. Its specific gravity varies from 0.9403 (the specific gravity of linseed-oil) to 0.9153 (the specific gravity of olive-oil).

Fixed oil is insoluble in water. When the two liquids are agitated together, the water loses its transparency, and acquires the white colour and consistency of milk. This mixture is known by the name of emulsion. When allowed to remain at rest, the oil soon separates, and swims upon the surface of the water.

Fixed oil does not evaporate till it is heated to about 600°. At that temperature it boils, and may be distilled over; but it is always somewhat altered by the process. Some water and sebacic acid seem to be formed, a little charcoal remains in the retort, and the oil obtained is lighter, more fluid, and has a stronger taste, than before. Oil thus distilled was formerly distinguished by the name of philosophical oil.

Fixed oil, when in the state of vapour, takes fire on the approach of an ignited body, and burns with a yellowish-white flame. It is upon this principle that candles and lamps burn. The tallow or oil is first converted into the state of vapour in the wick; it then takes fire, and supplies a sufficient quantity of heat to convert more oil into vapour; and this process goes on while any oil remains.

The wick is necessary to present a sufficiently small quantity of oil at once for the heat to act upon. If the heat was sufficiently great to keep the whole oil at the temperature of 600°, no wick would be necessary, as is obvious from oil catching fire spontaneously when it has been raised to that temperature.

When exposed to the action of cold, fixed oils lose their fluidity, and are converted into ice; but this change varies exceedingly in different oils.

When fixed oils are exposed to the open air or to oxygen gas, they undergo different changes according to the nature of the oil:

1. Some of them dry altogether, without losing their transparency, when thin layers of them are exposed to the atmosphere. These are distinguished by the name of drying oils, and are employed by painters. Linseed-oil, nut-oil, poppy-oil, and hempseed-oil, possess this property; but linseed-oil is almost the only one of these liquids employed in this country as a drying oil. The cause of this peculiarity has not been completely investigated; but it is well known that these oils possess the drying quality at first but imperfectly. Before they can be employed by painters, they must be boiled with a little litharge. During this operation the litharge is partly reduced to the metallic state. Hence it has been conjectured that drying oils owe their peculiar properties to the action of oxygen; which is supposed either to constitute one of their component parts, or to convert them into drying oils by diminishing their hydrogen.

2. Other fixed oils, when exposed to the atmosphere, gradually become thick, opaque, and white, and assume an appearance very much resembling wax or tallow. These have been distinguished by the term fat oils. Olive-oil, oil of sweet almonds, of rape-seed, and of ben, belong to this class.

When oil is poured upon water, so as to

form a thin layer on its surface, and is in that manner exposed to the atmosphere; these changes are produced much sooner. Berthollet, who first examined these phenomena with attention, ascribed them to the action of light: but Sennebier observed that no such change was produced on the oil though ever so long exposed to the light, provided atmospherical air was excluded; but that it took place on the admission of oxygen gas, whether the oil was exposed to the light or not. It cannot be doubted, then, that it is owing to the action of oxygen. It is supposed at present to be the consequence of the simple absorption of oxygen and its combination with the oils.

3. Both these classes of oils, when exposed in considerable quantity to the action of the atmosphere, undergo another change, well known under the name of rancidity. But the fat oils become rancid much more readily than the drying oils. Rancid oils are thick, have usually a brown colour, convert vegetable blues to red, and have the smell and taste of sebacic acid. During the change which they undergo, some drops of water also appear on their surface. The rancidity of oils then is owing to the formation of a quantity of acid in them. This, together with the water, is evidently the consequence of a partial decomposition.

Fixed oils readily dissolve sulphur when assisted by heat. The solution assumes a reddish colour. When distilled, there comes over a great quantity of sulphureted hydrogen gas. When the solution is allowed to cool, the sulphur is deposited in chrystals. By this process Pelletier obtained sulphur in regular octahedrons.

They likewise dissolve a small proportion of phosphorus when assisted by heat. These oily phosphurets emit the odour of phosphureted hydrogen, and yield, when distilled, a portion of that gas. When rubbed in the open air, or when spread upon the surface of other bodies, they appear luminous in consequence of the combustion of the phosphorus. When hot oils saturated with phosphorus are allowed to cool, the phosphorus chrystallizes in octahedrons, as Pelletier ascertained.

Charcoal has no sensible action on fixed oils; but when they are filtred through charcoal-powder, they are rendered purer, the charcoal retaining their impurities. Neither hydrogen nor azotic gas has any action on fixed oils.

Fixed oils have scarcely any action upon metals; but they combine with several metallic oxides, and form compounds known by the name of plasters. See Plaster.

They combine likewise with alkalies and earths, and form with them compounds called soaps. The fat oils enter into these combinations much more readily than the drying oils. See Soap.

Fixed oils absorb nitrous gas in considerable quantities, and at the same time become much thicker and specifically heavier than before.

Sulphuric acid decomposes fixed oils, at least when concentrated. It renders them first thick and of a brown colour; then water is formed, charcoal precipitated, and an acid formed. Nitric acid renders them thick and viscid. When nitrous acid is poured upon the drying oils, it inflames them without addition; but it does not produce that effect upon the fat oils, unless it is mixed with a portion of sulphuric acid.

The affinities of fixed oils are as follows:

Lime,	Ammonia,
Barytes,	Oxide of mercury,
Fixed alkalies,	Other metallic oxides,
Magnesia,	Alumina.

The importance of fixed oils is well known. Some of them are employed as seasoners of food; some are burnt in lamps; some form the basis of soap; not to mention their utility in painting, and the many other important purposes which they serve.

Oils, *volatile*, called also essential oils, are distinguished by the following properties:

1. Liquid; often almost as liquid as water; sometimes viscid.
2. Very combustible.
3. An acrid taste and a strong fragrant odour.
4. Boiling point not higher than 212°.
5. Soluble in alcohol; and imperfectly in water.
6. Evaporate without leaving any stain on paper.

By this last test it is easy to discover whether they have been adulterated with any of the fixed oils. Let a drop of the volatile oil fall upon a sheet of writing-paper, and then apply a gentle heat to it. If it evaporates without leaving any stain upon the paper, the oil is pure; but if it leaves a stain, it has been contaminated with some fixed oil or other.

Volatile oils are almost all obtained from vegetables, and they exist in every part of plants; the root, the bark, the wood, the leaves, the flower, and even the fruit: though they are never found in the substance of the cotyledons; whereas the fixed oils, on the contrary, are almost always contained in these bodies.

When the volatile oils are contained in great abundance in plants, they are sometimes obtained by simple expression. This is the case with the oil of oranges, of lemons, and of bergamot; but in general they can only be obtained by distillation. The part of the plant containing the oil is put into a still with a quantity of water, which is distilled off by the application of a moderate heat. The oil comes over along with the water, and swims upon its surface in the receiver. By this process are obtained the oils of peppermint, thyme, lavender, and a great many others, which are prepared and employed by the perfumer. Others are procured by the distillation of resinous bodies. This is the case in particular with oil of turpentine, which is obtained by distilling a kind of resinous juice, called turpentine, that exudes from the juniper.

The greater number of volatile oils are liquid, and some of them are as transparent and colourless as water. This is the case with the oil of turpentine; but for the most part they are coloured. Some of them are yellow, as the oil of lavender; some brown, as the oil of rhodium; some blue, as the oil of camomile; but the greater number of volatile oils are yellow or reddish-brown.

Their odours are so various as to defy all description. It is sufficient to say, that all the fragrance of the vegetable kingdom resides in the volatile oils. Their taste is always acrid, hot, and exceedingly unpleasant. Their specific gravity is for the most part less than that of water; but some volatile oils, as those of canella and sassafras, are heavier than water. The specific gravity of the volatile oils varies from 0.8697 to 1.0439.

Water dissolves a small portion of volatile oils, and acquires the odour and the taste of the oil which it holds in solution.

When heated, they evaporate very readily and without alteration. They are much more combustible than fixed oils, owing to their greater volatility. They burn with a fine bright white flame, exhale a great deal of smoke, deposit much soot, and consume a greater proportion of the oxygen of the atmosphere than fixed oils. The products of their combustion are water and carbonic acid gas. From these facts it has been concluded that they are composed of the same ingredients as the fixed oils, but that they contain a greater proportion of hydrogen.

When exposed to the action of cold they congeal like the fixed oils; but the temperature necessary to produce this effect, varies according to the oil. Some of them, as oil of anise and of fennel, become solid at the temperature of 50°; frozen oil of bergamot and of canella become liquid at 23°; oil of turpentine at 14°. Margueron exposed several volatile oils to a cold of 17°. They congealed or rather chrystallized partially, and at the same time emitted an elastic fluid. These chrystals consisted partly of the oils themselves, partly of other substances. Some of them had the properties of benzoic acid.

Volatile oils, when exposed to the action of light in close vessels, and excluded from common air, undergo very singular changes. Their colour becomes deeper, they acquire a great deal of consistency, and their specific gravity is considerably increased. The cause of these changes is but imperfectly known. Tingry, to whom we are indebted for these interesting researches, has proved that light is a necessary agent. It was supposed formerly that they were occasioned by the absorption of oxygen; and when oxygen is present, it has been ascertained that it is absorbed; but Tingry has proved that the same changes go on when oxygen is excluded. This philosopher ascribes them to the fixation of light. If this is the real cause, the quantity of light fixed must be enormous; for as the specific gravity of the oils is increased considerably while the bulk continues the same, it is evident that the absolute weight must be increased proportionably. One circumstance, however, renders this conclusion somewhat doubtful, at least in its full extent; and that is, that the quantity of change was always proportional to the quantity of the oil and the quantity of air contained in the vessel.

When exposed to the open air their colour becomes gradually deeper, and they acquire consistency, while they exhale at the same time a very strong odour. The air around, as Priestley first ascertained, is deprived of its oxygen, a quantity of water is formed, and the oils at last, for the most part, assume the form of resins.

Volatile oils dissolve sulphur and phosphorus, and the solutions have nearly the same properties as those made by means of fixed oils.

They have no action on the metals, and

seem scarcely capable of combining with the metallic oxides.

They combine only imperfectly, and in small quantities, with alkalies and earths. The French chemists have proposed to give these combinations the name of savonules, which Dr. Pearson has translated by the term saponules; but these denominations have not been adopted by chemists.

They absorb nitrous gas in great abundance, and with great facility, and seemingly decompose it, acquiring a thick consistence and a resinous appearance, as if they had absorbed oxygen.

Sulphuric acid decomposes volatile oils; carbureted hydrogen gas is emitted, and charcoal is precipitated. Nitric acid inflames them, and converts them into water, carbonic acid, and charcoal. Oxymuriatic acid converts them into substances analogous to resins.

Volatile oils are applied to a great number of uses. Some of them are employed in medicine; some of them, as oil of turpentine, are much used to dissolve resins, which are afterwards employed as varnishes; not to mention their employment in painting and in perfumery.

Besides the oils which exist ready formed in the vegetable and animal kingdoms, there are a variety of others which are obtained when animal or vegetable bodies are distilled by means of a heat above that of boiling water. These oils have received the appellation of empyreumatic, because they are formed by the action of the fire.

The following is a list of the plants which yield the fixed oils occurring usually in commerce:

1. Linum usitatissimum & perenne - -	Linseed oil
2. Corylus avellana 3. Juglans regia	Nut oil
4. Papaver somniferum -	Poppy oil
5. Cannabis sativa - -	Hemp oil
6. Sesamum orientale -	Oil of sesamum
7. Olea Europea - -	Olive oil
8. Amygdalus communis -	Almond oil
9. Guilandina Mohringa -	Oil of behen
10. Cucurbita pepo & melapepo	Cucumber oil
11. Fagus sylvatica - -	Beech oil
12. Sinapis nigra & arvensis	Oil of mustard
13. Helianthus annuus & perennis - -	Oil of sunflower
14. Brassica napus & campestris	Rapeseed oil
15. Ricinus communis -	Castor oil
16. Nicotiana tabacum & rustica - - -	Tobacco-seed oil
17. Prunus domestica -	Plum-kernel oil
18. Vitis vinifera - -	Grapeseed oil
19. Theobroma cacao -	Butter of cacao
20. Laurus nobilis - -	Laurel oil
21. Arachis hypogæa - -	Ground-nut oil.

The following Table contains a copious list of plants which yield volatile oils. The part of the plant from which it is extracted, and the English name of the oil, are added in separate columns.

Plants.	Parts.	Oil of	Colour.
1. Artemisia absynthium -	Leaves -	Wormood -	Green
2. Acorus calamus - - - -	Root -	Sweet flag -	Yellow
3. Myrtus pimenta - - -	Fruit -	Jamaica pepper	Yellow
4. Ancthum graveolens - -	Seeds -	Dill - -	Yellow
5. Angelica archangelica - -	Root -	Angelica	
6. Pimpinella anisum - -	Seeds -	Anise - -	White
7. Illicium anisatum - - -	Seeds -	Stellat. anise	Brown
8. Artemisia vulgaris - - -	Leaves -	Mugwort	
9. Citrus aurantium - - -	Rind of the fruit	Bergamot -	Yellow
10. Meloleuca leucodendra -	Leaves -	Cajeput - -	Green
11. Eugenia caryophyllata -	Capsules -	Cloves - -	Yellow
12. Carum carui - - - - -	Seeds -	Caraways -	Yellow
13. Amomum cardamomum -	Seeds -	Card. seeds -	Yellow
14. Carlina acaulis - - - -	Roots -	- - - -	White
15. Scandix chaerefolium - -	Leaves -	Chervil - -	Sulph. yellow
16. Matricaria chamomilla -	Petals -	Chamomile -	Blue
17. Laurus cinnamomum - -	Bark -	Cinnamon -	Yellow
18. Citrus medica - - - -	Rind of the fruit	Lemons - -	Yellow
19. Cochlearia officinalis - -	Leaves -	Scurvy grass -	Yellow
20. Copaifera officinalis - -	Extract -	Copaiba	White
21. Coriandrum sativum - -	Seeds -	Coriand. seed	White
22. Crocus sativus - - - -	Pistils -	Saffron - -	Yellow
23. Piper cubeba - - - -	Seeds -	Cubeb pepper	Yellow
24. Laurus culilaban - - -	Bark -	Culilaban -	Brown yellow
25. Cuminum cymium - - -	Seeds -	Cummi - -	Yellow
26. Inula helenium - - - -	Roots -	Elecampane -	White
27. Anethum fœniculum -	Seeds -	Fennel - -	White
28. Croton eleutheria - - -	Bark -	Cascarilla -	Yellow
29. Maranta galanga - - -	Roots -	Galanga -	Yellow
30. Hyssopus officinalis - -	Leaves -	Hyssop - -	Yellow
31. Juniperus communis - -	Seeds -	Juniper - -	Green
32. Lavendula spica - - -	Flowers -	Lavender -	Yellow
33. Laurus nobilis - - - -	Berries -	Laurel - -	Brownish
34. Prunus laurocerasus - -	Leaves -	Laurocerasus	
35. Levisticum logusticum -	Roots -	Loveage -	Yellow
36. Myristica moschata - -	Seeds -	Mace - -	Yellow
37. Origanum majorana - -	Leaves -	Marjoram -	Yellow
38. Pistacia lentiscus - - -	Resin -	Mastich -	Yellow
39. Matricaria parthenium -	Plant -	Motherwort -	Blue
40. Melissa officinalis - - -	Leaves -	Balm - -	White
41. Mentha crispa - - - -	Leaves -	- - -	White
42. ——— piperitis - - -	Leaves -	Peppermint -	Yellow
43. Achillea millefolium - -	Flowers -	Millefoil -	Blue and green
44. Citrus aurantium - - -	Leaves -	Neroli - -	Orange
45. Origanum creticum - -	Flowers -	Spanish hop -	Brown
46. Apium petroselinum - -	Roots -	Parsley - -	Yellow
47. Pinus sylvestris & abies -	Wood and resin	Turpentine -	Colourless
48. Piper nigrum - - - -	Seeds -	Pepper - -	Yellow
49. Rosmarinus officinalis - -	Plant -	Rosemary -	Colourless
50. Mentha pulegium - - -	Flowers -	Pennyroyal -	Yellow
51. Genista canariensis - - -	Root -	Rhodium -	Yellow
52. Rosa centifolia - - -	Petals -	Roses - -	Colourless
53. Ruta graveolens - - -	Leaves -	Rue - -	Yellow
54. Juniperus sabina - - -	Leaves -	Savine - -	Yellow
55. Salvia officinalis - - -	Leaves -	Sage - -	Green.
56. Santalum album - - -	Wood -	Santalum -	Yellow
57. Laurus sassafras - - - -	Root -	Sassafras -	Yellow
58. Satureia hortensis - - -	Leaves -	Satureia -	Yellow
59. Thymus serpillum - - -	Leaves & flowers	Thyme - -	Yellow
60. Valeriana officinalis - -	Root -	Valerian -	Green
61. Kæmpferia rotunda - -	Root -	Zedoary -	Greenish blue
62. Amomum Zinziber - -	Root -	Ginger - -	Yellow
63. Andropogon schænanthum	- - -	Sira - -	Brown.

Several of the gum-resins, as myrrh and galbanum, yield an essential oil; and likewise the balsams, as benzoin, &c.

Oil-mill. See Olea.

OLAX, a genus of the triandria monogynia class and order. The calyx is entire, trifid; corolla funnel-form, trifid; nect. four; berry three-celled, many-seeded. There is one species, a tree of Ceylon.

OLDENLANDIA, a genus of the tetrandria monogynia class and order. Its characters are these: the empalement of the flower is permanent, sitting upon the germen; the flower has four oval petals, which spread open, and four stamina, terminated by small summits; it has a roundish germen, situated under the flower, crowned by an indented stigma: the germen afterwards turns to a globular capsule, with two cells filled with small seeds. There are sixteen species, herbs of the Cape, &c.

OLD-WIFE, or Wrasse. See Labrus.

OLEA, the *olive-tree*, a genus of the monogynia order, in the diandria class of plants; and in the natural method ranking under the 44th order, sapieriæ. The corolla is quadrifid, with the segments nearly ovate. The fruit is a monospermous plum. There are seven species; the most remarkable are:

1. The Europea, or common olive-tree, rises with upright solid stems, branching numerously on every side, 20 or 30 feet high; spear-shaped, stiff, opposite leaves, two or three inches long, and half an inch or more broad; and at the axillas small clusters of white flowers, succeeded by oval fruit. This species is the principal sort cultivated for its fruit; the varieties of which are numerous, varying in size, colour, and quality. It is a native of the southern parts of Europe, and is cultivated in great quantities in the south of France, Italy, and Portugal, for the fruit to make the olive-oil.

2. The capensis, or Cape box-leaved olive.
3. Olea odoratissima, the flower of which is by some said to give the fine flavour to the green tea; but Thunberg attributes the flavour to the cemellie seserque.

Olive-trees are easily propagated by shoots, which, when care has been taken to ingraft them properly, bear fruit in the space of eight or ten years. Those kinds of olive-trees which produce the purest oil, and bear the greatest quantity of fruit, are ingrafted on the stocks of inferior kinds. Different names are assigned by the French to the different varieties of the olive-tree; and of these they reckon 19, whilst in Florence are cultivated no fewer than 32. Olive-shoots are ingrafted when in flower; if the operation has been delayed, and the tree bears fruit, it is thought sufficient to take off a ring of bark, two fingers' breadth in extent, above the highest graff. In that case the branches do not decay the first year; they afford nourishment to the fruit, and are not lopped off till the following spring. Olive-trees are commonly planted in the form of a quincunx, and in rows at a considerable distance from one another. Between the rows it is usual to plant vines, or to sow some kind of grain. It is observed, that olives, like many other fruit-trees, bear well only once in two years. The whole art of dressing these trees consists in removing the superfluous wood; for it is remarked, that trees loaded with too much wood produce neither so much fruit nor of so good a quality. Their propagation in England is commonly by layers.

Olives have an acrid, bitter, and extremely disagreeable taste; pickled (as we receive them from abroad) they prove less disagreeable. The Lucca olives, which are smaller than the others, have the weakest taste; the Spanish, or larger, the strongest; the Provence, which are of a middling size, are generally the most esteemed.

When olives are intended for preservation, they are gathered before they are ripe. The art of preparing them consists in removing their bitterness, in preserving them green, and in impregnating them with a brine of aromatised sea-salt, which gives them an agreeable taste. For this purpose, different methods are employed: formerly they used a mixture of a pound of quicklime, with six pounds of newly sifted woodashes; but of late, instead of the ashes, they employ nothing but a ley. This, it is alleged, softens the olives, makes them more agreeable to the taste, and less hurtful to the constitution. In some parts of Provence, after the olives have lain some time in the brine, they remove them, take out the kernel, and put a caper in its place. These olives they preserve in excellent oil; and when thus prepared, they strongly stimulate the appetite in winter. Olives perfectly ripe are soft, and of a dark red colour. They are then eaten without any preparation, excepting only a seasoning of pepper, salt, and oil; for they are extremely tart, bitter, and corrosive.

The oil is undoubtedly that part of the produce of olive-trees which is of greatest value. The quality of it depends on the nature of the soil where the trees grow, on the kind of olive from which it is expressed, on the care which is taken in the gathering and pressing of the fruit, and likewise on the separation of the part to be extracted. Unripe olives give an intolerable bitterness to the oil; when they are over-ripe, the oil has an unguinous taste; it is therefore of importance to choose the true point of maturity. When the situation is favourable, those species of olives are cultivated which yield fine oils; otherwise they cultivate such species of trees as bear a great quantity of fruit, and they extract oil from it, for the use of soaperies, and for lamps.

They gather the olives about the months of November or December. It is best to put them as soon as possible into baskets, or into bags made of wool or hair, and to press them immediately, in order to extract a fine oil. Those who make oil only for soaperies, let them remain in heaps for some time in their storehouses; when afterwards pressed, they yield a much greater quantity for oil. In order to obtain the oil, the olives are first bruised in a round trough, under a millstone, rolling perpendicularly over them; and when sufficiently mashed, put into the maye, or trough, *m*, of an olive-press (Plate Miscel. fig. 177), where *aa* are the upright beams, or cheeks; *b* the female, and *c* the male screw; *e*, the bar for turning the screw; *f*, the board on which the screw presses; *g*, a cubical piece of wood, called a block; *h*, the peel, a circular board to be put under the block. By turning the screw, all the liquor is pressed out of the mashed olives, and is called virgin-oil; after which, hot water being poured upon the remainder in the press, a coarser oil is obtained. Olive-oil keeps only about a year, after which it degenerates.

Oil of olives is an ingredient in the composition of a great many balsams, ointments, plasters, mollifying and relaxing liniments. It is of an emollient and solvent nature; mitigates gripes of the colic, and the pains accompanying dysentery; and is supposed a good remedy when any person has chanced to swallow corrosive poisons. It is an effectual cure for the bite of a viper; and, as M. Bourgeois tells us, for the sting of wasps, bees, and other insects. A bandage soaked in the oil is immediately applied to the sting, and a cure is obtained without any inflammation or swelling. Olive-oil is of no use in painting, because it never dries completely. The best soap is made of it, mixed with Alicant salt-wort and quicklime.

OLERON, *sea laws of*, certain laws relating to maritime affairs, made in the time of Richard I. when he was at the island of Oleron.

These laws, being accounted the most excellent sea-laws in the world, are recorded in the black book of the admiralty.

OLIBANUM, a dry resinous substance obtained from the juniperus lycia, and chiefly collected in Arabia. It is the frankincense of the antients. It is in transparent brittle masses about the size of a chesnut. Its colour is yellow. It has little taste, and when burnt diffuses an agreeable odour. Alcohol dissolves it; and with water it forms a milky liquid. When distilled, it yields a small quantity of volatile oil. Specific gravity, 1.73.

OLIVE. See Olea.

OLYMPIC Games, were solemn games, famous among the antient Greeks, so called from Olympian Jupiter, to whom they were dedicated.

OLYRA, a genus of the triandria order, in the monœcia class of plants, and in the natural method ranking under the 4th order, gramina. The male calyx is a biflorous and aristated glume; the corolla a beardless glume; the female calyx is an uniflorous, patulous, and ovate glume; the style is bifid, and the seed cartilaginous. There are two species, herbs of Jamaica.

OMBRE, a game at cards, played by 2, 3, or 5 persons; in all other respects resembling quadrille.

OMENTUM. See Anatomy.

OMNIUM, a term in use among stock-jobbers to express all the articles included in the contract between government and the original subscribers to a loan, which of late years has generally consisted of different proportions of 3 and 4 per cent. stock, with a certain quantity of terminable annuities. Those who dispose of their share soon after the agreement is concluded, generally get a premium of 2 or 3 per cent. for it, which fluctuates with the current prices of the public funds; and in a few instances the omnium has been at a considerable discount. Some of the subscribers pay their whole subscription at the time fixed for the first or second payment, and their shares become immediately transferable stock: others dispose of the several articles which make up the terms of the loan, separately; and in this state the 3 or 4 per cent. consols, &c. are distinguished by the name of scrip, till the whole sum has been paid in upon them.

OMPHALEA, a genus of the triandria order, in the monœcia class of plants, and in the natural method ranking with those of which the order is doubtful. The male calyx is tetraphyllous; there is no corolla; the receptacle, into which the antheræ are sunk, is ovate. The female calyx and corolla are as in the male; the stigma trifid; the capsule carnous and trilocular, with one seed. There are four species, shrubs of Jamaica.

ONCHIDIUM, a genus of insects of the order vermes mollusca: the generic character is; body oblong, creeping, flat beneath, mouth placed before; feelers two, situated above the mouth; arms two, at the sides of the head; vent behind, and placed beneath. The onchidium typhæ, the only species, inhabits Bengal, on the leaves of the typha elephantina, about an inch long, and three-quarters of an inch broad, but linear and longer when creeping. In appearance it very much resembles a limax, but differs principally in wanting the shield and lateral pore, and in being furnished with a vent behind.

Body above convex, beneath flat and smooth; head small, and placed beneath, which, when the animal is in motion, is perpetually changing its form and size, and drawn in when at rest; mouth placed lengthways, and continually varying its shape from circular to linear; feelers retractile, resembling those of a slug, and apparently tipt with eyes; arms dilatable, solid, compressed, and somewhat palmate when fully expanded.

ONION. See ALLIUM.

ONISCUS, a genus of insects of the order aptera: the generic character is; legs fourteen; antennæ setaceous; body oval. Of this genus, which consists of more than 40 species, the best known is the oniscus asellus, popularly known by the name of the woodlouse. It is a very common insect in gardens, fields, &c. and is observed in great quantities under the barks of decayed trees, beneath stones in damp situations, &c. Its general length is about half an inch, or rather more, and its colour livid brown, the larger specimens often exhibiting a double series of pale spots down the back: like the rest of the genus, it preys on the minuter insects.

2. Oniscus armadillo, or the medical woodlouse, is of somewhat larger size than the preceding, much darker colour, and of a polished surface: it is equally common with the preceding species, and is found in similar situations; when suddenly disturbed or handled, it rolls itself up into a completely globular form, in the manner of the curious quadrupeds called armadilios, frequently remaining in this state for a very considerable length of time, or so long as it is any ways disturbed. Swammerdam relates a ludicrous mistake of a servant-maid, who, finding in the garden a great many in this globular state, imagined she had discovered some handsome materials for a necklace, and betook herself to stringing them with great care; but on suddenly perceiving them unfold, was seized with a panic, and ran shrieking into the house.

Though considered as of but slight importance in the present practice of physic, these animals once maintained a very respectable station in the materia medica, under the title of millepedes.

3. Oniscus aquaticus is a native of the clearer kind of stagnant waters, and is of the general size and colour of the oniscus asellus, but of a more lengthened form, and with longer limbs in proportion; the two last legs being bifid. This species is viviparous, and of a considerably prolific nature.

Among the marine insects of this genus the largest is the oniscus entomon, measuring two inches in length: its general form and colour resemble that of the oniscus asellus, but the four lower pair of legs are longer in proportion, the three first pair being very small and short; the tail is long and pointed. It is a native of the European seas, and is found about rocks, &c. It is of a strong fabric, the divisions of the upper part being of an almost calcareous nature. This animal is capable of living several days in fresh water.

ONOCLEA, a genus of the class and order cryptogamia filices. The capsules are under the recurved and contracted pinnules of the frond, resembling pericarps. There are two species.

ONONIS, or ANONIS, *rest-harrow*, in botany. See ANONIS.

ONOPORDUM, a genus of the class and order syngenesia polygamia æqualis. The essential character is, calyx scales mucronate; recept. honey-combed. There are seven species, one of them well-known under the name of cotton-thistle or pig-leaves.

ONOSMA, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 41st order, asperifoliæ. The corolla is campanulated, with the throat pervious: there are four seeds. There are three species, rock plants of the South of Europe.

ONYX, in natural history, one of the semipellucid gems, with variously-coloured zones, but none red; being composed of crystal, debased by a small admixture of earth, and made up either of a number of flat plates, or of a series of coats surrounding a central nucleus, and separated from each other by veins of a different colour, resembling zones or belts. We have four species of this gem: 1. A blueish-white one, with broad white zones. 2. A very pure onyx, with snow-white veins. 3. The jasponyx, or horny onyx, with green zones. 4. The brown onyx, with blueish-white zones. The antients attributed wonderful properties to the onyx, and imagined that if worn on the finger it acted as a cardiac; they have also recommended it as an astringent, but at present no regard is paid to it. The word in the Greek language signifies nail; the poets feigning this stone to have been formed by the Parcæ from a piece of Venus's nails, cut off by Cupid with one of his arrows. See CHALCEDONY.

OOLITE. See PISOLITE.

OPACITY, in philosophy, a quality of bodies which renders them impervious to the rays of light.

The cause of opacity in bodies does not consist, as was formerly supposed, in the want of rectilinear pores, pervious every way; but either in the unequal density of the parts, in the magnitude of the pores, or in their being filled with a matter, by means of which the rays of light in their passage are arrested by innumerable refractions and reflections, become extinct, and are absorbed.

OPAL, in mineralogy: this stone is found in many parts of Europe, especially in Hungary, in the Crapacks near the village of Czennizka. When first dug out of the earth it is soft, but it hardens and diminishes in bulk by exposure to the air. The substance in which it is found is a ferruginous sand-stone.

The opal is always amorphous. Its fracture is conchoidal. Commonly somewhat transparent. Specific gravity from 1.958 to 2.540. The lowness of its specific gravity, in some cases, is to be ascribed to accidental cavities which the stone contains. These are sometimes filled with drops of water. Some specimens of opal have the property of emitting various-coloured rays, with a particular effulgency, when placed between the eye and the light. The opals which possess this property are distinguished by lapidaries by the epithet Oriental; and often by mineralogists by the epithet nobilis. This property rendered the stone much esteemed by the antients. Opals acquire it by exposure to the sun. Werner has divided this species into five subspecies:

1. Noble opal. Lustre internal, glassy. Colour, usually light bluish-white. When its position is varied, it reflects the light of various bright colours. Brittle. Specific gravity 2.114. Does not melt before the blowpipe. When heated it becomes opaque, and sometimes is decomposed by the action of the atmosphere. Hence it seems to follow that water enters essentially into its composition. A specimen of this variety, analysed by Klaproth, contained

90	silica,
10	water
100.	

2. Common opal. Fracture imperfectly conchoidal. Lustre external and internal, glassy or greasy. Its colours are very various; milk-white, yellows, reds, greens of different kinds. Infusible by the blowpipe.

Specimens of this variety sometimes occur with rifts: these readily imbibe water, and therefore adhere to the tongue. Some opals gradually become opaque, but recover their transparency when soaked in water by imbibing that fluid. They are then called hydrophanes, or oculi mundi. The constituents of the common opal, as ascertained by Klaproth, are

Opal of Kosemutz.		Opal of Telkobanya.	
98.75	-	93.5	silica
0.1	-	1.0	oxide of iron
0.1	-	0.0	alumina
0.0	-	5.0	water.
98.95		99.5	

3. Semi-opal. Colours, various shades of white, grey, yellow, red, brown, often mixed together. Lustre glassy, sometimes greasy. Fracture imperfectly conchoidal. Brittle. Sometimes adheres to the tongue. Specific gravity 2.540. Infusible before the blowpipe. Its constituents, as ascertained by Klaproth, are,

Semiopal of Telkobanya		Of Menal-montant.	
43.5	-	85.5	silica
47.0	-	0.5	oxide of iron
7.5	-	11.0	water
		1.0	alumina
98.0		0.5	lime.
		98.5	

4. Holz-opal or wood-opal. Colours, various shades of white, grey, brown, yellow, red. Found in large pieces, which have the form of wood. Lustre glassy, sometimes greasy. Fracture in one direction conchoidal, in another exhibiting the texture of wood. Usually opaque. Brittle. Considered as fragments of wood impregnated with semi-opal.

5. Under the opal may be placed also the mineral known by the name of cat's-eye. It comes from Ceylon, and is seldom seen by European mineralogists till it has been polished by the lapidary. Mr. Klaproth has described a specimen which he received in its natural state from Mr. Greville of London. Its figure was nearly square, with sharp edges, a rough surface, and a good deal of brilliancy. Its texture is imperfectly foliated. Lustre greasy. Specific gravity 2.625 to 2.66. Colour grey, with a tinge of green, yellow, or white; or brown, with a tinge of yellow or red. In certain positions it re-

fects a splendid white, as does the eye of a cat: hence the name of this stone.

Two specimens analysed by Klaproth, the first from Ceylon, the other from Malabar, were compo ed of

95.00	94.50	silica
1.75	2.00	alumina
1.50	1.50	lime
0.25	0.25	oxide of iron.
98.5	98.25	

OPATRUM, a genus of insects of the coleoptera order; the generic character is: antennæ moniliform, thicker towards the top; head projecting from a cavity in the thorax; thorax a little flattened, margined; shells immarginate, longer than the abdomen. There are about 28 species of this genus.

OPERATION. See SURGERY.

OPERATIONS in chemistry. See CHEMISTRY.

OPERCULARIA, a genus of the class and order tetrandria monogynia: the flower is compound; calyx common, one-leafed. There are three species, insignificant herbs of New Holland, &c.

OPHICEPHALUS, a genus of fishes of the order thoracici; the generic character is: head coated with dissimilar scales; body elongated.

1. Ophicephalus punctatus: length about ten inches; dorsal fin commencing at no great distance from the head, and continued nearly to the tail; it is of moderate breadth, and of a dusky colour spotted with black; anal fin of similar shape and colour. Native of India, inhabiting rivers and lakes, and considered as a delicate and wholesome food.

2. Ophicephalus striatus: length about 12 inches; shape rather longer than that of the preceding species. Native of India, inhabiting lakes, where it often grows to a much larger size than first mentioned. It is in equal esteem as a food with the former species, and even recommended as a proper diet for convalescents. Native name wrahl. There is one other species.

OPHIDIUM, a genus of fishes of the order apodes; the generic character is: head somewhat naked; teeth in the jaws, palate, and throat; branchiostegous membrane seven-rayed, patulous; body ensiform.

1. Ophidium barbatum: the head of this fish is small; the upper jaw rather longer than the lower, and both beset with a great many small teeth; the lips are strong and fleshy; in the throat are several small teeth; between the eyes and mouth are four small pores. It is commonly found of the length of eight or nine inches, and sometimes twelve or fourteen; and is met with in all parts of the Mediterranean sea, and in great plenty in the Adriatic. It is often taken by nets in Provence and Languedoc with other kinds of fish, and is most common during the summer season. It is not considered as an elegant fish for the table, the flesh being rather coarse. It feeds on small fishes, crabs, &c. &c.

The ophidium aculeatum, or prickly ophidium, inhabits the fresh rivers in India, feeds on worms and a fat kind of earth, is esculent and long. See Plate Nat. Hist. fig. 300. There are four species.

OPHIOGLOSSUM, *adder's tongue*, a genus of the natural order of filices, in the cryptogamia class of plants. The spike is articulated, flat, and turned to the two sides, with the articuli or joints opening across. There are nine species, of which the only remarkable one is the vulgatum, or common adder's-tongue, which is a native of several places of Britain, growing in meadows and moist pastures. The country-people make an ointment of the fresh leaves, and use it as a vulnerary to green wounds.

OPHIORHIZA, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 47th order, stellatæ. The corolla is funnel-shaped; the capsule twin, bilocular, and polyspermous. There are three species, the most remarkable of which is the Asiaticum, or true lignum colubrinum. The root of this is known in the East Indies to be a specific against the poison of that most dreadful animal called the hooded serpent.

The true root is called mungus, for the following reason: There is a kind of weasel in the East Indies, called mungutia by the natives, mungo by the Portuguese, and muncas by the Dutch. This animal pursues the hooded serpent, as the cat does the mouse with us. As soon as the serpent appears, the weasel attacks him; and if she chances to be bitten by him, she immediately runs to find a certain vegetable, upon eating which she returns, and renews the fight. That celebrated traveller Kæmpfer, who kept one of these weasels tame, that ate with him, lived with him, and was his companion wherever he went, says he saw one of these battles between her and the serpent, but could not certainly find out what root the weasel looked out for. But whether the weasel first discovered this antidote or not, it is an infallible remedy against the bite of the hooded serpent. And this he undertakes to ascertain.

OPHIOXYLUM, a genus of the monœcia order, in the polygamia class of plants, and in the natural method ranking with those of which the order is doubtful. The hermaphrodite calyx is quinquefid; the corolla quinquefid and funnel-shaped, with a cylindrical nectarium within its mouth. There are two species, shrubs of the East Indies.

OPHIRA, a genus of the monogynia order, in the octandria class of plants. The involucrum is bivalvular and triflorous; the corolla is tetrapetalous above; the berry unilocular. There is one species, a shrub of Africa.

OPHITES, in church history, christian heretics, so called both from the veneration they had for the serpent that tempted Eve, and the worship they paid to a real serpent. They pretended that the serpent was Jesus Christ, and that he taught men the knowledge of good and evil. They distinguished between Jesus and Christ: Jesus they said was born of the Virgin, but Christ came down from heaven to be united with him; Jesus was crucified, but Christ had left him to return to heaven.

OPHRYS, *twyblade*, a genus of the diandria order, in the gynandria class of plants, and in the natural method ranking under the 7th order, orchideæ. The nectarium is a little carinated below. There are 34 species; but the most remarkable are the following: 1. The ovata, oval-leaved ophrys, or common twyblade, has a bulbous fibrated root, crowned by two oval, broad, obtuse, veined, opposite leaves; an erect, succulent, green stalk, six or eight inches high, naked above, and terminated by a loose spike of greenish flowers, having the lip of the nectarium bifid. The flowers of this species resemble the figure of gnats. 2. The spiralis, spiral orchis, or triple ladies'-tresses, with a cluster of oval, pointed, ribbed leaves; erect simple stalks, half a foot high, terminated by long spikes of white odoriferous flowers, hanging to one side, having the lip of the nectarium entire, and crenated. 3. The nidus-avis, or bird's-nest; with loose spikes of pale-brown flowers, having the lip of the nectarium bifid. 4. The anthropophora, man-shaped ophrys, or man-orchis; with spikes of greenish flowers, representing the figure of a naked man: the lip of the nectarium linear, tripartite, with the middle segment longest and bifid. There is a variety with brownish flowers tinged with green. 5. The insectifera, or insect-orchis, has spikes of insect-shaped greenish flowers, having the lip of the nectarium almost five-lobed. This wonderful species exhibits flowers in different varieties, that represent singular figures of flies, bees, and other insects, and are of different colours in the varieties. 6. The monorchis, or musky ophrys, with a loose spike of yellowish musky-scented flowers.

OPHTHALMIA. See MEDICINE.

OPIUM. See NARCOTIC PRINCIPLE, PAPAVER, and MATERIA MEDICA.

OPOBALSAMUM, or *balm of Gilead*, a resin obtained from the amyris Gileadensis, a tree which grows in Arabia, especially near Mecca. It is so much valued by the Turks, that it is rarely imported into Europe. Little is therefore known of its composition. It is said to be at first turbid and white, and of a strong aromatic smell, and of a bitter, acrid, astringent taste; but by keeping, it becomes limpid and thin, and its colours change first to green, then to yellow, and at last it assumes the colour of honey.

OPOPONAX, a resin obtained from the pastinaca opoponax, a plant which is a native of the countries round the Levant. The gum-resin is obtained by wounding the roots of the plant. The milky juice, when dried in the sun, constitutes the opoponax. It is in lumps of a reddish-yellow colour, and white within: taste bitter and acrid. With water it forms a milky solution. Its specific gravity is 1.62.

OPOSSUM. See DIDELPHIS.

OPPOSITE SECTIONS, are two hyperbolas made by cutting two opposite cones by the same plane. See CONIC SECTIONS.

OPPOSITION, in astronomy, is that aspect or situation of two stars or planets, wherein they are diametrically opposite to each other, or 180° asunder.

OPPOSITION, in geometry, the relation of two things, between which a line may be drawn perpendicular to both.

OPTATIVE MOOD, in grammar, that which serves to express an ardent desire or wish for something. In the English language we have neither optative nor subjunctive mood.

OPTICS, the science which explains the properties of light.

Optical definitions and principles.

1. Light is a matter, the particles of which

are extremely small, and by striking on our visual organs, give us the sensation of seeing.

2. The particles of light are emitted from what are called luminous bodies, such as the sun, a fire, a torch, or candle, &c. &c. It is reflected or sent back by what are termed opake bodies, or those which have no power of affording light in themselves.

3. Light, whether emitted or reflected, always moves in straight or direct lines, as may easily be proved by looking into a bent tube, which evidently obstructs the progress of the light in direct lines.

4. By a ray of light, is usually meant the least particle of light that can be either intercepted or separated from the rest. A beam of light is generally used to express something of an aggregate or mass of light greater than a single ray.

5. Parallel rays are such as proceed equally distant from each other through their whole course. The distance of the sun from the earth is so immense, that rays proceeding from the body of that luminary are generally regarded as parallel.

6. Converging rays are such as, proceeding from any body, approach nearer and nearer to each other, and tend to unite in a point. The form of rays thus tending to an union in a single point has been compared to that of a candle-extinguisher; it is in fact a perfect cone.

7. Diverging rays are those which, proceeding from a point, continue to recede from each other, and exhibit the form of an inverted cone.

8. A small object, or a small single point of an object, from which rays of light diverge, or indeed proceed in any direction, is sometimes called the radiant, or radiant point.

9. Any parcel of rays, diverging from a point, considered as separate from the rest, is called a pencil of rays.

10. The focus of rays is that point to which converging rays tend, and in which they unite and intersect, or cross each other. It may be considered as the apex or point of the cone; and it is called the focus (or fire-place), because it is the point at which burning-glasses burn most intensely.

11. The virtual or imaginary focus is that supposed point behind a mirror or looking-glass, where the rays would have naturally united, had they not been intercepted by the mirror.

12. Plane mirrors or speculums are those reflecting bodies, the surfaces of which are perfectly plain or even, such as our common looking-glasses. Convex and concave mirrors are those the surfaces of which are curved.

13. An incident ray is that which comes from any body to the reflecting surface; the reflecting ray is that which is sent back or reflected.

14. The angle of incidence is the angle which is formed by the line which the incident ray describes in its progress, and a line drawn perpendicularly to the reflecting surface: and the angle of reflection is the angle formed by the same perpendicular and the reflected ray; thus, (Plate I. Optics, fig. 1) if *b u* is a reflecting surface, and *d c* an incident ray, then *d c* P is the angle of incidence, and *e c* P the angle of reflection.

15. By a medium opticians mean any thing which is transparent, such as void space, air, water, or glass, through which consequently the rays of light can pass in straight lines.

16. The refraction of the rays of light is their being bent, or attracted out of their course, in passing obliquely from one medium to another of a different density, and which causes objects to appear broken or distorted when part of them is seen in a different medium. It is from this property of light that a stick or an oar which is partly immersed in water, appears broken.

17. A lens is a transparent body of a different density from the surrounding medium, commonly of glass, and used by opticians to collect or disperse the rays of light. They are in general either convex, that is, thicker in the middle than at the edges, which collect, and by the force of refraction converge the rays, and consequently magnify; or concave, that is, thinner in the middle than at the edges, which by the refraction disperse the rays of light, and diminish the objects that are seen through them.

18. Vision is performed by a contrivance of this kind. The crystalline humour, which is seated in the fore-part of the human eye, immediately behind the pupil, is a perfect convex lens. As therefore every object is rendered visible by beams or pencils of light, which proceed or diverge from every radiant point of the object, the crystalline lens collects all these divergent rays, and causes them to converge on the back part of the eye, where the retina or optic nerve is spread out; and the points where each pencil of rays is made to converge on the retina, are exactly correspondent to the points of the object from which they proceed. As, however, from the great degree of convergence which this contrivance will produce, the pencils of light proceeding from the extreme points of the object will be made to cross each other before they reach the retina, the image on the retina is always inverted. (See Plate II. fig. 23.)

19. The magnitude of the image painted on the retina will also, it is evident, depend on the greatness or obtuseness of the angle under which the pencil of rays proceeding from the extreme points of the object enters the eye. For it is plain, that the more open or obtuse the angle is, the greater is the tendency of these rays to meet in a point and cross each other; and the sooner they cross each other after passing the crystalline lens, the larger will be the inverted image painted on the retina. (See Plate II. fig. 24.) The visual angle, therefore, is that which is made by two right lines drawn from the extreme points of any object to the eye; and on the measure of that angle, the apparent magnitude of every visible object will depend.

20. The prism used by opticians is a triangular piece of fine glass, which has the power of separating the rays of light.

History of discoveries. The most antient hypothesis which leads to the true theory of light and colours, is that of the Platonics, viz. that light, from whatever it proceeds, is propagated in right lines; and that when it is reflected from the surfaces of polished bodies, the angle of reflection is equal to the angle of incidence. To this may be added the opinion of Aristotle, who supposed that rainbows, haloes, and mock suns, were occasioned by the reflection of the sun's beams in different circumstances. We have reason to believe, that the use of convex glasses, both as magnifiers and as burning-glasses, was not unknown to the antients, though the theory was not understood. The magnifying power of glasses, and some other optical phenomena, were also largely treated of by Alhazen, an Arabic philosopher of the twelfth century. These observations were followed by those of Roger Bacon, who demonstrated by actual experiment, that a small segment of a glass globe would greatly assist the sight of old persons; and from the hints afforded by these two philosophers, it is not unreasonable to conclude, that the invention of spectacles proceeded. Concerning the actual author of this useful invention, we have no certain information; we only find, that it was generally known about the beginning of the fourteenth century.

In the year 1575, Maurolycus, a teacher of mathematics at Messina, published a treatise on optics, in which he demonstrates, that the crystalline humour of the eye is a lens, which collects the rays of light proceeding from external objects, and throws them on the retina, or optic nerve. From this principle he was led to discover the reason of what are called short and imperfect sights. In the one case, the rays converge too soon; in the other, they do not converge soon enough. Hence short-sighted persons are relieved by a concave glass, which causes the rays to diverge in some degree before they enter the eye, and renders it more difficult for them to converge so fast as they would have done after entering the crystalline humour. Hence too he proves that a convex lens is of use to persons who have weak but long sight, by causing the rays to converge sooner, and in a greater quantity, than would otherwise happen. He was the first also that solved a problem which had caused much perplexity in the antient schools, respecting the sun's image appearing round, though the rays that form it are transmitted into a dark room through an angular aperture. He considered, that as the rays of light are constantly proceeding, in every direction, from every part of the sun's disk, "they must be crossing each other from the extreme part of it in every point of the aperture; so that every such point will be the apex of two cones, of which the base of the one is the sun's disk, and that of the other his image on the opposite wall." The whole image, therefore, consists of a number of images, all of which are circular; the image of the sun formed of those images must be circular also; and it will approach the nearer a perfect circle, the smaller the aperture, and the more distant the image.

Nearly about the same time Johannes Baptista Porta, of Naples, invented the camera obscura; and his experiments upon that instrument convinced him that light is a substance, by the intromission of which into the eye, vision is performed; for it is proper to mention, that before his time the opinion was almost general, that vision depended upon what was termed visual rays, proceeding from the eye. In this the system of Porta corresponds nearly with that of Maurolycus: but it ought to be remarked, that the discoveries of each of these two philosophers were unknown to the other. He shews, moreover, that a defect of light is remedied by the dilatation of the pupil, which contracts involuntarily when exposed to a strong light, and opens when the light is faint and languid.

One Fletcher, of Breslau, in 1571, endeavoured to account for the phenomena of the rainbow, by a double reflection and one refraction; but Antonio de Dominis, whose treatise was published in 1611, was the first who came near to the true theory. He describes the progress of the ray of light through each drop of the falling rain; he shews that it enters the upper part of the drop, where it suffers one refraction; that it is reflected once, and then refracted again, so as to come directly to the eye of the spectator: why this refraction should produce the different colours, was reserved for sir Isaac Newton to explain.

The latter part of the sixteenth century was illustrious for the invention of telescopes. It is generally allowed to have been casual. That effect of refraction, which causes the rays of light, in passing through a dense medium thicker in the middle, to converge to a point, and also that which takes place when they pass through one thicker at the extremities, had been long observed; and the assistance which convex and concave glasses afforded to the sight, had brought them into common use. The inventor of the telescope is not certainly known. The most probable account is, that one Zacharias Jansen, a spectacle-maker of Middleburgh, trying the effect of a concave and convex glass united, found that, placed at a certain distance from each other, they had the property of bringing distant objects apparently nearer to the eye. An account which is very commonly received, is, that some of his children playing in his shop with spectacle-glasses, perceived that when they held two of these glasses between their fingers, at a certain distance from each other, the dial of the clock appeared greatly magnified, but in an inverted position. From this their father adopted the idea of adjusting two of these glasses on a board, so as to move them at pleasure. Telescopes were greatly improved by Galileo, who constructed one which magnified 33 times, and with this he made all his wonderful astronomical discoveries.

The rationale of telescopes was, however, not explained till Kepler, who described the nature and the degree of refraction, when light passed through denser or rarer mediums, the surfaces of which are convex or concave; namely, that it corresponds to the diameter of the circle of which the convexity or concavity are portions of arches. He suggested some improvements in the construction of telescopes, which, however, were left to others to put in practice.

To the Jansens we are also indebted for the discovery of the microscope; an instrument depending upon exactly the same principles as the former. In fact, it is not improbable, that the double lens was first applied to the observation of near but minute objects, and afterwards, on the same principles, to objects which appeared minute on account of their distance.

Much attention was given by Kepler to the investigation of the law of refraction; but he was able to advance no nearer the truth than the observation, that when the incident ray does not make an angle of more than 30 degrees with the perpendicular, the refracted ray proceeds in an angle which is about two-thirds of it. Many disputes arose about the time of Kepler (1600) upon this subject, but it appears that little was effected by them in the cause of truth.

Kepler was more successful in pursuing the discoveries of Maurolycus and B. Porta. He demonstrated that images of external objects were formed upon the optic nerve by the foci of rays coming from every part of the object: he also observed, that these images are inverted; but this circumstance, he says, is rectified by the mind, which, when an impression is made on the lower part of the retina, considers it as made by rays proceeding from the higher parts of the object. Habit is supposed to reconcile us to this deception, and to teach us to direct our hands to those parts of objects from which the rays proceed. Tycho Brahe, observing the apparent diminution of the moon's disc in solar eclipses, imagined that there was a real diminution of the disc by the force of the sun's rays; but Kepler said, that the disc of the moon does not appear less in consequence of being unenlightened, but rather that it appears at other times larger than it really is, in consequence of its being enlightened. For pencils of rays from such distant objects generally come to their foci before they reach the retina, and consequently diverge and spread when they reach it. For this reason, he adds, different persons may imagine the disc to be of different magnitudes, according to the relative goodness of their sight.

In the sixteenth century also many improvements were made in perspective; the ingenious device, in particular, of the reformation of distorted images by concave or convex speculums was invented, but it is uncertain by whom.

The true law of refraction was discovered by Snellius, the mathematical professor at Leyden; but not living to complete it, the discovery was published and explained by professor Hortensius. Some discoveries of lesser importance were made at this time, among others by Descartes, who very clearly explained the nature and cause of the figure of the rainbow, though he was able to give no account of the colours; he however considered the small portion of water, at which the ray issues, as having the effect of a prism, which was known to have the property of exhibiting the light, transmitted through it, coloured.

In 1625, the curious discovery of Scheiner was published at Rome, which ascertains the fact, that vision depends upon the images of external objects upon the retina. For taking the eye of an animal, and cutting away the coats of the back part, and presenting different objects before it, he displayed their images distinctly painted on the naked retina or optic nerve. The same philosopher demonstrated by experiment, that the pupil of the eye is enlarged in order to view remote objects, and contracted when we view those which are near. He shewed, that the rays proceeding from any object, and passing through a small hole in a pasteboard, cross one another before they enter the eye; for if the edge of a knife is held on the side next the eye, and is moved along till it in part covers the hole, it will first conceal from the eye that part of the object which is situated on the opposite side of the hole.

Towards the middle of the seventeenth century the velocity of light was discovered by some members of the Royal Academy of Sciences at Paris, particularly Cassini and Roemer, by observing the eclipses of Jupiter's satellites. About the same time Mr. Boyle made his experiments on colours. He proved that snow did not affect the eye by a native, but reflected light, a circumstance which, however, at this day, we should scarcely believe was ever necessary to be proved by experiment. By admitting also a ray of light into a dark room, and letting it fall on a sheet of paper, he demonstrated, that white reflected much more light than any other colour; and to prove that white bodies reflect the rays outwards, he adds, that common burning-glasses will not, for a long while, burn or discolour white paper; on the contrary, a concave mirror of black marble did not reflect the rays of the sun with near so much power as a common concave mirror. The same effect was verified by a tile, one half of the surface of which was white, and the other black.

Some experiments were made about this time on the difference of the refractive powers of bodies; and the first advance to the great discoveries by means of the prism was made by Grimaldi, who observed, that a beam of the sun's light, transmitted through a prism, instead of appearing round on the opposite wall, exhibited an oblong image of the sun. Towards the close of this century the reflecting telescope was invented by our countryman James Gregory. It was, however, only an idea conceived by him upon theory, and the first reflecting telescope was made by Newton.

The reader will soon perceive how very imperfect all the preceding discoveries were in comparison with those of sir Isaac Newton. Before this time, little or nothing was known concerning colours; even the remark of Grimaldi respecting the oblong figure of the sun, made by transmitting the rays through a prism, was unknown to our great philosopher, having been published only the year before. This fact, however, which he had observed himself, was, it appears, the first circumstance which directed the attention of Newton to the investigation of the theory of colours. Upon measuring the coloured image, which was made by the light admitted into a dark chamber through a prism, he found that its length was five times greater than its breadth. So unaccountable a circumstance induced him to try the effect of two prisms, and he found that the light, which by the first prism was diffused into an oblong, was by the second reduced to a circular form, as regularly as if it had passed through neither of them. After many conjectures and experiments relative to the cause of these phenomena, he at length applied to them what he calls the experimentum crucis. He took two boards, and placed one of them close to the window, so that the light might be admitted through a small hole made in it, and after passing through a prism might fall on the other board, which was placed at about twelve feet distance, and in which there was also a small aperture, in order that some of the incident light might pass through it. Behind this hole, in the second board, he also placed a prism, so that the light, after passing both the boards, might suffer a second refraction before it reached the wall. He then moved the first prism in such a manner as to make the several parts of the image cast upon the second board pass successively through the hole in it, that he might observe to what places on the wall the second prism would refract them. The consequence was, that the coloured light, which formed one end of the image, suffered a refraction considerably greater than that at the other end; in other words, rays or particles of light of one colour were found to be more refrangible than those of another. The true cause, therefore, of the length of the image was evident; since it was proved by the experiment, that light was not homogeneal, but consisted of different particles or rays, which were capable of different degrees of refrangibility, according to which they were transmitted through the prism to the opposite wall. It was further evident from these experiments, that as the rays of light differ in refrangibility, so they also differ in exhibiting particular colours, some rays producing the colour red, others that of yellow, blue, &c. and of these different-coloured rays, separated by means of the prism according to their different degrees of refrangibility, the oblong figure on the wall was composed. But to relate the great variety of experiments, by which he demonstrated these principles, or the extensive application of them, would lead us too much into detail; let it suffice to say, that he applied his principles to the satisfactory explanation of the colours of natural bodies, of the rainbow, and of most of the phenomena of nature where light and colour are concerned; and that almost every thing which we at present know upon these subjects was laid open by his experiments.

His observations on the different refractive powers of different substances are curious and profound; but chemistry was at that period scarcely in a state sufficiently advanced to warrant all his conclusions. The general result is, that all bodies seem to have their refractive powers proportional to their densities, excepting so far as they partake more or less of inflammable or oily particles.

The discovery of the different refrangibility of the component rays of light suggested defects in the construction of telescopes, which were before unthought of, and in the creative hand of a Newton led to some no less extraordinary improvements in them. It is evident, that since the rays of light are of different refrangibilities, the more refrangible will converge to a focus much sooner than the less refrangible, consequently that the whole beam cannot be brought to a focus in any one point; so that the focus of every object-glass will be a circular space of considerable diameter, namely, about one fifty-fifth of the aperture of the telescope. To remedy this, he adopted Gregory's idea of a reflector, with such improvements as have been the basis of all the present instruments of this kind.

When a science has been carried to a certain degree of perfection, subsequent discoveries are too apt to be considered as of little importance. The real philosopher will not, however, regard the discoveries on light and colours, since the time of Newton, as unworthy his attention. By a mere accident, a very extraordinary property in some bodies of imbibing light, and afterwards emitting it in the dark, was observed. A shoemaker of Bologna, being in quest of some chemical secret, calcined, among other things, some stones of a particular kind, which he found at the bottom of Mount Peteius; and casually observed, that when these stones were carried into a dark place, after having been exposed to the light, they possessed a self-illuminating power. Accident afterwards discovered the same property in other substances. Baldwin, of Misnia, dissolving chalk in aquafortis, found that the residuum, after distillation, exactly resembled the Bolognian stone in retaining and emitting light, whence it now has the name of Baldwin's phosphorus; and M. Du Fay observed the same property in all substances that could be reduced to a calx by burning only, or after solution in nitrous acid. These facts seem to establish the materiality of light.

Some very accurate calculations were made about the year 1725 by Dr. Bradley, which afforded a more convincing proof of the velocity of light, and the motion of the earth in its orbit. Nor must we forget M. Bouguer's very curious and accurate experiments for ascertaining the quantity of light which was lost by reflection, the most decisive of which was by admitting into a darkened chamber two rays of light, one of which he contrived should be reflected, and the other fall direct on the opposite wall; then by comparing the size of the apertures by which the light was admitted (that through which the direct ray proceeded being much smaller than that through which the reflected ray was suffered to pass, and the illumination on the wall being equal in both), he was enabled to form an exact estimate of the quantity of light which was lost. To prove the same effect with candles, he placed himself in a room perfectly dark, with a book in his hand, and having a candle lighted in the next room, he had it brought nearer to him till he could just see the letters, which were then 24 feet from the candle. He then received the light of the candle reflected by a looking-glass upon the book, and he found the whole distance of the book from the source of the light (including the distance from the book to the looking-glass) to be only 15 feet; whence he concluded, that the quantity of direct light is to that of reflected as 576 to 225; and similar methods were pursued by him for measuring the proportions of light in general.

The speculations of Mr. Melville concerning the blue shadows which appear from opaque bodies in the morning and evening, when the atmosphere is serene, are far from uninteresting. These phenomena he attributes to the power which the atmosphere possesses of reflecting the fainter and more refrangible rays of light, the blue, violet, &c. and upon this principle he also explained the blue colour of the sky, and some other phenomena.

The same period produced Mr. Dollond's great improvement in the construction of telescopes. It consists in using three glasses of different refractive powers, crown and flint glass, which correct each other. The great dispersion of the rays which the flint-glass produces, is the effect of the lead, and is in proportion to the quantity of that metal which is used in its composition. Mr. Martin found the refractive powers of different glasses to be in proportion to their specific gravity.

Several discoveries and improvements have been made since the time of Newton in that branch of optics which relates more immediately to vision. One of these is not only curious in itself, but led to the explanation of several circumstances relating to vision. M. De la Motte, a physician of Dantzick, was endeavouring to verify an experiment of Scheiner, in which a distant object appeared multiplied when viewed through several holes made with the point of a pin in a card, not further distant from one another than the diameter of the pupil of the eye; but notwithstanding all his labour, he was unable to succeed, till a friend happening to call upon him, he desired him to make the trial, and it answered perfectly. This friend was short-sighted; and when he applied a concave glass close to the card, the object, which seemed multiplied before, now appeared but one.

The last, though not least, successful adventurer in this branch of science, is Mr. Delaval, who, in a paper read before the Philosophical Society of Manchester, in 1784, has endeavoured, with great ingenuity, to explain the permanent colours of opaque bodies. The majority of those philosophers, who have treated of light and colours, have, he observes, supposed that certain bodies or surfaces reflected only one kind of rays, and therefore exhibited the phenomena of colours; on the contrary, Mr. Delaval, by a variety of well-conducted experiments, evinced, that colours are exhibited, not by reflected, but by transmitted light. This he proved by covering coloured glasses and other transparent coloured media, on the further surface, with some substance perfectly opaque, when he found they reflected no colour, but appeared perfectly black. He concludes, therefore, as the fibres or bases of all vegetable, mineral, and animal substances, are found, when cleared of heterogeneous matters, to be perfectly white; that the rays of light are in fact reflected from these white particles, through coloured media, with which they are covered; that these media serve to intercept and impede certain rays in their passage through them, while, a free passage being left to others, they exhibit, according to these circumstances, different colours. This he illustrates by the fact remarked by Dr. Halley, who, in diving deep into the sea, found that the upper part of his hand, when extended into the water from the diving-bell, reflected a deep-red colour, while the under part appeared perfectly green. The conclusion is, that the more refrangible rays were intercepted and reflected by particles contained in the sea-water, and were consequently reflected back by the under part of the hand; while the red rays, which were permitted to pass through the water, were in the same manner reflected by the upper part of the hand, which therefore appeared of a red rose-colour. Those media, our author thinks, transmit coloured light with the greatest strength, which have the strongest refractive power.

Of the nature of light. Numerous opinions have successively been adopted concerning this wonderful fluid. It has been sometimes considered as a distinct substance, sometimes as a quality, sometimes as a cause, frequently as an effect; by some regarded as a compound, and by others as a simple substance. Descartes and other philosophers of high repute, have imagined that the sensation which we receive from light is to be attributed entirely to the vibrations of a subtile medium or fluid, which is diffused throughout the universe, and which is put into action by the impulse of the sun. In this view they consider light as analogous to sound, which is known to depend entirely on the pulsations of the air upon the auditory nerves; and in support of this opinion, it has been even lately urged, 1st, That some diamonds, on being rubbed or chafed, are luminous in the dark. 2. That an electric spark, not larger, but much brighter, than the flame of a candle, may be produced, and yet that no part of the electric fluid is known to escape, in such a case, to distant places, but the whole proceeds in the direction to which it is destined by the hand of the operator. Weaker or stronger sparks of this fluid are also known to differ in colour; the strongest are white, and the weakest red, &c.

To this opinion, however, there are many pressing, and, indeed, insurmountable objections. 1st, The velocity of sound bears a very small proportion to that of light. Light travels, in the space of eight minutes, a distance in which sound could not be communicated in 17 years; and even our senses may convince us, if we attend to the explosion of gunpowder, &c. of the almost infinite velocity of the one compared with that of the other. 2dly, If light depended altogether on the vibrations of a fluid, no solid reason can be assigned why this fluid should cease to vibrate in the night, since the sun must always affect some part of the circumambient fluid, and produce a perpetual day. 3dly, The artifice of candles, lamps, &c. would be wholly unnecessary upon this hypothesis, since, by a quick motion of the hand, or of a machine contrived for this purpose, light might on all occasions be easily produced. 4thly, Would not a ray of light, admitted through a small aperture, put in motion, according to this theory, the whole fluid contained in a chamber? In fact, we know that light is propagated only in right lines; whereas sound, which depends upon vibration, is propagated in every direction. 5thly, The separation or extension of the rays, by means of the prism, can never be accounted for by the theory of a vibrating medium. 6thly, The texture of many bodies is actually changed by exposure to the light. The juice of a certain shell-fish contracts, it is well known, a very fine purple colour, when permitted to imbibe the rays of the sun; and the stronger the light is, the more perfect the colour. Pieces of cloth wetted with this fluid become purple, even though inclosed in glass, if the solar light only is admitted; but the effect is totally prevented by the intervention of the thinnest plates of metal, which exclude the light. Some of the preparations of silver, as luna cornea, will remain white if covered from the light, but contract a dark-purple colour when exposed to it; and even the colour of plants is derived from the light, since a plant which vegetates in darkness will be perfectly white. As colour is imparted by light, so it is also destroyed by it. It must have fallen within the observation of every reader, that silks and other stuffs of delicate colours, are greatly affected by the action of light. Experiments have been made upon the same stuffs by exposing them to both heat and moisture in the dark, and also by exposing them to the light in the vacuum of an air-pump, and it was found by all these experiments, that the change of colour was to be ascribed to the action of light. 7thly, With respect to the emission of light by diamonds and other stones, it is easily accounted for upon other principles; and the arguments founded upon the electric spark not being sensibly diminished, will meet with a satisfactory solution by considering the extreme rarity of light, and the minuteness of its particles.

It is, therefore, almost universally agreed by the moderns, that light consists of a number of extremely minute particles, which are actually projected from the luminous body, and act by their projectile force upon the optic nerve. Concerning the nature of these particles, or rather of the matter of which they consist, there is less unanimity in the philosophical world.

The first remarkable property of light is its amazing velocity. In the short space of one second a particle of light traverses an extent of 170,000 miles, which is so much swifter than the progress of a cannon-ball, that the light is enabled to pass a space in about eight minutes which could not be passed with the ordinary velocity of a cannon-ball in less than 32 years. The velocity of light is also found to be uniform, whether it is original, as from the sun, or reflected only, as from the planets.

The mode of calculating the velocity of light is a branch of astronomy. It will suffice, therefore, in this place to remark, that by mathematical observations made upon the transits of Venus in 1761 and 1769, the diameter of the earth's orbit was found to be about 163,636,800 geographical miles. When, therefore, the earth happens to be on that side of her orbit which is opposite to Jupiter, an eclipse of his satellites, or any other appearance in that planet, is observed to take place 15 or 16 minutes later than it would have done if the earth had been on that side of her orbit which is nearest to Jupiter. From the very accurate observations of Dr. Bradley, it appears, that the light of the sun passes from that luminary to the earth in eight minutes and twelve seconds.

The next property of light to which it is proper to advert is, that it is detached from every luminous or visible body in all directions, and constantly moves in right lines. It is evident that the particles of light move continually in right lines, since they will not pass through a bended tube; and since if a beam of light is in part intercepted by any intervening body, the shadow of that body will be bounded by right lines passing from the luminous body, and meeting the lines which terminate the interceding body. This being granted, it is obvious, that the rays of light must be emitted from luminous bodies in every direction; since, whatever may be the distance at which a spectator is placed from any visible object, every point of the surface which is turned towards him is visible to him, which could not be upon any other principle.

The rarity of light, and the minuteness of its particles, are not less remarkable than its velocity. If indeed the Creator had not formed its particles infinitely small, their excessive velocity would be destructive in the highest degree. It was demonstrated, that light moves about two millions of times as fast as a cannon-ball. The force with which moving bodies strike, is in proportion to their masses multiplied by their velocities; and consequently, if the particles of light were equal in bulk to the two-millionth part of a grain of sand, we should be no more able to endure their impulse than that of sand shot point-blank from the mouth of a cannon. The minuteness of the rays of light is also demonstrable from the facility with which they penetrate glass, chrystal, and other solid bodies, which have their pores in a rectilinear direction, and that without the smallest diminution of their velocity, as well as from the circumstance of their not being able to remove the smallest particle of microscopic dust or matter which they encounter in their progress. A further proof might be added, that if a candle is lighted, and there is no obstacle to obstruct its rays, it will fill the whole space within two miles around it almost instantaneously, and before it has lost the least sensible part of its substance.

To the velocity with which the particles of light are known to move, may in a great measure be attributed the extreme rarity and tenuity of that fluid. It is a well-known fact, that the effect of light upon the eye is not instantaneous, but continues for a considerable time. Now we can scarcely conceive a more minute division of time than the 150th part of a second. If, therefore, one lucid point of the sun's surface emits 150 particles of light in one second, we may conclude that this will be sufficient to afford light to the eye without any seeming intermission; and yet, such is the velocity with which light proceeds, that still these particles will be at least 1000 miles distant from each other. If it was not indeed for this extreme tenuity of the fluid, it would be impossible that the particles should pass, as we know they do, in all directions without interfering with each other. In all probability the splendour of all visible objects may be in proportion to the greater or less number of particles which are emitted or reflected from their surface in a given space of time; and if we even suppose 300 particles emitted successively from the sun's surface in a single second, still these particles will follow each other at the immense distance of above 500 miles.

Of the reflection of light, or *catoptrics*. It has been already intimated, that the rays of light which proceed from any luminous body move always in straight lines, unless this direction or motion is changed by certain circumstances; and these are reflection, refraction, and inflection.

The great law of reflection, and which serves to explain all its phenomena, is this, that the angle of reflection is always equal to the angle of incidence. It has been already intimated, that by the angle of incidence is meant the angle made by a ray of light with a perpendicular to the reflecting surface at the point where the ray falls; and by the angle of reflection, the angle which the ray makes with the same perpendicular on the other side.

A ray of light falling perpendicularly on a plane surface, is reflected back exactly in the same direction in which it came to the reflecting surface: rays falling obliquely observe the general law of reflection, and their angle of reflection is exactly equal to the angle of incidence. In Plate I. Optics, fig. 1., *fc* is a ray of light falling perpendicularly on the plane surface *ab*, and it is reflected back exactly in the same direction; *ec* is a ray falling obliquely on the surface at *c*, and it is reflected in the direction *cd*, making the angle of reflection *cd* P exactly equal to the angle of incidence *ec*P, as may be seen by inspection of the figure.

Parallel rays falling obliquely on a plane reflecting surface are reflected parallel, converging rays are reflected with the same degree of convergence, and diverging rays equally diverging. In other words, plane surfaces or mirrors make no change in the previous disposition of the rays of light.

A mirror is a body, the surface of which is polished to such a degree as to reflect most copiously the rays of light. Figs. 1, 2, 3, are plane mirrors: in fig. 2. the rays *db* and *ca*, which are parallel, after having reached the surface *ab* are reflected, the one towards *h* and the other towards *k*, and in both instances the angle of reflection is evidently equal to the angle of incidence.

The rays *db* and *ca* (fig. 3.) are convergent, and without the interposition of the mirror would unite in the point E; but being reflected, they unite in the opposite point F: the angle of reflection with respect to each being still equal to the angle of incidence, as may be seen by drawing perpendiculars to the points *a* and *b*.

The rays *db* and *ca* (fig. 4.) are on the contrary divergent, and after reflection towards *h* and *k*, preserve exactly the same distance from each other as they would have had if they had proceeded without interruption towards F and E, the angle of reflection being with respect to each ray still exactly equal to the angle of incidence.

Thus it is that plane surfaces reflect the rays of light; but the effects are materially different when the surfaces are convex or concave, though the same law still obtains with respect to these. From a convex surface, parallel rays, when reflected, are made to diverge; convergent rays are reflected less convergent, or are even made to diverge in proportion to the curvature of the surface compared with their degree of convergence; and divergent rays are rendered more divergent. Thus it is the nature of convex surfaces to scatter or disperse the rays of light, and in every instance to impede their convergence. From a concave surface, on the contrary, parallel rays when reflected are made to converge; converging rays are rendered more convergent; and diverging rays are made less divergent, or even in certain cases may be made to converge.

To understand this part of the subject, it is necessary to be aware, that all curvilinear surfaces are composed of right lines infinitely short, or points; and the reader will recollect, that only those rays which fall perpendicularly on a reflecting surface are reflected back in the same direction. All curves are arches or segments of circles: if therefore any curvilinear or spherical surface is presented to a number of parallel rays, it is evident that only that ray which strikes the spherical surface in such a direction that it would proceed in a right line to the centre of that circle, of which the reflecting surface is an arch or segment, can be said to fall perpendicularly upon it, of which the reader may convince himself by drawing a straight line with a ruler at any point of a given circle or curve. All the rest of the parallel rays, therefore, falling on the spherical surface, will fall obliquely upon it, and will consequently be subject to the general law of reflection, and the angle of their reflection will be equal to the angle of their incidence.

Perhaps the subject will be rendered still plainer, if, pursuing the idea thrown out in the preceding paragraph, that all curves are formed of a number of straight lines infinitely short, and inclining to each other like the stones in the arch of a bridge, we present to the reader the figures 5, 6, 7; which may be imagined so many mirrors bent or inclined in the form which is represented in the plate. The rays *ab* and *cd* (fig. 5.), which are parallel, are from their different points of incidence rendered divergent in *h* and *e*; the angle of reflection with respect to each being equal to the angle of incidence.

In fig. 6. the rays *ab* and *cd* are convergent, and would, without the interposition of the reflecting surface *bd*, unite in *m*; but according to the same principle, they now proceed to unite in *l*, which is more distant from the reflecting surface than the point *m*; and it is evident, that if the curvature of the two branches of the reflecting surface *b* and *d* was greater, they might be reflected parallel, or even divergent. In the same manner, as in fig. 7., the rays *ab* and *cd*, which, without the interposition of the convex surface *bd*, would diverge but very little at *m*, become after reflection much more divergent at *l*; and the angles of reflection will be found in all these cases exactly equal to the angles of incidence, if measured from the reflecting surface produced or lengthened, as at *fg* and *ik*.

Let now fig. 8 represent a concave mirror formed upon the same principles as those which we have been examining of the convex kind. The rays *ab*, *cd*, which were parallel before reflection, and which make their angles of reflection equal to their angles of incidence (measured for convenience in this figure from the reflecting surface produced), become evidently convergent at the point *l*; upon the same principles in fig. 9. the converging rays *ab* and *cd*, which would not have united before they reached the point *m*, are now after reflection united at *l*, which is much nearer the reflecting surface. In fine, the divergent rays *ab* and *cd* in fig. 10., which would have become more divergent at *m*, had they not been intercepted by the reflecting surface, become convergent after reflection, and are found actually to unite at *o*.

Mirrors are formed either of metal, or of glass plated behind with an amalgam of mercury and tin. The latter are most in common use; but they are improper for optical instruments, such as telescopes, &c. because they commonly present two images of the same object, the one vivid and the other faint, as may be perceived by placing the flame of a wax-taper before a common looking-glass. The reason of this double image is, that a part of the rays are immediately reflected from the anterior surface of the glass, and thus form the faint image; while the greatest part of the rays penetrating the glass are reflected by the amalgam, and form the vivid image.

From the principles laid down, most of the phenomena of reflection may be explained. In plane mirrors, the image appears of its natural size, and at the same distance behind the glass as the object is before it. To understand perfectly the reason of this, it will be necessary to advert to the subject of vision, as formerly explained. It will be remembered, that by the spherical form of the eye, and particularly by means of the chrystalline humour which is placed in the middle of it, the rays of light are converged; and those from the extreme points of the object cross each other, so as to form an inverted image on that part of the optic nerve which is called the retina. The apparent magnitude of objects will consequently depend upon the size of the inverted image, or, in other words, upon the angle which the rays of light form, by entering the eye from the extremities of any object.

As therefore the angle of reflection is always equal to the angle of incidence, it will be evident on the inspection of fig. 11. that the converging rays K*m*, L*n*, proceeding from the extremities of the object KL, and falling on the mirror *ab*, are reflected to the eye at *e* with the same degree of convergence, and consequently will cause the image *kl* to be seen under an angle equal to that under which the object itself would have been seen from the point *i* without the interposition of the mirror. The image appears also at a distance behind the mirror equal to that at which the object stands before it. For it must be remembered, that objects are rendered visible to our eyes not by a single ray proceeding from every point of an object, but that in fact pencils or aggregates of divergent rays proceed from every point of all visible objects, which rays are again, by the mechanism of the eye, converged to as many points on all those parts of the retina where the image is depicted. The point from which the rays diverge is called the focus of divergent rays; and the point behind a reflecting surface from which they appear to diverge, is called the virtual focus. As therefore the angle of reflection is exactly equal to the angle of incidence, it is evident that the virtual focus will be at the same distance behind the mirror as the real focus is at before it. Thus, in fig. 12., the diverging rays *ch* will after reflection appear to diverge from the point *g* which is behind the mirror *ab*, and that point for the reasons assigned (viz. no alteration being made in the disposition of the rays but only in the direction) will be at an equal distance behind the mirror with the luminous point *c* before it.

As every part of the image appears at a distance behind the mirror equal to that at which the object stands before it, and as the object KL (fig. 11.) is inclined or out of the vertical position, the image *kl* appears also inclined. Hence it is evident, that to exhibit objects as they are without any degree of distortion, looking-glasses should be always hung in a vertical position, that is, at right angles with the floor of the apartment.

It is clear, however, from what has preceded, that the case must be very different with those mirrors, the surfaces of which are spherical, whether convex or concave. Of the former it has been shewn that their property is to scatter and disperse the rays of light, to render those divergent which were parallel, to diminish the convergence of converging rays, and to augment the divergence of those which diverged before. The first obvious effect of these mirrors, therefore, must be to exhibit the image of the object which is opposed to them smaller than it is in reality. For the angle under which the rays strike the eye of the observer, must necessarily be smaller in proportion to the convexity of the mirror. Suppose, for instance, the object CD (fig. 13.) placed before the convex mirror *ab*; the two rays C*c* and D*d*, which proceed from the extremities of the object, and which, without the interposition of the mirror, would converge at *f*, are reflected less convergent, and unite at *i*, forming an angle much more acute than they would otherwise have done. The consequence, therefore, of the visual angle being so much more acute, is, that the image *gh* is proportionably smaller than the object itself.

The second effect of this dispersion of the rays is, that the image appears at a less distance behind the glass than it would have done in a plane mirror. To understand this effect, it is necessary again to advert to a principle of optics which has been just stated, viz. that objects are rendered visible not by a single ray of light proceeding from every point of the object, but that from every minute point of the surface of every visible object pencils of divergent rays proceed, which are again converged on the retina of the spectator's eye.

Suppose then G (fig. 14) a luminous point of any visible object, from which a pencil of divergent rays proceed, and fall upon the convex mirror *ab:* these rays, agreeably to the nature of these mirrors, are reflected more divergent, and have their fictitious point of re-union (or virtual focus) *g* much nearer to the eye and to the surface of the mirror, than they would otherwise have. The image, therefore, as may be seen in the figure, instead of being at a distance behind the mirror equal to the distance at which the object stands before it (as would be the case in a plane mirror), will appear at a smaller distance, and this distance will always be diminished in proportion to the convexity of the mirror.

For the same reasons an object of a certain size, placed either perpendicularly or obliquely before a convex mirror, will necessarily appear curved or bent, because the different points of the object are not at equal distances from the surface of the mirror. All these effects will be very apparent from inspecting one of those small glass globes, lined with the common amalgam for making looking-glasses, which are sometimes suspended in old-fashioned apartments. In these the company seated in the room or round the table, are represented by very minute images, which appear not at a certain distance behind as in plane looking-glasses, but very near the surface of the mirror, and always in some degree curved or distorted.

The effects and phenomena of concave mirrors will obviously, from what has been said, be the direct contrary to those of the convex kind. The surface of concave mirrors is generally spherical (or in in the form of a globe); though that is not always the most convenient form for optical purposes, but it is that which is least difficult to the workmen.

The general effect of concave mirrors is, we have already seen, to render the rays more convergent. The point in which the converged rays unite is called the focus of converging rays; but this focus cannot be the same for all the rays incident on a concave surface. The parallel rays *ab*, *de* (fig. 15.), are converged by the mirror at the point F, which is distant from the mirror one-fourth part of the diameter of that circle, of which the mirror is a part or section; and this is the point which is called the focus of parallel rays, and it is the real or principal focus of the mirror. The converging rays *fg*, *hi*, are reflected upon the same principles more convergent, and unite at the point K, nearer to the surface of the mirror than the principal focus. In fine, the divergent rays R*m* and R*o*, which proceed from the point R, beyond the principal focus, unite at the point P. But if the point of divergence was nearer the mirror than the principal focus, as for instance at K, they would still be reflected divergent, and would proceed one towards *f* and the other towards *h*.

Plane and convex mirrors exhibit, as has been already mentioned, the image behind the glass or mirror, and in a situation conformable to that of the object; but concave mirrors shew the image behind when the object is placed between the principal focus and the mirror, and then the image is larger than the object. Let AB (fig. 16.) be the object placed before the concave mirror EF, and nearer to the mirror than its principal focus. The two pencils of rays A*e*, B*f*, which proceed from the extremities of the object, and which, without the interposition of the mirror, would converge at *d*, are reflected more converging, and unite at D; and making an angle greater or more obtuse than they would otherwise have done, the image *ab* is consequently greater than the object.

This image too appears at a greater distance behind the mirror than the object is at before it. The reason of this will appear, if we suppose A (fig. 17.) a point of any object placed nearer to the mirror than the principal focus F, whence a pencil of divergent rays proceed, and falling on the mirror, are (according to the principles before laid down) reflected less divergent, and consequently have their virtual or imaginary focus at a greater distance, than if the object had been placed before a plane mirror.

If, on the contrary, the object is placed farther from the mirror than the principal focus, as for instance at *e*, the rays *eb*, *ed*, being only moderately divergent when they come in contact with the mirror, are reflected convergent, and will represent at E an image of the object. If the eye, therefore, is withdrawn to a sufficient distance (to *o* for example) for the rays to cross each other, it will perceive the image suspended in the air at E between the mirror and itself. The reason of this depends upon what has been already stated. Every object is rendered visible to us by pencils of divergent rays from every point of that object; it therefore ceases to be visible if these rays are converged to a point, and this happens when the object is not nearer to the mirror than the principal focus. To render, therefore, an object thus situated visible, it is necessary that the eye should recede so far beyond the place of the image E, as to allow the rays to cross each other, and meet the eye in a state of divergence.

The image is in this case always inverted. Such is the image *ba* of the object AB (fig. 18.). From this property of the concave reflector to form the image of an object, in these cases, before the reflector, many deceptions have been produced, to the great surprise of the ignorant spectator. He is made to see a bottle half-full of water inverted in the air without losing a drop of its contents; as he advances into a room, he is tempted to exclaim with Macbeth, " Is this a dagger that I see before me?" and when he attempts to grasp it, it vanishes into the air.

A variety of similar appearances may be represented, which are all produced by means of a concave mirror, having an object before it strongly illuminated, care being taken that only the rays of light reflected from the object shall fall upon the concave reflector, placed in such a manner that the image shall be in the middle of the adjoining room; or, if in the same room with the object and reflector, a screen must be placed so as to prevent the spectator from discovering them. A hole is then made in the partition between the two rooms, or in the screen, through which the rays pass by which the image is formed. The spectator then, when he casts his eyes upon the partition of the screen, will, in certain situations, receive the rays coming through this small aperture. He will see the image formed in the air; he will have no idea, if not previously acquainted with optics, of the nature of the deception; and may either be amused, according to the inclination of his friends, with tempting fruit, or be terrified at the sight of a ghastly apparition.

Since it is the property of a concave mirror to cause those rays which proceed in a parallel direction to its surface, to converge to a focus; and since the solar rays, from the immense distance of that body, may be considered as parallel; concave mirrors prove very useful burning-glasses: and the focus of parallel rays, or principal focus, is their focus or burning-point.

Cylindrical mirrors, such as that represented in fig. 19. are employed more for the purpose of amusement than of philosophy. They are called mixed mirrors, because they produce at the same instant the effects of plain and of convex mirrors. Suppose, for instance, GF (fig. 20.) to be the height of such a mirror, and AE an object placed before or rather below it; all the rays which proceed from the points A, B, C, D, E, falling on the surface GF of the mirror, and reflected to the eye at O, will represent the images of these different points at *a*, *b*, *c*, *d*, *e*, as they would be represented in a plane mirror; and with respect to these, the dimensions of the object will not be altered in the corresponding image. But since the mirror is also curved, if we suppose the space *q*, *t*, *y*, (fig. 21.) to represent a part of its circumference, the rays A*q*, L*r*, M*s*, N*t*, O*x*, P*z*, F*y*, being reflected to the eye at Z, will exhibit all these points A, L, M, N, &c. within the space *af*; which will in this direction diminish considerably the dimensions of the image, according to the principles already explained in treating of the convex mirror, viz. by diminishing the convergence of rays, and consequently reducing the size of the image in proportion to the convexity. In the cylindrical mirror, it must be observed, that it is in the breadth only that this diminution takes place. The same will take place with respect to all the points of the object which are visible within the lines BQG, CRH, DTI, ESK, concentric to the surface of the mirror. These parts must therefore be very much extended in the drawing or design, if a perfect image is to be represented in the mirror. Distorted drawings of this kind are common in the shops of the opticians, which, on a cylindrical mirror being placed on the board or drawing, display perfect figures. The principle of these will, however, be very easily understood from what has been now stated.

The conical mirror is represented in fig. 22, and this is also considered as a mixed mirror; for, as well as the cylindrical, it produces at once the effects of a convex and a plane mirror. Suppose, for instance, the angle CKF (fig. 23.) to represent this mirror, and the lines CK, FK, two of the right lines which compose it. These two lines would then answer to two plane mirrors inclined towards each other: and the rays proceeding from the points ABC, falling on the surface at *g*, *h*, *i*, and reflected towards the eye at O, would represent these points as if at the base of the mirror in the opposite order *a*, *b*, *c*; and the same observation will apply to the points D, E, F, which are represented at *d*, *e*, *f*, as well as all those which are in the circles AHD, BIE, CGF. But as there do not proceed from each point simple rays of light, but pencils of rays, they are modified in this mirror upon the same principles as in the convex mirror; and consequently the image will appear smaller than the object, and nearer to the eye, than in the plane mirror.

Hence it will be evident, that we may see in the centre the image of whatever is painted on the exterior circumference AHD, and the extremities of the image will be formed from the interior circle CGF; and as the curvature or convexity of the mirror is greater towards the apex or point of the cone, it follows, that that which is the most extended in the object will be the most compressed or concentrated in the image. Thus the dark part of the board (fig. 24.) is intended to represent in the mirror an ace of spades; and the points *a*, *b*, *c*, *d*, *e*, *f*, *g*, &c. which are nearest to the mirror, form the outer circumference of the image; and the points 1, 2, 3, 4, 5, 6, 7, 8, of the external circumference of the board, unite in the centre of the image at an almost imperceptible point.

Of the refraction of light, or *dioptrics*. It has been proved that light, like every known substance, is subject to the laws of attraction; it has been intimated too, that even its propensity to move in a direct line is, in certain cases, overcome by this superior influence; and that the direction of the rays of light is changed in passing from one medium to another. The space in which a ray of light moves is called a medium; whether pure space, air, water, glass, or any other transparent substance; and when a ray is bent out of its natural course in passing from one medium to another, it is said to be refracted or broken, probably from the broken appearance which a staff, &c. exhibits when part of it is immersed in water.

There are two circumstances essential to refraction: 1st, That the rays of light shall pass out of one medium into another of a different density, or of a greater or less degree of resistance. 2dly, That they pass in an oblique direction.

The denser the refracting medium, or that into which the ray passes, is, the greater will be its refracting power; and of two refracting mediums of the same density, that which is of an oily or inflammable nature will have a greater refracting power than the other.

The angle of refraction depends on the obliquity of the rays falling on the refracting surface being such always, that the sine of the incident angle is to the sine of the refracted angle in a given proportion.

The incident angle is the angle made by a ray of light, and a line drawn perpendicular to the refracting surface, at the point where the light enters the surface; and the refracted angle is the angle made by the ray in the refracting medium with the same perpendicular produced. The sine of the angle is a line which serves to measure the angle, being drawn from a point in one leg perpendicular to the other.

In passing from a rare into a dense medium, or from one dense medium into a denser medium, a ray of light is refracted towards the perpendicular, that is, so that the angle of refraction shall be less than the angle of incidence; on the contrary, in passing from a dense medium into a rare medium, or from one rare medium into a rarer, a ray of light is refracted from the perpendicular. Thus, in passing from empty space into air, or any other medium whatever, the ray is bent towards the perpendicular; and in passing from any other medium into pure space, it is bent the contrary way, that is, from the perpendicular; the same effects will take place in passing from air into glass, and from glass into air, &c.

To render this perfectly clear, let us have recourse to fig. 25. If a ray of light *p*G passes from air to water, in the direction *p*G, perpendicular to the plane D*d*, which separates the two mediums, it suffers no refraction, because one of the essentials is wanting to that effect, viz. the obliquity of the incidence.

But if a ray AG passes obliquely from air into water, instead of continuing its course in the direct line GB, it takes the direction G*a*, and approaches the perpendicular *p*P, in such a manner that the angle of refraction PG*a* is less than its angle of incidence *p*GA.

If the ray came in a more oblique direction, the refraction would be still greater; so that in all cases where the mediums are the same, the angle of refraction will always be found to bear a regular and constant proportion to the angle of incidence; or, to speak in technical language, the sine of incidence is to the sine of refraction in a given ratio, and this ratio is discovered by experience. Thus, when a ray passes out of air into water, the ratio is as 4 to 3.

out of water into air, as 3 to 4.
air into glass, as 3 to 2.
glass into air, as 2 to 3.
air into diamond, as 5 to 2.
diamond into air, as 2 to 5.

The refraction of light is attributed by sir Isaac Newton to the principle of attraction; and perhaps one of the most satisfactory proofs of this theory is the known fact, that the change in the direction of the ray commences, not when it comes in contact with the refracting medium, but a little before it reaches the surface, and the incurvation augments in proportion as it approaches this medium. Indeed no principle will account for the phenomenon of light passing more easily, that is, more directly, through a dense than through a rare medium, but that of attraction; since it is found by universal experience, that the attraction of all bodies is in proportion to their densities.

In passing from a dense into a rare medium, however, there is a certain degree of obliquity at which the refraction is changed into reflection. In other words, a ray of light will not pass out of a dense into a rare medium, if the angle of incidence exceeds a certain limit, but will be reflected back. Thus a ray of light will not pass out of glass into air, if the angle of incidence exceeds 40° 11; or out of glass into water, if the angle of incidence exceeds 59° 20.

As the rays of light, in passing from a dense medium to a rarer, are refracted from the perpendicular, in fact are bent or inclined towards the eye of the spectator, who looks at an object in the denser medium while standing at its side, the reason will be clear why the bottom of a river appears to us nearer than it really is. If the spectator stands on a bank just about the level of the water, it is about one-third deeper than it appears; and why an oar, partly in and partly out of the water, seems broken. Let Q*no* (fig. 26.) represent an oar, the part *n*Q being out of, and the part *no* being in, the water; the rays diverging from *o* will appear to diverge from *b* nearer to the surface of the water, and every point in *no* will be found nearer to the surface than its real place, and the part *no* will appear to make an angle with the part Q*n*. On this account also, a fish in the water appears much nearer the surface than it actually is; and a skilful marksman, in shooting at it, will aim considerably below the place which it seems to occupy.

On the same principle a common experiment is explained. Put a shilling into a bason, and walk back from it till the shilling is just obscured by the side of the bason; then by pouring water into the bason, the shilling instantly appears; for by what has been said above, the object, being now in a denser medium, is made to appear nearer to its surface.

As the refraction must in all cases depend on the obliquity of the ray, that part of any body which is most immersed will seem to be most materially altered by the refraction. When, however, the object extends to no great depth in the water, the figure is not materially distorted; but if the object is of a considerable size, or extends to a great depth, those rays which proceed from the more distant extremities come in a more oblique direction on their emergence into the air, and they consequently suffer a greater refraction than the rest. Thus a straight leaden pipe appears near the bottom of a deep water to be curved, and a flat bason seems deeper in the middle than near the sides.

To these laws of refraction is to be attributed the difference between the real and the apparent rising of the sun, moon, and stars, above the horizon. The horizontal refraction is something more than half a degree, whence the sun and moon appear above the horizon when they are entirely below it. From the horizon the refraction continually decreases to the zenith. Refraction is increased by the density of the air, and consequently it is greater in cold countries than in hot; and it is also affected by the degree of cold or heat in the same country.

Parallel rays, if refracted, preserve their parallel direction both in entering and in passing out of a refracting medium, provided the two surfaces of the refracting medium are parallel. The two rays, EA, EA, (fig. 27.) after refraction, while they approach the perpendiculars *pp*, continue parallel as before, the reason of which is evident on the principles already established; for the ray AC, (Pl. II. fig 3.) on coming in contact with the surface of the refracting medium EF, does not continue its course in the straight line C*b*, but being refracted at the point of contact C, it approaches the perpendicular P*p*, and comes out at *a*.

After coming out of the refracting medium, if we suppose the surface GH parallel to EF, it ought to proceed to B, having deviated from the perpendicular in the same degree in which it approached it on its first refraction; and thus it continues parallel to the line CB, which is that in which it would have proceeded if it had not been intercepted by the medium.

This parallelism cannot subsist if the two surfaces KI, HI, (fig. 4.) are inclined, as in the figure; because the ray entering at *a*, and emerging at *b*, the object A will be seen from the point B at *e*, which is out of its true place.

Converging rays become less convergent in passing from a rare to a denser medium, as from air into water; and on the contrary, their convergence is augmented by passing from a dense to a rarer medium, as from water into air. (See fig. 1.) In the same manner, diverging rays become less divergent in passing out of a rare medium into one which is denser, and their divergence is increased by passing out of a dense into a rarer medium. (See fig. 2.) This fact is a necessary consequence of the general law of refraction: but it will satisfactorily explain why an object under water appears larger to an eye above the surface than it really is, and why all objects appear magnified seen through a mist; for in all these cases, the converging rays, by which we see the extreme points of the object, and which during their passage through the water, &c. were refracted towards the perpendicular, on their emergence into the air are made more suddenly to converge, and consequently the visual angle is rendered more obtuse.

It is evident, that when parallel rays fall upon a spherical surface, that ray only which penetrates to the centre or axis will proceed in a direct course; for all the rest must necessarily make an angle more or less obtuse, in proportion to their distance from the centre; they are therefore rendered convergent or divergent according to the nature of the medium on which they are incident. If they fall on the convex surface of a medium denser than that which they leave, as in passing from air into glass, they will converge, as may be seen in Plate II. fig. 5. where that phenomenon is represented; for the parallel rays, *hi*, *fg*, (fig. 10.) falling in an oblique direction on the refracting medium terminated by the convex surface E*ig*, they will be refracted, and will each respectively approach the perpendiculars *i*C, or *g*C, and will consequently have a tendency to unite towards the axis AB.

It is however proper to remark, that the point at which they join the axis AB will be distant from the surface of the refracting medium, in proportion as the point on which they fall on the convex surface is distant from that axis; because the more distant that point is, the more oblique is the incidence of the ray. Thus the ray *hi* joins the axis at *k*; but the ray *fg* does not join the axis till it arrives at D.

Rays already convergent, falling on the convex surface of a dense medium, will be acted upon differently according to circumstances.

If their convergence is exactly proportioned to the convexity of the surface, they will not suffer any refraction; (see fig. 6.) because in that case one of the essentials is wanting to refraction, viz. the obliquity of the incidence; and each ray proceeds in a direct line to the centre of that circle, of which the convex surface is an arch or segment.

For instance, the rays *ef* and *dh*, (fig. 11.) which tend to unite at C, the centre of the convex surface, may be considered as perpendicular, being the radii of the circle.

If the rays have a tendency to converge before they reach the centre of the convexity, they will then be rendered less convergent for instead of converging to a point at *b* (fig. 7.), they will converge at B. The reason of this is evident; for the ray *ih* (fig. 11.) which, if not intercepted, would meet the axis at *k*, nearer the surface of the refracting medium than the centre of convexity C, being refracted towards the perpendicular or radius *d*C, meets the axis only at *o*.

If, on the contrary, the rays have a tendency to converge beyond the centre of the convexity, they will then, by the law of refraction, be rendered still more convergent, as in fig. 8; where their point of union, if not intercepted, would be *c*; but where, by the influence of the refraction, they are found to converge at C. For the ray *gh*, (fig. 11.) the tendency of which is towards *l*, is refracted towards the perpendicular *d*C, and joins the axis at *p*.

If diverging rays fall on the convex surface of a denser medium, they are always rendered less divergent, as in fig. 9.; and they may be rendered parallel, or even convergent, according to the degree of divergence compared with the convexity of the refracting surface, on the principles already explained.

If rays pass from a dense to a rarer medium, the surface of the dense medium being convex, in this case parallel rays become convergent; for the parallel rays *de*, *gi*, (fig. 12.) when they reach the convex surface *e*D*i*, instead of continuing their direct course, are refracted from the perpendiculars *a*C, *b*C, and converge at *k*.

Converging rays are also rendered more convergent. Thus the rays *le*, *ui*, which without any change in the medium, would have proceeded in the direction *m* and *o*, in consequence of the refraction which they suffer, and which bends them from the perpendiculars *a*C, *b*C, unite at *p*.

Diverging rays, if they proceed from the point C, the centre of convexity, suffer no refraction; because, for the reasons already assigned, they may be considered as perpendicular to the refracting surface, and consequently they are deficient in one of the causes of refraction, the obliquity of incidence.

If they proceed from a point which is nearer to the surface than the centre of convexity, such as *r*, they will be refracted from the perpendiculars *a*C, *b*C, and will be rendered more divergent towards *x* and *y*.

If, on the contrary, the diverging rays come from a point such as *q*, beyond the centre of convexity, they will be rendered less divergent; for instead of going towards *z* and *z*, they will be refracted from the perpendiculars *a*C, *b*C, towards *f* and *h*.

When rays pass from a rare into a dense medium, and the surface of the dense medium is concave, then parallel rays are rendered divergent, as in Plate II. fig. 13.; for the parallel rays *ab*, *de*, (fig. 17.) are refracted towards the perpendiculars *f*C and *g*C, and are consequently divergent.

Converging rays falling on the same concave surface will be rendered less convergent, as in fig. 14. For the rays *ab*, *de*, (fig. 18.) which would have converged at O if their progress had not been intercepted, will be refracted towards the perpendiculars *f*C and *g*C, and will unite only at *i*. If the convergence was less, they might by the refraction be rendered parallel, or even divergent.

Diverging rays proceeding from the centre of concavity will not suffer any refraction, for the reasons already assigned.

If, however, diverging rays proceed from any point nearer the refracting surface than the centre of concavity, they will be rendered less divergent, as in fig. 15. For the two diverging rays *kb* and *ke* (fig. 19.), instead of proceeding to *d* and *h*, are refracted towards the perpendiculars *f*C and *g*C.

If, on the contrary, which is the most general case, the diverging rays proceed from a point more distant from the surface than the centre of concavity, their divergence will be increased, as in fig. 16. For the diverging rays *lb* and *le* (fig. 19.), which tend towards *m* and *n*, are refracted towards the perpendiculars *f*C and *g*C, and become more divergent than they would otherwise have been.

When rays pass from a dense into a rarer medium, and the dense medium is terminated by a concave surface, then

Parallel rays become divergent; for the parallel rays *de*, *gi*, (fig. 20.) when they reach the concave surface *e*D*i*, instead of continuing their course in the direct lines towards *f* and *h*, proceed towards *m* and *p*, being refracted from the perpendiculars C*a*, C*b*, and are consequently divergent.

Converging rays, if their point of convergence is precisely at C, the centre of the concavity eDi, will not suffer any refraction, because they are perpendiculars, as already explained, therefore have no obliquity of incidence. If, on the other hand, the rays tend to a point, such as n, nearer to the surface than the centre of the concavity C, then they are rendered more convergent; for the rays qe, ri, which naturally tend to that point, are refracted from the perpendiculars Ce, Ci, and converge at o, nearer the concave surface.

Lastly, if the converging rays tend to a point l, which is beyond the centre C, they are rendered less convergent. For the rays se, ti, which would naturally unite at that point, are refracted from the perpendiculars Ce, Ci, and unite at k, which is more distant still.

Diverging rays in the same circumstances are rendered more divergent. For the rays Ee, Ei, diverging from the point E, instead of proceeding towards a and x, are refracted from the perpendiculars, and are directed towards y and z.

From the property which all spherical convex surfaces have, of rendering parallel rays passing out of a rarer medium convergent, glasses made in this form are very commonly used as burning-glasses; and as the sun's rays, proceeding from so vast a distance, may be considered as parallel, the focus of parallel rays will of course be their burning-point.

A lens is a transparent body of a different density from the surrounding medium, and terminated by two surfaces, either both spherical, or the one plane and the other spherical, whether convex or concave. They are therefore generally distinguished by their forms, and are called plano-convex or plano-concave, or double convex or double concave; a lens which has one side convex and the other concave, is called a meniscus, or concave-convex lens. See Plate II. fig. 21.

It is evident, that in lenses there may be almost an infinite variety with respect to the degree of convexity or concavity; for every convex surface is to be considered as the segment of a circle, the diameter and radius of which may vary to almost an infinite extent. Hence, when opticians speak of the length of the radius as applied to a lens, as for instance, when they say its radius is 3 or 6 inches, they mean that the convex surface of the glass is the part of a circle, the radius of which, or half the diameter, is 3 or 6 inches.

The axis of a lens is a straight line drawn through the centre of its spherical surface; and as the spherical sides of every lens are arches of circles, the axis of the lens would pass exactly through the centre of that circle, of which its sides are arches or segments.

From what has been already stated, it is obvious that the certain effect of a convex lens must be to render parallel rays convergent; to augment the convergence of converging rays; to diminish in like manner the divergence of diverging rays, and in some cases to make them parallel or even convergent, according to the degree of divergence compared with the convexity of the lens. In what is called a double-convex lens, this effect will be increased in a duplicate proportion, since both surfaces will act in the same manner upon the rays; and since it has been proved, that parallel or convergent rays have their convergence equally augmented by being incident on the convex surface of a dense, or the concave surface of a rare medium. These glasses then must necessarily have the effect of magnifying glasses, since by the convergence of the rays the visual angle is rendered more obtuse, and consequently the image which is depicted on the retina must be proportionably larger.

The focus of those rays which come in a parallel direction to the glass, is called the focus of parallel rays, or principal focus. In a plano-convex glass this focus is at the length of the diameter of that circle, of which the convex surface is a segment; and in a double-convex lens, or one which is convex on both sides, the focus is as the distance of the radius, or half the diameter, of the circle of which the lens is a segment. This focus therefore is easily found upon mathematical principles. It may also be found, though not with equal exactness, by holding a sheet of paper before the glass when exposed to the rays of the sun, and observing the distance of the paper from the glass when the luminous spot on the paper is very small, and when it begins to burn; or when the focal length does not exceed three feet, the focus may be found by holding the lens at such a distance from the wall opposite a window-sash, that the image of the sash may appear distinct upon the wall.

From this property in convex lenses, of rendering all rays in some degree convergent which fall upon their surfaces, it is evident that in all such cases there must be a point, which in general is at the focus, where pencils of rays proceeding from the extreme point of any object must first unite and then cross each other; and consequently an inverted image of the object will be exhibited at any distance beyond that point. This may be elucidated by a very easy experiment, viz. by holding a common reading or magnifying glass between a candle and a sheet of paper suspended on the wall, at a proper distance, when the image of the candle will appear on the paper inverted: and the reason of this is extremely clear; for it is evident that the upper pencils after refraction, are those which proceeded from the under part of the luminous body, and the under rays are those which come from its top. The position is therefore only inverted, and the image remains unimpaired.

From the same property, convex lenses will cause many rays to enter the eye which would otherwise have been scattered or dispersed, and therefore objects seen through them appear clearer and more splendid than when viewed by the naked eye. If, however, the glass is very thick (as in high magnifiers), some of the rays which enter it will be reflected or sent back, and consequently the brilliancy of the image will suffer some diminution.

A large object seen through a lens which is very convex will appear deformed; and this proceeds from the refraction not being equal at all points in such cases. The same cause operates also to render some parts of the image indistinct, while others are distinct and clear. Thus the extremities of the image seen through a lens of a very short focus are commonly confused and indistinct, because the refraction at the edges of the lens does not agree with that of the middle parts. The modes adopted for remedying these defects in optical glasses, will be hereafter explained.

The effects of a concave lens are directly opposite to those of the convex lens. In other words, by such a glass, parallel rays are rendered divergent, converging rays have their convergence diminished, and diverging rays have their divergence augmented, in proportion to the concavity of the lens. These glasses then exhibit objects smaller than they really are; for by causing the rays to diverge, or more properly by diminishing the convergence of the rays proceeding from the extreme points of the object, the visual angle is rendered more acute, and the image painted on the retina is smaller, than it would have been had these rays not been intercepted in their natural progress; and by the divergence of the rays the object is represented with less clearness than it would otherwise have had, since from this cause a less quantity of light enters the pupil of the eye. All concave lenses have a negative or virtual focus, which is a point corresponding with the divergence of parallel rays incident on the surface of the lens.

Light is, however, not so simple a substance as it may be supposed upon superficially considering its general effects; it is indeed found to consist of particles which are differently refrangible, that is, some of them may be refracted more than others in passing through certain mediums, whence they are supposed by philosophers to be different in size. The common optical instrument called a prism, is a triangular piece of glass, through which if a pencil or collection of rays is made to pass, it is found that the rays do not proceed parallel to each other on their emergence, but produce on an opposite wall, or any plane surface that receives them, an oblong spectrum, which is variously coloured, and it consequently follows that some of the rays or particles are more refrangible than others.

The spectrum thus formed is, perhaps, the most beautiful object which any of the experiments of philosophy presents to our view. The lower part, which consists of the least refrangible rays, is of a lively red; which, higher up, by insensible gradations, becomes an orange; the orange, in the same manner, is succeeded by a yellow; the yellow, by a green; the green, by a blue; after which follows a deep blue or indigo; and lastly, a faint violet.

Of Vision. There is not any part of the animal frame which displays in a more satisfactory manner to our reason, the wisdom and design of our Creator, than the eye. Its anatomical structure is however explained under the articles ANATOMY and PHYSIOLOGY. It is only necessary at present to consider it as an optical instrument. The external coat or case, which forms the globe of the eye, is at the back part strong and opake: the fore part is thin and transparent, so as to admit readily the rays of light; and it is therefore called the cornea, from its resemblance to polished horn. It incloses three pellucid matters called the humours, which are of different densities. That in the anterior part, immediately under the cornea, is called the aqueous humour; that immediately behind is the crystalline humour, which is a double-convex lens of great refracting power, and the rest of the eye is filled with a jelly-like substance called the vitreous humour. The iris, which is the coloured part of the eye, is an opaque membrane which is perforated by a small hole, the pupil, through which the rays of light must pass to the crystalline humour. The optic nerve enters at the under part, and is spread all over the interior surface, at the back of the eye, in the form of a fine net-work, and therefore is called the retina. The student of optics will see from this, that the eye is altogether calculated to act as a convex lens of strong refractive powers.

It has already been explained, that from every luminous point of a visible object, cones or pencils of light are emitted or reflected in every direction; but to produce vision, it is necessary that they should be concentrated or converged to such a point as to make a forcible impression on the retina. Thus from the luminous body A, Plate II. (fig. 22.) the rays *r*, *r*, *r*, are sent in various directions. Those which fall upon the transparent cornea CC, are there refracted in such a manner as to enter the pupil at *p*, and in passing the chrystalline lens or humour they suffer a second refraction, and are converged to a point or focus at the point *a* on the retina. Now it is evident, that if the rays could have passed the humours of the eye in their natural direction, that is, in the direction of the cone or pyramid CAC, they would have made upon the retina a very extensive but feeble impression, such as we know by experience could not produce distinct vision; to obviate this it is appointed by the all-wise Author of our existence, that by the force of the refraction which they suffer in the eye, they should form another cone opposed to the first at its base, and the apex of which is at *a*, and thus an impression sufficiently forcible to produce distinct vision is made on the retina.

In the preceding instance, the luminous body A was considered as a point; and what has been said of it will apply to every point of a visible object, which is capable of transmitting or reflecting to the eye a pencil or collection of rays. Thus we may easily suppose that from every part of the arrow O A B, (fig. 23.) cones or pencils of light may be transmitted; these, like all pencils or collections of rays, coming from a point, will diverge, and will fall upon the eye in some degree divergent, or in the form of cones or pyramids.

The pencil of rays OEIF will then paint the extremity O in the point I; the pencil BFME will also paint the extremity B in the point M; and since all the points between O and B are represented between I and M, of course IM will be the image of OB. Hence it is evident, that by means of this refraction there are certain points at which the rays of light, after passing the pupil, cross each other, and the image which is formed on the retina is consequently inverted.

Artificial eyes are sold by the opticians, in which all the humours are made of different kinds of glass, and may be separated at pleasure. At the back part, where the retina is supposed in the natural eye to receive the converged rays, is placed a piece of ground glass, where the image from the opposed object is rendered in an inverted position, as in a camera obscura. The same effect may be produced with a natural eye, and the nature of vision may be thus experimentally demonstrated: if a bullock's eye is taken fresh, the posterior coats dexterously removed even to the vitreous humour, and if a piece of white paper is then placed at the part, the image of any bright object which is placed before the eye will be seen distinctly painted on the paper, but in an inverted position.

If the humours of the eye, through age or weakness, have shrunk or decayed, the cornea will then be too flat; and the rays, not being sufficiently bent or refracted, arrive at the retina before they are united in a focus, and would meet, if not intercepted, in some place behind it, as in Plate II. fig. 25. They therefore do not make an impression sufficiently correct and forcible, but form an indistinct picture on the bottom of the eye, and exhibit the object in a confused and imperfect manner. This defect of the eye is therefore remedied by a double-convex lens, such as the common spectacle-glasses, which, by causing the rays to converge sooner than they otherwise would, afford that aid to this defect of nature which the circumstances of the case may require; the convexity of the glass being always proportioned, by one who is capable of directing in the choice of spectacles, to the deficiency in vision.

If, on the contrary, the cornea is too convex, the pencils of rays will unite in their foci before their arrival at the retina, as in fig. 26, and the image will also be indistinct. This defect is remedied by concave glasses, which cause the rays to diverge; and consequently, by being properly adapted to the case, will enable the eye to form the image in its proper place.

The rays of light being emitted or reflected from a visible object in all directions, it must be plain that some of them from every part of it must reach the eye. Thus the object AB (Plate II. fig. 28) is visible to an eye in any part where the rays *Aa*, *Ab*, *Ac*, *Ad*, *Ae*, B*a*, B*b*, B*c*, B*d*, B*e*, C*a*, C*b*, C*c*, C*d*, and C*e*, can come. But though rays are reflected from every point of the object to every part of the circumambient space, yet it is evident that only those rays which pass through the pupil of the eye can affect the sense; and those rays also give the ideas of colour, according to the properties of those bodies which transmit or reflect them.

As the direction in which the extreme pencils of light cross each other in the eye, bears a due proportion to the angle in which they are transmitted from the object to the eye, it is evident that the image formed upon the retina will be proportioned to the apparent magnitude; and thus we have our first ideas of the size and distance of bodies, which, however, in many cases are corrected by experience. The nearer any object is to the eye, the larger is the angle by which it will appear in the eye, and therefore the greater will be the seeming magnitude of that body. In Plate II. fig. 24, let AB be an object viewed directly by the eye QR. From each extremity draw the lines AN and BM, intersecting each other in the crystalline humour at I. Then draw the line IK in the direction in which the eye is supposed to look at the object. The angle AIB is then the optical or visual angle; and the line IK is called the optical axis, because it is the axis of the lens or crystalline humour continued to the object.

The apparent magnitude of objects, then, depending thus on the angle under which they are seen, will evidently vary according to their distances. Thus different objects, as AB, CD, EF, the real magnitudes of which are very unequal, may be situated at such distances from the eye as to have their apparent magnitudes all equal; for if they are situated at such distances that the rays AN, BM, shall touch the extremities of each, they will then appear all under the same optical angle, and the diameter MN of each image on the retina will consequently be equal.

In the same manner objects of equal magnitude, situated at unequal distances, will appear unequal. For let AB and GH, two objects of equal size, be placed before the eye at different distances, IK and IS; draw the lines GP and HO, crossing each other in I; then OP, the image formed by the object GH on the retina, is evidently of a greater diameter than the image MN, which represents the object AB; in other words, the object GH will appear as large as an object of the diameter TV, situated at the same place as the object AB.

To render the subject still clearer, suppose the object HK (see Plate II. fig. 27) to be at a hundred yards distance, it will form an angle in the eye at A. At two hundred yards distance the angle it makes will be twice as small in the eye at B. Thus to whatever moderate distance the object is removed, the angle it forms in the eye will be proportionably less, and therefore the object will be diminished in the same proportion.

Hence it follows, that objects situated at different distances, whose apparent magnitudes are equal, are to each other as their distances from the eye; and by the same rule, equal objects situated directly before the eye, have their apparent magnitudes in a reciprocal proportion to their distances.

This last proposition must, however, be received with some allowance; for it is only applicable to very distant objects, and to those where the sense is not corrected by the judgment. For if the objects are near, we do not judge of their magnitude according to the visual angle. Thus, if a man of six feet high is seen at the distance of six feet under the very same angle as a dwarf of only two feet high at the distance of two feet, still the dwarf will not appear as large as the man, because the sense is corrected by the judgment.

In most cases, however, where the distance is considerable, the rule will be found accurate; and as it has its foundation in nature, most of the phenomena of vision will be explained by having recourse to the principles here laid down. If the eye is placed above a horizontal plain, the different parts of this plain will appear elevated in proportion to their distance, till at length they will appear upon a level with it. For in proportion as the different parts are more distant, the rays which proceed from them form angles with the optical axis IK (Plate II. fig. 24) more and more acute, and at length become almost parallel. This is the reason why, if we stand on the sea-shore, those parts of the ocean which are at a great distance appear elevated: for the globular form of the earth is not perceptible to the eye; and if it was, the apparent elevation of the sea is far greater than the arch which a segment of the globe would form within any distance that our eyes are capable of reaching.

For the same reason, if a number of objects are placed on the same plane and at the same height below the eye, the more distant will appear taller than the others; and if the same objects are placed on a similar plane above the eye, the more distant will appear the lowest.

The distant parts of a long wall, for the same reason, appear to a person who stands near one end to curve, or incline towards him. In the same manner the high wall of a lofty tower seems to a spectator, placed directly under it, to bend over him, and threaten him with instant destruction. If any person inclined to make the experiment will lie down on his back in a situation of this description, at the distance of five or six feet from the wall of which he contemplates the tremendous height, he will immediately be made sensible of the phenomenon.

If the distance between two objects forms an insensible angle, the objects, though in reality at some distance from each other, will appear contiguous. This is assigned by some astronomers as the reason why the ring or belt of Saturn appears as one mass of light, while they contend that it is formed from a number of little stars or satellites ranged within a certain distance of each other.

If the eye is carried along, as in a boat, without being sensible of its own motion, the objects which are stationary on each side will appear to move in a contrary direction. Thus we attribute to the sun and the other heavenly bodies a diurnal motion, which only affects the earth which we inhabit.

If two or three objects at a considerable distance, and on which the eye of the spectator is fixed, move with equal velocity past a third object which is at rest, the moving objects will appear to be actually at rest, and that which is really stationary will appear in motion. Thus the clouds which pass over the face of the moon appear at rest, while the moon itself appears to proceed rapidly along in an opposite direction. This happens, because the eye which is fixed upon the clouds follows their motion mechanically, and therefore the moon appears to move and not the clouds; as in the boat we do not perceive its motion, but conceive the banks are retiring behind us.

If the centre of the pupil, that is, the optic axis, is directed along the surface of any slender object in a perfectly right line, this line will appear only a point, because, in fact, the extremities only are visible.

An extended and distant arch, viewed by an eye which is exactly in the same line, will appear as a plane surface; because all the parts appearing equally distant, the curvature will not be perceived.

If a circle is viewed obliquely it will appear an oval, because the diameter which is perpendicular to the eye is shortened; in other words, the rays which proceed from the extremities form an angle so much the more acute as the obliquity is greater; on the contrary, the diameter which is parallel to the eye is apparently extended.

Such are the general principles upon which vision is performed; but the sense of sight is limited not only with respect to distant objects, but with respect to those which are near. Every person will easily perceive that if a book, or any other object, is held too close to the eye, the letters or the object will appear very indistinct and confused. This distance varies with respect to different eyes. Very near-sighted persons can see at the distance of one or two inches; but where the eye is in a sound state, the point of distinct vision varies from six to ten inches, or eight inches as a medium.

To understand the reason of this, it is necessary to remember that objects are made visible by cones of diverging rays proceeding from every luminous point of an object; but to have the object clearly painted on the retina, the rays must not enter the pupil of the eye too divergent. Indeed they ought to come in almost a parallel direction, more in the form of a cylinder than a cone, otherwise the humours of the eye will not make them converge at the proper points on the retina. Thus, let us suppose CD (Plate III. fig. 22) to be the diameter of the pupil of the eye; O is then a luminous point of any object situated at the distance of about six inches, and OC and OD are divergent rays proceeding from this point. Let AC and BD then be parallel rays. It will then be evident that the divergency of the rays OC and OD is so very small, that they are almost parallel when they arrive at the pupil; and consequently the eye will be able to converge them in such a degree as to produce distinct vision.

If, on the contrary, the point O was nearer to the pupil, or if the pupil was larger, they would fall more diverging upon the eye, and the image of the object would be formed at a point behind the retina, so as to be very imperfect and confused. Hence we may easily perceive the use of a single lens of a short focus, or high magnifying power, such as is employed in the single microscope. It renders these divergent rays less divergent; and consequently assists the eye in making them converge to that point which is necessary to distinct vision.

From the principles laid down it may easily be understood why very minute objects are imperceptible to the naked eye. If those objects could, consistently with distinct vision, be brought near to the eye, they would be perceived as well as by the aid of a microscope: hence some very near-sighted persons may be said to have microscopic eyes; but at six or eight inches (the limit of distinct vision) these objects subtend too small an angle to be perceptible. Opticians say that the eye is not capable of perceiving any object which subtends an angle of less than half a minute of a degree. The image on the retina is in this case less than the $\frac{1}{7200}$ part of an inch, and the object itself at six inches distance less than the $\frac{1}{1200}$ part of an inch broad. All smaller objects are invisible.

All very distant objects, upon the same principles, appear indistinct; for their images on the retina are so extremely small, that the distinction of parts is not perceptible. Thus if a man, of six feet stature, is viewed at the distance of a mile, his image on the retina will not be more than the thousandth part of an inch in length. We cannot be surprised, therefore, if the eye can discern nothing of his features, or the minuter parts of his body.

Distant objects, however, appear not only indistinct but obscure; and this last effect is from a deficiency of light, very many of the rays being intercepted in their passage through the air. Hence the difference in the appearance of such objects in a dark and cloudy day, when the air is impregnated with vapours, from that which they assume when the sun shines full and strong upon them.

With a single glass the defects in sight, with respect to many objects, either too near, or at too great a distance, for the persons labouring under them, are remedied; but there are cases where the object is so far distant, or so minute, that, though its outline may reach the eye, its parts must still, even with the aid of a single lens, be indistinctly perceived. The art of man has discovered a remedy, in a great degree, for this imperfection; and by means of a combination of glasses has opened a wide field for his researches into the wonders of nature: he can now trace the limbs of an insect invisible to the naked eye; or he can make the celestial objects appear to him as if their distance had been on a sudden diminished by many millions of miles.

Optical instruments.—From what has been stated concerning vision, the principle of the single microscope will be easily understood. Since the eye cannot have a distinct perception of any object at a nearer distance than six or eight inches, and since there are many objects which at that distance must be wholly imperceptible, or at best appear as points, an instrument which can render them visible, is a very desirable attainment.

It has been sufficiently explained that objects appear larger or smaller in proportion to the angle under which they are seen. Since therefore the rays by which small objects are rendered visible by the microscope, must come from the extreme points of that object, it is manifest that though the apparent magnitude is increased by the interposition of the lens, its real magnitude remains the same. The lens enables us to view it at a shorter distance; it will therefore appear exactly as much larger in diameter through the lens, as its distance from the glass is less than the nearest distance of distinct vision with the naked eye.

Let A (Plate III. fig. 1) be then a point of an object not visible to the eye at a less distance than AB, because the rays are too divergent for distinct vision. Now if the same object is placed in the focus C of the lens D, the rays which proceed from it will be rendered parallel by passing the lens; and therefore the object is rendered distinctly visible to the eye at E. It will then of course appear as much larger through the lens than to the naked eye, as CD is less than AB.

If the object AB is in the one focus of the lens DE, and the eye in the other focus F (fig. 2), as much of the object will be visible as is equal to the diameter of the lens; for the rays AD and BE proceed through the extremities of the lens, and are united at the focus F, and render the extreme parts of the object visible. Hence a maxim in optics, "that when an object is placed in one focus of a lens, and the eye in the other, the object appears just twice as large as it would to the naked eye, whatever the size of the lens:" for the lines FD and FE, if protracted to the distance of A and B, would form an image exactly twice as large. "If, on the other hand, the eye is nearer to the lens than the focus, it will see the object still larger; and if it is farther than the focus it will not see it so large; and in all cases the visible part of the object will be to the lens, as the focal distance of the lens is to the distance of the eye."

From what has been said, the reason will be very plain why the magnitude of objects seen through a double-convex lens, that is, a single microscope, will be in the proportion which the focus of the lens bears to the limits of distinct vision. Thus, suppose AB, fig. 1, to be that distance, or about six inches, so that the eye B can but just perceive the object A, and let the focal distance of the lens D be one-half of an inch; then since CD is but one-twelfth of AB, the length of the object at C will appear twelve times as large as at A, and its surface will appear magnified 144 times.

The most powerful single microscopes are very small globules of glass, which any curious person may make for himself by melting the ends of fine threads of glass in the flame of a candle; or by taking a little fine powdered glass on the point of a very small needle, and melting it into a globule in that way. It was with such microscopes as these that Lewenhoeck made all his wonderful discoveries, most of which are deposited in the British Museum.

The double or compound microscope differs from the preceding in this respect, that it consists of at least two lenses, by one of which an image is formed within the tube of the microscope; and this image is viewed through the eye-glass, instead of the object itself as in the single microscope. In this respect the principle is analogous to that of the telescope, only that, as the latter is intended to view distant objects, the object-lens is of a long focus, and consequently of a moderate magnifying power, and the eye-glass of a short focus, which magnifies considerably the image made by the object lens. Whereas the microscope being intended only for minute objects, the object-lens is consequently of a short focus, and the eye-glass in this case is not of so high a magnifying power.

A single figure will serve to explain the principles on which all these instruments are constructed. Suppose therefore LN (Plate III. fig. 3) to be the object-lens, and FG to be the eye-glass. The object OB is placed a little beyond the principal focus of LN. The cones or pencils of rays then proceeding from the different points of the object, are by the lens made to converge to their respective foci, and form an inverted image of the object at PQ. This image is seen through the eye-glass FG, and the rays of each pencil will proceed in a parallel direction to the pupil of the eye.

The compound microscope was thus originally constructed of two glasses, but it was found that what is called the field of view was too confined in instruments of this construction. For the pencil of rays which emanates from the point O of the object, and is converged by the lens to D, would proceed afterwards diverging towards H, and therefore would never arrive at the lens FG, nor enter the eye at E; but the pencils which proceed from *o* and *b* will be converged to the lens FG, and sent to the eye at E in a parallel direction. Hence if the object is large, a very small part of it will be visible, because several pencils will fall without the eye-glass FG, and the field of view will consequently be very limited.

To remedy this inconvenience, a broad lens DE is interposed, either of a plano-convex, or of a double-convex, form. By this, it will be perceived, the pencils which would have proceeded towards H and I, will be refracted to the eye-glass, and the figure will be completely formed as in the plate. This glass is called by opticians the body-glass, because it is situated in the body of the microscope. Some artists now make these instruments with two eye-glasses, made rather thin, which in some degree corrects what is called the aberration, or dispersion of the rays. In all these microscopes the object is seen in an inverted position; but this is of little importance with regard to small insects and other minute bodies.

The solar microscope is a kind of camera obscura, which, in a darkened chamber, throws the image on a wall or screen. It consists of two lenses fixed opposite a hole in a board or window-shutter; one, which condenses the light of the sun upon the object (which is placed between them), and the other which forms the image. There is also a plain reflector placed without, moved by a wheel and pinion, which may be so regulated as to throw the sun's rays upon the outer lens. The reader may form some idea of this by inspecting the Plate III. fig. 12, of the camera obscura, only supposing the figures on the wall to be a microscopic object magnified by the lens. Mr. Adams's most ingenious invention, the lucernal microscope, is also to be considered as a kind of camera obscura; only the light in this latter case proceeds from a lamp, instead of from the sun, which renders it convenient to be used at all times. But for a description of this elegant and most amusing instrument, we must refer to his Microscopical Essays.

From what has been said on the nature of the compound microscope, the principle of the telescope may be easily understood. Telescopes are, however, of two kinds: the one depending on the principle of refraction, and called the dioptric telescope; the other on the principle of reflection, and therefore termed the reflecting telescope.

The parts essential to a dioptric telescope are, the two lenses AD and EY (Plate III. fig. 4). As in the compound microscope, AD is the object-glass, and EY is the eye-glass; and these glasses are so combined in the tube, that the focus F of the one is exactly coincident with the focus of the other.

Let OB then represent a very distant object, from every point of which pencils of rays will proceed so little diverging to the object-lens AD, that they may be considered as nearly parallel; IM will then be the image which would be formed on a screen by the action of the lens AD. For supposing OA and BD two pencils of rays proceeding from the extreme points of the object, they will unite in the focal point F, and intersect each other. But the point F is also the focus of the eye-glass EY; and therefore the pencil of rays, instead of going on to diverge, will pass through it in nearly a parallel direction, so as to cause distinct vision.

It is then plain that, as in the compound microscope, it is the image which is here contemplated; and this will account for the common sensation when people say the object is brought nearer by a telescope. For the rays, which after crossing proceed in a divergent state, fall upon the lens EY, as if they proceeded from a real object situated at F. All that is effected by a telescope then is, to form such an image of a distant object, by means of the object-lens, and then to give the eye such assistance as is necessary for viewing that image as near as possible; so that the angle it shall subtend at the eye shall be very large compared with the angle which the object itself would subtend in the same situation. This is effected by means of the eye-glass, which refracts the pencils of rays, so that they may be brought to their several foci by the humours of the eye, as has been described.

To explain clearly, however, the reason why it appears magnified, we must again have recourse to the figure. OB being at a great distance, the length of the telescope is inconsiderable with respect to it. Supposing, therefore, the eye viewed it from the centre of the object-glass C, it would see it under the angle OCB: let OC and BC then be produced to the focus of the glass, they will then limit the image IM formed in the focus. If then two parallel rays are supposed to proceed to the eye-glass EY, they will be converged to its focus H, and the eye will see the image under the angle EHY. The apparent magnitude of the object seen by the naked eye is, therefore, to that of the image which is seen through the telescope, as the magnitude of the angle OCB, or ICM, to that of EHY, or IGM. Now the angle IGM is to ICM as CF to FG; that is, as the focal length of the object-glass to that of the eye-glass.

The magnifying power of these glasses may be augmented to a considerable degree, because the focal length of the object-glass, with respect to that of the eye-glass, may be greatly increased. This however would require a tube of immense length; because an eye-glass of a very short focus would cause such a dispersion of the rays of light, particularly towards the edges of the glass, that the view would be intercepted by the prismatic colours.

Another manifest defect in these telescopes is, that the image appears inverted: this, however, is of no consequence with respect to the heavenly bodies; and on this account it is still used as an astronomical telescope. One of almost a similar construction is also used on board of ships as a night-glass, to discover rocks in the ocean, or an enemy's fleet. Notwithstanding the inconvenience of exhibiting the objects inverted, more glasses than two cannot be employed from the paucity of light; and habit soon enables the persons who use them to discern objects with tolerable distinctness.

Galileo, who had heard of the invention of telescopes, but had not seen one, constructed a telescope upon theoretical principles, and adopted a concave lens as an eye-glass, but whether with a view of obviating the disagreeable effect produced by the inversion of the image or not is uncertain. This effect is however produced by the Galilean telescope, the construction of which is as follows: Let AB, fig. 5, be a very distant object, from every point of which pencils of rays proceed to the convex lens DE, and are refracted towards their foci at FSG. But a concave lens HI, the virtual focus of which is at FG, being interposed, the rays are not suffered to converge to that point; but being made less convergent, as is the effect of these glasses, enter the pupil almost parallel, and are converged by the humours of the eye to their proper foci on the retina at PQR: and the object will appear erect, because the pencils of rays cross each other only once, as in natural vision. Objects are seen very distinct through this telescope; but the field of view is so small, that its use is almost exclusively confined to the common opera-glasses. For if the focus of the eye-glass is short, the pencils of rays are rendered so divergent, that but a few of them can enter the pupil.

It was necessary then, to render the dioptric telescope useful for terrestrial purposes, to cause the image to be seen in an erect position. This was effected by the addition of two other convex lenses; of this Kepler suggested the idea, though it was not reduced to practice till thirty years after his time. The principle on which this telescope is constructed will be easily understood from what has been premised, and by inspecting the Plate, fig. 6. It will be seen there, that to the common astronomical telescope, there are added two other eye-glasses of the same focus as the first, LM and QR; and the first of these is placed at twice its focal distance from HI. After the rays therefore have passed the first eye-glass HI, instead of being received by the eye, as in the former case of the astronomical telescope, they pass on; the rays which constitute each pencil being rendered parallel: and in this state the respective pencils cross each other in the common focus, and the rays are received in this parallel state by the second eye-glass LM. The rays then constituting the respective pencils converge to their foci at NO, where a second image is formed, but inverted with respect to the former image EF. This then is the image which is viewed through the third eye-glass QR; and being in the same position as the object itself, is painted on the retina at XZY, and causes the object to be seen erect, as if no glasses had been interposed. The apparent magnitude of the object is not changed by these glasses; and depends, as before, on the focal lengths of the first object-glass and the lens nearest to it. The brilliancy of the object, however, will be diminished, since several rays will be lost in their passage through the two additional glasses. In placing the glasses in this telescope, care must be taken that the axes of the lenses coincide, or, as it is evident from our principles, indistinct vision only will be produced.

The brightness of the appearance through any of these telescopes or microscopes, depends chiefly on the aperture of the object-glass. For if the whole of that glass was covered except a small aperture in the middle, the magnitude of the image would not be altered; but fewer rays of every pencil being admitted, the object would appear obscure.

In few words, the apparent distinctness or confusion of any object, viewed through glasses, depends on the mutual inclination of the rays in any one pencil to each other, when they fall on the eye; the apparent magnitude depends upon the inclination of the rays of different pencils to each other; the apparent situation depends upon the real situation of the extreme pencils; and the apparent brightness or obscurity depends on the quantity of rays in each pencil.

As the magnifying power of all dioptric telescopes depends on the proportion which the focal length of the eye-glass bears to that of the object-glass; and as an eye-glass of very high magnifying powers could not be used on account of the aberration or dispersion of the rays, from the unequal thickness of the glass; various contrivances were invented for the sake of employing object-glasses of a very long focus. Wooden tubes of a very great length were found unmanageable. At length the famous Huygens invented a mode of dispensing with the tube. He attached the object-glass to a high pole, with a piece of mechanism which enabled him to raise or lower it at pleasure; and he made the eye-glass correspond to it by a silk cord, which he held tight in his hand. This method is, we believe, still in use on the continent for celestial objects, and distinguished by the name of the aerial telescope.

These inventions were however all rendered nugatory by the discovery of the reflecting telescope. For a dioptric or refracting telescope, even of one thousand feet focus, if it could be used, could not be made to magnify with distinctness above one thousand times; whereas a reflecting telescope of the length of eight or nine feet will magnify with distinctness 1200 times.

The well-known property in concave speculums, of causing the pencils of rays to converge to their foci, and there forming an image of any object that may be opposed to them, gave rise to the reflecting telescope. In this the effect is precisely the same as that produced by the dioptric telescope; only that in the one case it is produced by reflected, and in the other by refracted, light. Reflecting telescopes are made in various forms; and those principally in use in this country are distinguished by the names of their respective inventors, and are called the Newtonian, Gregorian, and Herschelian telescopes. The reflecting telescope on the Gregorian principle, which is the most common, as it is found to be the most convenient, is consructed in the following manner:

At the bottom of the great tube (Plate III. fig. 7) TTTT, is placed a large concave mirror DUVF, whose principal focus is at m: and in the middle of this mirror is a round hole P, opposite to which is placed the small mirror L, concave toward the great one; and so fixed to a strong wire M, that it may be removed further from the great mirror, or nearer to it, by means of a long screw in the inside of the tube, keeping its axis still in the same line Pmn with that of the great one. Now, since in viewing a very remote object, we oan scarcely see a point of it but what is, at least, as broad as the great mirror, we may consider the rays of each pencil, which flow from every point of the object, to be parallel to each other, and to cover the whole reflecting surface DUVF. But to avoid confusion in the figure, we shall only draw two rays of a pencil flowing from each extremity of the object into the great tube; and trace their progress through all their reflections and refractions to the eye f at the end of the small tube tt, which is joined to the great one.

Let us then suppose the object AB to be at such a distance, that the rays C may flow from its upper extremity A, and the rays E from its lower extremity B; then the rays C falling parallel upon the great mirror at D, will be thence reflected converging in the direction DG; and by crossing at I in the principal focus in the mirror, they will form the lower extremity of the inverted image IK, similar to the upper extremity A of the object AB; and passing on to the concave mirror L (whose focus is at n), they will fall upon it at g, and be thence reflected, converging in the direction gN, because gm is longer than gn; and passing through the hole P in the large mirror, they would meet somewhere about r, and form the upper extremity a of the erect image ab, similar to the upper extremity A of the object AB. But by passing through the plano-convex glass R in their way, they form that extremity of the image at a. In the same manner the rays E, which come from the bottom of the object AB, and fall parallel upon the great mirror at F, are thence reflected, converging to its focus; where they form the upper extremity I of the inverted image IK, similar to the lower extremity B of the object AB: and thence passing on to the small mirror L, and falling upon it at h, they are thence reflected in the converging state hO; and going on through the hole P of the great mirror, they would meet somewhere about q, and form there the lower extremity b of the erect image ab, similar to the lower extremity B of the object AB; but by passing through the convex glass R in their way, they meet and cross sooner, as at b, where that point of the erect image is formed. The like being understood of all those rays which flow from the intermediate points of the object between A and B, and enter the tube TT, all the intermediate points of the image between a and b will be formed; and the rays passing on from the image through the eye-glass S, and through a small hole e in the end of the lesser tube tt, they enter the eye f, which sees the image ab (by means of the eye-glass) under the large angle ced, and magnified in length under that angle from c to d.

In the best reflecting telescopes, the focus of the small mirror is never coincident with the focus m of the great one, where the first image IK is formed, but a little beyond it (with respect to the eye) as at n; the consequence of which is, that the rays of the pencils will not be parallel after reflection from the small mirror, but converge so as to meet in points about q, e, r; where they would form a larger upright image than ab, if the glass R was not in their way, and this image might be viewed by means of a single eye-glass properly placed between the image and the eye: but then the field of view would be less, and consequently not so pleasant; for that reason the glass R is still retained, to enlarge the scope or area of the field.

To find the magnifying power of this telescope, multiply the focal distance of the great mirror by the distance of the small mirror from the image next the eye, and multiply the focal distance of the small mirror by the focal distance of the eye-glass; then divide the product of the former multiplication by that of the latter, and the quotient will express the magnifying power. The difference between the Newtonian and Gregorian telescope is, that in the former the spectator looks in at the side through an aperture upon a plane mirror, by which the rays reflected from the concave mirror are reflected to the eye-glass; whereas in the latter the reader will see that he looks through the common eye-glass, which is in general more convenient.

The immensely powerful telescopes of Dr. Herschel are of a still different construction. This assiduous astronomer has made several specula, which are so perfect as to bear a magnifying power of more than six thousand times in diameter on a distant object. The object is reflected by a mirror as in the Gregorian telescope, and the rays are intercepted by a lens at a proper distance, so that the observer has his back to the object, and looks through the lens at the mirror. The magnifying power will in this case be the same as in the Newtonian telescope; but there not being a second reflector, the brightness of the object viewed in the Herschelian is greater than that in the Newtonian or Gregorian telescope. In conclusion, sir Isaac Newton's excellent maxim must not be omitted: "The art," says he, "of constructing good microscopes and telescopes may be said to depend on the circumstance of making the last image as large and distinct and luminous as possible."

There are some instruments of rather an amusing than a useful description, the effects of which depend on a proper combination of plane or convex glasses. Our limits will not admit the notice of more than two of this kind, namely, the magic lanthorn, and the camera obscura. The former is a microscope upon the same principles as the solar microscope, and may be used with good effect for magnifying small transparent objects; but in general it is applied to the purpose of amusement, by casting the image of a small transparent painting on glass upon a white wall or screen, at a proper distance from the instrument.

Let a candle or lamp C (fig. 8) be placed in the inside of a box, so that the light may pass through the plano-convex lens NN, and strongly illuminate the object OB; which is a transparent painting on glass, inverted and moveable before NN, by means of a sliding piece in which the glass is set or fixed. This illumination is still more increased by the reflection of light from a concave mirror SS, placed at the other end of the box, which causes the light to fall upon the lens NN, as represented in the figure. Lastly, a lens LL, fixed in a sliding tube, is brought to the requisite distance from the object OB, and a large erect image IM is formed upon the opposite wall.

The camera obscura has the same relation to the telescope as the solar microscope has to the common double microscope, and is thus constructed:

Let CD (fig. 12) represent a darkened chamber perforated at L, where a convex lens is fixed, the curvature of which is such, that the focus of parallel rays falls upon the opposite wall. Then if AB is an object at such a distance that the rays which proceed from any given point of its surface to the lens L may be esteemed parallel, an inverted picture will be formed on the opposite wall; for the pencil which proceeds from A will converge to *a*, and the pencil which proceeds from B will converge to *b*, and the intermediate points of the object will be depicted between *a* and *b*.

For the use of painters these instruments are now constructed in a very convenient mode. The lens is made to slide in a small wooden box, so as to be easily adjusted to a proper focus; and the image falls upon a plane mirror, placed obliquely at the back part of the box, from which it is reflected on a piece of ground glass, or on a sheet of white paper extended over. The picture which is thus formed is very tender and beautiful. The moving objects give it animation; and the outline formed is so perfect that it may be easily traced, even by a person who is little skilled in drawing or perspective.

Of the doctrine of colours, or chromatics.—In some of the preceding sections we had occasion to use the word aberration, though we had not then an opportunity of explaining it; since in the optics of the mind, as well as in those of which we are treating, when too many images are presented at once, a certain degree of confusion must necessarily ensue. As there is no "royal road to science," so philosophy gradually developes her secrets, and the possession of one fact prepares the mind for another.

We have hitherto assumed as a principle, that a convex lens unites in one point, which we have called the focus, all the rays proceeding from any given point of an object. If this was exactly the case, the images formed by these glasses would be perfectly distinct and unconfused. The principle, however, holds strictly true only with respect to those rays which pass nearly through the centre of the lens; for those which pass near the extremities or edges of the glass, meet in foci still more distant, and from this multiplication of images great indistinctness results.

To shew the reason of this it is necessary to have recourse to a figure. Let PP then (Plate III. fig. 10) be a convex lens; and *Ee* an object, the point E of which corresponds with the axis of the lens, and sends forth the rays EM, EN, EA, EM, and EN, all of which reach the surface of the glass, but in different parts. Now it is manifest, upon the principles already explained, that the ray EA, which passes through the middle of the glass, suffers no refraction; the rays EM, EM, also, which pass through near to EA, will be converged to a focus at F, which we have been accustomed to consider as the focus of the lens. But the rays EN, EN, which are nearer to the edge of the glass, will be differently refracted; and will meet about G, nearer to the lens, where they will form another image G*g*. Hence it is evident that the first image F*f* is formed only by the union of those rays which pass very near the centre of the lens; but, in truth, as the rays of light proceeding from every point of an object are very numerous, there is a succession of images formed according to the parts of the lens where they penetrate, which necessarily produces great indistinctness and confusion; and this is what is meant by the word aberration.

This confusion or dispersion of the rays is increased in proportion as the arcs PAP, PBP, are larger segments of their respective circles: hence in very thick and convex lenses the aberration is such as to be intolerable. Even in the object-glasses of telescopes, though they are made thin, and are segments of large circles, and though from these reasons the dispersion of the rays may be insensible in itself, still the magnifying power multiplies it as often as the object itself. Hence the greater the magnifying power, the smaller should be the aperture of the object-glass; and when the dispersion of the rays is very great, the defect is in some degree remedied by covering the edge of the lens with an opaque ring; but in this case, while distinctness is restored, the brightness of the image is necessarily diminished. Opticians have therefore endeavoured to form such combinations of lenses, both concave and convex, varying in their respective foci, as must unite all the rays in a single point, and thus present a distinct image. Calculations have been formed for these combinations, but the hand of the artist has never been able to bring the speculations of theorists to entire perfection.

The plan most generally adopted by practical opticians is, to combine two shallow lenses together in such a manner that they act as a single lens. They use often plano-convex, for that figure admits of less aberration than any other; but shallow lenses of a double-convex kind will answer. In this combination the lenses are set near together, so that the second lens acts only in bringing the rays which pass through the first to a nearer focus. Thus in Plate III. fig. 9, AB and CD are two lenses of this description; and the focus of AB would be at F, but, by the second lens, the rays are made to converge at a nearer focus *f*: thus they act together as a single lens of double their magnifying power, with this advantage; that as the curvatures of both conjointly, are less than the curvature of a single lens of equal power, the aberration is greatly lessened.

The aberration which we have been describing results from the spherical form of the glasses; but there is another kind of aberration, which depends immediately upon the nature and properties of light itself. Each ray or beam of light, indeed, which gives us the sensation of white, is found to be compounded of seven other rays; and these component rays are each of them differently refrangible. Hence objects viewed through very convex glasses are often found to have their edges tinged with various colours. This effect was long felt, but it remained for Newton to explain the cause.

In the short history contained in the first part of this article, the discoveries on colours were briefly related; but it will perhaps be satisfactory to the reader to have the experiment described in the words of Newton himself, which will at the same time afford an example of the style and manner of this first of philosophers.

"In a very dark chamber, at a round hole F (Plate III. fig. 14), about one-third of an inch broad (says he), made in the shutter of a window, I placed a glass prism ABC, whereby the beam of the sun's light, SF, which came in at that hole, might be refracted upwards, toward the opposite wall of the chamber, and there form a coloured image of the sun, represented at PT. The axis of the prism (that is, the line passing through the middle of the prism, from one end of it to the other end, parallel to the edge of the refracting angle) was in this and the following experiments perpendicular to the incident rays. About this axis I turned the prism slowly; and saw the refracted light on the wall, or coloured image of the sun, first to descend, and then to ascend. Between the descent and ascent, when the image seemed stationary, I stopped the prism, and fixed it in that posture.

"Then I let the refracted light fall perpendicularly upon a sheet of white paper, MN, placed at the opposite wall of the chamber; and observed the figure and dimensions of the solar image PT, formed on the paper by that light. This image was oblong, and not oval, but terminated by two rectilinear and parallel sides, and two semicircular ends. On its sides it was bounded pretty distinctly; but on its ends very confusedly and indistinctly, the light there decaying and vanishing by degrees. At the distance of $18\frac{1}{2}$ feet from the prism, the breadth of the image was about $2\frac{5}{8}$ inches, but its length was about $10\frac{1}{4}$ inches, and the length of its rectilinear sides about 8 inches; and ACB, the refracting angle of the prism, whereby so great a length was made, was 64°. With a less angle the length of the image was less, the breadth remaining the same. It is farther to be observed, that the rays went on in straight lines from the prism to the image; and therefore at their going out of the prism had all that inclination to one another from which the length of the image proceeded. This image PT was coloured, and the more eminent colours lay in this order from the bottom at T to the top at P; red, orange, yellow, green, blue, indigo, violet, together with all their intermediate degrees, in a continual succession, perpetually varying."

The philosopher continued his experiments, and by making the rays thus decompounded pass, as was formerly related, through a second prism, he found that they did not admit of farther decomposition; and that objects placed in the rays producing one colour always appeared to be of that colour. He then examined the ratio between the sines of incidence and refraction of these decompounded rays; and found that each of the seven primary colour-making rays, as they may be called, had certain limits within which they were confined. Thus, let the sine of incidence in glass be divided into fifty equal parts, the sine of refraction into air of the least and most refrangible rays will contain respectively 77 and 78 such parts. The sines of refraction of all the degrees of red will have the intermediate degrees of magnitude, from 77 to $77\frac{1}{8}$; orange from $77\frac{1}{8}$ to $77\frac{1}{5}$; yellow from $77\frac{1}{5}$ to $77\frac{1}{3}$; green from $77\frac{1}{3}$ to $77\frac{1}{2}$; blue from $77\frac{1}{2}$ to $77\frac{2}{3}$; indigo from $77\frac{2}{3}$ to $77\frac{7}{9}$; and violet from $77\frac{7}{9}$ to 78.

According to the properties of bodies in reflecting or absorbing these rays, the colours which we see in them are formed. If every ray falling upon an object was reflected to our eyes it would appear white; if every ray was absorbed it would appear black; between these two appearances innumerable species of colours may be formed by reflection or transmission of the various combinations of the colour-making rays. If the rays also of light were not thus compounded, every object would appear of the same colour, and an irksome uniformity would prevail over the face of nature.

To leave, however, for the present, the further prosecution of this subject, and to return to that of the errors arising in optical glasses from the dispersion of the rays of light, it must be evident that, in proportion as any part of a glass bears a resemblance to the form of a prism, the component rays must be necessarily separated. The edges of every convex lens approach to this form; and it is on this account that the extremities of objects viewed through them are found to be tinged with coloured rays. In reality, as all the different colour-making rays are differently refrangible, in such a glass these different rays will have different foci, and will form their respective images at different distances from the glass. Thus imagine PP (Plate III. fig. 11) to be a double-convex lens, and OO an object situated at some distance from it. If the object OO was red, the rays proceeding from it would form a red image at R*r*; if it was violet, an image of that colour would be formed at V*v* nearer the glass; and if the object was white, or any other combination of the colour-making rays, these rays would have their respective foci at different distances from the glass, and form a succession of images, in the order of the prismatic colours, between the space R*r* and V*v*.

This dispersion depends on the focal length of the glass, the space which the coloured images occupy being about the 28th part. Thus, if the glass is of 28 feet focus, the space between R*r* and V*v* will be about one foot, and so in proportion. Now when viewed through one eye-glass or more, this succession of images will seem to form but one image, but that very indistinct, and tinged with various colours; and as the red image R*r* in the figure is largest, or seen under the greatest angle, the extreme parts of this confused image will be red, and a succession of the prismatic colours will be formed with this red fringe, as is frequently found in telescopes upon the old construction.

This defect in telescopes was long regarded as without a remedy; but who shall set bounds to the inventive powers of the human mind? It was in the different refractive powers of various media that a remedy was sought for this property in glasses, so adverse to the hopes and wishes of philosophers. Sir Isaac Newton had hinted the practicability of this plan; but he was too deeply engaged in the vast discoveries which the use of the reflector opened to his view, to pursue practically the idea. As water is known to have very different refractive powers from glass, the great Euler, proceeding upon the hint of Newton, projected an object-glass of two lenses, with water between them. The memoir of Euler excited powerfully the attention of Mr. Dollond, a practical optician in London; and after trying the refractive power of water combined with glass in the form of a prism, he conceived that the refractive powers of different glasses might serve to correct each other. He applied himself therefore to examine the qualities of every kind of glass he could procure, and found that the two which differed most essentially in their refractive powers were the common crown or window glass, and the white flint glass. He then formed two prisms, one of the white flint of an angle of about 25 degrees, and another of flint of 29. They refracted very nearly alike, but their power of making the colours diverge was very different. He next ground several others of crown glass, till he procured one which was equal as to the divergency of light with that of the flint glass. He placed them together, therefore, but in opposite directions, so as to counteract each other; and he found that the light which passed through them was perfectly white. This discovery, it was obvious, was immediately applicable to the object-glasses of telescopes. To make the glasses act as the two prisms, to refract the light in contrary directions, it was plain that the one must be concave and the other convex; and as the rays are to converge to a real focus, the excess of refraction must be in the convex lens. As the convex lens is to refract most also, it appeared from his experiments that it must be of crown glass. He therefore employed two convex lenses of crown glass, with a concave lens of flint glass; and these are the telescopes most in use at present, and well known by the name of achromatic telescopes. Some opticians however, we believe, now construct them with two lenses, one convex and the other concave.

In fig. 13, *a* and *c* shew the two convex lenses, and *bb* the concave one, of this telescope. They are all ground to spheres of different radii, according to the refractive powers of the different kinds of glass, and the intended focal distance of the object-glass of the telescope. According to Boscovich, the focal distance of the parallel rays for the concave lens is one-half, and for the convex glass one-third, of the combined focus. When put together they refract the rays in the following manner: Let *ab*, *ab* (fig. 18), be two red rays of the sun's light falling parallel on the first convex lens *c*. Supposing there was no other lens present but that one, they would then be converged into the lines *be*, *be*, and at last meet in the focus *q*. Let the lines *gh*, *gh*, represent two violet rays falling on the surface of the lens. These are also refracted, and will meet in a focus; but as they have a greater degree of refrangibility than the red rays, they must of consequence converge more by the same power of refraction in the glass, and meet sooner in a focus, suppose at *r*. Let now the concave lens of flint glass *dd* be placed in such a manner as to intercept all the rays before they come to their focus. If this lens was made of the same materials, and ground to to the same radius with the convex one, it would have the same power to cause the rays to diverge that the former had to make them converge. In this case, the red rays would become parallel, and move on in the line *oo*, *oo*: but the concave lens, being made of flint glass, and upon a shorter radius, has a greater refractive power, and therefore they diverge a little after they come out of it; and if no third lens was interposed, they would proceed diverging in the lines *opt*, *opt*; but, by the interposition of the third lens *ovo*, they are again made to converge, and meet in a focus somewhat more distant than the former, as at *x*. By the concave lens the violet rays are also refracted, and made to diverge: but, having a greater degree of refrangibility, the same power of refraction makes them diverge somewhat more than the red ones; and thus, if no third lens was interposed, they would proceed in such lines as *lmn*, *lmn*. As the differently-coloured rays then fall upon the third lens with different degrees of divergence, it is plain that the same power of refraction in that lens will operate upon them in such a manner as to bring them all together to a focus very nearly at the same point. The red rays, it is true, require the greatest power of refraction to bring them to a focus; but they fall upon the lens with the least degree of divergence. The violet rays, though they require the least power of refraction, yet have the greatest degree of divergence; and thus all meet together at the point *x*, or very nearly so. It was afterwards demonstrated by M. Zeiker of Petersburgh, that it is the lead used in the composition of the crown glass, which gives it this remarkable property of dispersing the extreme rays; and he found that this property was increased in proportion to the quantity of minium, or red lead, which was employed in the manufacture of the glass.

The more we investigate the works of nature, the greater reason have we to admire the wisdom of its author, and that wonderful adaptation of our organs, in the minuter particulars, to the general laws which pervade the universe. The subject before us affords a striking instance to corroborate this remark. We have hitherto supposed the eye to be a lens capable only of enlarging and contracting, and consequently, from the description now given of the rays of light, it must be incapable of obviating the confusion which must arise from their different degrees of refrangibility. But here the use of that wonderful structure of parts, and the different fluids in the eye, is clearly seen. The eye is, in fact, a compound lens. Each fluid has its proper degree of refrangible power. The shape of the lenses is altered at will, according to the distance of the object; and the three substances having the proper powers of refrangibility, the effects of an achromatic glass are without difficulty produced by the eye, whose mechanical structure and exact arrangement of substances it is in vain for the art of man to imitate.

From what has been stated, the principal phenomena of colours may, without much difficulty, be explained.

If all the different-coloured rays which the prism affords are reunited in the focus of a convex lens, the produce will be white; yet these same rays, which, taken together, form white, give, after the point of their reunion, that is, beyond the point where they cross each other, the same colours as those which departed from the prism, but in a reversed order, by the crossing of the rays: the reason of which is clear; for the ray being white before it was divided by the prism, must necessarily become so by the reunion of its parts, which the difference of refrangibility had separated, and this reunion cannot in any manner tend to alter or destroy the nature of the colours; it follows then that they must appear again beyond the point of crossing. A similar effect will be produced, if the dispersed rays are received from the prism upon a concave reflector. In the focus of the reflector they will unite and form a white or colourless image of the sun. But it is curious to remark, that if any one of the colours is stopped in its progress to the reflector by the interposition of a wire, or any other slender opaque body, then the image in the focus will be an imperfect white, or a mixed colour. Beyond the focus the rays separate again, as in the case of their passing through a convex lens, and form the coloured spectrum, only the order of the colours from the crossing of the rays is inverted.

In the same manner, if we mix a certain proportion of red colour with orange, yellow, green, blue, indigo, and violet, a colour will be produced which resembles that which is made by mixing a little black with white, and which would be entirely white if some of the rays were not lost or absorbed by the grossness of the colouring matter.

A colour nearly approaching to white, is also formed by colouring a piece of round pasteboard with the different prismatic colours, and causing it to be turned round so rapidly, that no particular colour can be perceived.

If to a single ray of the sun, divided by the prism, which will then form an oblong coloured spectrum, a thick glass deeply coloured with one of the primitive colours is applied, for example red, the light which passes through will appear red only, and will form a round image.

The component rays of light may be separated by other means than by the prism. It is a common amusement of children to blow round bubbles of soap, dissolved in water, from the bowl of a tobacco-pipe; and these bubbles will, in the sunshine, commonly exhibit most of the prismatic colours. Indeed the same thing may be at any time observed in the bubbles made by agitating soap and water. As these bubbles are thin vesicles of the matter dissolved in the fluid, they are commonly supposed to vary in their thickness, and to act in this way in separating the rays. If two pieces of glass, also of an unequal surface, are gently pressed together, round the point of contact circles of different colours will be formed. Sir Isaac Newton employed for this experiment the object-glasses of two telescopes of a long focus, which it is well known are much less convex than the common spectacle-glasses. One was a plano-convex for a telescope of 14 feet, and the other a double-convex for one of 50 feet. Upon pressing the glasses close together, at the point of contact circles of coloured light appeared, and they increased in number and size as the pressure was increased. The order of the colours next to the point in contact, which was black, was blue, yellow, white, yellow, and red. Without this circle another appeared, consisting of violet, blue, green, yellow, and red. A third succeeded of purple, blue, green, yellow, and red; and a fourth of green and red. The outer circles were paler, and more obscure, than those within.

The appearance of these circles is delineated in fig. 15. where *a*, *b*, *c*, *d*, *e*; *f*, *g*, *h*, *i*, *k*; *l*, *m*, *n*, *o*, *p*; *q*, *r*; *s*, *t*; *u*, *x*; *y*, *z*; denote the colours in order from the centre, namely, black, blue, green, yellow, red; purple, blue, green, yellow, red; green, red: greenish blue, red; greenish blue; reddish white.

Various theories have been offered to account for this separation of the rays, but none of them are quite satisfactory. Perhaps if Mr. Deleval's experiments on transmitted and reflected light were carefully pursued, they might afford some illustration of the phenomenon.

If two thick glasses, the one red and the other green, are placed one upon another, they will produce a perfect opacity, though each of them, taken separately, is transparent; because the one permits the red rays only to pass through it, and the other only green ones; therefore when these two glasses are united, neither of those kind of rays can reach the eye; because the first permits only red rays to pass, and green ones are the only rays which the second can transmit.

If the rays of the sun are made to fall very obliquely upon the interior surface of a prism, the violet-coloured rays will be reflected, and the red, &c. will be transmitted; if the obliquity of incidence is augmented the blue will be also reflected, and the other transmitted; the reason of which is, that the rays which have the most refrangibility are also those which are the easiest reflected.

In whatever manner we examine the colour of a single prismatic ray, we shall always find, that neither refraction, reflection, nor any other means, can make it forego its natural hue; but if we examine the artificial colouring of bodies by a microscope, it will appear a rude heap of colours, unequally mixed. If we mix a blue and yellow to make a common green, it will appear moderately beautiful to the naked eye; but when we regard it with microscopic attention, it seems a confused mass of yellow and blue parts, each particle reflecting but one separate colour.

Of the rainbow, and other remarkable phenomena of light.—Since the rays of light are found to be decompounded by refracting surfaces, we can no longer be surprised at the changes produced in any object by the intervention of another. The vivid colours which gild the rising or the setting sun, must necessarily differ from those which adorn its noon-day splendour. There must be the greatest variety which the liveliest fancy can imagine. The clouds will assume the most fantastic forms, or will lour with the darkest hues, according to the different rays which are reflected to our eyes, or the quantity absorbed by the vapours in the air. The ignorant multitude will necessarily be alarmed by the sights in the heavens; by the appearance at one time of three, at another of five, suns; of circles of various magnitudes round the sun or moon; and thence conceive that some fatal change must take place in the physical or the moral world, some fall of empires or tremendous earthquake: while the optician contemplates them merely as the natural and beautiful effects produced by clouds or vapour in various masses upon the rays of light.

One of the most beautiful and common of these appearances deserves particular investigation, as, when this subject is well understood, there will be little difficulty in accounting for others of a similar nature, dependant on the different refrangibility of the rays of light. Frequently, when our backs are turned to the sun, and there is a shower either around us, or at some distance before us, a bow is seen in the air, adorned with all or some of the seven primary colours. The appearance of this bow, in poetical language called the iris, and in common language the rainbow, was an inexplicable mystery to the antients; and, though now well understood, continues to be the subject of admiration to the peasant and the philosopher.

We are indebted to sir Isaac Newton for the explanation of this appearance; and by various easy experiments we may convince any man that his theory is founded on truth. If a glass globe is suspended in the strong light of the sun, it will be found to reflect the different prismatic colours exactly in proportion to the position in which it is placed; in other words, agreeably to the angle which it forms with the spectator's eye and the incidence of the rays of light. The fact is, that innumerable pencils of light fall upon the surface of the globe, and each of these is separated as by a prism. To make this matter still clearer, let us suppose the circle BAW (Plate III. fig. 16) to represent the globe, or a drop of rain, for each drop may be considered as a small globe of water. The red rays, it is well known, are least refrangible; they will therefore be refracted, agreeably to their angle of incidence, to a certain point A in the most distant part of the globe; the yellow, the green, the blue, and the purple rays, will each be refracted to another point. A part of the light, as refracted, will be transmitted, but a part will also be reflected; the red rays at the point A, and the others at certain other points, agreeably to their angle of refraction.

It is very evident that if the spectator's eye is placed in the direction of MW, or the course of the red-making rays, he will only distinguish the red colour; if in another situation, he will see only by the yellow rays; in another by the blue, &c.: but as in a shower of rain there are drops at all heights and all distances, all those that are in a certain position with respect to the spectator will reflect the red rays, all those in the next station the orange, those in the next the green, &c.

To avoid confusion let us, for the present, imagine only three drops of rain, and three degrees of colours in the section of a bow (Plate III. fig. 20). It is evident that the angle CEP is less than the angle BEP, and that the angle AEP is the greatest of the three. This largest angle then is formed by the red rays, the middle one consists of the green, and the smallest is the purple. All the drops of rain, therefore, that happen to be in a certain position to the eye of the spectator, will reflect the red rays, and form a band or semicircle of red; those again in a certain position will present a band of green, &c. If he alters his station, the spectator will still see a bow, though not the same bow as before; and if there are many spectators they will each see a different bow, though it appears to be the same.

There are sometimes seen two bows, one formed as has been described, the other appearing externally to embrace the primary bow, and which is sometimes called a secondary or false bow, because it is fainter than the other; and what is most remarkable is, that in the false bow the order of the colours appears always reversed.

In the true or primary bow we have seen that the rays of light arrive at the spectator's eye after two refractions and one reflection; in the secondary bow the rays are sent to our eyes after two refractions and two reflections, and the order of the colours is reversed, because in this latter case the light enters at the inferior part of the drop, and is transmitted through the superior. Thus (fig. 19) the ray of light which enters at B is refracted to A, whence it is reflected to P, and again reflected to W, where, suffering another refraction, it is sent to the eye of the spectator. The colours of this outer bow are fainter than those of the other, because, the drop being transparent, a part of the light is transmitted, and consequently lost, at each reflection.

The phenomenon assumes a semicircular appearance, because it is only at certain angles that the refracted rays are visible to our eyes. The least refrangible, or red rays, make an angle of 42 degrees two minutes, and the most refrangible or violet rays an angle of 40 degrees 17 minutes. Now if a line is drawn horizontally from the spectator's eye, it is evident that angles formed with this line, of a certain dimension in every direction, will produce a circle; as will be evident by only attaching a cord of a given length to a certain point, round which it may turn as round its axis, and in every point will describe an angle with the horizontal line of a certain and determinate extent.

Let HO, for instance (Plate III. fig. 19), represent the horizon, BW a drop of rain at any altitude, SB a line drawn from the sun to the drop, which will be parallel to a line SM drawn from the eye of the spectator to the sun. The course of part of the decompounded ray SB may be first by refraction from B to A, then by reflection from A to W, lastly by refraction from W to M. Now all drops, which are in such a situation that the incident and emergent rays SB, MW, produced through them make the same angle SNM, will be the means of exciting in the spectators the same idea of colour. Let MW turn upon HO as an axis, till W meets the horizon on both sides, and the point W will describe the arc of a circle: and all the drops placed in its circumference will have the property we have mentioned, of transmitting to the eye a particular colour. When the plane HMWA is perpendicular to the horizon, the line MW is directed to the vertex of the bow, and WK is its altitude.

This altitude depends on two things, the angle between the incident and emergent rays, and the height of the sun above the horizon; for since SM is parallel to SN, the angle SNM is equal to NMI: but SMH, the altitude of the sun, is equal to KMI; therefore the altitude of the bow WMK, which is equal to the difference between WMI and KMI, is equal to the difference between the angles made by the incident and emergent rays and the altitude of the sun.

The angle between the incident and emergent rays is different for the different colours, as was already intimated; for the red, or least refrangible, rays, it is equal to 42° 2′; for the violet, or most refrangible, it is equal to 40 17′; consequently when the sun is more than 42° 2′ above the horizon, the red colour cannot be seen; when it is above 40° 17′ the violet colour cannot be seen.

The secondary bow is made in a similar manner; but the sun's rays suffer, in this case, two reflections within the drop. The ray SB (Plate III. fig. 19) is decompounded at B; and one part is refracted to A, thence reflected to P, and from P reflected to W, where it is refracted to M. The angle between the incident and emergent rays SNM is equal as before to NMI; and NMK, the height of the bow, is equal to the difference between the angle made by the incident and emergent rays and the height of the sun. In this case the angle SNM, for the red rays, is equal to 50° 7′, and for the violet rays it is equal to 54° 7′; consequently the upper part of the secondary bow will not be seen when the sun is above 54° 7′ above the horizon, and the lower part of the bow will not be seen when the sun is 50° 7′ above the horizon.

In the same manner innumerable bows might be formed by a greater number of reflections within the drops; but as the secondary is so much fainter than the primary, that all the colours in it are seldom seen, for the same reason a bow made with three reflections would be fainter still, and in general altogether imperceptible. Since the rays of light, by various reflections and refractions, are thus capable of forming, by means of drops of rain, the bows which we so frequently see in the heavens, it is evident that there will be not only solar and lunar bows, but that many striking appearances will be produced by drops upon the ground, or air on the agitated surface of the water. Thus a lunar bow will be formed by rays from the moon affected by drops of rain; but as its light is very faint in comparison with that of the sun, such a bow will very seldom be seen, and the colours of it, when seen, will be faint and dim.

The marine or sea bow is a phenomenon sometimes observed in a much agitated sea; when the wind, sweeping part of the tops of the waves, carries them aloft, so that the sun's rays, falling upon them, are refracted, &c. as in a common shower, and paint the colours of the bow.

Rohault mentions coloured bows on the grass, formed by the refraction of the sun's rays in the morning dew.

Dr. Langwith, indeed, once saw a bow lying on the ground, the colours of which were almost as lively as those of the common rainbow. It was extended several hundred yards. It was not round, but oblong, being, as he conceived, the portion of an hyperbola. The colours took up less space, and were much more lively, in those parts of the bow which were near him than in those which were at a distance.

The drops of rain descend in a globular form, and thence we can easily account for the effects produced by them on the rays of light; but in different states of the air, instead of drops of rain, vapour falls to the earth in different forms of sleet, snow, and hail. In the two latter states there cannot be a refraction of the rays of light; but in the former state, when a drop is partly in a congealed and partly in a fluid form, the rays of light will be differently affected, both from the form of the drop and its various refracting powers. Hence we may expect a variety of curious appearances in the heavens; and to these drops, in different states, we may attribute the formation of halos, parhelia, and many other phenomena, detailed in the Philosophical Transactions, or in the histories of every country.

The halo, or corona, is a luminous circle surrounding the sun, the moon, a planet, or a fixed star. It is sometimes quite white, and sometimes coloured like the rainbow. Those which have been observed round the moon or stars are but of a very small diameter; those round the sun are of different magnitudes, and sometimes immensely great. When coloured, the colours are fainter than those of the rainbow, and appear in a different order, according to their size. In those which sir Isaac Newton observed in 1692, the order of the colours, from the inside next the sun, was in the innermost blue, white, red; in the middle purple, blue, green, yellow, pale red; in the outermost pale blue, and pale red. Huygens observed one red next the sun, and pale blue at the extremity. Mr. Weidler has given an account of one yellow on the inside, and white on the outside. In France one was observed, in which the order of the colours was white, red, blue, green, and a bright red on the outside.

Artificial coronas may be made in cold weather, by placing a lighted candle in the midst of a cloud of steam; or if a glass window is breathed upon, and the flame of a candle placed at some distance from the window, while the operator is also at the distance of some feet from another part of the window, the flame will be surrounded with a coloured halo.

When M. Bouguer was on the top of mount Pichinea, in the Cordilleras, he and some gentlemen who accompanied him, observed a most remarkable phenomenon. When the sun was just rising behind them, and a white cloud was about thirty paces from them, each of them observed his own shadow (and no other) projected upon it. All the parts of the shadow were distinct; and the head was adorned with a kind of glory, consisting of three or four concentric crowns, of a very lively colour, each exhibiting all the varieties of the primary rainbow, and having the circle red on the outside.

Similar to this appearance was one which occurred to Dr. M'Fait, in Scotland. This gentleman observed a rainbow round his shadow in a mist, when he was situated on an eminence above it. In this situation the whole country appeared to be immersed in a vast deluge, and nothing but the tops of hills appeared here and there above the flood; at another time he observed a double range of colours round his shadow.

The parhelia, or mock suns, are the most splendid appearances of this kind. We find these appearances frequently adverted to by the antients, who generally considered them as formidable omens. Four mock suns were seen at once by Scheiner at Rome, and by Muschenbroeck at Utrecht; and seven were observed by Hevelius at Sedan, in 1661.

The parhelia generally appear about the size of the true sun, not quite so bright, though they are said sometimes to rival their parent luminary in splendour. When there are a number of them they are not equal to each other in brightness. Externally they are tinged with colours like the rainbow. They are not always round, and have sometimes a long fiery tail opposite the sun, but paler towards the extremity. Dr. Haller observed one with tails extending both ways. Mr. Weidler saw a parhelion with one tail pointing up and another downward, a little crooked; the limb which was farthest from the sun being of a purple colour, the other tinged with the colours of the rainbow.

Coronas generally accompany parhelia: some coloured, and others white. There is also, in general, a very large white circle, parallel to the horizon, which passes through all the parhelia; and, if it was entire, would go through the centre of the sun: sometimes there are arches of smaller circles concentric to this, and touching the coloured circles which surround the sun; they are also tinged with colours, and contain other parhelia.

One of the most remarkable appearances of this kind was that which was observed at Rome by Scheiner, as intimated above; and this may serve as a sufficient instance of the parhelion.

This celebrated phenomenon is represented in Plate III. fig. 17, in which A is the place of the observer, B his zenith, C the true sun, and AB a plane passing through the observer's eye, the true sun, and the zenith. About the sun C there appeared two concentric rings, not complete, but diversified with colours. The lesser of them, DEF, was fuller, and more perfect; and though it was open from D to F, yet those ends were perpetually endeavouring to unite, and sometimes they did so. The outer of these rings was much fainter, so as scarcely to be discernible. It had, however, a variety of colours, but was very inconstant. The third circle, KLMN, was very large, and entirely white, passing through the middle of the sun, and every where parallel to the horizon. At first this circle was entire; but towards the end of the phenomenon it was weak and ragged, so as hardly to be perceived from M towards N.

In the intersection of this circle and the outward iris GKI, there broke out two parhelia, or mock suns, N and K, not quite perfect, K being rather weak, but N shone brighter and stronger. The brightness of the middle of them was something like that of the sun; but towards the edges they were tinged with colours like those of the rainbow, and they were uneven and ragged. The parhelion N was a little wavering; and sent out a spiked tail NP, of a colour somewhat fiery, the length of which was continually changing.

The parhelia at L and M, in the horizontal ring, were not so bright as the former, but were rounder, and white, like the circle in which they were placed. The parhelion N disappeared before K; and while M grew fainter, K grew brighter, and vanished the last of all.

It is to be observed farther, that the order of the colours in the circles DEF, GKN, was the same as in the common halos, namely, red next the sun; and the diameter of the inner circle was also about 45°, which is the usual size of a halo.

Parhelia have been seen for one, two, three, and four hours together; and in North America they are said to continue some days, and to be visible from sun-rise to sun-set. When they disappear it sometimes rains, or snow falls in the form of oblong spiculæ.

Mr. Wales says, that at Churchill, in Hudson's-bay, the rising of the sun is always preceded by two long streams of red light. These rise as the sun rises; and, as they grow longer, begin to bend towards each other, till they meet directly over the sun, forming there a kind of parhelion, or mock sun.

These two streams of light, he says, seem to have their source in two other parhelia, which rise with the true sun; and in the winter season, when the sun never rises above the haze or fog which he says is constantly found near the horizon, all these accompany him the whole day, and set with him in the same manner as they rise. Once or twice he saw a fourth parhelion under the true sun; but this, he adds, is not common.

The cause of these is apparently the reflection of the sun's light and image from the thick and frozen clouds in the northern atmosphere, accompanied also with some degree of refraction. To enter upon a mathematical analysis of these phenomena would be only tedious, and very foreign to our purpose. From what has been said upon this subject it is evident, that all the phenomena of colours depend upon two properties of light, the refrangibility and reflexibility of its rays.

Of the inflection of light.—The direction of the rays of light is changed, as we have seen, in their approach to certain bodies, by reflection and refraction; and consequently we must admit that there is some power in these bodies by which such effects are universally produced. If reflection was produced simply by the impinging of particles of light on hard or elastic bodies, or if they were in themselves elastic, the same effects would follow as in the impulse of other elastic bodies; but the angle of incidence could not be equal to the angle of reflection, unless the particles of light were perfectly elastic, or the bodies on which they impinged were perfectly elastic. Now we know that the bodies on which these particles impinge are not perfectly elastic; and also that if the particles of light were perfectly elastic, the diffusion of light from the reflecting bodies would be very different from its present appearance: for as no body can be perfectly polished, the particles of light, which are so inconceivably small, would be reflected back by the inequalities on the surface in every direction; consequently we are led to this conclusion, that the reflecting bodies have a power which acts at some little distance from their surfaces.

If this reasoning is allowed to be just, it necessarily follows, that if a ray of light, instead of impinging on a body, should pass so near to it as to be within the sphere of that power which the body possesses, it must necessarily suffer a change in its direction. Actual experiments confirm the truth of this position; and to the change in the direction of a particle of light, owing to its nearness to a body, we give the name of inflection.

From one of these experiments, made by sir Isaac Newton, the whole of this subject will be easily understood. At the distance of two or three feet from the window of a darkened room, in which was a hole three-fourths of an inch broad, to admit the light, he placed a black sheet of pasteboard, having in the middle a hole about a quarter of an inch square, and behind the hole the blade of a sharp knife, to intercept a small part of the light which would otherwise have passed through the hole. The planes of the pasteboard and blade were parallel to each other; and when the pasteboard was removed at such a distance from the window, as that all the light coming into the room must pass through the hole in the pasteboard, he received what came through this hole on a piece of paper two or three feet beyond the knife, and perceived two streams of faint light shooting out both ways from the beam of light into the shadow. As the brightness of the direct rays obscured the fainter light, by making a hole in his paper he let them pass through, and had thus an opportunity of attending closely to the two streams, which were nearly equal in length, breadth, and quantity of light. That part which was nearest to the sun's direct light was pretty strong for the space of about a quarter of an inch, decreasing gradually till it became imperceptible; and at the edge of the knife it subtended an angle of about twelve, or, at most, fourteen degrees.

Another knife was then placed opposite to the former, and he observed, that when the distance of their edges was about the four-hundredth part of an inch, the stream divided in the middle, and left a shadow between the two parts, which was so dark, that all light passing between the knives seemed to be bent aside to one knife or the other; as the knives were brought nearer to each other, this shadow grew broader, till upon the contact of the knives the whole light disappeared.

Pursuing his observations upon this appearance, he perceived fringes, as they may be termed, of different-coloured light, three made on one side by the edge of one knife, and three on the other side by the edge of the other; and thence concluded, that as in refraction the rays of light are differently acted upon, so are they at a distance from bodies by inflection; and by many other experiments of the same kind he supported his position, which is confirmed by all subsequent experiments.

We may naturally conclude, that from this property of inflection some curious changes will be produced in the appearances of external objects. If we take a piece of wire of a less diameter than the pupil of the eye, and place it between the eye and a distant object, the latter will appear magnified (Plate III. fig. 21). Let A be a church-steeple, B the eye, C the wire. The rays by which the steeple would have been otherwise seen are intercepted by the wire; and it is now seen by inflected rays, which make a greater angle than the direct rays, and consequently the steeple will be magnified.

In nearly shutting the eyes, and looking at a candle, there appear rays of light extending from it in various directions, like comets' tails; for the light, in passing through the eye-lashes, is inflected; and consequently many separate beams will be formed, diverging from the luminous object. The power of bodies to inflect the rays of light passing near to them will produce different effects, according to the nature of the rays acted upon; consequently a separation will take place in the differently refrangible rays, and those fringes which were taken notice of by sir Isaac Newton will appear in other objects which are seen by the means of inflected rays. From considering thus the action of bodies upon light, we come to this general conclusion, for which we are indebted to our great philosopher: that light, as well as all other matter, is acted upon at a distance; and that reflection, refraction, and inflection, are owing to certain general laws in the particles of matter, which are equally necessary for the preservation of the beautiful harmony in the objects nearest to us, and to produce by their joint action that great law by which the greater bodies in their system are retained in their respective orbits.

OPTION. Every bishop, whether created or translated, is bound immediately after confirmation, to make a legal conveyance to the archbishop of the next avoidance of such dignity or benefice belonging to the see, as the said archbishop shall choose, which is therefore called an option.

OR, in heraldry, denotes yellow, or gold-colour. See HERALDRY.

ORANGE. See CITRUS.

ORBICULARIS. See ANATOMY.

ORBIT. See ASTRONOMY.

ORCHARD, a plantation of fruit-trees. In planting an orchard great care should be taken that the soil is suitable to the trees planted in it; and that they are procured from a soil nearly of the same kind, or rather poorer than that laid out for an orchard. As to the situation, an easy rising ground, open to the south-east, is to be preferred. Mr. Miller recommends planting the trees four-score feet asunder, but not in regular rows; and would have the ground between the trees plowed, and sown with wheat and other crops, in the same manner as if it was clear from trees; by which means the trees will be more vigorous and healthy, will abide much longer, and produce better fruit. If the ground has been pasture, the green sward should be plowed in the spring before the trees are planted; and if it is suffered to lie a summer fallow, it will greatly mend it, provided it is stirred two or three times to rot the grass, and prevent the growing of weeds. At Michaelmas it should be plowed pretty deep, in order to make it loose for the roots of the trees, which if the soil is dry, should be planted in October; but if it is moist, the beginning of March will be a better season. If several sorts of fruit-trees are to be planted on the same spot, you should observe to plant the largest-growing trees backwards, and so proceed to those of less growth, continuing the same method quite through the whole plantation; by which means the sun and air will more easily pass through the whole orchard. When you have planted the trees, you should support them with stakes, to prevent their being blown out of the ground by the wind; and the following spring, if the season should prove dry, cut a quantity of green turf, and lay it about the roots, with the grass downwards; by which means a great expence of watering will be saved, and after the first year they will be out of danger. Whenever you plow the ground betwixt these trees, you must be careful not to go too deep amongst their roots, which would greatly damage the trees; but if you do it cautiously, your stirring the face of the ground will be of great service to them: though you should observe, never to sow too near the tree, nor to suffer any great rooting weeds to grow about them; because this would starve them, by exhausting the goodness of the soil, which every two or three years should be mended with dung or other manure. These trees, after they are planted out, will require no other pruning besides cutting off their bad branches, or such as cross each other.

ORCHIS, *fool-stones*, a genus of the gynandria diandria class of plants, the corolla of which is of a corniculated form; and its fruit is an oblong unilocular capsule, containing numerous scobiform seeds.

The essential character is, nect. a horn or spur behind the flower. There are 50 species of this genus, which exceedingly resembles the ophrys. The most remarkable species are the following:

1. The mascula, or male fool-stones, has a root composed of two bulbs, crowned with oblong, broad, spotted leaves; upright stalks, a foot high, with one or two narrow amplexicaule leaves, and terminated by a long spike of reddish-purple flowers having the petals reflexed backward; a quadrilobed crenated lip to the nectarium, and an obtuse horn. The flowers of this species possess a very agreeable odour.

2. The morio, or female orchis, has a few amplexicaule leaves; and terminated by a short loose spike of flowers, having connivent petals, a quadrified crenated lip to the nectarium, and an obtuse horn.

3. The militaris, or man-orchis, has erect flower-stalks, eight or ten inches high, terminated by a loose spike of ash-coloured and reddish flowers, having confluent petals; a quinquefid, rough, spotted lip to the nectarium, and an obtuse horn. The structure of the flowers exhibits the figure of a naked man; and is often of different colours in the same flower, as ash-colour, red, brown, and dark-striped.

All the orchises are very hardy perennials, with bulbous fleshy roots. The flowers appear in May, June, and July, but principally in June: their mode of flowering is universally in spikes, many flowers in each spike; and each flower is composed of five petals in two series, and a nectarium. The season for removing them is in summer, after they have done flowering, when their leaves and stalks decay: plant them three inches deep, and let them remain undisturbed several years; for the less they are removed the stronger they will flower.

This plant flourishes in various parts of Europe and Asia, and grows in our country spontaneously, and in great abundance. It is assiduously cultivated in the East; and the root of it forms a considerable part of the diet of the inhabitants of Turkey, Persia, and Syria. From it is made the alimentary powder called salep; which, prepared from foreign roots, is sold at five or six shillings per pound, though it might be furnished by ourselves at a sixth part of that price, if we chose to pay any attention to the culture of this plant. The orchis mascula is the most valued for this purpose. A dry, and not very fertile soil, is best adapted to its growth.

The properest time for gathering the roots is when the seed is formed, and the stalk is ready to fall; because the new bulb, of which the salep is made, is then arrived to its full maturity, and may be distinguished from the old one, by a white bud rising from the top of it, which is the germ of the orchis of the succeeding year.

ORDEAL, a form of trial, or of discovering innocence or guilt, formerly practised over almost all Europe, and which prevailed in England from the time of Edward the Confessor, till it was abolished by a declaration of Henry III. It was called purgatio vulgaris, or judicium, in opposition to bellum, or combat, the other form of purgation.

In England an offender, on being arraigned, and pleading Not guilty, had it in his choice to put himself upon God and his country; that is, upon the verdict of a jury; or upon God alone, on which account it was called the judgment of God, it being presumed that God would deliver the innocent. The more popular kinds of ordeal were those of red-hot iron and water: the first for freemen and people of fashion, and the last for peasants. Fire ordeal was performed either by taking up in the hand a piece of red-hot iron, of one, two, or three pounds weight; or else by walking barefoot and blindfold over nine red-hot ploughshares, laid at unequal distances; and if the party escaped unhurt he was adjudged innocent, if not he was condemned as guilty. Water ordeal was performed either by plunging the bare arm up to the elbow in boiling water, and escaping unhurt thereby: or by casting the person suspected into a river or pond of water; and if he floated therein, without any action of swimming, it was deemed an evidence of his guilt; but if he sunk he was acquitted. 4 Black. 340.

ORDER. See ARCHITECTURE.

ORDERS, or ORDINATION. No person shall be admitted to the holy order of deacon under 23 years of age; nor to the order of priest unless he is 24 complete; and none shall be ordained without a title, that is, a nomination to some cure or benefice, and he shall have a testimonial of his good behaviour, for three years past, from three clergymen; and the bishop shall examine him, and if he sees cause may refuse him. And before he is ordained he shall take the oath of allegiance and supremacy before the ordinary, and subscribe the thirty-nine articles

ORDINARY, in common and canon law, is one who has ordinary or immediate jurisdiction in ecclesiastical causes in such a place. In which sense archdeacons are ordinaries, though the appellation is more frequently given to the bishop of the diocese, who has the ordinary ecclesiastical jurisdiction. The archbishop is the ordinary of the whole province, to visit and receive appeals from inferior judicatures.

ORDINATES, or ORDINATE APPLICATES, in geometry, are parallel lines, MM, *mm* (Plate Miscell. fig. 178), terminating in a curve, and bisected by a diameter, as AD. The half of these, as MP, *mp*, is properly the semiordinate, though commonly called ordinate.

ORDNANCE, a general name for all sorts of great guns used in war. See GUNNERY.

ORDNANCE, *boring of.* Guns are thus bored: the piece A (Plate Observatory, fig. 7.) is placed upon two standards BB, by means of two journeys, turned round by a water-wheel; the breech D being introduced into the central line of the wheel, with the muzzle towards the sliding carriage E, which is pressed forwards by a ratch F and weights. Upon this sliding carriage is fixed, truly horizontal and central to the gun, the drill-bar G, to the end of which is fixed a carp's tongue drill or cutter H; which, being pressed forward upon the piece whilst it is turning round, perforates the bore, which is afterwards finished with bars and cutters.

The machinery for boring of ordnance is sometimes put in motion by a steam-engine: and in this way, from 18 to 24 great guns have been boring at the same time; the borer in each piece being brought up to its proper place in the gun, by a lever and weights. In this method of bringing up the borer the pressure may always be made equable, and the motion of the borer regular; but the disadvantage is, that without due attention the borer may work up too far towards the breech, and the piece be spoiled. In the royal arsenal at Woolwich, only one piece is bored at a time in the same mill: the gun to be bored lies with its axis parallel to the horizon, and in that position is turned round its axis by means of wheel-work, moved by one or more horses. The borer is laid, as above described, in the direction of the axis of the gun, and is incapable of motion in any direction except that of its length; and in this direction it is constantly moved by means of a small rack-wheel, kept in proper motion by two men, who thus make the point of the borer so to bear against the part of the gun that is boring, as to pierce and cut it. The outside of the gun is smoothed at the same time by men with instruments fit for the purpose, whilst it turns round, so that the bore may be exactly in the centre of the metal. See Gregory's Mechanics.

ORDNANCE, *office of*, an office kept within the Tower of London, which superintends and disposes of all the arms, instruments, and utensils of war, both by sea and land, in all the magazines, garrisons, and forts, in Great Britain.

ORES, METALLIC. This class comprehends all the mineral bodies, composed either entirely of metals, or of which metals constitute the most considerable and important part. It is from the minerals belonging to this class that all metals are extracted; for this reason they have obtained the name of ores.

As the metals at present known amount to 23, we shall divide this class into 23 orders, allotting a distinct order for the ores of every particular metal.

Metals exist in ores in one or other of the four following states: 1. In a metallic state, and either solitary, or combined with each other. 2. Combined with sulphur. 3. In the state of oxides. 4. Combined with acids. Each order therefore may be divided into the four following genera:

1. Alloys. 3. Oxides.
2. Sulphurets. 4. Salts.

It must be observed, however, that every metal has not hitherto been found in all these four states, and that some of them are hardly susceptible of them all. Some of the orders, therefore, want one or more genera, as may be seen from the following table, taken from Dr. Thomson's incomparable work on chemistry; a work of which every student of that science, or of natural philosophy, ought to be possessed.

ORDER I. *Gold.*
1. Alloys.

ORDER II. *Platinum.*
1. Alloys.

ORDER III. *Silver.*
1. Alloys.
2. Sulphurets.
3. Oxides.
4. Salts.

ORDER IV. *Mercury.*
1. Alloys.
2. Sulphurets.
3. Oxides.
4. Salts.

ORDER V. *Copper.*
1. Alloys.
2. Sulphurets.
3. Oxides.
4. Salts.

ORDER VI. *Iron.*
1. Alloys.
2. Sulphurets.
3. Oxides.
4. Salts.

ORDER VII. *Tin.*
1. Sulphurets.
2. Oxides.

ORDER VIII. *Lead.*
1. Sulphurets.
2. Oxides.
3. Salts.

ORDER IX. *Nickel.*
1. Sulphurets.
2. Oxides.

ORDER X. *Zinc.*
1. Sulphurets.
2. Oxides.
3. Salts.

ORDER XI. *Antimony.*
1. Alloys.
2. Sulphurets.
3. Oxides.
4. Salts.

ORDER XII. *Bismuth.*
1. Alloys.
2. Sulphurets.
3. Oxides.

ORDER XIII. *Tellurium.*
1. Alloys.

ORDER XIV. *Arsenic.*
1. Alloys.
2. Sulphurets.
3. Oxides.
4. Salts.

ORDER XV. *Cobalt.*
1. Alloys.
2. Sulphurets.
3. Oxides.
4. Salts.

ORDER XVI. *Manganese.*
1. Oxides.
2. Salts.

ORDER XVII. *Tungsten.*
1. Oxides.

ORDER XVIII. *Molybdenum.*
1. Sulphurets.

ORDER XIX. *Uranium.*
1. Oxides.

ORDER XX. *Titanium.*
1. Oxides.

ORDER XXI. *Chromium.*
1. Oxides.

ORDER XXII. *Columbium.*
1. Alloys.

ORDER XXIII. *Tantalium.*
1. Oxides.

ORES, *analysis of.* The diversity of metallic ores is so great, that no general method of analysis can be given. We shall therefore follow the different orders, and point out the proper method of analysing each. In the rules we shall follow Bergman, to whom we are indebted for the first precise treatise on the analysis of ores, except when his methods have been superseded by the improvements of succeeding chemists.

Gold ores. The presence of gold may easily be detected by treating the mineral supposed to contain it with nitro-muriatic acid, and dropping muriat of tin into the solution. If the solution contains any gold, a purple precipitate immediately appears.

Native gold ought to be dissolved in nitro-muriatic acid: the silver, if any is present, falls to the bottom in the state of muriat, and may be separated by filtration, and weighed. Pour sulphat of iron into the solution, and the gold is precipitated in the metallic state. The copper, if any is present, may be precipitated by means of a plate of iron. The presence of iron may be ascertained by dropping tincture of nutgalls into a portion of the solution.

The auriferous pyrites may be treated with diluted nitrous acid, which dissolves the iron, and separates the sulphur. The gold remains insoluble, and is found in the state of small grains.

Ores of platinum. Proust's method is, first to separate the sand with which the grains of platinum are mixed, by exposing them to a blast of air. By heat he evaporates the mercury, which still adheres to them, and then picks out the grains of gold, which are always mixed with platinum, and which are thus rendered visible. The ore is then dissolved in an acid composed of one part of nitre and three parts of muriatic acid. A black powder remains. This powder, when roasted, gives out phosphorus and sulphur. After this it is dissolved by nitro-muriatic acid, except a small residuum, which is plumbago. The solutions are then to be mixed. They consist of muriats of platinum, and oxymuriats of copper and iron. By evaporating till the liquid when cold assumes a consistency greater than honey, and inclining the retort, the oxymuriats run off, and leave the muriat of platinum, which may be obtained pure by repeated solutions and crystallizations. The solution containing the muriats, and perhaps also a little platinum, is to be diluted with a great proportion of water; and pure ammonia dropt in. The red oxide of iron precipitates, and may be estimated by weighing it. When the solution is somewhat concentrated, ammonia precipitates the platinum in the state of a triple salt; and the copper, which now only remains, may be precipitated by a plate of iron.

Ores of silver. The analysis of the ores of silver has been always considered as very important, on account of the great value of the metal which they contain in greatest abundance.

1. Native silver is to be dissolved in nitric acid. The gold, if the ore contains any, remains in the state of a black powder, and may be dried and weighed. The silver may be precipitated by common salt. One hundred parts of the precipitate dried denote about seventy-five parts of silver. The presence of copper may be ascertained by the greenish-blue colour of the solution, and by the deep-blue colour which it assumes on adding ammonia. The copper may be precipitated by a plate of iron, or by the rules laid down hereafter. When the ore contains arsenic, its proportion may be estimated by weighing before and after fusion; for the arsenic is dissipated by heat, or the ore may be dissolved as before in nitric acid, which acidifies the arsenic. After the separation of the silver, the arsenic acid may be precipitated by nitrat of lead, 100 parts of the dry precipitate indicating about 22 of arsenic.

2. Alloy of silver and antimony is to be treated with nitric acid, which dissolves the silver, and oxidizes the antimony. The silver is estimated as above. The oxide of antimony may be reduced by fusion with four times its weight of black flux and a little soap.

3. Sulphuret of silver is to be treated with diluted nitric acid, which dissolves the silver, leaving the greater part of the sulphur untouched. The residuum is to be dried, and then the sulphur burnt off. The loss of weight gives the sulphur. The residuum, if any, is undecomposed sulphuret, to be treated as at first. The silver is to be precipitated by common salt; and the other metals, if any are present, may be ascertained as above. Part of the sulphur is always acidified. The acid thus formed may be precipitated by nitrat of barytes, 100 parts of the dried precipitate indicating about 14.5 of sulphur.

4. Antimoniated silver ore was analysed by Klaproth in the following manner: 100 parts of it were boiled in diluted nitric acid. The residuum, washed and dried, was 26. These 26 were digested into nitro-muriatic acid. The residuum now weighed 13 (so that 13 had been dissolved), 12 of which were sulphur, and burnt away, leaving behind them one part of silica. The nitro-muriatic solution, when diluted largely with water, let fall a precipitate which weighed 13 (or 10 of pure antimony), and had the properties of oxide of antimony; for they did not evaporate till heated to redness, but at that temperature were dissipated in a grey smoke.

The nitric solution was green. Common salt occasioned a precipitate which weighed 87.75, equivalent to 65.81 of pure silver. After the separation of this muriat of silver, sulphat of soda occasioned no precipitate. Therefore the solution contained no lead. When supersaturated with soda, a grey precipitate fell, weighing five parts. On burning coals this precipitate gave out an arsenical smell. It was redissolved in nitric acid; sulphurated alkali occasioned a smutty brown precipitate; and prussic alkali a Prussian blue, which after torrefaction was magnetic. Hence he concluded, that these five parts were a combination of iron and arsenic acid.

The nitric solution which had been supersaturated with ammonia was blue; he therefore suspected that it contained copper. To discover this, he saturated it with sulphuric acid, and put it into a polished plate of iron. The quantity of copper was so small, that none could be collected on the iron.

5. Sulphuret of silver and copper may be analysed as No. 3. separating the copper by means of a plate of iron.

6. Black silver ore may be analysed as No. 2. separating the copper, if any is present, by means of an iron plate, and estimating the carbonic acid that escapes when the ore is heated or dissolved in nitric acid.

7. Red silver was analysed by Vauquelin in the following manner: one hundred parts of it were digested in 500 parts of nitric acid previously diluted with water. The undissolved residuum, being washed and dried, weighed 42.06. Being treated with muriatic acid, it was all dissolved except 14.66 parts, which were sulphur. The muriatic solution, when diluted with a great quantity of water, deposited a white powder, which weighed 21.25, and was oxide of antimony. The nitric acid solution remained still to be examined. Muriatic acid occasioned a heavy precipitate, which weighed 72.66 parts, and which was muriat of silver. Reagents shewed that the acid retained no other substance of solution.

8. Muriat of silver was analysed by Klaproth: one hundred parts of it were mixed with thrice their weight of pure carbonat of potass, and melted together in a glass retort. The mass was dissolved in water, and the solution filtred. A residuum remained, which was dissolved in nitric acid, with the exception of a red powder, which, treated with nitro-muriatic acid, was dissolved, except a little muriat of silver, which, when reduced, yielded .5 of pure silver. Ammonia precipitated from the nitro-muriatic solution 2.5 parts of oxide of iron. The nitric solution was precipitated by common salt; the muriat of silver, thus obtained, yielded, when reduced, 67.25 of pure silver.

The original aqueous solution of the alkaline mass was saturated with acetous acid, on which it deposited 1.75 parts of alumina. The solution was evaporated to dryness, and the dry mass treated with alcohol, which dissolved the acetite of potass. The residuum, amounting to 58.75 parts, was dissolved in water, and being treated with muriat of barytes, 15 parts of sulphat of barytes precipitated, indicating the presence of about .5 of sulphuric acid, or 0.75 sulphat of potass. The remaining 58 parts were muriat of potass, indicating about 21 parts of muriatic acid.

Ores of mercury. We have very few exact analyses of the ores of mercury, owing, perhaps to the facility with which the mercury is extracted from them by distillation.

Native mercury and amalgam may be dissolved in nitric acid. The gold, if any is present, remains in the state of powder, and may be estimated by its weight. The affusion of water precipitates the bismuth, if the solution happens to contain any. Common salt precipitates the silver, and also part of the mercury; but the latter may be redissolved by a sufficient quantity of water, or, which is far better, of oxymuriatic acid, while the muriat of silver remains insoluble. Lastly, the mercury may be precipitated by sulphat of iron, and estimated.

2. Native cinnabar may be treated with a mixture of three parts muriatic and one part nitric acid, which dissolves the mercury, and leaves the sulphur. The mercury may be estimated as in the last paragraph.

3. Hepatic mercurial ore has not been analysed. Its analysis may be attempted as in No. 2. or by dissolving it in nitric acid.

4. Muriat of mercury may be digested in muriatic acid till the whole is dissolved. Muriat of barytes precipitates the sulphuric acid, 100 parts of which are equivalent to 186 of sulphat of mercury; and the proportion of this salt being known, we have that of the muriat.

Ores of copper. Native copper sometimes contains gold, silver, or iron. It may be dissolved in nitric acid; the gold remains in the state of a blackish or rather violet-coloured powder; the silver may be separated by a polished plate of copper (or it may be precipitated from a separate portion of the solution by common salt); the iron may be separated by boiling the solution to dryness, and treating the residuum with water. By this process, the nitrat of iron is decomposed; the oxide of iron remains, while the water dissolves the nitrat of copper. This last salt may be decomposed by boiling it with potass; the precipitate dried in a red heat, is black oxide of copper. One hundred parts of it denote 80 of metallic copper.

2. Sulphuret of copper may be dissolved in diluted nitric acid. Part of the sulphur remains unaltered, and may be estimated by weighing it, and burning it off. Part is acidified, and may be precipitated by nitrat of barytes; 100 parts of the dried precipitate indicating 14.5 of sulphur. By evaporation to dryness, and solution in water, the iron is separated; and the copper may be estimated as in the last paragraph; or muriatic acid may be used instead of nitric; but in that case it is more difficult to obtain a complete solution.

3. Grey copper ore was analysed by Klaproth in the following manner: three hundred parts of it were digested with four times their weight of nitric acid. This operation was repeated, and the two acid liquids mixed. The undissolved residuum was 188 parts. The nitric solution was green, and when common salt was added to it, muriat of silver precipitated. The solution being now supersaturated with ammonia, 9.5 parts of a fleaky red precipitate were obtained, which was found to be composed of silica, alumina, and iron, by dissolving it in muriatic acid, and proceeding by the rules laid down in the first section. A polished iron plate precipitated from the nitric solution 69 parts of copper.

The 188 parts of residuum were boiled with six times their weight of muriatic acid; 105.5 parts remained undissolved, which were sulphur and silica. The muriatic acid solution being concentrated, yielded a little muriat of silver. Being diluted with a large portion of water, a white powder precipitated, which weighed 97.5 parts, and was oxide of antimony.

4. Red copper ore has only to be dissolved in muriatic acid, and the copper precipitated by a plate of iron; 88 parts of the precipitated copper being equivalent to 100 of the orange oxide of which the ore is composed.

5. The analysis of the oxides and carbonats of copper scarcely requires any remarks. The water and carbonic acid must be estimated by distillation in close vessels, and collecting the products. The ore may then be dissolved in nitric acid, and its copper ascertained as above.

6. Arseniat of copper was analysed by Mr. Chenevix, in the following manner: the ore was dissolved in diluted nitric acid, and nitrat of lead poured in. The solution was evaporated till a precipitate began to appear, and then mixed with alcohol. Arseniat of lead precipitated. One hundred parts of this salt indicate 33 of arsenic acid. The copper was separated from the nitric acid by boiling it with potass.

Ores of iron. Notwithstanding the great variety of iron ores, they may be all, as far as analysis is concerned, arranged under three heads; namely, 1. Sulphurets; 2. Oxides; and 3. Salts.

1. Pyrites, or sulphureted iron, may be treated repeatedly with boiling nitric acid till the sulphur is acidified. Muriatic acid is then to be added, and the digestion continued till the whole is dissolved. Muriat of barytes is then to be added to precipitate the sulphuric acid; 100 of the dried precipitate indicate 14.5 of sulphur. If the solution contains only iron, it may be precipitated by carbonat of soda, calcined to redness, and weighed. But if earths or manganese are present, we must proceed by the rules laid down in the first section.

2. If the oxides of iron are pure, that is, contain nothing but iron, we have only to dissolve them in muriatic acid, and precipitate them as above. But it is very seldom that ores possess this perfect degree of purity. The iron is usually combined with manganese, alumina, silica, or with all of these together. The analysis is to be conducted exactly according to the rules already laid down.

3. The sparry iron ore may be analysed in the same manner, excepting only that the carbonic acid gas must be separated by distillation or solution in close vessels.

4. Arseniat of iron was analysed by Mr. Chenevix in the following manner: One hundred parts of it were boiled with potass till the arsenic acid was separated. Nitrat of lead was mixed with the solution; 100 parts of the precepitate indicated 33 of arsenic acid. That portion of the ore which eluded the action of the potass was treated with muriatic acid; the undissolved residuum was silica. The muriatic acid was supersaturated with ammonia. The iron precipitated; but the copper was dissolved by the ammonia.

Ores of tin. 1. The sulphuret of tin was thus analysed by Klaproth: 120 parts of the ore were digested with nitro-muriatic acid; 43 parts remained undissolved. Of these, 30 burnt away with a blue flame, and were sulphur; of the remaining 13, eight dissolved in nitro-muriatic acid. The undissolved five were heated with wax, and yielded a grain of iron attracted by the magnet. The rest was a mixture of alumina and silica. The nitro-muriatic solution was completely precipitated by potass, and the precipitate redissolved in muriatic acid. A cylinder of tin precipitated 44 parts of copper from this solution, and lost itself 89 parts of its weight. A cylinder of zinc precipitated 130 parts of tin; so that, deducting the 89 parts of tin dissolved during the precipitation of the copper, 41 remain for the tin contained in the ore.

2. Tin stone was thus analysed: One hundred parts of the ore were heated to redness, with 600 parts of potass, in a silver crucible; and the mixture being treated with warm water, 11 parts remained undissolved. These 11, by a repetition of the treatment with potass, were reduced to $1\frac{1}{4}$th. This small residuum dissolved in muriatic acid. Zinc precipitated from the solution one-half part of tin, and the Prussian alkali gave a blue precipitate, which indicated one-fourth part of iron.

The alkaline solution was saturated with muriatic acid; a white precipitate appeared, but it was redissolved by adding more acid. The whole was precipitated by carbonat of soda. The solution, which had a yellowish colour, was redissolved in muriatic acid; and a cylinder of zinc being inserted into the solution, 77 of tin were obtained, indicating nearly 98 parts of oxide of tin.

Ores of lead. 1. Sulphuret of lead usually contains a little silver, and sometimes also antimony and zinc. It may be treated with diluted nitric acid, which leaves only the sulphur undissolved, the weight of which is to be taken, and its purity determined by combustion. If antimony is present, it will either remain in the state of a white oxide, or if dissolved, it will be precipitated by diluting the solution with water. Muriatic acid is to be added, and the solution evaporated till it is reduced to a small portion. Muriat of lead and of silver precipitate. The first of these may be dissolved in boiling water, the second remains insoluble. Westrum separated the muriat of silver by digesting the precipitate with ammonia. The liquid from which the muriats were separated may contain iron, zinc, copper. The iron may be precipitated by ammonia added in excess; the copper, by a plate of zinc; the zinc may be precipitated by carbonat of soda reduced to the metallic state, and weighed; subtracting what had been separated from the plate of zinc.

2. Arseniated peroxide of lead was thus analysed by Vauquelin: 100 parts roasted for half an hour, and occasionally treated with a little tallow, lost 38 parts, which were considered as oxide of arsenic. The residue was treated with concentrated muriatic acid, and boiled in it for a quarter of an hour. The liquid assumed a red colour, and emitted abundance of oxymuriatic acid gas. A white needleform salt was deposited, and some of it was obtained by evaporation. This salt, dissolved in water, and treated with sulphat

of soda, yielded 25 parts of sulphat of lead, = 20.2 parts of lead. The liquor thus freed from lead was treated with ammonia. The precipitate obtained weighed 39 parts. It consisted of oxide of iron mixed with oxide of arsenic. The production of oxymuriatic acid induced Vauquelin to consider the lead as in the state of peroxide.

3. Carbonat of lead was thus analysed: One hundred grains were thrown into 200 grains of nitric acid diluted with 300 grains of water. It dissolved completely with effervescence. The loss of weight was 16 grains. It was equivalent to the carbonic acid. The solution, which was colourless, was diluted with water, and a cylinder of zinc put into it. In 24 hours the lead was precipitated in the metallic state. It weighed 77 grains, = 82 grains oxide. If muriatic acid is suspected, it may be easily detected, and its weight ascertained, by means of nitrat of silver.

4. Sulphat of lead was thus analysed by Klaproth: One hundred grains of the ore, heated to redness, lost two grains, which were considered as water. It was then mixed with 400 grains of carbonat of potass, and heated to redness in a platinum crucible. The reddish yellow mass thus obtained was digested in water, and the whole thrown on a filtre. The oxide of lead thus obtained weighed 72 grains. It was dissolved in diluted nitric acid. One grain of oxide of iron remained behind. Into the solution a cylinder of zinc was put. The lead thrown down weighed $66\frac{1}{2}$ grains. The alkaline solution was supersaturated with nitric acid, and then treated with acetat of barytes. The sulphat of barytes obtained weighed 73 grains, which Klaproth considers as indicating 25 grains of sulphuric acid.

5. Phosphat of lead was thus analysed: One hundred grains were dissolved in diluted nitric acid. Nitrat of silver dropt into the solution formed a precipitate weighing 11 grains, = 1.7 grains muriatic acid. The solution was mixed with sulphuric acid. The sulphat of lead precipitated weighed 106 grains, = 78.4 oxide of lead. The solution was freed from sulphuric acid by means of nitrat of barytes, and then almost neutralized with ammonia. Acetat of lead was then dropt in. The phosphat of lead which precipitated weighed 82 grains, = 18.37 phosphoric acid. The solution was now mixed with muriatic acid, evaporated to dryness, and the dry mass washed in alcohol. The alcohol, when evaporated, left a small residue, which dissolved in water, and formed Prussian blue with prussiat of potass. It contained about $\frac{1}{10}$ grain of oxide of iron.

6. Molybdat of lead was thus analysed by Mr. Hatchet. The ore was boiled repeatedly with sulphuric acid till the acid refused to dissolve any more. The solution contained the molybdic acid. The undissolved powder (sulphat of lead) was boiled for an hour with carbonat of soda, and then washed. Nitric acid now dissolved it, except a little silica. The lead was precipitated from this solution by sulphuric acid; after which ammonia separated a little oxide of iron. The sulphuric acid solution was diluted with 16 parts of water, and saturated with ammonia; a little oxide of iron gradually precipitated. The solution was now evaporated to dryness, and the mass strongly heated to separate the sulphat of ammonia. The residuum repeatedly treated with nitric acid was converted into yellow molybdic acid.

Ores of nickel. Kupfer nickel may be dissolved in nitric acid, by which the greatest part of the sulphur will be separated. The arsenic may be afterwards precipitated by the affusion of water. A plate of iron will expel the copper, if any should be present. Precipitate by potass added in excess, and boil the precipitate, which will separate the arsenic and sulphur completely. Dissolve the precipitate (previously exposed moist for some time to the air) in acetic acid, and add an excess of ammonia. The iron is precipitated; but the cobalt and nickel remain in solution. Evaporate, and the cobalt is deposited; then by continuing the evaporation to dryness the nickel is obtained.

Ores of zinc. 1. Blende may be treated with diluted nitric acid, which will separate the sulphur, the siliceous gangue, &c. The purity of the sulphur is to be ascertained by combustion, and the residuum analysed in the manner formerly described. Precipitate the nitric solution by soda, redissolve in muriatic acid, precipitate the copper (if any should be present) by a plate of iron; separate the iron by adding an excess of ammonia. The zinc now only remains in the solution, which may be obtained by evaporating to dryness, redissolving in muriatic acid, and precipitating by soda.

2. Calamine may be digested in nitric acid, noting the loss of weight for carbonic acid, and the insoluble residuum boiled with muriatic acid repeatedly; what remains after dilution with boiling water is silica. The nitric solution contains zinc, and probably also iron and alumina; evaporate to dryness, redissolve, and add an excess of ammonia. The iron and alumina either remain undissolved or are precipitated, and they may be separated by potass. The zinc may be precipitated by an acid, or by evaporation to dryness. The muriatic solution probably contains iron and alumina, which may be precipitated by the rules already laid down.

Ores of antimony. Native antimony was thus analysed: One hundred grains were digested in nitric acid till the whole was converted into a white powder. When the acid emitted no longer any nitrous gas, the mixture was diluted with water and thrown upon a filtre. The solution was then treated with nitrat of silver. The precipitate yielded by reduction one grain of silver. The prussiat of potass threw down from the residuum solution a precipitate which contained $\frac{1}{4}$ grain of iron. The white oxide formed by the nitric acid was digested in muriatic acid; the whole dissolved and formed a transparent solution. It was diluted with six times its weight of water, and the precipitate redissolved in muriatic acid, and a cylinder of zinc put into it. The antimony obtained weighed 98 grains.

2. Sulphuret of antimony is to be treated with nitro-muriatic acid. The sulphur and the muriat of silver (if any silver is present) will remain. Water precipitates the antimony; sulphuric acid, the lead; and ammonia the iron.

3. Klaproth analysed the red ore of antimony as follows: One hundred grains were digested in muriatic acid till the whole dissolved, except $1\frac{1}{2}$ grains of sulphur. A little sulphuret of antimony rose with the sulphureted hydrogen gas exhaled, and was deposited in the beak of the retort. The solution was diluted with water. The whole precipitated in the state of a white powder; for potass threw nothing from the liquid. The powder was redissolved in muriatic acid, an excess added, and the solution diluted. A plate of iron threw down $67\frac{1}{2}$ grains of antimony. The ore then contained 78.3 grains of oxide of antimony. One hundred grains of the ore yielded by solution in muriatic acid 37 cubic inches of sulphureted hydrogen gas. From this, Klaproth concluded that it contained 20 grains of sulphur.

Ores of bismuth. Native bismuth may be treated with nitric acid. Repeated concentrations and affusions of water precipitate the bismuth, and perhaps the arsenic; but this last may be redissolved in boiling water. The cobalt remains, and may be examined by the rules to be hereafter laid down. The same analysis succeeds with the other ores of bismuth. The sulphur when present remains undissolved.

We shall give as an example of these ores Klaproth's analysis of a sulphuret of bismuth. Fifty grains of the ore were digested in nitric acid. The whole was dissolved except $2\frac{1}{2}$ grains of sulphur. The solution being diluted with water, a white powder precipitated. The filtred solution was treated with common salt; at first it produced no change, but by and by the whole became milky. The precipitate consisted, like the last, of oxide of bismuth. The solution continuing clear for some time, indicated that no silver was present. The white precipitate was not altered by exposure to the light; an additional proof that no silver was present.

Ores of tellurium. Klaproth dissolved the white gold ore of Fatzbay in nitro-muriatic acid, and added potass in excess to the solution. A brown precipitate remained undissolved, which was a mixture of gold and iron. It was redissolved in nitro-muriatic acid, the gold first precipitated by nitrat of mercury, and then the iron by potass. The potass in the first solution being saturated with muriatic acid, the oxide of tellurium precipitated.

The other ores may be analysed in the same manner; only the precipitate occasioned by the potass must be treated according to the metals of which it consists. The rules have been already laid down.

Ores of arsenic. Native arsenic may be treated with nitro-muriatic acid. The silver and gold remain; the first in the state of a muriat; the second may be dissolved by means of nitro-muriatic acid, and precipitated by sulphat of iron. The arsenic may be precipitated by concentrating the nitric solution, and then diluting with water. The iron may then be precipitated by ammonia.

2. The sulphureted ores of arsenic may likewise be treated with diluted nitro-muriatic acid. The sulphur remains undissolved; the arsenic may be precipitated by concentration and the affusion of water; the iron by ammonia.

3. Oxide of arsenic may be dissolved in sixteen parts of water. The solution displays acid properties, and nitrat of silver and of mercury occasion precipitates in it.

Ores of cobalt. White cobalt ore was thus analysed by Tassaert. To ascertain the proportion of arsenic he treated the ore with diluted nitric acid, and obtained a complete solution. Crystals of white oxide of arsenic were deposited, and by repeated evaporations he separated the whole of the arsenic, and ascertained its weight. He then boiled a new portion of the ore with four times its weight of nitric acid, and thus acidified the arsenic, and obtained a solution. This solution was treated with potass, which retained the arsenic acid, and separated the other bodies. A precipitate of arseniat of cobalt, which had fallen when the nitric solution was diluted with water, was treated with potass for the same reason. The residuum, together with the precipitate occasioned by the potass, was dissolved in nitric acid, and ammonia added in excess. Part was retained in solution by the ammonia; but part was precipitated. The precipitate was dissolved in acetic acid, and the solution repeatedly evaporated to dryness. By this process the oxide of iron gradually separated in the form of a red powder. The dissolved part was acetat of cobalt. It was decomposed by the addition of ammonia in excess, which redissolved the cobalt. By these processes the arsenic and iron were separated; the cobalt was retained by the ammonia, and was obtained by evaporation. To ascertain the proportion of sulphur in the ore a new portion was boiled with nitric acid. On cooling, crystals of white oxide of arsenic were deposited. These being separated, nitrat of barytes was added to the solution; 100 parts of the dried precipitate indicated 14.5 of sulphur.

The other ores of cobalt may be analysed nearly in the same way.

Ores of manganese. 1. Barytated manganese was treated by Vauquelin with muriatic acid; oxymuriatic gas passed over, and the whole was dissolved except a little charcoal and silica. The solution when evaporated yielded crystals of muriat of barytes. These were separated; and the liquid, evaporated to dryness, yielded a yellow mass soluble in alcohol, and tinging its flame with yellow brilliant sparks. The proportion of barytes was ascertained by precipitating it in the state of a sulphat; the manganese, by precipitating it by carbonat of potass.

2. The grey ore of manganese was treated by the same chemist with muriatic acid; some silica remained undissolved. Carbonat of potass was added to the solution. The precipitate was at first white, but became black when exposed to the air. It was treated with nitric acid, which dissolved every thing but the manganese and iron (if any had been present). The nitric solution, when mixed with carbonat of potass, deposited only carbonat of lime. The black residuum was mixed with sugar, and treated with nitric acid. The solution was complete; therefore no iron was present.

The same processes will succeed with the other ores of manganese. When iron is present, it may be separated either as above, or by the rules laid down in the first section; or what succeeds better, we may dissolve the mixture in acetic acid, and evaporate to dryness two or three times repeatedly. The oxide of iron is left behind, while the acetat of manganese continues soluble in water.

Ores of tungsten. Wolfram was analysed nearly as follows: The ore was boiled with muriatic acid, and then digested with ammonia alternately till the whole was dissolved. The ammoniacal solutions being evaporated to dryness and calcined, left the yellow oxide of tungsten in a state of purity. The muriatic solutions were mixed with sulphuric acid, evaporated to dryness, and the residuum redissolved in water. A little silica remained. Carbonat of potass precipitated a brown powder from this solution. This powder was treated with boiling nitric acid repeatedly, till the iron which it contained was oxidized to a maximum. It was then digested in acetic acid, which dissolved the manganese, and left the iron. Finally, the manganese was precipitated by an alkali.

Tungstat of lime was thus analysed by Klaproth: One hundred grains of it were digested in nitric acid. The yellow-coloured residue was washed and digested in ammonia. The residue was digested in nitric acid and ammonia alternately, till a complete solution was obtained. Two grains of silica remained behind. The nitric acid solution was mixed with ammonia, but no precipitate appeared. It was then mixed with a boiling solution of carbonat of soda. The precipitate dried weighed 33 grains. It was carbonat of lime; but when redissolved in nitric acid, it left one grain of silica. Thirty-two grains of carbonat are equivalent to 17.6 of lime. The ammoniacal solution, by evaporation, yielded small needleform crystals. When heated to redness in a platinum cruible, they left $77\frac{3}{4}$ grains of oxide of tungsten.

Ores of molybdenum. Molybdena may be treated with nitric acid successively boiled upon it till it is converted into a white powder. This powder, washed and dried, is molybdic acid. The liquid obtained by washing the acid, on the addition of potass, deposits some more molybdic acid. This being separated, muriat of barytes is to be dropt into it as long as any precipitate appears. One hundred parts of this precipitate indicate 14.5 of sulphur.

Ores of uranium. 1. Pechblende, or the black ore of uranium, was dissolved by Klaproth in nitric acid. The undissolved part is a mixture of silica and sulphur. By evaporating the solution, nitrat of lead was precipitated; then nitrated uranium in crystals. The solution being now evaporated to dryness, and treated again with nitric acid, left the iron in the state of red oxide.

2. Uranitic ochre may be treated with nitric acid, which dissolves the uranium, and leaves the iron. The purity of the iron may be tried by the rules already laid down.

3. Green mica was dissolved by Klaproth in nitric acid, and ammonia added in excess to the solution. The oxide of uranium was precipitated; that of copper retained.

Ores of titanium. The ores of titanium, reduced as usual to a fine powder, are to be fused with potass or its carbonat. The melted mass is then to be dissolved in hot water. A white precipitate gradually separates, which is the white oxide of titanium. This is all that is necessary to analyse the first species. But when iron and silica are present, the following method of Chenevix may be adopted: Saturate the alkaline solution with muriatic acid. White oxide of titanium precipitates. Separate the precipitate, and evaporate the solution to dryness. Redissolve the residuum in water. The silica remains behind. Precipitate the solution by an alkali; add the precipitate to the white oxide obtained at first, and dissolve the whole in sulphuric acid. From this solution phosphoric acid precipitates the titanium, but leaves the iron.

The third species, which contains lime and no iron, is to be fused with potass, dissolved in muriatic acid, and the silica separated in the usual way. After this the titanium is first to be separated from the muriatic solution by ammonia; and afterwards the lime by an alkaline carbonat.

Ores of chromium. Vauquelin analysed the chromat of lead in the following manner: When boiled with a sufficient quantity of carbonat of potass, a lively effervescence takes place; the acid combines with the potass, and the carbonat of lead is formed, and remains undissolved. It may be dissolved in nitric acid, and its quantity ascertained by precipitation with sulphuric acid. Or the chromat may be treated with muriatic acid; muriat of lead precipitates, and chromic acid remains in solution. This process must be repeated till the whole of the ore is decomposed. There remains in solution chromic acid mixed with a little muriatic, which may be separated by means of oxide of silver.

ORGAN, in general, is an instrument or machine designed for the production of some certain action or operation; in which sense the mechanic powers, machines, and even the veins, arteries, nerves, muscles, and bones of the human body, may be called organs.

The organs of sense are those parts of the body by which we receive the impressions or ideas of external objects, being commonly reckoned five, viz. the eye, ear, nose, palate, and cutis.

ORGAN, a wind-instrument blown by bellows, and containing numerous pipes of various kinds and dimensions, and multifarious tones and powers. Of all musical insruments this is the most proper for the sacred purpose to which it is most generally applied in all countries wherever it has been introduced. Its structure is lofty, elegant, and majestic; and its solemnity, grandeur, and rich volume of tone, have justly obtained it an acknowledged pre-eminence over every other instrument.

An organ, when complete, is of threefold construction, and furnished with three sets of keys; one for what is called the great organ, and which is the middle set; a second (or lower set) for the choir organ; and a third (or upper set) for the swell. In the great organ, the principal stops are the two diapasons, the principal, the twelfth, the fifteenth, the sesquialtra, the mixture or furniture, the trumpet, the clarion, and the cornet. The choir organ usually contains the stopt diapason, the dulciana, the principal, the flute, the twelfth, the bassoon, and the vox humana. The swell comprises the two diapasons, the principal, the hautboy, trumpet, and cornet. Besides the complete organ, there are other organs of lesser sizes, and more limited powers, adapted to church, chapel, and chamber use. There is also the barrel or hand organ, consisting of a moveable turning cylinder called a barrel, on which, by means of wires, pins, and staples, are set the tunes it is intended to perform. These pins and staples, by the revolution of the barrel, act upon the keys within, and give admission to the wind from the bellows to the pipes. The barrel organ is generally portable; and so contrived that the same action of the hand which turns the barrel, supplies the wind by giving motion to the bellows.

The invention of the organ, which is attributed to the Greeks, is very antient, though it is generally allowed to have been little used before the eighteenth century.

It has been a subject of debate at what time the use of organs was first introduced into the church. Some writers say, that they were first applied to sacred use in the time of pope Vitalian, about the year 660; others that they were not employed in that way till the ninth century. A learned author has, however, shewn that neither of these dates can be just: and Thomas Aquinas expressly says, that in his time (about the year 1250) the church did not use musical instruments; and Bingham says, that Marinus Sauntus, who lived about the year 1290, first introduced the use of them into churches. But if we may give credit to the testimony of Gervas, the monk of Canterbury, who flourished at the beginning of the thirteenth century, organs were introduced more than one hundred years before his time. Bede, who died in 735, says nothing of the use of organs, or other musical instruments, in our churches or convents, though he minutely describes the manner in which the psalms and hymns were sung; yet Mabillon and Muratori inform us, that organs, during the 10th century, became common in Italy and Germany, as well as in England; and that about the same time they had admission into the convents throughout Europe.

The church-organ consists of two parts; the main body, called the great organ, and the positive or little organ, which forms a small case or buffet, commonly placed before the great organ. The size of an organ is generally expressed by the length of its largest pipe; thus they say, an organ of 8, 16, 32 feet, &c. The organ in the cathedral church at Ulm in Germany is 93 feet high and 28 broad; its largest pipe is 13 inches diameter, and it has 16 pair of bellows.

Plate Organ, represents a barrel-organ made by Mr. Lincoln, Holborn, A, figs. 2 and 6, is the handle by which it is played; on its spindle is a crank *a*, that works the bellows which supply the organ with air: these bellows are in two distinct parts BD; and as the lower boards move round *f* as a centre, one of the sides is always filling with air by a valve in its under side, while the other is forcing its way through a valve in the board E into the regulator F, the moveable or upper board of which is pressed down by two wire springs *bb*. When the handle A is turned, the crank *a* by the rod *d*, moves the lower boards BD of the bellows up and down, so that they force the air alternately through their respective valves into the regulator: when a great quantity of air is forced into the regulator, it overcomes the springs, and raises the upper board; and during the time that the bellows supply no air, which is when the valves in the boards BD are shutting, the springs *bb* force down the board of the regulator, and drive the air out of it for the supply of the organ, till the bellows begin to act. The board E has a hole cut through it, which communicates with a passage *ee*, fig. 2; which conveys the air from the regulator to a trunk *g*, called the wind-chest, and which extends the whole length of the organ under the pipes G and H: the board which forms the top of this has a hole through it under every pipe, and is covered by a valve as *h*. *i* is a small wire, the end of which rests upon the valve, so as to open it when the wire is pushed down the passage; for the air is conveyed through the upper board of the wind-chest, under two sliders *kl*, called stops, which have handles (shewn in fig. 6.) coming through the frame, by which they can be moved in or out: these stops slide in tubes, lined with leather, which they fit very exactly, so as to prevent any air getting through by the sides of them; and the stops have as many holes cut through them as there are valves and pipes, and at the same distance from one another; so that when the stops are pushed in, the holes in them coincide with the passage from the valves to the pipes GH, so as to give the air free vent; and when they are drawn out, the spaces between the holes in the stops are brought over the passages, so as to close them, and prevent any air getting through. From the stop *k* the air is conveyed by a crooked passage to the wooden pipes H, and the slider *l* is to intercept the air for the metal pipes G. A section of each kind of pipe is shewn in figs. 3 and 4: *aa* fig. 3 is a cylindric pipe, usually of lead; to one end of this is soldered a conical pipe *bb* of the same metal, at the end *d* of which the air is admitted. Near the junction of the two pipes a piece of metal *e* is soldered, which fills up all the pipe, except a small cavity on one side, which is cut straight; and the edge of the conical pipe *bb* is bent straight, so as to leave a small crack, through which the air issues. The edge *n* of the cylindric pipe is cut to a sharp edge, and bent down to the line with the opening through which the air comes: when the air is blown through the end *d*, it rushes through the opening between the piece *e* and the edge of the pipe *bb*, the sound is formed by the edge *n* dividing the current of air, and the vibration of the air in the remainder of the tube *aa*: in large pipes a small piece of metal *o*, called the ear, is soldered on, which adds much to the sound. The wooden pipe, fig. 4, is composed of a square trunk of wood *aa*: in one end a block of wood *b* is glued; a small wooden pipe *d* is inserted into the lower end of this block to bring the air to the pipe, the end of which is partly closed by a plug of wood to adjust the quantity of air; in the leaden pipes this is done by pinching them up at the end. On one side of the block *b* a piece of oak is glued, between the edge of which and the block *b* the air issues, and is divided, as in the metal pipes, by the edge of one of the boards of the trunk, which is cut sharp for the purpose: the ends of the wooden pipes are closed by a plug of wood *h*, which is slid farther in or out, to adjust the pipe to the proper note. The spindle of the handle A, fig. 6, has an endless screw *m* upon it, which works into a wheel L, the barrel K (shewn separately in fig. 1.). This barrel is made of wood, and has pins drove into it, which pins, as it is turned round, lift up the keys *h*, fig. 6. shewn in fig. 5, where A is the barrel, the pins of which, as it turns, take hold of the end *e* of the keys *n*, and lift them up: these keys are supported by a bar B called the key-frame, on each side of which a brass plate *bb* is screwed, which has notches cut in it to guide each key: a wire *d* is put through each key, round which it moves as a centre; the end *f* of the key has a piece of mahogany fastened to it, to which is jointed the rod I, by a piece of leather. The lower end of this rod is jointed to the wire *i*, fig. 2, by which the valve *h* is opened as before described:- the spring under this valve throws the rod I upwards; and to prevent the end *e* of the key from touching the barrel, a screw *p* is put through the key-frame, the bottom of which is covered with leather, to catch the key without making any noise. The operation of the machine is as follows: When the handle A, fig. 6, is turned, it works the bellows by the crank *a*, and forces the air to the wind chest *g*, fig. 2; at the same time the screw *m* turns the barrel K, fig. 6, slowly round: the pins in its surface lift up the end *e*, fig. 5, of the key, which depresses the other end, and by the rods I and wire *i*, fig. 2, opens the valve, and allows the air (if the stops *k* or *l* are open) to enter the pipe of the proper note, and sound it. As the barrel turns, that key is dropped, and the spring shuts the valve; another pipe, corresponding to the next note of the tune, is then opened and so on till the tune is completed. If the tune is wanted to be played in a high key, the stop *l* is drawn out, and the metal pipes are used; if in a low key the wooden pipes, which are an octave lower, are played, by pulling out the stop K and pushing in the other; if the tune is to be played very loud, both are drawn out; and when both are pushed in, no sound is produced. As a different quantity of air is wanted for playing the metal and wooden pipes, the bellows are made large enough to supply both at once; and when only one is used, the air escapes through a valve in the upper board of the regulator F: this valve has a long handle, and is kept shut by a wire spring; when the board of the regulator is raised to a certain height, the handle of the valve *m* meets a part of the frame, the valve is opened, and the air escapes. The frame in which the barrel is mounted, fig. 1. is slid into a groove M, figs. 2 and 6: to one of the uprights of the frame, a piece of brass N, fig. 1, is screwed; this projects through the outside board of the organ, as shewn in fig. 7, and has as many notches cut in it as the barrel plays different tunes; a bolt O slides into any of these notches, so as to keep the piece N in any place where it is set over the end of this bolt; another bolt P slides so that P must be withdrawn before O can be moved. The bolt P has a wire *w*, figs. 2, 5, and 6, projecting from the back of it through the board: this wire acts upon one end of the lever *r*, so as to push it down when the bolt is drawn back. The key-frame E, fig. 5, is not fastened down to the frame of the organ, but has two pieces of iron plate *g* fastened to the ends of it: the other end of this moves round a screw, as a centre, so that the frame and keys can be turned up clear of the barrel; it has a wire spring S, to keep it down, and a screw *t* regulates its distance from the barrel when down. One end of the lever *r* is put under the key-frame, so that when the outer end is pushed down by drawing back the bolt P, fig. 7, the other will raise the key-frame: the bolt O is then at liberty to be drawn back; and the piece N can be set, and fixed at another notch, which causes the organ to play another tune, by moving the barrel along a small distance, which brings a fresh set of pins under the keys, which are differently disposed. By the arrangement of the bolts as above, the barrel can never be moved without first fitting up the keys, so that there is no danger of breaking the keys of pins in the barrel.

The pannels of the organ are slid into grooves cut in the four uprights of the frame.

ORIBASIA, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the forty-seventh order, stellatæ. The corolla is small, tubulated, and monopetalous. The pericarpium is a globular berry, grooved longitudinally; is quinquelocular, and contains one seed. Of this there are six species, all natives of the warmer parts of America, viz. 1. Officinalis: the natives of Guiana make infusions of the leaves, and give them in cases of spasmodic asthma. 2. Racemosa. 3. Violacea. 4. Lutea. 5. Paniculata. 6. Longiflora.

ORICHALCUM. See Zinc.

ORIGANUM, *origany*, or *marjoram*, a genus of the gymnospermia order, in the didynamia class of plants, and in the natural method ranking under the forty-second order, verticillatæ. There is a strobilus or cone collecting the calcyes together. The principal species are, two hardy perennials and an annual for the open ground, and five perennials for the greenhouse: viz. 1. The vulgare, or wild pot-marjoram. 2. The heracleoticum, or winter sweet-marjoram. These are finely-scented aromatics, excellent for culinary purposes, particularly for broths, soups, &c. they have likewise merit for medical uses, and for giving fragrance to ointments; so that the plants are proper both for kitchen and physic gardens, and may also be employed in the pleasure-ground as plants of variety. 3. The marjorana, or annual sweet-marjoram, is an aromatic of the highest fragrance, is admirable for kitchen use, and excellent for nosegays. It is often called knotted marjoram, from the flowers growing in close knotted-like heads. The following mostly assume an undershrubby growth; frequently with abiding stalks, if they shelter here in winter: 4. The dictamnus or dittany of Crete. 5. The sipyleum, or origanum of mount Sipylus. 6. The creticum, or Cretan origany. 7. The smyrnæum, or Smyrna origany. 8. The ægyptiacum, or Egyptian origany. There are four other species.

ORIGENISTS, in church-history, a Christian sect in the fourth century, so called from their drawing their opinions from the writings of Origen. The origenists maintained, that the souls of men had a pre-existent state, that they were holy intelligences, and had sinned in heaven before the body was created: that Christ is only the son of God by adoption.

ORIGINAL, in the court of king's bench, the usual original writ issued in the actions, as for action of trespass upon the case. And this court does not issue originals in actions of debt, covenant, or account, &c. whereas the court of common-pleas proceeds by original in all kinds of actions; but to arrest and sue a party to outlawry, it is used in both cases. See Impey's B. R. and C. B.

ORIOLUS, *oriole*, in ornithology, a genus belonging to the order of picæ. The bill in this genus is straight, conic, very sharp-pointed; edges cultrated, inclining inwards; mandibles of equal length. Nostrils small, placed at the base of the bill, and partly covered. Tongue divided at the end. Toes, three forward, one backward; the middle joined near the base to the outmost one. These birds are inhabitants of America, except in a few instances; they are a noisy, gregarious, frugivorous, granivorous, and voracious race, very numerous, and often have pensile nests. The several species, which are very numerous, since Mr. Latham describes no less than forty-five, seem to be principally distinguished by their colour.

1. The first species, is called the oriolus Baltimore, by Linnæus, and the Baltimore oriole by Pennant, and is an inhabitant of North America, which country it quits before winter, and probably retires to Mexico; the xochitotl of Fernandez seeming to be of the same species. The head, throat, neck, and upper part of the back of the male, are described to be black; the lesser coverts of the wings orange; the greater black, tipt with white; the breast, belly, lower part of the back, and coverts of the tail, of a bright orange. The head and back of the female are orange, edged with pale brown; the tail dusky, edged with yellow. The length both of the male and female is seven inches. This bird suspends its nest to the horizontal forks of the tulip and poplar trees, formed of the filaments of some tough plants, curiously woven, mixed with wool, and lined with hairs. It is of a pear-shape, open at top, with a hole on the side through which the young are fed. In some parts of North America, this species, from its brilliant colour, is called the fiery hang-nest. It is named the Baltimore bird, from its colours resembling those in the arms of the late lord Baltimore, whose family were proprietors of Maryland.

2. The sharp-tailed oriole is about the size of a lark; the bill is dusky; the crown is brown and cinereous; the cheeks are brown, bounded above and below with deep dull yellow. The throat is white; the breast, sides, thighs, and vent, are a dull pale yellow, spotted with brown; the belly is white; the back is varied with ash-colour, black, and white; the wing-coverts are dusky, with ferruginous edges.

The other species of the oriole, (see Plate Nat. Hist. figs. 301 and 302.) according to Mr. Pennant's enumeration, are the white-backed, the bastard, the black, the brown-headed, the rusty, the white-headed, the Hudsonian white-headed, the olive, the yellow-throated, the unalaschka, the sharp-tailed, and the red-wing. This last species is known in America by the name of the red-winged starling and the swamp blackbird. Although they appear at New York only from April to October, they probably continue through the whole year in the southern parts; at least, Catesby and Latham make no mention of their departure. They are seen at times in such prodigious flocks, as even to obscure the sky. They were esteemed the pest of the colonies, making most dreadful havock among the maize and other grain, both when newly-sown and ripe. They are very bold, and not to be terrified by a gun; for, notwithstanding the sportsman makes slaughter in a flock, the remainder will take a short flight, and settle again in the same field. The farmers sometimes attempt their destruction, by steeping the maize before they sow it in a decoction of white hellebore. The birds that eat this prepared corn, are seized with a vertigo, and fall down, which sometimes drives the rest away. This potion is particularly aimed at the purple grackles or purple jackdaw, which consorts in myriads with this species, as if in conspiracy against the labours of the husbandman. The fowler seldom fires among the flocks without killing some of each. They appear in the greatest numbers in autumn, when they receive additions from the retired parts of the country, to prey on the ripened maize. Some of the colonies established a reward of three-pence a dozen for the extirpation of the jackdaws; and in New England, the intent was almost effected at the cost of the inhabitants; who discovered, at length, that Providence had not formed these seemingly destructive birds in vain. Notwithstanding they caused such havock among the grain, they made ample recompence, by clearing the ground of the noxious worms, the caterpillar of the bruchus pisi, or peas-beetle, in particular, with which it abounds. As soon as the birds were destroyed, the reptiles had full leave to multiply; and the consequence was the total loss of the grass in 1749, when the New Englanders, repenting too late, were obliged to get their hay from Pennsylvania, and even from Great Britain.

ORION, in astronomy, a constellation of the southern hemisphere. See Astronomy.

Orion's ring, in astronomy, a constellation more usually called Eridanus. See Eridanus.

ORNITHOGALUM, *star of Bethlehem*, a genus of the hexandria monogynia class of plants, the corolla whereof consists of six petals, of a lanceolated figure from the base to the middle, erect from thence to the points, plano-patent; they are permanent, but lose their colour: the fruit is a round angulated capsule, formed of three valves, and containing three cells; the seeds are numerous and roundish, the receptacle columnar.

There are thirty-five species, all of them herbaceous and perennial, rising from three to six feet high, having stalks terminated with long spikes of hexapetalous, star-shaped, white and yellow flowers. Six of the species are very hardy, and will prosper in any situation: but one, namely the capense, a native of the Cape of Good Hope, requires the assistance of artificial warmth to preserve it in this country.

ORNITHOLOGY, that branch of zoology, which treats of birds. See Bird. Linnæus, whose ornithology we have followed, arranges the whole class of birds under six orders, according to the different figures of their beaks, viz.

1. Accipitres, upper mandible with an an-

gular projection. 2. Picæ, bill compressed convex; with feet formed for perching or climbing. 3. Anseres, bill covered with skin, broad at the tip; some with and some without teeth. 4. Grallæ, bill roundish, tongue fleshy; some with three some with four toes. 5. Gallinæ, bill convex, upper mandible arched. 6. Passeres, bill conic, sharp-pointed.

ORNITHOPUS, *bird's foot*, a genus of the diadelphia decandria class of plants, with a papilionaceous flower: its fruit is an oblong jointed pod, of a cylindrical figure, and containing in each joint a single roundish seed; add to this, that several of these pods usually grow together. There are five species.

The leaves of this plant are said to be good for a hernia, and for breaking and expelling the stone of the kidneys or bladder.

ORNITHORHYNCHUS PARADOXUS, from New South Wales, a singular quadruped, which has not yet been properly classed in the Linnæan system. The most remarkable circumstance in this curious animal, is the great similarity of its head with that of a duck, which, however, is still more striking in its internal structure. From the external form of the scull of this animal, one might be more easily led to conclude that it belonged to such an aquatic bird, than to a creature of the mammalia tribe. Both the jaws are as broad and low as in a duck, and the calvaria has no traces of a suture, as is generally the case in full-grown birds. There is likewise a singularity in the cavity of the scull, of which nothing like it is known in any quadruped animal of the mammalia, though there exists something analogous in the class of birds, namely, a considerable bony falx, which is situated along the middle of the os frontis, and the ossa bregmatis. This processus is in general scarcely to be seen in the mammalia, even in those that have a bony tentorium cerebelli. The mandible of this animal is very singular, consisting of a beak, the under part of which has its margin indented as in ducks, and of the proper instrument for chewing that is situated behind, within the cheeks. This has no teeth, nor even the traces of alveoli, but only two broad processes of a peculiar formation on each side, whose undulated superficies fit one another. Dr. Shaw says of the specimen he examined, that it had no teeth, "dentium nulla sunt vestigia." But sir Joseph Banks informs us, that Mr. Home has found, in a specimen that belongs to the Society of Natural History at Newcastle, on each side of the jaws, two small and flat molar teeth. The fore part of this anomalous mandible, or the beak, is covered and bordered with a coriaceous skin, in which three parts are to be distinguished: 1. The proper integument of the beak (integumentum rostri). 2. The labiated margins of it (margines labiales). 3. A curious edge of the skin of the beak (limbus transversarius). Into these three parts of that membrane numerous nerves are distributed, of which those in the upper part of the beak arise from the second branch of the fifth pair, viz. in the limbus transversarius; that which penetrates through the foramen infraorbitale, in the margo labialis; that which comes forth behind the ossa intermaxillaria, and to the integumentum rostri, three branches, which run out between the ossa intermaxillaria. From this quantity of nerves, with which the integument of the beak is provided, no doubt is left of this part being intended as the organ of feeling, a sense which, besides men and the quadrumanes, very few mammalia enjoy, that is to say, few animals possess the faculty of distinguishing the form of external objects and their qualities by organs destined for that purpose; a property that is different from the common feeling, by which every animal is able to perceive the temperature and presence of sensible objects, but without being informed by the touch of them, of their peculiar qualities. Thus, for instance, the skin in the wings of a bat, and its ear, serve probably as organs of common feeling, by means of which they are enabled to flutter, after being blinded, without flying against any thing. The whiskers (vibrissæ) of many animals seem likewise to serve for the purpose of informing them of the presence of sensible bodies, on which account Dr. Darwin compares them with the antennæ of insects; but they are not able to inform themselves of the properties of those objects. It is true that the snout of a mole has been considered by Derham, and the snout and tongue of many other animals likewise by Buffon, as organs of touching; but this seems only to be their secondary use. The same may be said of the elephant's trunk, which Buffon also conceives to be an organ of touching, although from its manner of living, the necessity of such an organ of touching does not appear. The ornithorhynchus, however, is an animal which, from the similarity of its abode, and the manner of searching for food, agrees much with the duck, on which account it has been equally provided by nature with an organ for touching, viz. with the integument of the beak, richly endowed with nerves. This instance of analogy in the structure of a singular organ of sense in two species of animals from classes quite different, is highly instructive for comparative physiology, and on this account the ornithorhynchus belongs to one of the most remarkable phenomena of zoology, and may in general be looked upon as one of the most interesting discoveries with which that part of natural history has been enriched during the last century. See Plate Nat. Hist. fig. 303.

OROBANCHE, *broom-rape*, a genus of the didynamia angiospermia class of plants, ranking under the 40th order, personatæ. The corolla is monopetalous and ringent; and its fruit an oblong capsule formed of two valves, and containing a great many minute seeds; the calyx is bifid. There is a glandule under the base of the germen. There are fourteen species.

OROBUS, *bitter vetch*, a genus of the decandria order, in the diadelphia class of plants; and in the natural method ranking under the 32d order, papilionaceæ. The style is linear; the calyx obtuse at the base, with the upper segments deeper and shorter than the rest. There are 16 species. All of them have fibrated roots, which are perennial, but are annual in stalk, rising early in spring and decaying in autumn. They are very hardy plants, and prosper in any common soil of a garden. Most of the sorts are very floriferous, and the flowers conspicuous and ornamental for adorning the flower-compartments. The Scotch Highlanders have a great esteem for the tubercles of the roots of the tuberosus, or species sometimes called wood-pea. They dry and chew them in general to give a better relish to their liquor; they also affirm that they are good against most disorders of the breast, and that by the use of them they are enabled to resist hunger and thirst for a long time. In Breadalbane and Ross-shire, they sometimes bruise and steep them in water, and make an agreeable fermented liquor with them. They have a sweet taste, something like the roots of liquorice; and, when boiled, we are told, they are nutritious and well flavoured; and in times of scarcity have served as a substitute for bread.

ORONTIUM, a genus of the monogynia order, in the hexandria class of plants; and in the natural method ranking under the second order, piperitæ. The spadix is cylindrical, covered with florets; the corolla hexapetalous and naked; there is no style; the follicles are monospermous. There are two species, marsh plants of Canada and Japan.

ORPHAN: in the city of London there is a court of record established for the care and government of orphans.

ORPIMENT. See Arsenic.

ORRERY, a curious machine for representing the motions and appearances of the heavenly bodies. We shall in this place merely shew the theory of the wheels, leaving a more particular description for the article Planetarium. We must first compare and find out the proportion which the periodical times, or revolutions, of the primary planets, bear to that of the earth; and they are such as are expressed in the table below: where the first column is the time of the earth's period in days and decimal parts; the second, that of the planets; the third and fourth are numbers in the same proportion to each other: as

365,25 : 88	☿	:: 83 : 20,	for Merc.
365,25 : 224,7	♀	:: 52 : 32,	for Venus.
365,25 : 686,9	♂	:: 40 : 75,	for Mars.
365,25 : 4332,5	♃	:: 7 : 83,	for Jupiter.
365,25 : 10759,3	♄	:: 5 : 148,	for Saturn.

If we now suppose a spindle or arbor with six wheels fixed upon it in an horizontal position, having the number of teeth in each corresponding to the numbers in the third column, viz. the wheel AM (see Plate Observatory, fig. 6.) of 83 teeth, BL of 52, CK of 50 (for the earth), DI of 40, EH of 7, and FG of 5; and another set of wheels moving freely about an arbor, having the number of teeth in the fourth column, viz. AN of 20, BO of 32, CP of 50 (for the earth), DQ of 75, ER of 83, and FS of 148; then, if those two arbors of fixed and moveable wheels are made of the size, and fixed at the distance from each other, as here represented in the scheme, the teeth of the former will take those of the latter, and turn them very freely, when the machine is in motion.

These arbors, with their wheels, are to be placed in a box of an adequate size, in a perpendicular position: the arbor of fixed wheels to move in pivots at the top and bottom of the box; and the arbor of moveable wheels to move in pivots at the top and bottom of the box; and the arbor of moveable wheels to go through the top of the box, on a proper height, on the top of which is to be placed a round ball, gilt with gold, to represent the sun. On each of the moveable wheels is to be fixed a socket, or tube, ascending above the top of the box, and having on the top a wire fixed, and bent at a proper distance into a right angle upwards, bearing on the top a small round ball, representing its proper planet.

If then on the lower part of the arbor of fixed wheels is placed a pinion of screw-teeth, a winch turning a spindle with an endless screw, playing in the teeth of the arbor, will turn it with all its wheels; and these wheels will move the others about with their planets, in their proper and respective periods of time, very exactly. For, while the fixed wheel CK moves its equal CP once round, the wheel AM will move AN a little more than four times round, and so will nicely exhibit the motion of Mercury; and the wheel FG will turn the wheel FS about $\frac{1}{29,5}$ round, and so will truly represent the motion of Saturn, and the same is to be observed of all the rest.

ORTEGIA, a genus of the class and order triandria monogynia. The calyx is five-leaved; corolla none; capsule one-celled; seeds many. There are two species, trailing plants of Spain and Italy.

ORTHOGRAPHY, that part of grammar which teaches the nature and affections of letters, and the just method of spelling or writing.

ORTHOGRAPHY, in geometry, the art of drawing or delineating the fore-right plan of any object, and of expressing the heights or elevations of each part. It is called orthography, from its determining things by perpendicular lines falling on the geometrical plane.

ORTHOGRAPHY, in architecture, the elevation of a building.

ORTHOGRAPHY. See PERSPECTIVE.

ORTOLAN. See EMBERIZA.

ORYZA, *rice*, a genus of the digynia order, in the hexandria class of plants; and in the natural method ranking under the 4th order, gramina. The calyx is a bivalved uniflorous glume; the corolla bivalved, nearly equal, and adhering to the seed. There is but one species, namely, the sativa or common rice. This plant is greatly cultivated in most of the Eastern countries, where it is the chief support of the inhabitants; and great quantities of it are brought into England and other European countries every year, where it is much esteemed for puddings, &c. it being too tender to be produced in these northern countries without the assistance of artificial heat; but from some seeds which were formerly sent to Carolina there have been great quantities produced, and it is found to succeed there as well as in the Eastern countries.

This plant grows upon moist soils, where the ground can be flowed over with water after it is come up.

Rice is the chief commodity and riches of Damieta in Egypt, and Dr. Hasselquist gives the following description of the manner in which they dress and separate it from the husks. "It is pounded by hollow iron pestles of a cylindrical form, lifted up by a wheel worked by oxen. A person sitting between the two pestles, pushes forward the rice when the pestles are rising; another sifts, winnows, and lays it under the pestles. In this manner they continue working it until it is entirely free from chaff and husks. When clean, they add a thirtieth part of salt, and pound them together; by which the rice, formerly grey, becomes white. After this purification, it is passed through a fine sieve to part the salt from the rice; and then it is ready for sale." Damieta sells every year 60,800 sacks of rice, the greatest part of which goes to Turkey, some to Leghorn, Marseilles, and Venice.

Rice, according to Dr. Cullen, is preferable to all other kinds of grain, both for largeness of produce, quantity of nourishment, and goodness. This, he says, is plain from macerating the different grains in water; for, as the rice swells to the largest size, so its parts are more intimately divided. Rice is said to affect the eyes; but this is purely prejudice. Thus it is alleged a particular people of Asia, who live on this grain, are blind-eyed; but if the soil is sandy, and not much covered with herbage, and the people are much employed in the field, this affection of their eyes may be owing to the strong reflection of the rays of light from this sandy soil; and our author is the more inclined to this opinion, because no such effect is observed in Carolina, where rice is commonly used.

OSBECKIA, a genus of the octandria monogynia class and order. The cal. is four-cleft; cor. four and five-petalled; stam. eight or ten; anthers beaked; caps. inferior, four-celled. There is one species, a trifling plant of China.

OSCILLATION, in mechanics, the vibration, or reciprocal ascent and descent, of a pendulum. See PENDULUM.

It is demonstrated, that the time of a complete oscillation in a cycloid, is to the time in which a body would fall through the axis of that cycloid, as the circumference of a circle to its diameter; whence it follows, 1. That the oscillations in the cycloid are all performed in equal times, as being all in the same ratio to the time in which a body falls through the diameter of the generating circle. 2. As the middle part of the cycloid may be conceived to coincide with the generating circle, the time in a small arch of that circle will be nearly equal to the time in the cycloid; and hence the reason is evident, why the times in very little arches are equal. 3. The time of a complete oscillation in any little arch of a circle, is to the time in which a body would fall through half the radius, as the circumference of a circle, to its diameter; and since the latter time is half the time in which a body would fall through the whole diameter, or any chord, it follows that the time of an oscillation in any little arch, is to the time in which a body would fall through its chord, as the semicircle to the diameter. 4. The times of the oscillations in cycloids, or in small arches of circles, are in a sub-duplicate ratio of the lengths of the pendulums. 5. But if the bodies that oscillate are acted on by unequal accelerating forces, then the oscillation will be performed in times that are to one another in the ratio compounded of the direct subduplicate ratio of the lengths of the pendulums, and inverse subduplicate ratio of the accelerating forces. Hence it appears that if oscillations of unequal pendulums are performed in the same time, the accelerating gravities of these pendulums must be as their lengths; and thus we conclude, that the force of gravity decreases as you go towards the equator, since we find that the lengths of pendulums that vibrate seconds are always less at a less distance from the equator. 6. The space described by a falling body in any given time, may be exactly known; for finding, by experiments, what pendulum oscillates in that time, the half of the pendulum will be to the space required, in the duplicate ratio of the diameter of a circle to the circumference.

Centre of OSCILLATION. See CENTRE.

OSMITES, a genus of the class and order syngenesia polygamia frustranea. The cal. is imbricate, scariose; cor. of the ray ligulate; down obsolete; recept. chaffy. There are four species, shrubs of the Cape.

OSMUNDA, *moon-wort*; a genus of the order of filices, in the cryptogamia class of plants. There are twenty-seven species; the most remarkable of which is the regalis, osmund-royal, or flowering fern. This is a native of Britain, growing in putrid marshes. Its leaf is doubly winged, bearing bunches of flowers at the ends. The root boiled in water is very slimy; and is used in the north to stiffen linen instead of starch. Some of the leaves only bear flowers.

OSSIFICATION, the formation of bones. See CONCRETIONS.

OSTEOLOGY. See ANATOMY.

OSTEOSPERMUM, a genus of the class and order syngenesia polygamia necessaria. The cal. is simple, in two rows, many-leaved, almost equal; seeds globular, coloured, bony; down none; recept. naked. There are 17 species, shrubs of the Cape.

OSTRACION, in ichthyology, a genus of the branchiostegous order of fishes, of a globose, oval, or ovato-quadrangular figure: the skin is always very firm and hard; and is in some species smooth, in others entirely covered with spines; and, finally, in some the spines entirely occupy only particular places; there are no belly-fins, and the others are five in number, viz. two pectoral or lateral fins, one on the back, the pinna ani, and the tail. There are 12 species of this genus: the triqueter has a triangular body unarmed; inhabits India; the back appearing as if covered with rhombic marks cut transversely. The quadricornis, with frontal and subcaudal spines, inhabits India and Guinea.

OSTRACION, trunk-fish, a genus of fishes, of the order nantes; the generic character is, teeth pointing forwards, cylindric, rather blunt; body mailed by a bony covering.

1. Ostracion triqueter, triquetral trunk-fish; the ostracions or trunk-fishes are so strikingly distinguished by their bony crust or covering, that no difficulty can arise to the ichthyological student in referring them to their proper genus. The investigation of the species however demands a greater degree of attention, and such is the similarity between some of these, that it remains doubt-

ful whether they should be considered as truly distinct, or as constituting mere sexual differences.

The triquetral trunk-fish measures about twelve inches in length, and is, as its name imports, of a trigonal shape, the sides sloping obliquely from the ridge of the back, and the abdomen being flat; the whole animal, except to within a small distance from the tail, is completely enveloped in a bony covering, divided into well-defined hexagonal spaces, and covered (as in the whole genus) with a transparent epidermis like that of the armadillo among quadrupeds; the usual colour is a subferruginous brown, with a white spot in the centre of each hexagon, which is also marked by fine rays diverging from the centre to the edges: the fins are yellowish, and the tail rounded; the naked part of the extremity of the body or base of the tail being marked with white specks, similar to those on the crustaceous part of the animal: the pectoral fins are rather small than large, and of a rounded shape: the dorsal and anal are also rather small, and are situated opposite each other towards the extremity of the body, and, like the rest of the genus, this fish is destitute of ventral fins. It is a native of the Indian and American seas, and is supposed to feed on the smaller crustacea, shell-fish, and sea-worms. It is said to be considered as an excellent fish for the table, and is held in high estimation among the East Indians. There are ten species.

2. Ostracion quadricornis, four-horned trunk-fish; length twelve inches; shape subtrigonal; the back, when viewed in profile, strongly arched, and having a smooth outline; mail divided into large hexagons marked with numerous and very small tubercles; on the top of the head two very strong spines pointing forwards; and from the hind part of the abdomen, immediately before the anal fin, two more spines pointing backwards; colour of the mailed part subviolaceous brown, with darker streaks irregularly dispersed over the whole; naked part of the body near the tail, yellowish-brown, marked with deep-brown spots; fins and tail yellowish-brown. Native of the Indian and American seas. See Plate Nat. Hist. fig. 304.

OSTREA, the *oyster*, in zoology, a genus belonging to the order of vermes testacea. The shell has two unequal valves; the cardo has no teeth, but a small hollowed one with transverse lateral streaks. There are thirty-one species, principally distinguished by peculiarities in their shells. The common oyster is reckoned an excellent food; and is eaten both raw and variously prepared. The character of the genus, in the words of Barbut, is, "The animal a tethys; the shell bivalve, unequivalve, with something like ears; the hinge void of teeth, with a deep oval hole, and transverse streaks on the sides. There is no womb nor anus." The genus is divided into four families, of which ostrea is the last.

The oyster differs from the muscle in being utterly unable to change its situation. It is entirely without a tongue which answers the purposes of an arm in the other animal, but nevertheless is often attached very firmly to any object it happens to approach. Nothing is so common in the rivers of the tropical climates, as to see oysters growing even amidst the branches of the forest. Many trees, which grow along the banks of the stream, often bend their branches into the water, and particularly the mangrove, which chiefly delights in a moist situation. To these the oysters hang in clusters, like apples upon the most fertile trees; and in proportion as the weight of the fish sinks the plant into the water, where it still continues growing, the number of oysters encrease, and hang upon the branches. This is effected by means of a glue proper to themselves, which when it cements, the joining is as hard as the shell, and is as difficultly broken.

Oysters usually cast their spawn in May, which at first appears like drops of candle-grease, and sticks to any hard substance it falls upon. These are covered with a shell in two or three days; and in three years the animal is large enough to be brought to market. As they invariably remain in the places where they are laid, and as they grow without any other seeming food than the afflux of sea-water, it is the custom at Colchester, and other parts of England, where the tide settles in marshes on land, to pick up great quantities of small oysters along the shore, which, when first gathered, seldom exceed the size of sixpence. These are deposited in beds where the tide comes in, and in two or three years grow to a tolerable size. They are said to be better tasted for being thus sheltered from the agitations of the deep; and a mixture of fresh water entering into these repositories, is said to improve their flavour, and increase their growth and fatness.

The oysters, however, which are prepared in this manner, are by no means so large as those found sticking to rocks at the bottom of the sea, usually called rock-oysters. These are sometimes found as broad as a plate, and are admired by some as excellent food. But what is the size of these compared to the oysters of the East Indies, some of whose shells have been seen two feet over! The oysters found along the coast of Coromandel, are capable of furnishing a plentiful meal for eight or ten men; but it seems universally agreed that they are no way comparable to ours for delicacy of flavour.

OSTRICH. See STRUTHIO.

OSYRIS, *poet's rosemary*, a genus of the diœcia triandria class of plants, without any flower-petals; the fruit is a globose unilocular berry, containing a single osseous seed. There are two species. This whole shrub is astringent, and consequently good in fluxes.

OTHERA, a genus of the tetrandria monogynia class and order. The cal. is four-parted; pet. four; stigma sessile; caps. There is one species, a shrub of Japan.

OTHONNA, a genus of the polygamia necessaria order, in the syngenesia class of plants; and in the natural method ranking under the 49th order, compositæ. The receptacle is naked; there is almost no pappus; the calyx is monophyllous, multifid, and nearly cylindrical. There are 27 species.

OTIS, the **bustard**, in ornithology, a distinct genus of birds, of the order of the gallinæ, the characters of which are these: there are three toes on each foot, all turned forwards; and the head is naked, or has no comb. There are four species, principally distinguished by their colour. One of the species, the tarda, or bustard (see Plate Nat. Hist. fig. 305.), is the largest of the British land fowl, the male at a medium weighing 25 pounds; there are instances of some very old ones weighing 27: the breadth nine feet; the length near four. Besides the size and difference of colour, the male is distinguished from the female by a tuft of feathers about five inches long on each side of the lower mandible. Its neck and head are ash-coloured; the back is barred transversely with black, and bright rust-colour; the greater quill-feathers are black; the belly white; the tail is marked with broad red and black bars, and consists of twenty feathers; the legs dusky.

The female is about half the size of the male: the crown of the head is of a deep orange, traversed with black lines; the rest of the head is brown. The lower part of the fore-side of the neck is ash-coloured; in other respects it resembles the male, only the colours of the back and wings are more dull.

The birds inhabit most of the open countries of the south and east parts of this island, from Dorsetshire as far as the Wolds in Yorkshire. They are exceedingly shy, and difficult to be shot; run very fast; and when on the wing can fly, though slowly, many miles without resting. It is said, that they take flight with difficulty, and are sometimes run down with greyhounds. They keep near their old haunts, seldom wandering above twenty or thirty miles. Their food is corn and other vegetables, and those large earth-worms that appear in great quantities on the downs before sun-rising in the summer. These are replete with moisture, answer the purpose of liquids, and enable them to live long without drinking on those extensive and dry tracts. Besides this, nature has given the males an admirable magazine for their security against drought, being a pouch whose entrance lies immediately under the tongue, and which is capable of holding near seven quarts; and this they probably fill with water, to supply the hen when sitting, or the young before they can fly. Bustards lay only two eggs of the size of those of a goose, of a pale olive-brown, marked with spots of a dark colour; they make no nest, only scrape a hole in the ground. In autumn they are (in Wiltshire) generally found in large turnip-fields near the downs, and in flocks of 50 or more.

OTTER. See MUSTELA.

OVAL, an oblong curvilinear figure, otherwise called ellipsis. The proper oval, however, or egg-shape, differs considerably from that of the ellipsis, being an irregular figure, narrower at one end than at the other; whereas the ellipsis, or mathematical oval, is equally broad at each end; though it must be owned, these two are commonly confounded together, even geometricians calling the oval a false ellipsis.

OVARIES. See ANATOMY, and COMPARATIVE ANATOMY.

OVIEDA, a genus of the didynamia angiospermia class and order. The cal. is five-cleft; cor. tube subylindric, superior, very long; berry globular. There are two species, shrubs of South America.

OVER-HALE, in the sea language. A rope is said to be overhaled when drawn too stiff, or haled the contrary way.

OVER-RAKE, among seamen: when a ship riding at anchor, so overbeats herself into a head-sea, that she is washed by the waves breaking in upon her, they say the waves over-rake her.

OVERSEERS *of the poor*. The proper number of overseers of the poor for each parish, must be duly appointed, and sworn before two justices of the peace, one whereof must be of the quorum.

The overseers thus appointed, and taking on them the office, shall within fourteen days, receive the books of assessments, and of accounts, from their predecessors, and what money and materials shall be in their hands, and reimburse them for their arrears. 17 Geo. II. c. 38.

And shall take order from time to time, with the consent of two such justices as aforesaid, for setting to work the children of such parents who shall not by the said overseers be thought able to keep or maintain them, and using no ordinary or daily trade of life to get their living by. 43 Eliz. c. 2.

By the 17 Geo. II. c. 38. if any person shall be aggrieved by any thing done or omitted by the churchwardens and overseers, or by any of his majesty's justices of the peace, he may, giving reasonable notice to the churchwardens or overseers, appeal to the next general or quarter-sessions, where the same shall be heard, or finally determined; but if reasonable notice is not given, then they shall adjourn the appeal to the next general or quarter-sessions; and the court may award reasonable costs to either party, as they may do by 8 and 9 W. in case of appeals concerning settlements. See POOR.

OVERT ACT. In the case of treason in compassing or imagining the death of the king, this imagining must be manifested by some open act; otherwise being only an act of the mind, it cannot fall under any judicial cognizance. Bare words are held not to amount to an overt act, unless put into writing, in which case they are then held to be an overt act, as arguing a more deliberate intention. No evidence shall be admitted of any overt act, that is not expressly laid in the indictment. 7 W. c. 3.

OVIS, *sheep*, a genus of quadrupeds of the order pecora: the generic character is, horns hollow, wrinkled, turning backwards, and spirally intorted; front-teeth, eight in the lower jaw; canine-teeth, none.

1. Ovis ammon, argali. As the capra ægagrus, or Caucasan ibex, is supposed to be the original of the domestic goat, so the ovis ammon, argali, or musimon, is believed to be the chief primæval stock from which all the kinds of domestic sheep have proceeded; many of which differ full as widely both from each other and their archetype as the goats.

Argali, or wild sheep, is an inhabitant of rocky or mountainous regions, and is chiefly found in the alpine parts of Asia. It was first observed by Dr. Pallas throughout the vast chain of mountains extending through the middle of the continent to the Eastern sea. In Kamtschatka it is plentiful; it occurs also in Barbary, in the mountains of Greece, and in the islands of Corsica and Sardinia; differing merely in a few slight particulars of colour and size, according to its climate.

The general size of the argali is that of a small fallow deer. Its colour is a greyish ferruginous brown above, and whitish beneath; the face is also whitish, and behind each shoulder is often observed a dusky spot or patch; the legs, at least in the European kind, are commonly white; the head strongly resembles that of a ram, but the ears are smaller in proportion, the neck more slender; the body large; the limbs slender but strong; the tail very short, being hardly more than three inches in length; the horns in the full-grown or old animals, are extremely large, placed on the top of the head, and stand close at their base, rising first upwards, and then bending down and twisting outwards as in the common ram; the body is covered with hair instead of wool, in which particular consists its chief difference from the general aspect of a sheep; but in winter the face, and particularly the part about the tip of the nose, becomes whiter, the back of a more ferruginous cast, and the hair, which in summer is close, like that of a deer, becomes somewhat rough, wavy, and a little curled, consisting of a kind of wool intermixed with hair, and concealing at its roots a fine white woolly down; the hair about the neck and shoulders, as well as under the throat, is considerably longer than on the other parts. The female is inferior in size to the male, and has smaller and less curved horns.

In Siberia the argali is chiefly seen on the tops of the highest mountains exposed to the sun, and free from woods. The animals generally go in small flocks; they produce their young in the middle of March, and have one, and sometimes two, at a birth. The young, when first born, are covered with a soft, grey, curling fleece, which gradually changes into hair towards the end of summer.

The horns of the old males grow to a vast size, and have been found of the length of two Russian yards, measured along the spires; weighing fifteen pounds each. We are assured by father Rubruquis, a traveller in the thirteenth century, that he had seen some of the horns so large that he could hardly lift a pair with one hand, and that the Tartars make great drinking-cups of them. A more modern traveller has asserted, that young foxes occasionally shelter themselves in such as are here and there found in the deserts.

In Corsica, the argali is known by the name of mufro; where it is so wild as rarely to be taken alive, but is shot by the hunters, who lie in wait for it among the mountains. When the young are taken, however, which is sometimes the case when the parent is shot, they are observed to be very readily tamed.

From the above description it will sufficiently appear, that the wild sheep is by no means that seemingly helpless animal which we view in a state of confinement in artificial life; but in the highest degree active and vigorous. It is supposed to live about fourteen years.

2. Ovis aries, the common sheep. This animal is so generally known, that a particular description of its form and manners becomes unnecessary. The domestic sheep, in its most valuable or woolly state, exists hardly any where in perfection except in Europe, and some of the temperate parts of Asia. When transported into very warm climates, it loses its peculiar covering, and appears coated with hair, having only a short wool next the skin. In very cold climates also, the exterior part of the wool is observed to be hard and coarse, though the interior is more soft and fine. In England, and some other European regions, the wool acquires a peculiar length and fineness, and is best adapted to the various purposes of commerce. That of Spain is still finer, but less proper for using alone; and is mixed with the English for the superior kinds of cloth.

Of all the domestic animals, none is so subject to various disorders as the sheep. Of these, one of the most extraordinary, as well as the most fatal, is the rot, owing to vast numbers of worms, of the genus fasciola, which are found in the liver and gall-bladder. They are of a flat form, of an oval shape, with slightly pointed extremities, and bear a general resemblance to the seeds of a gourd.

3. Ovis strepsiceros, Cretan sheep; this variety is principally found in the island of Crete, and is kept in several parts of Europe for the singularity of its appearance; the horns being very large, long, and twisted in the manner of a screw; those of the male are upright, those of the female at right angles to the head. This animal is ranked as a distinct species in the Systema Naturæ. See Plate Nat. Hist. fig. 306.

4. Ovis Guineensis, African sheep. This, which is sometimes termed the Cape sheep, and which is erroneously mentioned in Buffon's Natural History as of Indian extraction, is supposed to be most frequent in Guinea, and is distinguished from others by its remarkably meagre appearance, length of neck and limbs, pendant ears, and long arched or curved visage. It is covered rather with hair than wool, and has a pair of pendant hairy wattles beneath the neck, as in goats. The horns are small, and the tail long and lank. This variety is also considered as a distinct species in the twelfth edition of the Systema Naturæ. See Plate Nat. Hist. figs. 307, 308.

5. Ovis laticaudata, broad-tailed sheep; this extraordinary and awkward variety occurs in Syria, Barbary, and Ethiopia. It is also found in Tartary, Tibet, &c. Its general appearance, as to other parts of the body, scarcely differs from that of the European sheep, and in Tibet it is remarkable for the exquisite fineness of its wool. The tails of these sheep sometimes grow so large, long, and heavy, as to weigh, according to some reports, from fifteen to fifty pounds; and in order to enable the animal to graze with convenience, the shepherds are often obliged to put a board, furnished with small wheels, under the tail. This part of the sheep is of a substance resembling marrow, and is considered as a great delicacy.

6. Ovis pudu. This is a newly discovered species, having been first described by Molina, in his Natural History of Chili. He informs us that it is a native of the Andes;

that it is of a brown colour; about the size of a kid of half a year old; with very much the appearance of a goat; but with small smooth horns, bending outwards, and without any appearance of beard. It is of a gregarious nature, and when the snow falls on the upper parts of the mountains, descends into the valleys in large herds, to feed in the plains of Chili, at which time it is easily taken, and readily tamed. The female is without horns.

OUNCE, a little weight, the sixteenth part of a pound avoirdupois, and the twelfth part of a pound troy; the ounce avoirdupois is divided into eight drams, and the ounce troy into twenty pennyweights.

OUNCE. See FELIS.

OUTLAWRY, is being put out of the law, or out of the king's protection. It is a punishment inflicted for a contempt in refusing to be amenable to the process of the higher courts. By outlawry in civil actions, a person is put out of the protection of the law, so that he is not only incapable of suing for the redress of injuries, but may be imprisoned, and forfeits all his goods and chattels, and the profits of his land; his personal chattels immediately upon the outlawry, and his chattels real, and the profits of his lands, when found by inquisition. 1 Salk. 395.

It seems that originally process of outlawry only lay in treason and felony, and was afterwards extended to trespass of an enormous nature; but the process of outlawry at this day lies in all appeals, and in all indictments of conspiracy and deceit, or other crimes of a higher nature than trespass vi et armis; but it lies not in an action, nor on an indictment on a statute, unless it is given by such statute either expressly, as in the case of a præmunire; or impliedly, as in cases made treason or felony by statute; or where a recovery is given by an action in which such process lay before, as in case of forcible entry. Staundf. 192.

Process of outlawry. The exigent must be sued in the county where the party really resides, for there all actions were originally laid; and because outlawries were at first only for treason, felony, or very enormous trespasses, the process was to be executed at the *torn,* which is the sheriff's criminal court; and this held not only before the sheriff, but before the coroners, who were antient conservators of the peace, being the best men in each county, to preside with the sheriff in his court, and who pronounced the outlawry in the county-court on the parties being quintò exactus; and therefore antiently there was no occasion for any process to any other county than that in which the party actually resided. But the modern practice being different, the reader is referred to Tidd's Pract. K. B.

Of the reversal of outlawries. There are two ways of reversing an outlawry: first, by a writ of error returnable coram nobis; secondly by motion founded on a plea, averment, or suggestion of some matter apparent; as in respect of a supesedeas, omission of process, variance, or other matter apparent on the record.

OUTLICKER, in a ship, a small piece of timber made fast to the top of the poop, and standing out right astern. At the outmost end thereof is a hole, into which the standing part of the sheet is reeved.

OUTWORKS, in fortification, all those works made withoutside the ditch of a fortified place, to cover and defend it. See FORTIFICATION.

OX. See BOS.

OXALATS, salts formed by the oxalic acid. This genus of salts was first made known by Bergman, who described the greater number of them in his Dissertation on Oxalic Acid, published in 1776. These salts may be distinguished by the following properties: 1. When exposed to a red heat, their acid is decomposed and driven off, and the base only remains behind. 2. Lime-water precipitates a white powder from their solutions, provided no excess of acid is present. This powder is soluble in acetic acid, after being exposed to a red heat. 3. The earthy oxalats are in general nearly insoluble in water: the alkaline oxalats are capable of combining with an excess of acid, and forming superoxalats much less soluble than the oxalats. 4. The insoluble oxalats are rendered easily soluble by an excess of the more powerful acids.

OXALIC ACID. When nitric acid is poured upon sugar, and a moderate heat applied, the sugar soon melts, an effervescence ensues, a great quantity of nitrous gas and carbonic acid gas is emitted; and when the effervescence ceases, and the liquid in the retort is allowed to cool, a number of small transparent chrystals appear in it. These chrystals constitute a peculiar acid, which has received the name of oxalic acid, because it exists ready-formed, as Scheele has proved, in the oxalis acetosella, or woodsorrel. At first, however, it was called the acid of sugar, or the saccharine acid.

Oxalic acid is in the form of four-sided prisms, whose sides are alternately larger, and they are terminated at the extremities by two-sided summits. They are transparent, and of a fine white colour, with considerable lustre. They have a very acid taste, and redden vegetable blues.

When this chrystallized acid is exposed to heat in an open vessel, there arises a smoke from it, which affects disagreeably the nose and lungs. The residuum is a powder of a much whiter colour than the acid had been. By this process it loses three-tenths of its weight, but soon recovers them again on exposure to the air. When distilled, it first loses its water of chrystallization, then liquefies and becomes brown; a little phlegm passes over, a white saline crust sublimes, some of which passes into the receiver; but the greatest part of the acid is destroyed, leaving in the retort a mass one-fiftieth of the whole, which has an empyreumatic smell, blackens sulphuric acid, renders nitric acid yellow, and dissolves in muriatic acid without alteration. That part of the acid which sublimes is unaltered. When this acid is distilled a second time, it gives out a white smoke, which, condensing in the receiver, produces a colourless unchrystallizable acid, and a dark-coloured matter remains behind. During all this distillation, a vast quantity of elastic vapour makes its escape. From 279 grains of oxalic acid, Bergman obtained 109 cubic inches of gas, half of which was carbonic acid, and half carbureted hydrogen. Fontana, from an ounce of it, obtained 430 cubic inches of gas, one-third of which was carbonic acid, the rest carbureted hydrogen. From these facts, it is evident, that oxalic acid is composed of oxygen, hydrogen, and carbon.

The chrystals of oxalic acid are soluble in their own weight of boiling water. Water at the temperature of 65.7° dissolves half its weight of them. The specific gravity of the solution is 1.0593. One hundred parts of boiling alcohol dissolve 56 parts of these chrystals; but at a mean temperature only 40 parts. Liquid oxalic acid has a very a rid taste when it is concentrated, but a very agreeable acid taste when sufficiently diluted with water.

It changes all vegetable blues, except indigo, to a red. One grain of chrystallized acid, dissolved in 1920 grains of water, reddens the blue paper in which sugar-loaves are wrapt: one grain of it, dissolved in 3600 grains of water, reddens paper stained with turnsole. According to Morveau, one part of the chrystalline acid is sufficient to communicate a sensible acidity to 2633 parts of water.

Its fixity is such, that none of it is sublimed when water containing it in solution is raised to the boiling temperature.

Oxalic acid is not affected by exposure to the air, or to the action of oxygen gas. The effect of the simple combustibles on it has not been tried.

It is capable of oxidizing lead, copper, iron, tin, bismuth, nickel, cobalt, zinc, and manganese.

It does not act upon gold, silver, platina, nor mercury.

Oxalic acid combines with alkalies, earths, and metallic oxides, and forms salts known by the name of oxalats.

Muriatic and acetic acids dissolve oxalic acid, but without altering it. Sulphuric acid decomposes it partly by the assistance of heat, and a quantity of charcoal is formed. Nitric acid decomposes it at a boiling heat, and converts it into water and carbonic acid. From this result, and from the products obtained by distilling pure oxalic acid, it follows, that this acid is composed of oxygen, hydrogen, and carbon. Fourcroy informs us, that Vauquelin and he have ascertained that it is composed of

77	oxygen
13	carbon
10	hydrogen
100.	

But the experiments upon which this result is founded, have not been published; so that it is impossible to judge of their accuracy.

The affinities of oxalic acid, according to Bergman, are as follows:

Lime,
Barytes,
Strontian,
Magnesia,
Potass,
Soda,
Ammonia,
Alumina.

This acid is too expensive to be employed for the purposes of domestic economy; but it is extremely useful in chemistry to detect the presence of lime held in solution. For this purpose, either a little of the pure acid, or of the solution of oxalat of ammonia, is dropt into the liquid supposed to contain lime. If any is present, a white powder immediately precipitates. The reason of this is, that oxalat of lime is altogether insoluble, and oxalic acid in consequence is capable of taking lime from every other acid.

OXALIS, *woodsorrel*, a genus of the pentagynia order, in the decandria class of plants, and in the natural method ranking under the 14th order, gruinales. The calyx is pentaphyllous, the petals connected at the heels, the capsule pentagonal, and opening at the angles. There are 96 species; of which the common woodsorrel grows naturally in moist shady woods, and at the sides of hedges, in many parts of Britain, and is but seldom admitted into gardens. The roots are composed of many scaly joints, which propagate in great plenty. The leaves arise immediately from the roots upon single long footstalks, and are composed of three heart-shaped lobes. They are gratefully acid, and of use in the scurvy and other putrid disorders. The bulbous kinds from the Cape are elegant ornaments of the greenhouse.

OXIDE, any substance combined with oxygen, in a proportion not sufficient to produce acidity.

Oxygen is capable of combining with bodies usually in various proportions, constituting a variety of compounds with almost every substance with which it is capable of uniting. Now the whole of the compounds into which oxygen enters, may be divided into two sets: 1. Those which possess the properties of acids; and, 2. Those which are destitute of these properties. The first set of compounds are distinguished by the term acids; to the second, the term oxide has been appropriated. By oxide, then, is meant a substance composed of oxygen and some other body, and destitute of the properties which belong to acids. It is by no means uncommon to find a compound of the same base and oxygen belonging to both of these sets, according to the proportion of oxygen which enters into the compound. In all these cases, the smaller proportion of oxygen constitutes the oxide; the larger the acid. Hence it follows, that oxides always contain less oxygen than acids with the same base.

Oxygen combines with three distinct set of bodies, the simple combustibles, the incombustibles, and the metals, and forms oxides with every individual belonging to these sets. These oxides vary as the substance which constitutes the base; but all the oxides of the simple combustibles are combustible, except the oxide of hydrogen, which is a product of combustion; all the oxides of the simple incombustibles are supporters of combustion; and all the oxides of the metals are either products of combustion or supporters. Of course, the first set of oxides (except that of hydrogen) cannot be formed by combustion; neither can the second set; but part of the third set are formed by combustion, a part by the union of the oxygen of supporters without combustion.

Besides these oxides, which may be considered as simple, because they contain but one ingredient combined with oxygen, there is another set much more numerous than they, consisting of oxygen united at once with two or more simple substances. These bodies may be distinguished from the others by giving them the name of compound oxides.

Oxides are often distinguished according to the degree of oxygen they contain. Thus the protoxide or first oxide denotes a metal combined with the least portion of oxygen; deutoxide, or second oxide, a metal combined with two doses of oxygen; and when a metal has combined with as much oxygen as possible, the compound is called a peroxide.

Oxide, *carbonic*. When a mixture of purified charcoal and oxide of iron or zinc is exposed to a strong heat in an iron retort, the metallic oxide is gradually reduced, and during the reduction a great quantity of gas is evolved. This gas is a mixture of carbonic acid gas, and another which burns with a blue flame. This last is carbonic oxide.

OXYBAPHUS, a genus of plants as yet unclassed, nearly allied to the mirabilis, a native of Peru.

OXYGEN, in chemistry, a simple substance that enters into the composition of water and air. The term oxygen signifies that which generates or produces acids. This, one of the most characteristic properties of this body, was discovered by Dr. Priestley in 1774. It was at first called dephlogisticated air, and afterwards successively known by the names of eminently-respirable air, pure air, vital air, as long as it was not known that this aerial form is merely one of its states of combination; which, notwithstanding its frequency, and its being less impure in this than in any other condition, does not prevent its being concealed in other states; and more particularly as, by combining with many bodies, it loses this elastic state or appearance of air. As soon as this truth was well proved, and clearly explained by Lavoisier, the necessity was admitted of giving it a different name, which might be applicable to all the states in which it could exist, as well that of gas as of the liquid or solid form. Lavoisier first called it the oxygenous principle; and the French school having decided for the word oxygen, by admitting a simple change of termination in the first word proposed by Lavoisier, this name became generally adopted.

The effect of oxygen is of such importance, that its presence must be stated as the most indispensable condition of combustion; which would not otherwise take place. It truly constitutes the essential part of that process, because its most decided and extensive character is its indispensability in that process.

Oxygen, like many other natural bodies, is found in three states, but in neither of them is it alone or insulated. In the gaseous form it is dissolved in caloric; in the liquid and solid form it is combined with different substances, and can never exist concrete and pure without combination, like many other substances no less decomposable than itself. And though we can, in imagination, conceive it alone, insulated, pure, and in a solid state, experiment has never yet exhibited this fact. It is a discovery which still remains concealed in the bosom of nature; or may exist, ill understood, under the name of some substance yet unknown in our collections of minerals.

As oxygen is frequently contained in a more or less solid form in several natural fossils which have undergone combustion, and as it has much attraction for caloric, it is only required that some one of those fossils should be heated more or less, or penetrated with a great quantity of caloric, in order to disengage this principle, and obtain it in the form of air or gas. This is done by chemists to procure oxygen gas. They expose certain substances, particularly metals burned by nature or by art, to a fire of considerable activity in closed vessels, so disposed as to conduct and receive, under inverted jars, the elastic fluid intended to be collected. The burned matter passes again to a combustible state; and the oxygen which gave it the burned state, being separated and fused by caloric, for which it has a great attraction, becomes developed in the form of gas. It is the product of a true combustion.

Of the two bodies which form oxygen gas, the caloric, which is the solvent, and gives it the state of invisibility and elastic fluid, not being ponderable; the solidifiable base which is dissolved, or oxygen, being the only ponderable and fixable body in all the substances with which this gas can combine; and chemists having no other means of obtaining oxygen in a simpler state than that of gas, in which they use it for a great number of operations or combinations; many of them are habituated to denote this gas by the simple name of oxygen. This is, nevertheless, an error of nomenclature, and inimical to the perspicuity of chemical doctrine; because the word oxygen ought only to be used to denote the base of this gas considered alone, or in all the possible states, but parcularly in the numerous combinations wherein it possesses the liquid or solid state.

Oxygen gas. See Air.

OXYMEL, in pharmacy, a composition of vinegar and honey.

OXYMURIATIC ACID. This acid was discovered by Scheele in 1774, during his experiments on manganese. He gave it the name of dephlogisticated muriatic acid, from the supposition that it is muriatic acid deprived of phlogiston. The French chemists, after its composition had been ascertained, called it oxygenated muriatic acid; which unwieldy appellation Kirwan has happily contracted into oxymuriatic acid.

It may be procured by the following process: Put into a tubulated retort a mixture of three parts of common salt, and one part of the black oxide of manganese in powder. Place the retort in the sand-bath of a furnace, plunge its beak into a small water-trough, and lute a bent funnel into its mouth. When the mixture has acquired a moderate heat, pour into it at intervals through the bent funnel two parts of sulphuric acid, which ought to be somewhat diluted with water. An effervescence ensues; a yellow-coloured gas issues from the retort, which may be received in large phials fitted with ground stoppers.

Oxymuriatic acid gas is of a yellowish-green colour. Its odour is intolerably acrid and suffocating. It cannot be breathed without proving fatal. The death of the ingenious and industrious Pelletier, whose chemical labours have been so useful to the world, was occasioned by his attempting to respire it. A consumption was the consequence of this attempt, which, in a short time, proved fatal. When atmospheric air containing a mixture of it is breathed, it occasions a violent and almost convulsive cough, attended with much pain in the chest. This cough usually continues to return at intervals for a day or two, and is accompanied with a copious expectoration.

It is capable of supporting combustion; in many cases even more capable than common air. When a burning taper is plunged into it, the flame is diminished, and acquires a very red colour; a great quantity of smoke is emitted, and at the same time the taper consumes much more rapidly than in common air. The facility with which bodies take fire in this gas, seems to depend on the ease with which it parts with its oxygen.

This gas is neither altered by exposure to light nor to caloric. It passes unaltered through red-hot porcelain tubes.

It does not unite readily with water. Scheele found, that after standing 12 hours over water, four-fifths of the gas were absorbed: the remainder was common air, which no doubt had been contained in the vessel before the operation.

It renders vegetable colours white; and not red, as other acids do; and the colour thus destroyed can neither be restored by acids nor alkalies. It has the same effects on yellow wax. If the quantity of vegetable colours to which it is applied is sufficiently great, it is found reduced to the state of common muriatic acid. Hence it is evident, that it destroys these colours by communicating oxygen. This property has rendered oxymuriatic acid a very important article in bleaching.

When a mixture of oxymuriatic acid gas and hydrogen gas is made to pass through a red-hot porcelain tube, a violent detonation takes place. By electricity a feeble explosion is produced.

When melted sulphur is plunged into it, inflammation also takes place, and the sulphur is converted into sulphuric acid; but cold sulphur, though it is partly acidified by this gas, does not take fire in it.

When phosphorus is plunged into this gas, it immediately takes fire, burns with considerable splendour, and is converted into phosphoric acid.

Oxymuriatic acid oxidizes all the metals without the assistance of heat. Several of them take fire as soon as they come into contact with the gas. All that is necessary is, to throw a quantity of the metal reduced to a fine powder into a vessel filled with the gas. The inflammation takes place immediately; the metal is oxidized; while the acid, decomposed and reduced to common muriatic acid, combines with the oxide, and forms a muriat. Arsenic burns in oxymuriatic acid gas with a blue and green flame; bismuth, with a lively bluish flame; nickel, with a white flame, bordering on yellow; cobalt, with a white flame, approaching to blue; zinc, with a lively white flame; tin, with a feeble bluish flame; lead, with a sparkling white flame; copper and iron, with a red flame. Several of the metallic sulphurets, as cinnabar, realgar, sulphuret of antimony, take fire when thrown in powder into this gas.

When oxymuriatic acid gas and ammoniacal gas are mixed together, a rapid combustion, attended with a white flame, instantly takes place; both the gases are decomposed, water is formed, while azotic gas and muriatic acid are evolved. The same phenomena are apparent, though in a smaller degree, when liquid ammonia is poured into the acid gas. The same decomposition takes place, though both the acid and alkali are in a liquid state. If four-fifths of a glass tube are filled with oxymuriatic acid, and the remaining fifth with ammonia, and the tube is then inverted over water, an effervescence ensues, and azotic gas is extricated. It was by a similar experiment that Berthollet demonstrated the composition of ammonia.

Oxymuriatic acid is composed of

84	muriatic acid
16	oxygen
100.	

Though oxymuriatic acid has hitherto been placed among acids by chemists, it does not possess a single property which characterises that class of bodies. Its taste is not acid but astringent; it does not convert vegetable blues to red, but destroys them; it combines very sparingly with water, and is incapable of combining with alkalies, earths, or metallic oxides. It ought, therefore, to be placed among the oxides rather than the acids.

OYER OF DEED, is when a man brings an action upon a deed, bond, &c. and the defendant appears and prays that he may hear the bond, &c. wherewith he is charged, and the same shall be allowed him: and he is not bound to plead till he has it, paying for the copy of it.

The time allowed for the plaintiff to give oyer of a deed, &c. to the defendant, is two days exclusive after it is demanded. Carth. 454. 2 Durnf. & East, 40.

OYER AND TERMINER, is a court held by virtue of the king's commission, to hear and determine all treasons, felonies, and misdemeanors. This commission is usually directed to two of the judges of the circuit, and several gentlemen of the county; but the judges only are of the quorum, so that the rest cannot act without them. 4 Black. 269. See ASSIZES.

OYES, or OYEZ, signifies hear ye; and is frequently used by the cryers in our courts on making proclamation, or to enjoin silence.

OYSTER. See OSTREA.

OZÆNA, a malignant ulcer of the nose, frequently accompanied with a caries of all the bones of that part. See SURGERY.

OZOPHYLLUM, a genus of the class and order monadelphia pentandria. It is one-styled; calyx five-toothed; petals five, long; filaments sheathing; the style five-toothed at top; teeth antheriferous; stigma one; capsules five-celled. There is one species, a native of Guiana.

P

P, the fifteenth letter of the alphabet, as an abbreviature, stands for Publius, pondo, &c.; PA. DIG. for patricia dignitas; P. C. for patres conscripti; P. F. for Publii filius; P. P. for propositum, or propositum publice; P. R. for populus Romanus; PR.S. for prætoris sententia; and PRS. P. for præses provinciæ. In the Italian music, P. stands for piano, or softly; P.P. for piu piano, *i. e.* more softly; and PPP. for pianissimo, or very softly. Among astronomers, P. M. is used to denote post meridiem, or afternoon; and sometimes for post mane, *i. e.* after midnight. As a numeral, P. signifies the same as G, viz. 400; and with a dash over it, thus G, 400,000. Among physicians, P. denotes pugil or the eighth part of a handful; P. Æ. partes æquales, or equal parts of the ingredients.

PACE, *passus*, a measure taken from the space between the two feet of a man in walking; usually reckoned two feet and a half, and in some men a yard or three feet.

The geometrical pace is five feet; and 60,000 such paces make one degree of the equator.

PACK, in commerce, denotes a quantity of goods, made up in loads or bales for carriage. A pack of wool is 17 stone and two pounds, or a horse's load.

PACKERS, persons whose employment it is to pack up all goods intended for exportation; which they do for the great trading companies and merchants of London, and are answerable if the goods receive any damage through bad package.

PACOS. See CAMELUS.

PÆDERIA, a genus of the pentandria monogynia class and order. It is contorted; berry void, brittle, two-seeded; style bifid. There are two species, climbers of the East Indies.

PÆDEROTA, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 30th order, contortæ. The berry is empty, brittle, and dispermous; the style bifid. There are three species.

PÆONIA, *peony*, a genus of the digynia order, in the polyandria class of plants, and in the natural method ranking under the 26th order, multisiliquæ. The calyx is pentaphyllous; the petals five; there are no styles; the capsules are polyspermous. There are five species, most of them hardy. They are large herbaceous flowery perennials, with tuberous roots, sending up strong annual stalks from one to three feet in height, terminated by very large flowers of a beautiful red colour, and much larger than any rose. The common officinal, or male peony, is also remarkable for its capsules turning backward, opening and displaying their red inside, together with the numerous seeds in a singularly agreeable order, appearing very ornamental after the flower is past. The plant may be propagated either by parting the root or by seed. This plant was formerly celebrated in nervous distempers, but the present practice pays very little regard to it.

PAGE, a youth of state retained in the family of a prince or great personage, as an honourable servant, to attend in visits of ceremony, carry messages, bear up trains, robes, &c. and at the same time to have a genteel education, and learn his exercises. The pages in the king's household are various, and have various offices assigned them, as pages of honour, pages of the presence-chamber, pages of the back stairs, &c.

PAGOD, or PAGODA, a name whereby the East Indians call the temple in which they worship their gods. The pagod usually consists of three parts; the first is a vaulted roof, supported on stone or marble columns: it is adorned with images; and, being open, all persons without distinction are allowed to enter it. The second part is filled with grotesque and monstrous figures, and no person is allowed to enter it but the bramins themselves. The third is a kind of chancel, in which the statue of the deity is placed. It is shut up with a very strong gate.

PAGOD, or PAGODA, is also the name of a gold or silver coin, current in several parts of the East Indies, value 5*s*.

PAINTING, is the art of representing all objects of nature visibly, by lines and colours on a plain surface. It has also the power of expressing by the same means conceptions and images of the mind which do not actually exist in any of the usual forms of nature. It is to be considered as an art displaying either conjointly or separately the powers of imagination and imitation: and may be divided into invention, which regards the original thought or conception of the subject; and into composition, design, and colouring, which regard the execution of the work.

Invention consists generally in the choice of such subjects as are best calculated to answer some great and interesting end; and particularly in discovering or selecting such subjects as are capable of being most appropriately expressed by painting, and of producing a powerful effect by such means as are distinctively placed within the compass of that art.

Composition regards the arrangement of the subject both as to forms, and to the general effects of light and shade, and of colour. It comprehends the general distribution and grouping of the figures, their combination or contrast, the choice of attitudes, the disposal of draperies, the situation of the scene itself, as well as the distribution and connection of all the various parts of scenery and ornament.

The important objects which design embraces, will be found fully explained under that article. See DESIGN.

Colouring regards, first, the infinite variety of hues with which nature distinguishes her forms, agreeably to the degree and mixture of the rays of light which their surfaces reflect; and, secondly, the distribution, apposition, and accompaniment, of various hues or tints, so as to produce the effect most pleasing to the sight, a circumstance in which nature not always delights. It embraces also the light and shade of objects, as far as by the diminution or increase of these the harmony of tints before-mentioned can be effected; but that mixed effect of colour and of light and shade which is denominated chiaro-scuro, is more justly regarded as a branch of composition.

Art of painting. The art of painting is justly ranked among the highest of that class of arts which are denominated liberal. Its tendency and powers are congenial with those of poetry, and it has of course been considered as an employment worthy of men in the most elevated ranks of life. The honours with which it has been distinguished in various countries, will be found in the history of its professors.

We shall proceed, in consistence with a general plan, to describe, first, the means by which the student may hope to forward his progress in this admirable but difficult art. We shall then state the different branches of painting, and the methods of practice; and shall lastly add a summary of its history in all ages and countries.

Course and methods of study requisite to attain the art of painting.

The process of study requisite for the attainment of the art of painting, has been in part already described under the article DESIGN; the knowledge of design being, as was there said, the basis of painting, and its various attainments the necessary steps by which the painter must commence his advance in the art. The student having completed the various studies which lead to excellence in drawing, must proceed to transfer the principles he has learned to his canvas; and, before he can arrive at eminence, must acquire a complete mastery of the new materials in which he is to display at once the stores of his mind and the skill of his hand. For this purpose, he must add to the knowledge he already possesses, the study of colours and colouring in all their branches. It is the knowledge of this department of art which peculiarly characterizes the profession he is about to undertake. The various branches of design have formed the commencement of his studies, and he may be supposed a perfect master of them; but these alone cannot constitute him a painter; neither can he acquire that title by the knowledge of every rule of invention or composition. If we consider a painter in regard of these last powers of skill, we rank him with the poet or the draughtsman; if in regard of anatomic knowledge or perspective, we confound him with the anatomist or the mathematician; if in regard of symmetry, grace, and proportions of forms, we cannot distinguish him from the geometer or the sculptor. The painter, who is supposed the perfect imitator of nature, necessarily makes colouring his chief object, since he only considers nature as she is imitable: she is only imitable by him as she is visible; and she is only visible as she is coloured.

Although the perfect idea, therefore, of a painter depends on invention, composition, design, and colouring, conjointly, yet it is by the last of these only that he can establish a special idea of his art, since by this we distinguish him from such other artists as have for their object the various powers which can be expressed by design (whose art cannot come up to that perfect imitation of nature, which is within the scope of painting); and by this only we can be decidedly understood to speak of a painter.

To this it is to be added, that as colouring specifically distinguishes the art of the painter from all the other arts of design, so it is the ultimate accomplishment of all his studies in the art of painting.

We shall, therefore, first treat of colouring, and proceed to consider more minutely the component parts which form the art of colouring.

Colouring. Colouring is that mode of art by which the artist imitates the appearance of colours in all natural objects, and gives to artificial objects those hues which are most calculated to please or to deceive the sight.

It is the duty of the colourist to consider, that as there are two sorts of objects, the natural or real, and the artificial or painted, so there are also two sorts of colours, viz. the natural, or that which makes all the objects in nature visible to us, and the artificial, or that which, by a judicious mixture of simple colours, imitates those natural ones in all their various situations and circumstances.

The painter must first endeavour to acquire a perfect knowledge of these two sorts of colours; of the natural, in order to distinguish with precision which of them he ought to imitate; and of the artificial, in order to compose the tint most proper for representing the natural colour. These acquirements include the study of dioptrics, or that part of optics which has for its object the nature of light and colours, and an acquaintance at least with the general principles of chemistry. (See OPTICS.) He will learn also that the natural colour is of three sorts: 1st, the true colour of the object; 2d, the reflected colour; 3d, the colour of the light incidental to the object. In the artificial colours, he will distinguish their force and softness separately and by comparison, in order that he may use a proper judgment in heightening or attenuating them, according as his subject may require.

To this end he will also consider, that a picture is, for the most part, a flat superficies; that, some time after the colours are laid on, they necessarily lose their freshness; and that the distance at which a picture is viewed takes from it much of its brightness and vigour; and it is therefore impossible to guard against these drawbacks on the effect of his pencil, without a complete mastery of that artifice which is the chief object of the art of colouring.

Although imitation is the principal aim of colouring, the painter must by no means be the slave of natural objects, but the judge and judicious imitator of them: he must not imitate all the colours which present themselves indifferently to his eye; but he must chuse the most proper for his purpose, and add or temper with others, to complete the beauty of effect in his work. He must sometimes abate the vivacity of life, and sometimes strive to heighten it by superior force and brightness of colours, in order to convey to the eye with precision and truth the spirit and real character of the object. There are few, and those only among the greatest painters, who have arrived at the perfect management of this difficult part of art.

On the apposition of colours, and on the knowledge of chiaro-scuro, depends all the harmony of colouring. In what that happy arrangement of colours consists, which produces effects delightful to the eye, no rules can pretend to ascertain. If the source of information in this point is not in the mind of the painter, he will in vain seek for it elsewhere. Improvement, however, may, and must, be superadded to natural discrimination: to acquire the necessary improvement, he will find the best school in the works of those great masters who have possessed the power of colouring in an eminent degree. Such are Titian and Rubens. But he must be careful that, in studying even these great examples of the art, he does not forget that he is only learning from them the road to nature, the final source of his imitation.

Of the few maxims which can be offered on the subject of colouring, the following are the least questionable:

We must learn to view nature to advantage, in order to represent her well. There are two manners of colouring: the one depending on habit, the other on the true knowledge of colours. The first is confined, the second unlimited.

The harmony of nature in her colours arises from objects participating of one another by reflection; for there is no light which does not strike some body; nor is there any enlightened body which does not reflect its light and colour at the same time, in proportion to the force of the light, and according to the nature of the colour. This participation of reflection in light and colour, constitutes that union of colouring which it is the business of the painter to imitate.

This desirable union of colour is sometimes considerably aided in pictures by the process of glazing; that is, by the use of colours which, having little body, are diaphonous; and are, by means of a light brush or pencil, passed over (or, as painters express it, *scumbled* over) such parts of the work as are unpleasantly staring or otherwise discordant. This use of transparent colour is by some called toning, or tuning; and probably affords the justest explanation of the well-known passage in Pliny, where he speaks of the *atramentum* used by one of the antient painters to give harmony and sweetness to his pictures.

Variety of tints, very nearly of the same tone, employed in the same figure, and often upon the same part, with moderation, contribute much to harmony.

The turn of the parts, and the outlines which insensibly melt into their grounds and artfully disappear, bind the objects together, and preserve them in union; as they seem to conduct the eye beyond what it sees, and persuade it that it sees what it really does not see, or at least that it conceives that continuity which the extremities of the objects conceal.

Any loading or overcharging of colouring, for whatever purpose it is used, must be so discreetly managed, as not to destroy the character of the object.

The repetition of the same colour in a picture is to be avoided, unless where it serves to connect the various masses of a composition. The eye becomes tired with viewing the same object: it loves variety artfully presented to it.

The apparent value of colours in a picture (as in all things) arises from comparison.

Several colours which, placed unmixed by one another, have a kind of aerial brightness, when mixed together, produce a disagreeable earthy colour: for instance, ultramarine with fine yellow, or fine vermilion.

Colours which by mixture lose strength and become harmonious, are called broken colours, and contribute as greatly to the sweetness and softness of tones in pictures as they subtract from their brightness.

Chiaro-scuro. The knowledge of lights and shades evidently forms a part of that essential distinction of painting, which we have just described under the head of colouring, and is requisite to that part of colouring which refers to composition. But the incidence of particular lights and shades on bodies placed on certain planes and exposed to certain lights (a knowledge to be gained from the study of perspective), is a very small part of that general knowledge of effect which is denominated chiaro-scuro, by which is meant the art of skilfully distributing the lights and shades which ought to appear in a picture as well for the repose as satisfaction of the eye. The incidence of light may be demonstrated by lines supposed to be drawn from the source of that light to the body enlightened; whereas the chiaro-scuro depends entirely on the painter's imagination, who, as he invents the objects, may dispose them to receive such lights and shades as he proposes for his picture, and introduce such accidents of colour as he deems most advantageous to the effect of the whole.

Chiaro-scuro, therefore, demands a perfect knowledge of the effects of light and shade, of aerial perspective, of the proportional force of colours, or of those qualities by which they appear to advance to, or recede from, the eye, and of their various degrees of transparency or opaqueness.

The art of chiaro-scuro consists, 1st, in connecting and combining the figures or objects of a composition in such masses of light and of shade, as are both the most pleasing to the eye and the best calculated for the just developement and display of the subject. 2dly, In assigning to each object the colour most corresponding (on account of the force or qualities above-mentioned) to its respective place in the general mass or group, and at the same time best harmonizing with the other colours of the picture, either by its natural and proper tone, or by the reflected hues which it receives from adjoining or surrounding objects. The beauty of these reflexes depends on the skilful adaptation of transparent or opaque colours. 3dly, In the judicious introduction of such accidents as contribute to strengthen the general effect and character of the work. It is on chiaro-scuro, says Mengs, that depends the expression of the character of a picture, whether it is gay or gloomy, cheerful or solemn.

The distribution of objects forms the masses of chiara-scuro, by combining or connecting their lights and shades in such a manner as to prevent the eye from wandering confusedly over the work. Titian exemplified this precept in the instance of a bunch of grapes, of which each grape, if seen separately, would have its light and shade in a similar degree, and thus distracting the sight, would produce a tiresome confusion; but when collected in one bunch, and becoming but one mass of light and shade, the eye is capable of embracing them all together as a single object.

The distribution of colours has an evident power of uniting the masses of light and shade; as the painter may for instance introduce a figure clothed in dark-brown drapery, so nearly approaching in colour to the shade of any two objects between which it is placed, that they will appear but one mass, and will be embraced by the eye as such. The same effect will be produced by the apposition of similar or accordant colours in various objects.

The distribution of accidents, by which accessory lights or shades are introduced, has the same obvious tendency to unite the masses of visible colour. Torches, clouds, &c. are comprized under this head.

The art of chiaro-scuro is that which, of all others comprehended under the general head of painting, appears to have the greatest power of attracting the eye of the spectator, and of exciting the admiration of the artist in particular.

In the same manner that we have here endeavoured to define the general principles of that distinctive branch of the painter's art called colouring, and as we have before fully described the requisite progress of study in drawing or design, we shall now proceed to the remaining branch, composition; and afterwards add a few words respecting invention.

Composition. Composition may be divided into the general distribution of objects, the grouping, the choice of attitudes, the contrast, the cast of draperies, and the management of the back-ground or the connection of the whole effect.

In composition, as far as regards the general distribution of objects, the painter ought to contrive that the spectator may, at the first sight, be struck with the general character of the subject, or at least may comprehend its principal scope. This effect is most readily produced by placing the most essential figures in the most conspicuous places, provided it can be done without violence or impropriety. Besides this distinctness in the general expression of the subject, the beauty of the composition will depend on the variety, connection, and contrast, displayed in the distribution of objects; provided, in like manner, that these are conformable to the nature of the subject, whether gay, familiar, full of motion and hurry, or still, solemn, and melancholy.

The grouping regards both design and chiaro-scuro. In the former, it respects the figures principally concerned in the expression of the subject, which must necessarily be near to, or distant from, one another, as their actions, conversations, or other mutual relations, require. In the latter, it regards those masses which are formed from objects which may be properly arranged together, and those effects of light and shade which are formed in consequence of such assemblage or union. These are the points to which the attention must be principally and diligently directed in forming the groups of a composition.

The choice of attitudes is the principal subordinate division of grouping. Whatever attitude is given, it must not only contribute its due portion to the completion of the group, but the greatest care must be taken by the painter, that it does not appear to be introduced for that purpose merely. It must be appropriate to the character of the individual figure, and expressive of its requisite action; and it must, at the same time, combine whatever beauty of form can be shewn by such a selection of turns or views of the body, as the necessary circumstances will admit. The knowledge of generic characters, under the various modifications of sex, age, and condition; of the various operations of the passions in the human mind; and a thorough acquaintance with the circumstances of the history or other subjects to be represented; are the best guides to a good choice of attitudes.

To the effect produced by well-chosen attitudes, contrast gives the most powerful aid. Contrast has been already defined (see Contrast); and it is only to be observed here that in composition it extends not to human figures only, but to objects of every kind, animate or inanimate, and also to the effects of light or chiaro-scuro.

Of draperies, and the proper modes of casting or disposing them, notice has been taken under the article Drawing.

The management of the back-ground, or connection of the general effect, is, of all other parts of composition, at once the most difficult to be defined or performed. It consists in the general accordance and subordination of objects with and to one another, so that they shall all concur to constitute but one single object. It is to the whole what the grouping of lines, forms, and chiaro-scuro, is to a part. It is effected by a due combination of lights and shades, by an union of colours, and by such oppositions or contrasts as are sufficient to relieve the distinct groups, and to give repose to the eye. Amidst several groups (if the picture consists of such), it requires that one should be justly predominant in force and colour, and that all detached objects should be so united with their respective grounds as to form together one general mass of repose for the support of the principal object.

The satisfaction of the eye is the ultimate purpose of this difficult part of composition.

Invention. It now remains to enlarge on the most arduous attainment of the painter, and which we have placed the last in the order of his studies, because it is that which gives the highest character to the artist, as it affords the greatest opportunities of displaying the powers of his mind.

Invention comprises every kind of subject which can be represented to sight; but it is generally divided into historical, allegorical, and mystical.

Invention simply historical, is the selection of such objects as plainly relate to or represent a subject. Its degrees are more or less valuable according to its matter or subject, and its requisite properties are fidelity and perspicuity. It extends also to the introduction of all such embellishments as are consistent and congenial with the history represented, in the same manner as in poetry. The same illustration by collateral erudition, the same enlivening by incidental ornament, the same blending of poetic imagery (not over-stepping truth), is admired in the painter as in the poet.

The cartoons of Raffaelle are among the works which present the finest examples of this species of invention. The battles of Constantine, and some others by the same master, in the Vatican, are equally excellent.

Allegorical invention is a choice of objects which serve to represent either wholly or partly what they are not; and of which the expression arises from illusion. Calumny dragged in, at the feet of Truth, as described by Lucian, and sketched by Raffaelle, is wholly of this class. Such also is Hercules placed between Virtue and Pleasure (generally called the Choice of Hercules); and such also is the picture of the School of Athens, by Raffaelle, in which many persons of various times, countries, and conditions, are brought together, to represent the various modes of philosophy.

Other works are partly allegorical and partly historical; in which the spectator easily distinguishes the figures purely historical from others mixed with them in the same picture, and entirely allegorical. Such are the well-known pictures of the history of Mary de Medici, painted by Rubens.

The first great requisite of allegorical painting is, that it be intelligible. An allegory not understood, is a loss of labour both to painter and spectator. For this purpose, it must, in general, consist of such symbols as are established on good authority, or, if new, are obvious to the mind.

In addition to this first requisite, the proper choice of allegory demands, either that the subject could in no other way be represented, or that it could not be represented by historical invention in an equal degree of force and beauty.

Mystical invention respects the expression of such ideas as are inculcated in our minds by the precepts of religion. The paintings in the Capella Sistina at Rome, by Michael Angelo, exhibit an illustrious instance of this kind of invention; and the student (with certain modifications) can enter no better school of this part of art. The Transfiguration of our Saviour, by Raffaelle, the Annunciation, Holy Families, &c. of numerous painters, are of the same kind.

The style of mystical painting is sometimes familiar and tender, as in subjects of the Holy Family, but chiefly majestic and elevated.

We have thus accompanied the painter, and slightly, but it is hoped justly, traced his path, through the long course of his studies; in the prosecution of which he must himself contribute the fullest share of unwearied diligence and attention. Nor are his pursuits to be considered as bounded by the rules which have been given. Enough remains behind to exercise both his industry and genius.

Beyond the complete possession of the various component parts of art which have been enumerated, expression, in all its distinct powers of vivacity, justness, and delicacy, calls for every exertion of talent. See Expression. And to all this, in order to attain perfection, must be superadded the rare and transcendant charm of grace, that indefinable excellence which no painters are allowed to have reached, except Apelles, Raffaelle, and Correggio.

Of the different classes of painting.

Painting is chiefly divided into historical (comprehending allegorical and mystical), grotesque, portrait, fancy, animals, fruits and flowers, battles, landscape, sea-views, architecture, still life. The subordinate divisions of all these are endless.

The first has been sufficiently spoken of under the head of *invention*, in the present article.

Grotesque painting being also already explained under its proper article, it is only necessary here to add, that the finest examples of this species are to be found in the celebrated Loggia of the Vatican palace at Rome, painted from the designs of Raffaelle, and in the ceiling of the portico of the Capitol, carved from those of Michael Angelo.

Of portrait, as being a branch of painting to which our country is peculiarly addicted, it is requisite to give a more detailed account.

Portraiture. If the accurate imitation of nature is, on any occasion, capable of forming the principal merit of a picture, it must certainly be in portraiture, which not only represents a man in general, but such an one as may be distinguished from all other men. The greatest perfection of a portrait is extreme likeness, and the greatest fault is the resemblance of a person for whom it was not designed, unless we are inclined to except a still more grievous defect, viz. the want of resemblance to any person whatever. The resemblance of men to one another, is indeed frequently found in living nature, but it is seldom or never so complete and entire, but that some particular turn or view of the face will betray the difference; and it is the business of the artist ever to discriminate, and to appropriate to his pencil, those peculiar features, lines, and turns of the face, the representation of which will effectually convey to the spectator the distinct especial idea of the person whose portrait is set before him.

Various difficulties attend, and not seldom impede, the execution of this task. It is true, that there is not a single person in the world, of whatever age, sex, or condition, who has not a peculiar character both in body and face; but it is also the essential duty of portraiture, that it not only imitate what we see in nature, but that it exhibit such views of nature as are confessedly the most advantageous to the person represented. The moment that the idea raised by the sight of the portrait is inferior to that raised by the sight of the person, the labour of the artist sinks into the debasing region of caricature.

Likeness, however, being the essence of portrait, it is unquestionably the part of the painter to imitate defects as well as beauties, since, by this means, the resemblance will be more complete. He is only to be aware that he strictly preserves that balance which constitutes the character of the object. It has been sometimes suggested by those who are more willing to court favour than fame, that all appearances of deformity, when the air, temper, and general likeness of the face, can be discerned without them, ought to be omitted or corrected in portraiture; but this must be done at least with considerable discretion; for, by too strenuous endeavours to correct, nature, it is always found that the painter insensibly falls into a habit of giving a general air to his portraits, as suitable to one person as to another, or perhaps properly suited to none.

In the portraits of particularly distinguished characters, of men illustrious either for rank, virtue, great actions, or exalted talents, exactitude of representation, whether in beauties or defects, cannot be too closely pursued. Portraits of such persons are to become the standing monuments of their high name to posterity; and in this instance every thing is precious that is faithful.

The resemblance, as well as every other excellence, of a portrait, depends on feature, expression, air, colouring, attitude, and attire.

The features require to be carefully examined and studied by inspection in many different views, so that at the moment when the painter puts his pencil to the canvas, he may be possessed not only of the apparent form of each particular feature in the view in which he represents it, but of its real and characteristic form also, the full expression of which is not discernible in every view. Each particular feature should appear so distinctly shaped, as that an exact model of the real head could be formed from the picture, if requisite; and they must be at the same time so blended in the general mass of the face, that no one shall obtrude itself on the eye beyond the rest. The peculiar mode of touch, or execution, whereby each feature is best discriminated, can only be learned from practice, and the attentive study of the best masters.

For expression, the student is referred to the general rules already given under that article. See Expression. In addition to which, it is requisite to observe, that the greatest care is to be used in a portrait, in order that the expression of the features is uniform and consistent with each other. Errors in this respect are among the most frequent in portrait-painting. The mouth is sometimes represented smiling, while the eyes are sad, and vice versa, &c. The painter must therefore constantly bear in mind the general idea that he has formed of the countenance he intends to express, and must be watchful of the corresponding forms of the features in moments of similar expression. The portraits of Titian and Raffaelle are pre-eminent in this point. The same remark here applied to the various minute parts of the face may be extended to all the larger portions of the figure. The same expression must be clearly perceived in the motion or direction of the hands, arms, legs, and body, that appears to prevail in the countenance and turn of the head. It is this combination only which can give the exact resemblance of the expression of nature, under the impulse of which no particular limb ever deviates from the general intention of the whole body. See Expression.

The air principally regards the lines of the face or figure, the attire of the head or person, and the stature or make of the general form.

The proper lines of the face or figure depend on accuracy of drawing, and an entire agreement of the parts of the same form with one another. Nothing so entirely disguises or alters the appearance of an individual person as the change of head-dress, whether it is the adjustment of hair or attire. The greatest attention, therefore, is to be used in adapting the arrangement of this part of the portrait to the general character of the person represented.

The stature and make, in the same manner, contribute to the force of resemblance (as the least observation on nature will teach us), and never fail considerably to influence the air of the person. It is therefore requisite for the truth of portrait, that this part of the picture should be as faithfully studied from the sitter as the face itself.

With regard to the methods of proceeding in the execution of a portrait, they have been, and are, so exceedingly various in various masters, that a discussion of them would lead to an endless labyrinth. We shall, however, select a curious statement of Vandyck's mode of practice, in the latter time of his eminence in this branch of painting, as it is related by Du Piles, on the authority of Jabac, a man well known to all the lovers of the fine arts, and a friend of Vandyck, who thrice painted his portrait:

"Vandyck's custom, as Jabac told me, was this: he appointed both the day and hour for the person's sitting, and worked not above an hour on any portrait, either in rubbing in or finishing; so that as soon as the clock informed him that the hour was out, he rose, and dismissed his sitter, appointing another hour on some other day. His servant then came to clean his pencils, and brought a fresh pallet, while he was receiving another sitter, whose day and hour he had also appointed.

"After having lightly dead-coloured the face, he put the sitter into some attitude which he had before contrived; and on grey paper, with white and black crayons, he designed in a quarter of an hour his shape and drapery, which he disposed in a grand manner, and an exquisite taste. This drawing he gave to skilful persons whom he kept about him, to paint from the sitter's own clothes, which at Vandyck's request were sent to him for that purpose. When his disciples had done the most they could to these draperies, he lightly went over them again; and so in a little time, by his great knowledge, displayed the art and truth which we at this day admire in them."

Nothing varies more quickly, more discernibly, or more frequently, than the colour of a sitter's face. Great care must therefore be taken to establish an uniform judgment of the sitter in this respect also; for the colouring of the skin or complexion, being an effusion of nature, tending to discover the true tempers of persons, exactness of imitation here becomes essential to the exhibition of character. It may be therefore expedient to watch the first moments of the appearance of colour in the sitter, who, sooner or later, from a continuance in one posture, loses those spirits, which, at his first sitting down, gave to every part of the face a livelier and fresher hue. There is no other point of painting in which the paradox may be more truly asserted, "that the painter who only paints what he sees will never arrive at perfect imitation."

The other classes of painting are sufficiently denoted by their names, excepting the last, viz. *still life*, of which it may be requisite to add that the term is applied to all inanimate objects, but chiefly to household furniture, ornaments, and instruments of use, &c. &c. &c.

Modes and materials of painting.

The different modes of painting now in use are:

Oil painting; preferable to all other methods, as it admits of a perfect gradation of tints in the most durable of all materials, except those of

Mosaic painting; in which an imitation of objects is produced by the junction of a great number of small pieces of natural marble of different colours fixed in stucco, a mortar, so that if the mortar is well prepared, the monuments of this art may descend to the most remote ages. Some of the works of the great Italian masters have been excellently copied in mosaic, and are to be seen in St. Peter's church at Rome.

Fresco painting; which is performed with colours diluted in water, and laid on a wall newly plaistered, with which they incorporate, and are sometimes as durable as the stucco itself.

Crayon painting; in which colours, either simple or compound, are ground in water mixed with gum, and made into small rolls of a hard paste, which are then used on paper or parchment.

Miniature painting; which consists of colours prepared with water or gum, and laid on vellum or ivory. It is of course confined to works of a very small size.

Enamel painting; which is performed on copper or gold, with mineral colours, dried by fire. This method is also very durable.

Wax, or encaustic painting; performed by the mixture of wax with the varnish and colours.

Painting on glass, too well known to need description, and performed by various methods.

Painting in distemper; which is with colours mixed with size, whites of eggs, or any thin glutinous substance, and used on paper, linen, silk, board, or wall.

Painting in water-colours, more properly called limning: it is performed with colours mixed with water, gum, size, paste, &c. on paper, silk, and various other materials.

To these is to be added elydoric painting, consisting of a mixed use of oil-colours and water.

For a full account of some of these methods, see their repesctive articles in this work. Those of which a farther explanation remains to be given are distemper, fresco, oil-painting, miniature, mosaic, and the elydoric method.

The three former shall be treated of according to their order in point of time.

Fresco. Fresco is the most antient of all kinds of paints, the most speedily executed, and sometimes the most remarkable for its durability. Norden speaks of some ruins of Egyptian palaces, on the walls of which are colossal paintings, which are shewn by Winckelman to have been executed in fresco. The fragments of antient painting handed down to us by the Romans are likewise in fresco. Could this stability of colour be certain and constant, this mode of art would be preferable to all others, particularly in the decoration of palaces, temples, or other large public edifices; as it has a freshness, splendour, and vigour, unknown either to oil or water-colours. It is at the same time the most difficult of accomplishment, requiring, in the opinion of Vasari, "the greatest force of genius, boldness of execution, and readiness of pencil." The reasons for such an opinion will be seen in the following account of the mechanical process of this beautiful mode of art.

Method of painting in fresco. Before you begin to paint, it is necessary to apply two layers of stucco on the place where your work is to be executed. If you are to paint on a wall of brick, the first layer is easily applied; if of free-stone closely joined, it is necessary to make excavations in the stone, and to drive in nails or pegs of wood, in order to hold the layer together.

The first layer is made of good lime and a cement of pounded brick, or, which is better, river-sand, which latter forms a layer more uneven, and better fitted to attach the second smooth layer to its surface. The antients appear to have possessed the art of making this species of mortar superior to any now in use.

Before applying the second layer, on which you are to paint, it is requisite that the first is perfectly dry, as the lime while moist emits a pernicious effluvium.

When the first layer is perfectly dry, wet it again with water, in proportion to its dryness, that the second layer may more easily incorporate with it.

The second layer is composed of lime, slaked in the air, and exposed for a whole year, and of river-sand of an equal grain, and moderately fine. The surface of this second layer must be uniformly even. It is laid on with a trowel; and the workman is provided with a small piece of wood, to remove the large grains of sand, which, if they remained, might render the surface uneven.

To give a fine polish to this surface, a sheet of paper should be applied on it, and the trowel passed and repassed over the paper; this caution will prevent any little inequalities which might injure the effect of the painting at a distance.

The workman must not extend the layer over a greater space than the painter is able to finish in a day, as it is necessary that the ground should always be fresh and moist under his pencil; and it is on this account that the readiness of the artist's hand becomes so requisite a quality in the execution of works in fresco.

The ground being thus prepared, the painter begins his work; but as painting in fresco must be executed rapidly, and as there is not time to retouch any of the strokes of the brush with good effect, he will first have taken care to provide himself with large finished drawings in chalk, or paintings in distemper, of the same size as the work which he has to paint, so that he shall have only to copy these drawings on the wall.

These drawings are generally made on large sheets of paper pasted together, and have thence been generally termed cartoons (cartoni).

The painter traces the outlines of the figures on the plaister, by passing a steel point over them, or pricking them closely and passing very finely powdered charcoal through the pricked holes. He then proceeds to the completion of his work, having his chief tints ready prepared in separate earthen pots, and generally first trying their effect on a dry smooth tile, which quickly imbibing their moisture discovers the hue which they will have when dry on the wall.

All natural earths are good for painting in fresco. The colours are ground and tempered with water. It is to be remarked, that all the colours used in this method of painting brighten as they grow dry, excepting the pavonazzo or red varnish, the brownish red-ochre, ruth-ochre, and the blacks, particularly those that are passed through the fire.

The best colours are white, made of old lime, and white marble-dust (the proportional quantity of the latter depends on the quality of the lime, and must be found by trial, as too great a quantity of marble-dust will turn the colour black;) ultramarine-blue, the black of charcoal, yellow ochre, burnt vitriol, red earth, green of Verona, Venetian black, and burnt ochre.

Other colours, which require to be used with greater precaution, are amel, or enamel-blue, and cinnabar. Enamel-blue must be applied instantaneously, and while the lime is very moist, otherwise it will not incorporate; and if you retouch with it, you must do it an hour or more after the first application of it, in order to increase its lustre.

Cinnabar has a splendour almost beyond all other colours, but it loses it when mixed with lime. It may, however, be employed in places not exposed to the air, if proper care is used in preparing it. For this purpose, reduce a quantity of the purest cinnabar to powder, put it into an earthen vessel, and pour lime-water on it two or three times. By this process the cinnabar receives some impression from the lime-water, and you may then use it with greater safety.

The white of lime is formed by mixing lime, slaked a long time before, with good water. The lime deposits a sediment at the bottom of the vessel; when the water is poured off, this sediment is the white of lime.

Another kind of white may likewise be made from egg-shells, pounded, in great quantities, and boiled in water, together with quick-lime, and afterwards put into a strainer and washed repeatedly with spring water.

The shells must be again pounded until the water employed for that purpose becomes pure and limpid; and when the shells are completely reduced to powder, they are ground in water, made up in small pieces, and dried in the sun.

The effect of this colour must be ascertained by experiment.

Ochres of all kinds make good colours for fresco, being previously burnt in iron boxes.

Naples yellow is dangerous to be used, when the painting is much exposed to the air.

Blacks, from charcoal, peach-stones, and vine-twigs, are good; that extracted from bones is of no value.

There is another black used by the Italians, which they call fescia da botta. It is made of the lees of burnt wine.

Roman vitriol gathered at the furnaces, and called burnt vitriol, being afterwards ground in spirits of wine, resists the air extremely well. There is also a red extract from this preparation, somewhat like that of lac. This colour is a good preparatory for the layers where cinnabar is afterwards to be used; draperies painted with these two colours are as bright as fine lac used with oil.

Ultramarine never changes, and seems to communicate its permanent quality to the colours with which it is mixed.

Distemper. In addition to what has been said of this method of painting under its proper article, the following particulars are worthy of notice.

Until the discovery of oil-painting, the methods most generally adopted by all Italian painters were those of distemper and fresco.

In distemper, when they painted on boards, they often pasted over the boards a piece of fine cloth, to prevent them from parting; they then laid on a layer of white; after which, having tempered their colours with water and paste (or rather with water and yolks of eggs beat together with little fig-tree branches, the milk of which mixed with the eggs), they painted their pictures with this mixture.

All colours are proper for distemper, except the white of lime, which is used in fresco only.

Azure and ultramarine must be used with a paste made of glove-skin, or parchment, as they will turn green when mixed with yolks of eggs.

If the work is on walls, care must be taken that they are quite dry. The painter must even lay on two layers of hot paste before he applies the colours, which, if he pleases, he may also temper with paste, the composition of eggs and fig-tree branches being only retouching, and the paste rendering the work more durable. When used, it must be kept hot by fire. This paste, as has been said, is made of glove-skin or parchment.

All their designs for tapestry were made on paper, in the same manner as has been mentioned in the account of the cartoons used for fresco-painting.

When a painter in distemper would work on cloth, he must chuse that which is very old and smooth; then press pounded plaister with glove-skin paste, and lay it over the cloth; when dry, add another layer of the same paste.

All the colours are pounded with water, and as the painter wants them for his work, he tempers each with paste-water; or if he will only make use of yolks of eggs, he takes of water one glass, to which he adds an equal quantity of vinegar, the yolk, white, and shell of an egg, and some ends of fig-tree branches cut into small pieces, and beats them all well together in an earthen pan.

If he wishes to varnish his picture when finished, he must rub it with the white of an egg well beaten, and then put on a single coat of varnish.

Oil painting. The principal advantage of oil-painting over other methods consists in the colours drying less speedily, so that it allows the painter to finish, smooth, and retouch his works, with greater care and precision. The colours also being more blended together, produce more agreeable gradations, and a more delicate effect.

The antients are said (see the historical part of this article) to have been ignorant of the secret of painting in oil, which is only the grinding the usual colours in several kinds of oil, as poppy-oil, nut-oil, and linseed-oil. This method was likewise unknown to the first masters of the modern Italian schools, and is generally thought to have been discovered in the 14th century. It was first used on board or pannel, afterwards on plates of copper, and on linen cloth. Whichever of these materials is used for the purpose of painting on, it is requisite that a ground of colour is previously laid, which is called the priming; or else that they are covered with a layer of size, or other glutinous substance, to prevent the oil from penetrating, and being wholly absorbed during the painting of the picture. These preparations are familiarly known to all colourmen.

In some of the pictures of Titian and Paolo Veronese, there is reason to believe that they laid their ground with water-colours, and painted over it with oil, which contributed much to the vivacity and freshness of their works, by the ground gradually imbibing so much of the oil as may be requisite to preserve the brightness of the natural colours.

As the superior beauty of oil-painting depends on the vividness and delicacy of durable tints, we shall present the student with the best rules drawn from a careful study of the works of Vandyck and Rembrandt, two of the most remarkable colourists in different styles. These rules are arranged in so easy a method, that the student may be led, step by step, through all the difficulties of this nice and pleasing progress.

We shall first treat of the painting of flesh, next of draperies, then of the back-ground, and lastly of landscapes.

OF PAINTING FLESH.

Principal colours from which all the tints of the flesh are made, and their qualities in painting.

Flake-white is the best white known to us. This colour should be ground with the finest poppy-oil that can be procured. It is often found to turn yellow, on account of the oil, generally sold by that name, not being really drawn from poppies.

White comes forward to the eye with yellows and reds, but retires with blues and greens. It is the nature of all whites to sink into whatever ground they are laid on, therefore they should be laid on white grounds.

Ivory-black is the best black: it is a colour which mixes kindly with all the others. It is the true shade for blue; and when mixed with a little Indian red, it is the best general shadow-colour that can be used. It is generally ground with linseed-oil, and used with drying oil.

Black is a cold, retiring colour.

Ultramarine is the finest blue in the world: it is a tender retiring colour, and never glares, and is a beautiful glazing colour. It is used with poppy-oil.

Prussian-blue is a very fine blue, and a kind-working colour: it is ground with linseed-oil, though nut-oil is more proper. It should never be used in the flesh, but in green tints and the eyes.

Light-ochre is a good mixing colour, and of great use in the flesh: it is usually ground with linseed-oil, but nut-oil is better. All yellows are strengthened with red, and weakened with blues and greens.

Light-red is nothing but fine light ochre burnt. This and white, in mixing, produce a most perfect flesh-colour. It is a beautiful, clean colour; but too strong for the white, and therefore will grow darker. It should be ground and used with nut-oil.

No vermilion but what is made of the true native cinnabar should be used. It will not glaze; but is a fine colour when it is glazed. It is ground with linseed-oil, and should be used with drying oil.

Carmine is the most beautiful crimson: it is a middle colour, between lake and vermilion; is a fine-working colour, and glazes well It should be ground with nut-oil, and used with drying oil.

Lake is a tender deep red, but of no strong body; therefore it should be strengthened with Indian red. It is the best glazing colour that can be used. It is ground with linseed-oil, and used with drying oil.

Indian red is a strong pleasant-working colour, but will not glaze well; and when mixed with white, falls a little into lead: it is ground and used as the lake.

Brown pink is a fine glazing colour, but of no strong body. In the flesh it should never join or mix with the lights, because this colour and white antipathize, and mix of a warm dirty hue; for which reason their joinings should be blended with a cold middle tint. In glazing of shadows it should be laid before the other colours that are to enrich it: it is one of the finishing colours, and therefore should never be used in the first painting. It is strengthened with burnt umber, and weakened with terraverte; ground with linseed-oil, and used with drying oil.

Burnt umber is a fine warm brown, and a good working strong colour: it is of great use in the hair, and mixes finely with the warm shade.

Principal tints, composed from the foregoing principal colours, and necessary for painting flesh.

Light red tint is made of light red and white: it is the best-conditioned of all colours, for the general ground of the flesh. With this colour and the shade tint, you should make out all the flesh, like claro-obscuro, or mezzotinto. Remember, that this colour will grow darker, because it is in its nature too strong for the white; therefore you should improve it, by mixing vermilion and white with it, in proportion to the fairness of the complexion.

Vermilion tint is only vermilion and white mixed to a middle tint: it is the most brilliant light red that can be. It agrees best with the white, light red, and yellow tints.

Carmine tint is carmine and white only, mixed to a middle tint; it is, of all colours, the most beautiful red for the cheeks and lips: it is one of the finishing colours, and should never be used in the first painting, but laid upon the finishing colours without mixing.

Rose tint is made of the red shade and white, mixed to a middle degree, or lighter: it is one of the cleanest and most delicate tints that can be used in the flesh, for clearing up the heavy dirty colours, and in changing will sympathize and mix kindly.

Yellow tint is often made of Naples yellow and white; but it is as well to use light ochre and white, which is a good working colour. The ochre is too strong for the white; therefore you should make a little allowance in using it. It follows, the light red tints and yellows should always be laid before, the blues. If you lay too much of it, you may recover the ground it was laid on with the light red tints.

Blue tint is made of ultramarine and white, mixed to a lightish azure: it is a pleasant-working colour; with it you should blend the gradations. It follows the yellows, and with them it makes the greens; and with the reds it produces the purples. No colour is so proper for blending down, or softening the lights into keeping.

Lead tint is made of ivory-black and fine white, mixed to a middle degree: it is a retiring colour, and therefore is of great use in the gradations, and in the eyes.

Green tint is made of Prussian blue, light ochre, and white. This colour will dirty the lights, and should be laid sparingly in the middle tints. It is of most use in the red shadows, where they are too strong.

Shade tint is made of lake, Indian red, black, and white, mixed to a beautiful murrey colour, of a middle tint. This is the best mixture for the general ground of shadows. It mixes well with the lights, and produces a pleasant clean colour, a little inclined to the reddish pearl. As all the four colours of its composition are of a friendly sympathizing nature, so consequently this will be the same, and therefore may be easily changed by the addition of any other colours.

Red shade is nothing but lake and a very little Indian red. It is an excellent working colour, and a good glazer: it strengthens the shadows on the shade tint, and receives, when it is wet, the green and blue tints agreeably. It is a good ground for all dark shadows.

Warm shade is made of lake and brown pink, mixed to a middle degree. It is a fine colour for strengthening the shadows on the shade tint, when they are wet or dry. Take care that it does not touch the lights, because they mix of a dirty colour, and therefore should be softened off with a tender cold tint.

Dark shade is made of ivory-black and a little Indian red only. This colour mixes very kindly with the red shade, and blends agreeably with the middle tints in the dead colouring. It is excellent for glazing the eyebrows and the darkest shadows.

Process. The process of oil-painting, particularly in the colouring of flesh and in landscape, is to be divided into three stages, or paintings.

The colours and tints necessary for the first and second stages of painting flesh, are; 1. flake, or fine white; 2. light ochre and its tints; 3. light red and its two tints; 4. vermilion and its tint; 5. a tint composed of lake, vermilion, and white; 6. rose tint; 7. blue tint; 8. lead tint; 9. green tint; 10. half-shade tint, made of Indian red and white; 11. shade tint; 12. red shades; 13. warm shade.

The finishing pallet for a complexion requires five more, viz. 1. carmine and its tint; 2. lake; 3. brown pink; 4. ivory-black; 5. Prussian blue.

First stage, or dead-colouring of flesh.

The first lay of colours consists of two parts; the one is the work of the shadows only, and the other that of the lights.

The work of the shadows is, to make out all the drawing very correctly with the shade tint, in the same manner as if it was to be done with this colour only; and remember to drive or lay the colour sparingly. The lights should be all laid in with the light red tint, in different degrees, as we see them in nature. These two colours united, produce a clean, tender, middle tint. In uniting the lights and shades, you should use a long softener, about the size of a large swan-quill, which will help to bring the work into character, and leave the colouring more delicate; then go over the darkest shadows with the red or warm shade, which will finish the first lay.

The warm shade being laid on the shade tint, improves it to a warmer hue; but if laid instead of the shade tints, it will dirty and spoil the colours it mixes with; and if the red shade is laid first, instead of the shade tint, the shadows would then appear too red; therefore, notwithstanding these two colours are the best that can be for the shadows, yet they are too strong to be laid alone, which is a proof of the great use and merit of the shade tint. Here we may observe that the shade and light-red tints are so friendly in their nature, that even in continually altering and changing, they always produce a clean colour of a pearly hue.

Next. In order to finish the first painting, improve the reds and yellows to the complexion, and after them the blues; observing, that the blues on the reds make the purple, and on the yellows produce the green. The same method is to be understood of the shadows; but be sure to leave them clean, and not too dark; therefore allowance should be made in the grounds with the light red, because glazing them will make them darker. When the cloth is of a dark, or bad colour, there must be a strong body of colour laid all over the shadows, such as will not sink into the ground, but appear warm, and a little lighter than the life, so that it may be of the same forwardness to finish as if it had been a light ground; therefore the business of dead-colouring is, that you leave it always in the same order for finishing, though the colour of the cloth is quite the reverse.

The grounds of shadows, in what we call the dead-colouring, should be such as will support the character of the finishing colours; which ground must be clean, and a little lighter than the finishing colours, because the finishing of the shadows is glazing; and no other method than glazing can leave such brilliancy and beauty as they ought to have. If you begin the first painting with glazing, it will stare, and be of no use; and the solid colours which are laid on it, will look heavy and dull; therefore, all shadows and colours that are to be glazed, should be done with colours of a clean solid body, because the glazing is more lasting, and has the best effect, on such colours. Remember to leave no roughness, that is, none such as will appear rough, and interrupt or hurt the character of the finishing colours; which, by examining the work, whilst it is wet, with a soft tool, or when it is dry with a knife, may be avoided, as it will easily take off the knots and roughest parts.

The light red and white improved is superior to all other colours for the first lay or ground; which should be always done with a full pencil of a stiff colour, made brighter than the light, because it will sink a little in drying. The greater the body and quantity of colour, and the stiffer it is laid, the less it will sink. Every colour in drying will sink, and partake, in proportion to its body, of the colour it is laid on; therefore, all the lights of the flesh, if not laid on a light ground, must consequently change a little from the life, if there is not allowance made. The shade tint for the shadows should fall into the rose tint, as the complexion grows delicate; all which should be lightly united, with a soft long pointed hog-tool, to the lights, making out the whole like mezzotinto. The great masters very seldom softened or sweetened the colours; but in uniting the first lay, they were very careful in preserving the brightness of their colours, and therefore did not work them below the complexion: for to force or keep up a brilliancy in the grounds, can only be done with the whites, reds, and yellows, which method will make up for the deficiency of the white grounds; therefore, the first painting should be left bright and bold, and the less the colours are broken the better. You should forbear using any colours that will produce them, and be contented to add what is wanting in the next painting; where, if you fail, a clean rag will restore the first ground.

Second painting, or second stage.

The second painting begins with laying on the least quantity, that can be, of poppy-oil; then wipe it almost all off, with a dry piece of a silk handkerchief.

The second painting is also divided into two parts: one, the first lay of the second painting; which is scumbling the lights, and glazing the shadows; the other, finishing the complexion with the virgin tints, and improving, as far as you can, without daubing.

First. Scumbling is going over the lights, where they are to be changed, with the light red tints, or some other of their own colours, such as will always clear and improve the complexion, with short stiff pencils; but such parts only as require it, otherwise the beauty of the first painting will be spoiled.

The light red tint improved is the best colour for scumbling, and improving the complexion in general. Where the shadows and drawing are to be corrected, you should do it with the shade tint, by driving the colour very stiff and bare, that you may the easier retouch and change it with the finishing tints. Some parts of the shadows should be glazed with some of the transparent shadow-colours, such as will improve and come very near to the life; but be sure not to lay on too much of it, for fear of losing the hue of the first painting, the ground of which should always appear through the glazing. Be very careful in uniting the lights and shades, that they do not mix dead and mealy; for the more the lights mix with the shades, the more mealy those shades will appear. Thus far the complexion is prepared and improved, in order to receive the virgin tints.

Second. Go over the complexion with the virgin tints. These are the colours which improve the colouring to the greatest perfection, both in the lights and shadows.

This should be done in the same manner as you laid them in the second part of the first painting; that is, with the reds, yellows, and blues, blending them with delicate light touches of the tender middle tints, without softening. Leave the tints and their grounds clean and distinct, and be content to leave off whilst the work is safe and unsullied, leaving what is farther required for the next sitting; for in attempting the finishing touches before the other is dry, you will lose the spirit and drawing, and your colours will become of a dirty hue.

Third painting, or finishing.

It is to be supposed, the complexion now wants very little more than a few light touches; therefore there will be no occasion for oiling.

Begin with correcting all the glazing; first, where the glazing serves as a ground or under part; then determine what should be done next, before you do it, so that you may be able to make the alteration on the part with one stroke of the pencil. By this method you preserve both the glazing and the tints; but if it happens that you cannot lay such a variety of tints and finishing colours as you intended, it is much better to leave off while the work is safe and in good order; because those few touches, which would endanger the beauty of the colouring, may easily be done, if you have patience to stay till the colours are dry; and then, without oiling, add those finishings with free light strokes of the pencil.

Rembrandt touched up his best pictures a great many times, letting them dry between. It was this method which gave them their surprising force and spirit. It is much easier to soften the over-strong tints when they are dry, than when they are wet; because you may add the very colours that are wanting, without endangeaing the dry work. If any of the colours of the pallet want to be a little changed to the life, when you are painting, it is much better to do it with the knife on the pallet than with the pencil, because the knife will mix and leave it in good order for the pencil.

Of painting draperies.

In order to shew the nature and different degrees of colours of tints used in painting draperies, we must first determine how many divisions are absolutely necessary to make the first lay of colours, and after that the reflections and finishing tints.

The right method of painting draperies in general is to make out the whole, or the first lay, with three colours only, viz. the lights, middle tint, and shade tint.

Observe that the lights should rather incline to a warmish hue; and the middle tint should be made of friendly-working colours, such as will always mix of a clean, tender, coldish hue. The shade tint should be made of the same colours as the middle tint, only with less light; therefore this tint will also mix of a tender clean colour. The beauty and character of the folds, the shape, attitude, and principal lights and shades, are all to be considered, and made with these three colours only; which should be done to your satisfaction, before you add any of the reflects, or finishing tints.

The reflections of draperies and satins are generally productions of their own, and are always lighter than the shadows on which they are found; and being produced by light, will consequently have a light warm colour, mixed with the local colour that receives them. Here it will be necessary to notice the general method of managing the colours of the first lay, and those of the reflections and finishing tints.

In the first lay, the high lights should be laid with plenty of stiff colours, and then shaped and softened into character with the middle tint very correctly. Where the gradations of the lights are slow, as in the large parts, it will be proper to lay the middle tint first at their extremities, with a tool that will drive the colour, and leave it sparingly; because the lights will mix and lie the better upon it. Next make out all the parts of the shadows with the tint driven bare. After this comes the middle tint, for the several lights and gradations; which should be very nicely wrought up, to character without touching any of the high lights which finish the first lay.

The reflects and finishing tints are in general the antipathies of the first lays: they will, without great care, dirty the colours on which they are laid; and therefore should be laid with a delicate light touch, without softening. If it is overdone, endeavour to recover it with the colour of the part on which it was laid: this may be done directly, or when it is dry. Whether the reflects proceed from the same colour, or any other, the method of using them is the same.

Before we proceed to the particular colours, it will be proper to make some observations on their grounds.

It often happens, that the colour of the cloth is very improper for the ground of the drapery; and when it is so, you should change it with those colours which are most proper to improve and support the finishing colours. This method of dead-colouring must consequently preserve them in the greatest lustre. In dead-colouring, you should lay the lights and shades in a manner so as only to shew a faint idea of them, with regard to the shape and roundings of the figure. If you have a design to work from, then it will be proper to make all the large and principal parts in their places: which should always be done with a colour that is clean, and lighter than the intended drapery, though in general of the same hue; and let the shadows be no darker than a middle tint. These should be mixed and broke in a tender manner, and then softened with a large tool, so that nothing rough and uneven is left to interrupt or hurt the character of the finishing colours.

White satin. All whites should be painted on white grounds, laid with a good body of colour, because this colour sinks more into the ground than any other.

There are four degrees of colours in the first lay, to white satin. The first is the fine white for the lights; the second is the first tint, which is made of fine white and a little ivory-black, mixed to an exact middle degree between the white and the middle tint. This colour follows the white; and it is with this you should shape the lights into character before you lay on any other: and take care that this first tint appears distinctly between the white and the middle tint, otherwise the beauty and the character of the satin will be spoiled.

The middle tint should be made of white, black, and a little Indian red. These three colours are very friendly, and mix to a beautiful clear colour of a pearly hue, which has the true brightness and warmth of the general hue of the satin. Remember to allow for the red hue changing a little to the lead. If there is occasion to make any part in the middle tint lighter, do it with the first tint only. This colour should also be laid sparingly before the white, in all the little lights that happen in the middle tints and shadows; on which you should lay the white with one light touch, and be sure not to cover all the parts that were made with the first tint; if you do, it will spoil the character, and look like a spot, for want of the softening edge or border, which must be between the white and the middle tint. The shade tint should be made of the same colour as the middle tint, but with less white, so that it is dark enough for the shadows in general; with which make out all the parts of the shadows nicely to character, which is the work of the first lay.

Next follow the reflects and finishing tints.

Brown ochre, mixed with the colour of the light, is the most useful colour in general for all reflects in draperies, that are produced from their own colours. All accidental reflexes are made with the colour of the parts from which they are produced, and the local colours that receive them. There are but two reflecting tints wanted for draperies in general: one should be lighter than the middle tint, the other darker. These colours may be a little changed on the pallet with the first and middle tints, as occasion requires, or lightly broken on the part that receives them; but this last method is not so safe as the other. The tint sufficient for blending the dark shadows to the mellow tender hue, is made with the shade tint and a little brown ochre, which should be laid on very sparingly, with soft light touches, for fear of making them dull and heavy; if it is overdone, recover it with the colour it was laid upon.

We often see a little blue used in the first tint of white satin. Van Haecken, who was the best drapery-painter in England, did so; and sometimes, instead of the blue, he used blue-black, till he found it to be a pernicious colour, and was therefore obliged to use blue; because his middle tint, which was only of black and white, was so very cold, that no other colour but blue would make a colder tint; yet he managed these cold colours, in all the lights and middle tints, so agreeably, and so light and easy was his touch, that we may learn something from him.

Blue satins. Blue satin is made of Prussian blue and fine white.

The best ground for blue is, white for the lights, and black and white for the shadows.

The first lay of colours for blue is divided into three degrees or tints. First make the middle tint of a beautiful azure; then mix the colour for the light about a middle degree, between that and white. Make the shade tint dark enough for the shadows in general. All the broad lights should be laid with plenty of colour, and shaped to character with the middle tint, before you lay on any other colours. Remember, the less colours are mixed, the better they will appear and stand; for the lights of blue should be managed with as much care as those of white satin. Next follow with the rest of the middle tint, and then make out all the shadows. The more you drive the shade tint, the better it will receive the reflects and finishing tints. The shadows should be strengthened and blended with ivory-black, and some of their own colour, which will mix with them into a tender mellow hue.

The reflects are made as those of white satin, that is, with ochre, and some of the lights; which should be perfectly done, as you intend them, at once painting. The shadows, when dry, may be a little improved, if there is occasion to alter them, with the colours they were made with. The Prussian proper to be used, is that which looks of the most beautiful azure before it is ground; and the sooner it is used after it is ground, the better it will work and appear.

Velvet may be painted at once. The method is, to make out the first lay with the middle tint and shade tint; on which lay the high lights, with light touches, and finish the shadows in the same manner as those of satin: but the nearest imitation of velvet is done by glazing; the method of which is, to prepare a ground, or dead-colouring, with such colours as will, when dry, bear out and support the glazing colour in its highest perfection. The nature of the glazing colour is to be of a fine transparent quality, and used simply with oil only, so that whatever ground it is laid on, the whole may appear distinctly through it. The best ground for blue is made with white and ivory-black: the white is for the high lights, which, with the middle tint and shade tint, makes out the first lay like mezzotinto. Remember to make the middle tint lighter in proportion to the glazing, because that will make it darker. It is often necessary to cover all but the high lights, with a thin glazing, laid in less quantity than if it was to be done once only. If any of it touches the lights, wipe it off with a clean rag. The very high lights should be improved, and made of a fine white, and left to dry. The glazing colour is Prussian, ground very fine with nut oil; and should be laid with a large stiffish tool. It is on the last glazing we should strengthen and finish the shadows.

The greatest fault in the colouring of draperies is the painting the shadows with strong glaring colours, which destroy the beauty of the lights. This is not only the reverse of art, but of nature, whose beauty always diminishes in proportion with the lights. For this reason, take care to blend and soften the shadows with such friendly colours as will agree with their local character and obscurity. Here observe, that glazing the middle tint, which is made of black and white, will not produce a colour so blue as if it had been prepared with Prussian and white; yet this colour will preserve the beauty of the lights in the highest perfection, by reason of its tender obscure hue, when the blueness of the other would only diminish them. This method of glazing the blue is the general rule for all glazing.

When glazing blue, the lights may be glazed with ultramarine, though all the other parts are done with Prussian. This method saves a great quantity of that valuable colour, and answers the purpose as well as if it had been done with ultramarine.

Though this general method of painting satins is to make the first lay of colours with three degrees, or tints, yet you should understand, in using them, that they produce two more; for the mixing of two different colours together on the cloth will make another of a middle tint between them; so it is with the lights and middle tints, and with the middle tint and shade tint: the first answers to the first tint in white satin, and the last will consequently be a sort of gradating, or half shade.

If the lights and middle tint mix to a beautiful clean colour, of a middle hue between both, there will be no occasion for a colour to go between them, as in blue satin: but if in mixing they produce a tint inclined to a dirty warm hue, then another of a sympathizing nature should be laid between them, in order to preserve the beauty of the lights, as the first tint in the white satin; for if it was not so, the red in the middle tint would certainly dirty and spoil the white.

It is highly necessary to understand these principles of the first lay of colours, in order to have a perfect knowledge of the general rule of colouring.

Scarlet and crimson. A light yellow red, made of light ochre, light red, and white, is the proper ground for scarlet; the shadows are Indian red, and in the darkest parts mixed with a very light black.

The second painting should be a little lighter than you intend the finishing colour, that is, in proportion to the glazing, which will make it darker.

The high lights are vermilion and white for satin and velvet, and vermilion for cloth. The middle tint is vermilion, with a very little lake or Indian red; the shade tint is made with Indian red and lake, with the addition of a little black in the darkest shadows. The difference between scarlet and crimson is, that the high lights of crimson are whiter, and the middle tint is made darker. Their reflects are made with light red and vermilion. The high light should be laid and managed in the same manner as those of the blue, for fear of dirting them; and sometimes they require to be touched over the second time before we glaze them. The more the colours of the second painting are drove, the easier and better they may be managed to character; but the high lights should have a good body of colour, and be left with a delicate light touch. After it is well dry, finish with glazing the whole with fine lake, and improve the reflects and shadows. Remember that the scarlet requires but a very thin glazing; and it is better to glaze the crimson twice over, than lay too much at once painting.

Pink colour. There are two different methods of painting a pink colour; one is by glazing, the other is done with a body of colours at one painting. The same grounds do for both: which should be a whitish colour, inclining to a yellow, for the lights; and Indian red, lake, and white, for the shadows.

The second painting, for the glazing method, is done with the same colours, and a little vermilion and white for the high lights. When it is dry, glaze it with fine lake, and then break and soften the colours into harmony directly.

The other method is to make the high lights with carmine and white; the middle tint with lake, white, and a little carmine; and the shadows with lake and Indian red, with a little vermilion for the reflections. But remember, the shadows will require to be broken with some tender obscure tint.

Yellow. The ground for yellow should be a yellowish white for the lights, and a mixture of the ochres for the shadows.

There are the same number of tints in the yellow, as there are in the white satin, and the method of using them is the very same. The lights are made with king's yellow, ground with clean good drying oil. The first tint is light ochre, changed with a little of the pearl tint, made with the dark shade and white, which should be laid and managed as the first tint in white satin. The middle tint is a mixture of the light and brown ochre, softened with the pearl tint. The shade tint is made with brown pink and brown ochre; these belong to the first lay.

The reflects are light ochre, and sometimes in the warmest parts mixed with a little light red. The shadows are strengthened with brown pink and burnt umber.

Green. The proper ground for green is a light yellow green, which is made of light ochre, a little white, and Prussian blue, for the lights, and the ochre, brown pink, and Prussian, for the shadows.

The finest green for draperies is made of king's yellow, Prussian blue, and brown pink. The high lights are king's yellow, and a very little Prussian; the middle tint should have more Prussian; and the shadow tint is made with some of the middle tint, brown pink, and more Prussian; but the darkest shadows are brown pink and a little Prussian. The lights and middle tint should be managed in the same manner as those of the blues. The shadow tint should be kept entirely from the lights, because the brown pink that is in it will, in mixing, dirty them, as the black does those of the blues. Remember to allow for their drying a little darker; and that the king's yellow must be ground with good drying oil; for the longer it is drying, the more it will change and grow darker; and the sooner it is used, the better it will stand. It is proper to have two sorts of king's yellow, one to be very light, for the high lights of velvet.

Changeable colours. Changeable colours are made with four principal tints, viz. the high lights, middle tint, shade tint, and reflecting tint.

The greatest art lies in finding the exact colour of the middle tint, because it has more of the general hue of the silk than any of the others. The shade tint is of the same hue with the middle tint, though it is dark enough for the shadows. The high lights, though often very different from the middle tint, should be of friendly-working colour, that will, in mixing with it, produce a tint of a clean hue.

The method of painting silks is to make out the folds with the shade tint, and then fill them up in the lights with the middle tint. This first lay should be done to your satisfaction before you add any other colours; and the stiffer the middle tint is used, the better the high lights may be laid upon it. The reflecting tint falls generally upon the gradating half-shades, and should be laid with tender touches sparingly, for fear of spoiling the first lay.

This method of painting answers for all coloured silks, as well as changeable, with this difference only; that the plain colours require not so much art in matching the tints, as the changeable do. The last part of the work is the finishing and strengthening the shadows with an obscure tint, a little inclining to a mellowish hue; such as will not catch the eye, and interrupt the beauty of the lights.

Black. The best ground for black is light red for the lights, and Indian red and a little black for the shadows.

The finishing colours are, for the lights, black, white, and a little lake. The middle tint has less white, and more lake and black; the shade tint is made of an equal quantity of lake and brown pink, with a very little black.

The method of painting black is very different from that of other colours; for as in these the principal thing is to leave their lights clear and brilliant; so in black, it is to keep the shadows clear and transparent. Therefore begin with the shade tint, and glaze over all the shadows with it. Next lay in the darkest shadows with black, and a little of the shade tint, very correctly. After that, fill up the whole breadth of lights with the middle tint only. All which should be done exactly to the character of the satin, velvet, cloth, &c. &c. and then finish with the high lights.

Here observe, the ground, being red, will bear out and support the reds, which are used in the finishing colours. The lake in the lights takes off the cold hue, and gives it a more beautiful colour. If the shade tint was of any other colour than a transparent warm hue, the shadows would consequently be black and heavy; because no other colours can preserve the warm brilliancy which is wanting in the shadows of the black, like lake and brown pink. Black is of a cold heavy nature, and always too strong for any other colour; therefore you should make an allowance in using it. There will be a few reflects in satin, which should be added as those of other colours; but they should be made of strong colours, such as burnt umber, or brown ochre, mixed with a little shade tint.

Though the grounds mentioned for the draperies are absolutely necessary for the principal and nearest figures in a picture, such as a single portrait, or the like; yet for figures which are placed behind the principal or front figures, their grounds should always be fainter in proportion to their local finishing colours.

Linen. The colours used in linen are the same as those in white satin, except the first tint, which is made of white and ultramarine ashes, instead of the black, and mixed to a very light bluish tint.

In the dead-colouring, take particular care that the grounds are laid very white and broad in the lights. The shadows are made with black, white, and a little Indian red, like the middle tint of white satin. These should be left very light and clean, in order to support the finishing colours.

The second painting begins with glazing all the lights, with a stiff pencil and fine white only, driven bare, without using any oil. The shadows may be scumbled with poppy-oil, and some of the colour they were made of. This is the first lay, on which you are to follow with the finishing colours directly. The middle tint of white satin is the best colour for the general hue of the shadows. With this and white, in different degrees, make out all the parts to character, with free light touches, without softening; then, with a large long-pointed pencil and fine white, lay the high lights very nicely with one stroke. After this comes the fine light bluish tint, which should be mixed light, and laid in the tender gradations, very sparingly and lightly, without filling them up.

Remember, the first lay should be left clear and distinct; the more it appears, the better. It is the overmixing and joining all the colours together, which spoils the beauty of the character; therefore it is better to let it dry before we add the reflects and finishing tints.

The method of letting the beautiful clear colour dry, before you add the warm reflects, and harmonizing tints, prevents them from mixing and dirting each other.

The principal blending colours used in the reflects are the yellow tint, green tint, and rose tint; which last is made of lake, Indian red, and white. Glazing the pearl and lead-colour with white, though it seems to answer our purpose at the time when it is done, will certainly sink and be lost in the grounds on which it is laid; therefore you should make the dead-colouring as white as you intend the finishing colours, by reason they will sink a little in proportion to the colour of the cloth, which the glazing with pure white only will recover.

Of painting back grounds.

The principal colours that are necessary for painting of back-grounds, as walls, buildings, or the like, are white, black, Indian red, light and brown ochre, Prussian, and burnt umber; from which the eight principal tints are made, as follows:

1. Pearl is made of black, white, and a little Indian red.
2. Lead, of black and white, mixed to a dark lead-colour.
3. Yellow, of a brown ochre and white.
4. Olive, of light ochre, Prussian, and white.
5. Flesh, of Indian red and white, mixed to a middle tint.
6. Murrey, of Indian red, white, and a little black, mixed to a kind of purple, of a middle tint.
7. Stone, of white, umber, black, and Indian red.
8. Dark shade, of black and Indian red only.

Here the lead tint serves for the blues, the flesh tint mixes agreeably with the lead, and the murrey is a very good blending colour, and of great use where the olive is too strong; the umber, white, and dark shade, will produce a fine variety of stone colours; the dark shade and umber, used plentifully with drying oil, make an excellent warm shadow-colour. All the colours should be laid with drying oil only, because they mix and set the better with the softener.

Where the marks of the trowel are so strong in the priming of the cloth, that one body of colours will not be sufficient to conceal it, lay a colour to prevent it, which should be dry before you begin with those parts you expect to finish at once painting.

Process. The process of painting back-ground is divided into two parts in stages; the first is the work of the first lay, the second that of the finishing tints.

Begin the first lay from the shadowed side of the head, and paint the lights first; from them go into the gradations and shadows, which should be done with a stiffish tool, very sparingly, with the dark shade and white, a little changed with the colours that will give it more of the required hue, but very near in regard to tone and strength, leaving them like mezzotinto.

The dark and warm shadows should be laid before the colours that join them. This do with the dark shade and umber, driven with drying oil. If those colours were laid on first, they would spoil the transparency, which is their greatest beauty. The more the first lay is driven, the easier and better you may change it with the finishing tints, therefore you may lay them with the greater body.

The second part is to follow directly, whilst the first lay is wet, with those tints that are the most proper to harmonize and finish with.

Begin with the lights first, and remember, as you heighten and finish them, to do it with warmer colours; and let those be accompanied with fine tender cold tints. The lightest parts of the ground should be painted with a variety of light warm clear colours, which vanish and lose their strength imperceptibly in their gradations. Take care that you do not cover too much of the first lay, but consider it as the principal colour.

From the lights, go to the gradations and shadows; for when the lights are well adapted to produce and support the figure, it is easy to fall from them into whatever kind of shadows you find most proper; then soften and blend the whole with a long large hog-tool; which, with the strength and body of the drying oil, will melt and sweeten altogether, in such a manner, as will seem surprisingly finished. Remember the tints will sink, and lose a little of their strength and beauty in drying. All grounds, as walls, &c. should be finished at once painting; but if they want to be changed, glaze them with a little of the dark shade and drying oil, driven very bare; on which, with a few light touches of the colour that is wanting, you may improve their hue. The dark shadows may also be strengthened and improved by glazing, which should be done after the figures are nearly finished, for fear of making them too strong.

Rembrandt's grounds are rather brighter in the lights, and have more variety of tints than any other painter's; for he had observed, that those tints diminish in proportion with the lights; therefore his shadows have but a faint appearance of tints. He understood the gradations in perfection, by mixing and breaking the first lay of colours so artfully, that they deceive in regard to their real strength.

Vandyck's general method was, to break the colours of the ground with those of the drapery. This will certainly produce harmony.

Fresnoy says, let the field or ground of the picture be pleasant, free, transient, light, and well united with colours which are of a friendly nature to each other; and of such a mixture as that there may be something in it of every colour that composes your work, as it were the contents of your pallet.

Curtains should be dead-coloured when we paint the ground; and should be done with clean colours, of a near hue to the intended curtain, such as will support the finishing colours; do it with a tender sort of keeping, and near in regard to their tone in the lights, but much softer in the shadows; all which should be mixed and broken with the colours of the ground. It will often happen, that we cannot make the folds the first painting; we should then leave the masses of light and shadow, in regard to the keeping of the picture, broad and well united together, such as may seem easy to finish on. The colours of the landscape, in back-grounds, should be broke and softened also with those of the parts which join them. This method will make all the parts of the ground, as it were, of one piece.

The sky should be broke with the lead and the flesh-tints. The murrey tint is of great use in the grounds of distant objects; and the umber and dark shades in the near grounds. The greens should be more beautiful than you intend them, because they will fade and grow darker. After all is painted, go over the whole very lightly with the softener, as you did the grounds, which will make it look agreeably finished.

Of painting landscapes.

The principal colours used in landscapes are; 1. flake white; 2. white lead, or common white; 3. fine light ochre; 4. brown ochre; 5. brown pink; 6. burnt umber; 7. ivory black; 8. Prussian blue; 9. ultramarine; 10. terreverte; 11. lake; 12. Indian red; 13. vermilion, or native cinnabar; 14. king's yellow.

The principal tints are, 1. Light ochre and white; 2. Light ochre, Prussian blue, and white; 3. Light ochre, and Prussian blue; 4. The same darker; 5. Terreverte and Prussian blue; 6. Brown pink and Prussian blue; 7. Brown pink and brown ochre; 8. Brown pink, ochre, and Prussian blue; 9. Indian red and white; 10. Ivory-black, Indian red, and lake.

The colours necessary for dead-colouring, are: common white, light ochre, brown ochre, burnt umber, Indian red, ivory-black, and Prussian blue.

The principal colours and tints for painting the sky, are, fine white, ultramarine, Prussian blue, light ochre, vermilion, lake, and Indian red.

The tints are, a fine azure, lighter azure, light ochre and white, vermilion and white; and a tint made of white, a little vermilion, and some of the light azure, at your discretion.

Process. Sketch or rub in your design faintly, with burnt umber used with drying oil, and a little oil of turpentine; leaving the colour of the cloth for the lights. Remember, in doing this, to leave no part of the shadows so dark as you intend the first lay or dead-colouring, which also is to be lighter than the finishing colours. Though the foliage of the trees is only rubbed in faintly, yet the trunks and bodies should be in their proper shapes, with their breadths of light and shadow. All kind of buildings should be done in the same manner, leaving the colour of the cloth for their lights. The figures on the fore-ground may also be sketched in the same manner, and then left to dry.

First painting or dead-colouring.

Let the first lay, or dead-colouring, be without any bright, glaring, or strong dark colours; so that the effect is made more to receive and preserve the finishing colours, than to shew them in their first painting.

The sky should be done first, then all the distances; and so work downwards to the middle group, and from that to the fore-ground, and nearest parts. Remember, all the parts of each group, as trees, buildings, or the like, are all painted with the group they belong to.

The greatest secret in dead-colouring is, to find the two colours which serve for the ground of shadows in general, the sky excepted; and the method of using them with the lights: the first of which is the dark shade with a little lake in it; the other colour is only burnt umber. These should be a little changed to the natural hue of the objects, and then laid on with drying oil, in the same manner as we shade with Indian ink, which is a kind of glazing, and as such they should be left; otherwise they will be dark and heavy, and therefore would be entirely spoiled for the finishing glazing. Both these colours mix and sympathize agreeably with all the lights, but should be laid before them.

The sky. The sky should be laid with a good body of colours, and left with a faint resemblance of the principal clouds, more in the manner of claro obscuro than with finishing colours; the whiter it is left, the better it will bear out and support them; the distances should be made out faint and obscurely, with the dark shades, and some of their lights in different degrees, and laid so as best to find and shew their principal parts. All the grounds of the trees should be laid or rubbed in, enough only to leave an idea of their shapes and shadows faintly. The ground of their shadows must be clean, and lighter than their finishing colours.

In painting the lights, it is better to incline more to the middle tint, than to the very high lights; and observe to leave them with a sufficient body of clean colours, which will preserve the finishing colours better; all which may be done with a few tints. After this, go over the whole with a sweetener very lightly, which will soften and mix the colours agreeably for finishing.

Second painting.

Begin with the sky, and lay in all the azure, and colours of the horizon; then soften them: after that, lay in the general tint of the clouds, and finish on it with the high lights, and the other tints that are wanting, with light tender touches; then soften the whole with a sweetener, very lighty. The finishing of the sky should be done all at one painting, because the tender character of the clouds will not do so well as when the whole is wet. Observe, that the stiffer the azure and colours of the horizon are laid, the better the clouds may be painted upon them.

The greatest distances are chiefly made with the colour of the sky; as they grow nearer and darker, glaze and scumble the parts very thin, with such glazing shadow-colours as come nearest to the general hue of the group the objects are in. This glazing should be understood of a darkish hue; and that the first painting or dead-colour should be seen through it distinctly. On this lay, or ground, add the finishing colours.

Now, supposing this glazed ground properly adapted to the object and place, it will be easy to find the other colours, which are wanted for the lights and finishings of the same; but in laying them, you must take care not to spoil the glazing; therefore be very exact in making those colours on the pallet, and then be sure to lay them with light free touches.

Before we proceed any farther, it will be proper to say something of the most useful glazing colours.

Lake, terreverte, Prussian blue, and brown pink, are the four principal. The more you manage them like Indian ink, and the more distinctly you leave them, the better their transparent beauty will stand and appear, provided you do it with good drying oil. After these four glazing colours, burnt umber is a very good glazing warm brown, and of great use in the broken grounds and nearest parts; but the most agreeable colour for the darkest shadows, is the dark shade improved with lake. It is a fine warm shade; mixes harmoniously with all the lights, as well as the shadows; and is excellent in the trunks and bodies of trees, and in all kinds of buildings.

Make out all the ground of the objects with such glazing shadow-colours as seem nearest to the natural hue of the object in that situation; but as the principal glazing colours themselves are often too strong and glaring, they should therefore be a little changed, and softened with such colours as are of a near resemblance to themselves and the objects: thus, if it is in the distances, the terreverte and the azure, which are the principal glazing colours, may be improved and made lighter with some of the sky tints; and as the distance comes nearer with the purple. In the middle group, the terreverte and Prussian blue may be changed with some of the green tints; such as are made without white, for white is the destruction of all glazing colours. As you approach the first group, there is less occasion for changing them; but the fore-ground and its objects require all the strength and force of glazing, which the colours are capable of producing.

After this glazing ground, follow with strengthening the same in the shadows, and darkest places, in such manner as will seem easy to finish; which is the first lay of the second painting.

The colours that come next for finishing, are in the degree of middle tints: these should be carefully laid over the greatest breadth of lights, in such manner as not to spoil and cover too much of the glazing. Do it with a good body of colour, as stiff as the pencil can agreeably manage. Remember, the colours of the middle tint should be of a clean beautiful hue. According to these methods, it will be easy to finish all the second painting down from the sky, through the middle group. As you come to the first group, where all the objects should be perfectly finished, finish their under or most distant parts, before you paint any of the other, which appear nearer. Observe this method down to the last and nearest objects of the picture: and where it so happens that painting one tree over another does not please, forbear the second until the first is dry. Thin near trees of different colours will do better, if you let the under parts dry before you add the finishing colours.

Third and last painting.

If oiling is necessary, lay the least quantity that can be; which should be done with a stump tool or pencil, proportioned to the place that is to be oiled, so as to oil no more than is wanted: then wipe the whole place that is oiled, with a piece of silk handkerchief.

When going to finish any objects, remember to use a great variety of tints, very nearly of the same colour, but most of all when finishing trees. This gives a richness to the colouring, and produces harmony. The greens will fade, and grow darker; therefore it is highly necessary to improve and force them, by exaggerating the lights, and making an allowance in using them so much the lighter. For the same reason, take great care not to overcharge and spoil the beauty of the glazing; for if you do, it will be dull and heavy, and will consequently grow darker.

The method of painting near trees is, to make the first lay very near to nature, though not quite so dark, but more in the degree of a middle tint, and follow it with strengthening the shadows; then the middle tints; and last of all lay the high lights and finishing colours. All this cannot be done as it should be, at one painting; therefore the best way is, to do no more than the first lay with the faint shadows, and leave it to dry.

Then begin with improving the middle tints and shadows, and let them dry.

The third and last work is, adding all the lights and finishing colours in the best manner you are able. This method of leaving the first and second parts to dry separately, not only makes the whole much easier, and more agreeable, but leaves the colours in the greatest perfection; because most of the work may be done with scumbling and glazing, and some parts without oiling. The lights also may be laid with a better body of colour, which will not be mixed and spoiled with the wet ground.

The figures in the landscape are the last work of the picture; those in the fore-ground should be done first, and those in the distances should be done next; for after the figures in the first and farthest group are painted, it will be much easier to find the proportions of those in the middle parts of the picture. And observe, that the shadows of the figures should be of the same hue, or colour, with those of the group or place they are in.

Miniature.

The art of painting in miniature is of very antient date. It is practised either on vellum or ivory.

The best method, in painting on vellum, is to glue the edge of the vellum to a copper-plate or board, over which it is strained, in this manner: Let your vellum be every way a finger's breadth larger than what you strain it on. Moisten the fair side of the vellum with a piece of fine wet linen, and put a piece of white paper to the other side. Then apply it to the plate or board, stretching it equally in all directions, lap the edges nicely round and glue them, taking care to let no glue pass under the part of the vellum on which you mean to paint. When the glue dries, and the edges of your vellum are thus fastened, you may proceed with your work; or you may (agreeably to the practice of some painters) previously give the vellum a light wash of white lead well purified, to serve as a ground.

But ivory being the material most frequently used at present for painting in miniature, we shall here give the most approved rules for painting on ivory.

It is scarcely necessary to remark, that the first essential point towards excellence in this, as in all other branches of painting, is a thorough and well-grounded knowledge in drawing, both from plaister, and from the life; without correctness of drawing the greatest brilliancy of tints will at last be unsatisfactory. We should therefore recommend to the student in miniature, to continue, at his leisure hours, to copy from large drawings or busts, in chalks or water-colours, as correctly as possible, which is the best means of giving facility to the hand in the drawing of smaller figures.

Painting in miniature is of all others the most delicate and tedious in its process, being performed wholly with the point of the pencil. It is only fitted for works of a small size, and must be viewed near.

Colours used in miniature painting.

In painting the face, the yellows that are used are five, viz. gall-stone, terra sienna, Nottingham ochre, Roman ochre, and Naples yellow; the latter three of which are opaque colours, the other transparent. The greens are confined to one, which is sap-green. The blues are verditer, Prussian, indigo, smalt, ultramarine, and Antwerp. The reds are, carmine, drop lake, Chinese vermilion, and Indian red. Under the class of reds, may also be put burnt terra Sienna, its colour inclining much that way, though more to the orange. The only browns, if any are used in the face, are burnt umber and terra de Cassel, and they are only to be used in the mixture of dark shades.

For painting draperies, we shall only add to the above colours, lamp-black, king's yellow, and flake white.

Qualities of the above colours when used in miniature.

Yellows. Gall-stone is one of the finest and brightest colours, and a lasting one; but it should be sparingly used in the flesh tints, its brilliancy being apt to overpower all the other colours.

Terra di Sienna unburnt, is of a greasy nature, but is used as a warm yellow: burned, it is more beautiful, partaking of three tints, yellow, red, and brown.

Nottingham ochre works well; but on account of its heavy qualities must be used with caution.

Roman ochre is used with success in miniature painting, as it works, when properly portioned with gum-water, extremely sharp and neat; and being in itself a warm colour, communicates that quality to the tints it is worked in.

Naples yellow, although adopted by some artists, is of a sickly hue, and has this very bad quality, that it absorbs all colours that are either worked on it, or mixed with it.

Blues. Ultramarine excels all others in permanency.

Prussian blue has no substitute, on account of its strength of effect and transparency.

Smalt is so hard that nothing but an agate flag and muller will pulverize it sufficiently. It is not to be depended on for permanency.

Indigo is a useful blue, though it must be sparingly used, on account of its extreme depth of colour, nearly approaching to black; the best is called the rock indigo. The way to judge of its qualities is to break it, and, if good, it will have a copperish hue; but if bad, it will be of a dead blackish cast.

Verditer is a fine blue, and much used by miniature painters, not only in their sky-grounds, but likewise in the delicate parts of the face. It requires to be very finely ground on a hard flag. As to durability, it changes in time to a dirty greenish colour; on account of its being made from copper, care should be taken not to put the pencil it is used with much in the mouth, as its qualities are pernicious.

Antwerp blue, is one of the greatest deceptions in the world, being, when dry, a most beautiful bright blue; but when wet and prepared, a very dingy colour, and totally unfit for the face of a miniature. It may be used in blue draperies or back-grounds, but in nothing else.

Sap-green is a highly useful colour, when judiciously mixed with other colours; producing warm fleshy tints, which cannot be produced without it. Its extreme transparency and its permanency, are strong recommendations in its favour.

Reds. Carmine, is a fine bright crimson, inclining to the scarlet, and is rather an opaque colour: from it a variety of fine tints may be made. There are various kinds of it prepared by chemists, but the deep kind is the best, the lighter sort being frequently made so by adulteration.

Drop-lake, made from the shearings of scarlet cloth, is a pleasing crimson colour: its inclining to the purple makes it peculiarly useful for the carnation tints in painting delicate subjects.

Chinese vermilion, when good, is a bright red, and useful in miniature pictures, though not to be freely used, its opacity rendering it dangerous to mix much with other colours; but by itself, in touching the parts that require extreme brightness, it is of wonderful service. It is very difficult to find the real kind, the common vermilion, mixed with lake or carmine, being a general substitute; but the spurious and the genuine kind very materially differ in working, the former being thick and heavy, the other the contrary.

The native or mineral cinnabar, or vermilion, is likewise very fine in Spain; and the French have mines of it in Normandy. There is a method of preparing factitious cinnabar, viz. Take six ounces of sulphur, and eight of quicksilver, mix them well; then set them on the fire, till part of the sulphur is consumed, and the powder remains black; after this, it is sublimed twice in open pots, at the bottom of which the cinnabar remains very heavy, and streaked with the lines or needles, some red, and others brilliant like silver: then take it and purify it in the following manner: grind it well in fair water, on a marble, put it into a glass or earthen vessel to dry, then put urine to it, and mix it so that it be thoroughly wet and swim; then let it settle, and the cinnabar being precipitated or fallen, pour off the urine by inclination, and put fresh in the room of it, leaving it so all night, and repeating the same charge four or five days, till the cinnabar is thoroughly purified. Continue the process with beating up the white of an egg, which mixing with fair water, pour it upon the cinnabar, and stir the whole about with a walnut-tree stick; change this liquor two or three times as above, and keep the vessel close covered from dust; when used for water-colours, temper it with gum-water, and a small quantity of saffron dissolved will add to its brilliancy.

Indian red is an excellent colour, not only for touching the deep red parts, but likewise in strong flesh tints, in bright back-grounds, and draperies.

Browns. Umber is very greasy, and mixes unkindly; but, when burnt, is very useful in many parts of miniature.

Terra de Cassel, or Vandyck brown, so called from the very great estimation the inimitable painter of that name held it in, is the finest rich brown in the world; in itself producing a more beautiful colour than can be formed by the junction of any colours whatever. It is, in its natural state, rather coarse and sandy; but when prepared, it amply repays the labour.

Lamp-black is useful for mixing in hair colour and in painting draperies. The smoke of a candle received on a plate, is found the best, being blacker than the common lamp-black.

King's yellow is a bright opaque colour, admirably calculated for painting lace, gilt buttons, &c. &c. but is a rank poison, therefore should be cautiously used.

Flake white, or refined white lead, is not to be used by itself as a white, for to a certainty it will turn black, which circumstances should be nicely attended to by all artists. If used in miniature painting, for linen, &c. it should be immediately covered with a glass, which method is the only one which stands a chance of preserving its purity. For a farther account of the qualities of these colours, see Colour.

Among the above necessary colours, there are three which require to be burnt; viz. terra di Sienna, umber, and lamp-black. For this purpose, the two former are to be put in a crucible, which is to be covered and placed on a hot fire: and when you think that the lump of colour is hot through, take the crucible from the fire, and let the colour cool.

The lamp-black is to be prepared thus: Take some of the common kind; put it on a clean fire-shovel or plate of iron, over the fire; immediately on receiving the heat, it will begin to smoke, on the ceasing of which you will find your lamp-black freed from the oily substance it originally contained, and fit for immediate use.

Gum water. Choose the large white pieces of gum arabic, which are brittle and clear. Put them into a clean phial; and pour water on them, well-strained and divested of all sandy particles. Let the gum-water be about the thickness of water-gruel, that is, so thick that you can feel it in your fingers. The fresher made, the better.

Grinding the colours, and preparing them for the pallet.

Provide yourself, if possible, with an agate flag and muller; but if that cannot conveniently be had, glass ones may answer, though not quite so well. The glass muller and flag must be lightly roughened with fine flour emery, which will give it a surface that will continue a long time. After being particularly careful that your flag, &c. are quite clean, lay some of the colour to be ground on it, bruising it whilst dry, gently with the muller; then put a few drops of water on it, and grind it very carefully, not making it too wet, as that will prevent it from keeping sufficiently under the muller. When you think it is finely ground in the water, take your pallet-knife, or a thin-edged piece of ivory, scrape your colour together in a little heap on your flag, which let dry for a short time, then add your gum-water to it gradually, having a piece of ivory near you, on which you are frequently to lay some of the colour with a camel-hair pencil, thin; and if you perceive the colour in the smallest degree to shine, when dry, it is gummed enough; then you are to scrape it off your flag and transfer it to your pallet.

There are some colours which will not bear a sufficient quantity of gum to make them shine, without injuring their qualities, as smalt, ultramarine, and verditer blues.

Of hair pencils. Manner of choosing them, &c.

Pencils for painting in miniature are not made of camel's hair, but of the tips of squirrel's tails, and of these there are two kinds, the dark brown, and yellowish red. Pencils made of the latter kind are called sable pencils, and are of a stiffer nature than the others. They are a useful kind of pencil, as long as the fine flue at the end of the hair remains, on account of their elasticity; but the instant the flue is worn off, they, from their harshness, become useless; at all events, no pencil can be superior to one made of the common kind of hair. The error too prevalent amongst young miniature painters, is that of preferring a very small pencil for their work, vainly hoping, by the assistance of such a one, to execute their picture with more neatness and accuracy; but in this, they will, by experience, find themselves mistaken; the finest and most highly finished pictures being executed with a middle-sized pencil, the point of which being not only sufficiently neat, but from its body containing a quantity of colour in fluid, enables the artist to give that mellow firm touch which is so generally admired by connoisseurs in the art. The young artist should choose a middle-sized pencil, with a good spring and point, both of which he will know by drawing the pencil lightly through his mouth, and touching it on his thumb-nail; if he finds it, on being moderately wet, to spring again into its form, after being bent, it is a good sign; but as there are many pencils possessed of that quality, which are deficient in another material one, namely, that of a good point, that must be very cautiously looked to, by turning the pencil round on the nail, in every direction, observing the hairs at the point keep equally together of a length, and none shooting out on either side (which is often occasioned by the pencil-maker putting the hair into the quill with a twist in it). All these defects being carefully guarded against, you are sure of being in possession of a very principal material for miniature painting.

Ivory.

Method of choosing, bleaching, and preparing it.

Of ivory there are various kinds, the distinction of which in this art is of very material consequence. Ivory, newly cut, and full of sap, is not easily to be judged of; the general transparency it exhibits in that state, almost precluding the possibility of discovering whether it is coarse-grained or fine, streaky or the contrary, unless to the artist who, by a long course of experience, is familiarised to it. The best way to discover the quality of it is, by holding it grainways to the light, then holding it up and looking through it, still turning it from side to side, and very narrowly observing whether there are any streaks in it; this you will, unless the ivory is very freshly cut, easily discover; and in this you cannot be too particular. There is a species of ivory which is very bad for painting on, although it has no streaks in it, being of a horny coarse nature, which will never suffer the colours to be thrown out in the brilliant manner a fine species of ivory will; you are therefore not only to be cautious in choosing ivory free from streaks, but likewise that which has the finest grain and close. We shall now proceed to treat on the manner of preparing the ivory for painting on.

You are to heat a smoothing iron in so small a degree that you can hold your hand on the face of it, so long as you can reckon three or four in moderate time: then put your ivory between a clean piece of folded paper, on which place the hot iron, turning your ivory frequently, until it becomes a transparent white; for you are to observe that very particularly, an opaque white not answering for face-painting in miniature, as it would give a harshness and unpleasant appearance to your picture.

When you think your ivory is sufficiently white for your purpose, lay it under some flat weight until it cools, as that will prevent its warping. Then proceed to prepare it: for which purpose you must pound some pumice-stone in a mortar, as clear and fine as you can, which put into a fine linen or cambric bag, tying it about midway, tight, but leaving room for the pumice-dust to sift through the bottom. Then get a long mustard-bottle, perfectly clean and dry, in which suspend the pumice-dust, covering the top with the muzzle of the bag, so that nothing can come out; then shake the bottle smartly in your hand, when the fine particles of the pumice will sift out, and remain at the bottom of the bottle, thereby preventing any coarse grains from being amongst what you are going to use, which would very materially injure your ivory. Your pumice-dust being prepared, scrape the leaves of ivory with a sharp pen-knife, until the scratches of the cutting saw are entirely obliterated; then take either a piece of Dutch polishing rush, or a piece of middling fine patent glass paper, and carefully polish your ivory with it, not by passing your hand backwards and forwards, but in a circular manner, until you have it pretty level; then strew some of your pumice-dust on the ivory, and put a few drops of water on it: which done, with your muller work on it in a circular manner as before, until you find every part has equally received the pumice, which you will know by its exhibiting a dead grave appearance; those parts which have not received the pumice continuing to shine in spots, which you must still labour to do away with your pumice and muller. When you find it pumiced to your satisfaction, take a clean sponge and fair water, with which gently wash your ivory free from the pumice-dust; taking care not to rub it hard, for fear of giving the ivory a gloss that would prevent your colours from taking on it so pleasant as you could wish; after this lay your ivory to dry, and in a few hours it will be fit for use. Then paste it on a piece of wove paper, by touching the back of it merely at the edges; as gum-water, or any other cement, being put near the centre of your ivory, will cause a dark unpleasant spot perhaps to appear through, in the very part where your face is to be painted.

Instructions for mixing compound tints for the face.

Purple is formed of either ultramarine, Prussian blue, smalt, or indigo, mixed with either carmine or drop lake. Ultramarine, although the most beautiful and brilliant of colours by itself, yet in any mixture it loses that perfection, but still retains a sufficient seare of brightness to render it a desirable tint in the purplish grey shadows of the face. Prussian blue mixed as before-mentioned, makes a bright or dark purple, according as the quantities of either colours are portioned; but indigo makes still darker, owing to its great natural depth of colour. Smalt and carmine, or lake, form nearly the same tint as ultramarine, and may be used nearly for the same purposes.

Grey. Of grey tints there are various kinds, according to the subjects they are required for. A warm grey tint may be made by duly portioning burnt terra Sienna, Prussian blue, and drop lake: the more terra Sienna in it, the warmer the tint; the more Prussian blue and lake, the colder. Another grey tint, used with success by some eminent miniature painters, was composed of Prussian blue and Chinese vermilion, but on account of the unkind manner with which vermilion incorporates with any other colour, it required a greater proportion of gum than ordinary to make them work or keep together. A third grey tint, which is an excellent one, is formed of drop lake, sap green, and Prussian blue.

Olive tints. A very fine olive tint is formed of gall stone, Nottingham ochre, and carmine, or lake; and another of sap green and lake simply.

Of hair tints. A beautiful hair colour, either dark or light, according to the quantities of colours, is made of carmine, lamp-black, and sap green. The manner of forming it is only to be acquired by practice; but when once attained, will be found worth the time of the trial. That very difficult tint which is often to be met with in children's hair, by the proper junction of these colours will be produced to perfection. Other hair tints may be made of terra de Cassel simply, or by the addition of lamp-black. Some excellent painters make all their hair tints of burnt terra Sienna, lamp-black, and Nottingham ochre, the latter being added only when there is light hair wanting to be represented. Burnt umber has been substituted for terra Sienna, along with the lamp-black, and forms a good tint; but care must be taken to avoid either the greenish or reddish cast, which it is apt to produce.

Tints for fine linen, gauze, &c. Of all tints in transparent painting, such as are the miniature works of the present day, there are none more difficult to ascertain; for the delicacy not only of mixture, but the delicacy of touch, conveys the idea of beauty in the thinness and folding of fine linen or gauze, the true painting of which throws a veil over the defects in other parts of the picture. We shall therefore only observe, that any of the tints, under the head of grey, will, properly managed, answer the purpose. Having now pointed out the manner of preparing the delicate transparent tints for miniature painting, we proceed to treat of the grosser ones, namely, those for draperies.

Of colours proper for men's draperies.

We shall, under this head, make some general observations; the first of which is, that in all cloth draperies for men's portraits, it is necessary to add some flake white; as it not only gives the colour the dead appearance which cloth exhibits, but likewise its being incorporated with the flake white, gives it a body which makes the flesh tints appear to more advantage. The next observation is, that in grinding up your draperies, you are to make them appear several degrees lighter in colour than you want them to be when dry, for this reason; the flake white is a colour so very heavy, that, after you float in your coat, it will sink to the bottom, and leave your colours several degrees darker than when it was wet; and finally you are not to be too heavy or thick in floating in your draperies, but merely to see that your colour is evenly spread over the part.

There are four modes of working in miniature painting; namely, floating, washing in, handling, and marking. The first process, which is floating, and is chiefly used for draperies, is thus performed: Having marked with your pencil where your drapery is to be, grind up your colour on your flag (not putting a quantity of gum water, that would make it shine, as it would frustrate your purpose); then take a large soft hair pencil, and, having previously laid your ivory on a very level table, fill your pencil plentifully with the colour, and lay it quick all over the parts of the ivory you want covered, seeing that it runs on every part equally, which, if kept in a proper fluid state, it will readily do; then lay it in some place to dry, where it is not likely to receive dust, when you will have a fine level surface ready to work the shadows of your drapery on in a couple of hours. Washing in is performed when your picture is on your desk, by filling your pencil moderately with colour, and giving a very broad stroke rather faintly, as the contrary would not answer; this manner is chiefly used in beginning the hair, back grounds, and likewise in laying on the general flesh tint of the face. It is also used in the first touches of the dark shadows, which ought to be begun faint and broad. Handling is the manner in which all the fleshy parts of the miniature must be worked, after the first washing in; and lastly, marking consists in the sharp-spirited touches given to the different features, in order to give that animated appearance so necessary to constitute a fine picture.

Black drapery is formed of lamp-black burnt, and flake white; and must be laid in with a good deal of the latter, as otherwise it would be very difficult to manage the shadows so as to produce a pleasing effect.

Blue drapery may be made of either Prussian blue, or Antwerp blue, mixed with white; indigo being too much inclined to a blackish cast.

Green drapery is well made of king's yellow, and Prussian and Antwerp blue. The more blue, the darker the green; and the more yellow, the contrary.

Yellow drapery cannot be so well represented by any colour as king's yellow, laid thin, with a moderate quantity of gum in it.

Drab-colour is well represented by a judicious mixture of umber, in its raw state, and flake white.

A queen's brown, as it is called, is made of burnt Roman ochre, a little lamp-black and lake, with flake white amongst it.

Claret colour may be well represented by a mixture of terra de Cassel, a little lamp-black, and lake. The more black and lake, the deeper the colour.

Dark brown can be formed by a junction of Nottingham ochre, lake and lamp-black.

Lilac is made of carmine, Prussian blue and flake white.

Grey can be formed only of lamp-black, flake-white, and the smallest quantity of lake laid in very thin.

Reddish brown is best made of Indian red, very little lamp-black, and flake white.

Scarlet is a colour very difficult to lay down rules for making, as in some pictures it is dangerous to make it too bright, for fear of hurting the effect of the face, by its brilliancy catching the eye too readily; consequently, if the subject you are painting from life is very pale, you run a very great risk by annexing a very bright scarlet to his picture. We shall therefore only mention that a very bright scarlet is made of Chinese vermilion and carmine, ground together (without any flake and white); and if you want it still rendered brighter, when it is dry, fill your pencil with plain carmine, mixed with thin gum-water, and glaze over it nicely; but if, on the contrary, you wish to sadden, or take away a share of its brilliancy, add a little flake white to it, and that will have the desired effect.

Of painting the face in miniature.

You are first to provide yourself with a mahogany desk for painting on, which is a box about fourteen inches high, and a foot broad on the top; there is to be a lid covered with green cloth, which is to have a pair of small hinges at the front, and to lift occasionally with a supporting rail at the back, and notches, so as readily to adjust it to any height. About the middle of the green cloth there is to be a slip of very thin mahogany, glued at each end, but the centre of it left free, to fasten your ivory by, slipping it between the mahogany and green cloth.

The next thing you are to observe is the choice of your light, which in this kind of painting cannot be too particularly attended to; it not being like oil-painting, where the rays of the sun may be kept out by blinds, &c. without causing any material inconvenience. A north light, or as nearly as possible to it, must be attained. If there are more than one window in the room, the second must be closed, so as to admit no light; and the one you sit at is to have a green baize curtain against the lower part of it, to reach about a foot higher than your head, as you sit at your painting desk, with your left hand towards the light.

Having placed your sitter at the distance of about a yard and a half from you, begin drawing the outlines of the face; and in this be very particular, as much depends on it. When you have them drawn correctly, begin to lay in the colour, faintly, of the iris of the eye, the shadows under the eye brows in a grey tint, and under the nose rather a warm purple, in broad faint washes: ever keeping this in your mind; that you must, in the process of painting the face of a miniature picture, go on faintly at the beginning, and not hurry in your colours, as such conduct will, to a certainty, make your tints look dirty, and your picture harsh and disagreeable. Having, as before observed, laid in your grey tints where your shadows are to fall, go on heightening them by degrees, working in hatches with a middling full pencil, not too washy, nor too dry; as the former would be the means of muddying your colours, and the latter would make them raw. When you think you have pretty strongly marked out, and worked up the shadows, mix a wash of either gall stone, or Nottingham ochre, and drop lake, with which faintly go over the fleshy pasts of the face, where the shadows do not come; and then proceed to heighten the carnations on the cheeks, the colour of the beard, if any such appears, still working in the handling manner already mentioned, in various directions; so that, after some time working, the intersections appear like so many nice points or dots. Observe, as a general rule, that it is much easier to warm the tints of your face, than to cool them, by working proper colours over it. It is therefore best to begin with cool greys and purples, and towards the finishing of the picture, to add warmth, if necessary, by gradually working such colours as gall-stone, terra Sienna, or the like, over, in addition to the carmine or lake that may be necessary to produce the tint of nature.

General Observations.

From the variety of style adopted by different miniature painters, it is very difficult for a young beginner to ascertain which is best to be followed; and as there is a certain degree of mechanical attention to be paid to the management of the water-colours, to preserve them clear and free from muddiness, which is difficult to attain, we recommend to the young artist to procure a good miniature, if possible, and keep it by him, observing the style of penciling and management of the colour, at the same letting nature be his guide in the marking of his features and colouring of his picture.

In the management of back-grounds, the young painter is to observe their twofold purpose: that of giving the lights their proper value; and on the other hand, of harmonizing the colours of the face, by artfully engaging the eye with somewhat of similitude in the back-ground to a tint in the face, which otherwise, in course of working to express a particular part, might appear too prevalent.

In painting a head, on an oval piece of ivory, such as the present form of a miniature picture, draw the chin as nearly as possible in the centre of the ivory, unless the person is very tall, in which case it must be higher up; and if very short, the contrary.

Mosaic painting. This wonderful branch of art, improperly called painting, almost defying the hand of time, has been practised in many countries; but the finest works of their kind, and those by which the moderns have retrieved the art, which was in a manner lost, are those in the church of St. Agnes, formerly the temple of Bacchus, at Rome, at Pisa, Florence, and other cities of Italy.

The most esteemed among the works of the moderns are those in the church of St. Peter, at Rome. There are also very good ones at Venice.

Mosaic work is composed of small pieces of glass, marble, precious stones, &c. of various colours, cemented on a ground of stucco or mortar, in imitation of painting. It is generally employed in copying original pictures of the highest value in the art.

In performing this work, it is requisite to provide little pieces of glass of as many different colours as can possibly be got.

For this purpose a glass-maker's furnace being prepared, and the pots and crucibles full of the matter of which glass is made, put into each crucible what colour or dye you think fit, always beginning with the weakest, and augmenting the strength of the colour from crucible to crucible till you come to the deepest tincture.

When the glass has been thoroughly concocted, and the colours are in their perfection, take out the glass, hot as it is, and pour it on a smooth marble, flatting it down with another similar marble, and then cut it into slices of equal bigness, and about the thickness of an inch and a half.

Then with an instrument, which the Italians call bocca di cane, you must make some pieces square, and others of different forms and sizes, as occasion requires. These pieces are to be orderly disposed in cases, as in painting in fresco. It is usual to range all the different tints in shells, and according to their colour.

If it is desired to have gold, either in the ground of the painting, or in the ornaments or draperies, take some of the pieces of glass, formed and cut in the manner before mentioned; moisten these on one side with gum-water, and afterwards lay them over with leaf gold; then put this piece, or several pieces at a time, on a fire-shovel, and place it in the mouth of the furnace, after you have first covered them with another hollow piece of glass. Let these stand till they are just red-hot, then draw the shovel out all at once, and the gold will become so firmly attached to the glass, that it will never afterwards come off.

Now in order to apply these several pieces, and, out of them, to form a picture, in the first place provide a cartoon or design, as this is to be transferred to the ground or plaister by calking, as in painting in fresco. See Fresco.

As the plaister is to be laid thick on the wall, and therefore will continue fresh and soft for a considerable time, there may be enough prepared at once to serve for as much work as will take up three or four days.

This plaister is composed of lime made of hard stone, with brickdust very fine, gum tragacanth, and whites of eggs; and having been thus prepared and laid on the wall, and the design of what is to be represented transferred to it, take out the little pieces of glass with a pair of plyers, and range them one after another, still keeping strictly to the light, shadow, different tints and colours which are to be represented; pressing or flatting them down with a ruler, which serves both to sink them within the ground, and to render the surface even.

A long time and tedious labour are requisite to finish the work, which will be more beautiful as the pieces of glass are more uniform and ranged at an even height.

Pieces of mosaic work performed with exactness appear as smooth as a table of marble, and as finished and masterly as a painting in fresco, with this advantage, that they have a fine lustre and will last for ages.

Mosaic work of marble, and precious stones.

These two kinds of mosaic bear so near a resemblance to each other, as to the manner of working, that, to avoid repetition, we shall give them both under one, taking notice as we proceed, wherein the one differs from the other, either in the sawing or the ranging of the stones.

Mosaic work of marble is used in large works, as in pavements of churches and palaces, and in the incrustation and veneering of the walls of edifices of the same kind.

Mosaic of precious stones is only used in small works, as ornaments for altar-pieces, tables for cabinets, &c. on account of the exceeding price of the materials.

Process of mosaic painting.

The ground of mosaic works wholly marble, is usually a massive marble, either white or black.

On this ground the design is cut with a chisel, after it has been first calked.

After it has been cut of a considerable depth, i. e. an inch or more, the cavities are filled up with marble of a proper colour, (first selected according to the colours of the design, or original picture to be copied,) and reduced to the thickness of the indentures with various instruments.

To make the pieces thus inserted into the indentures cleave fast, (whose several colours are to imitate the tints of the original design,) a stucco is composed of lime and marble-dust, or a kind of mastic, which is prepared by each workman after a different manner peculiar to himself.

The figures being marked out, the painter or sculptor himself draws with a pencil the colours of the figures not determined by the ground, and in the same manner makes strokes or hatchings in the place where shadows are to be; and after he has engraven with the chisel all the strokes thus drawn, he fills them up with a black mastic, composed partly of Burgundy pitch poured on hot, taking off afterwards what is superfluous with a piece of soft stone or brick, which, together with water and beaten cement, takes away the mastic, polishes the marble, and renders the whole so even that one would imagine it only consisted of one piece.

This is the kind of mosaic work that is seen in the church of the Invalids in Paris, and the chapel at Versailles, and with which some entire apartments of that palace are incrustated.

As for mosaic work of precious stones, other and finer instruments are required than those used in marble, as drills, wheels, &c. used by lapidaries, and engravers on stone.

As none but the richest marbles and stones are used in this work, to make them go the further they are sawn into the thinnest slices or coats imaginable, scarce exceeding half a line in thickness: the block to be sawn is fastened firmly with cords on the bench, and only raised a little on a piece of wood one or two inches high.

Two iron pins, which are on one side o the block, and which serve to fasten it, are put into a vice contrived for the purpose; and with a kind of saw or bow, made of fine brass wire bent on a piece of spungy wood, together with emery steeped in water, the slice is gradually fashioned by following the stroke of the design made on paper and glued on the piece.

When there are pieces enough fastened to form any one entire part of the design, they are applied to the ground.

The ground which supports this mosaic work is usually of free-stone.

The matter with which the stones are joined together is a mastic, or a kind of stucco, laid very thin on the slices of marble, &c. as they are fashioned; this being done, the slices are applied with plyers; and if in any part they are not either squared or rounded sufficiently, so as to fit the place exactly into which they are to be inserted, they are brought down, when too large, with a brass file or rasp; and when too little, a drill, and other instruments, used by lapidaries, are used to supply the deficient part.

Manner of performing mosaic work of gypsum.

Gypsum is a kind of coarse talc, or a shining transparent stone, found in the quarries of Mont-Martre, near Paris. It is different from the plaister of Paris, but retains the name which the Romans gave to the plaister, viz. gypsum.

Of this gypsum, or stone calcined in a kiln, and beaten in a mortar, and sifted, the French have made a sort of artificial marbles, imitating precious stones, and of these they compose a kind of mosaic work, which does not come far short either of the durableness or the vivacity of the natural stones; and which, besides, has this advantage, that it admits of continued pieces or paintings of entire compartments without any visible joining.

Some make the ground of plaister of Paris, others of free-stone. If it is of plaister of Paris, they spread it in a wooden frame, of the length and breadth of the work intended, and in thickness about an inch and a half.

This frame is so contrived that the tenons being only joined to the mortises by single pins, they may be taken asunder, and the frame be dismounted, when the plaister is dry.

The frame is covered on one side with a strong linen cloth, nailed all round, which being placed horizontally with the linen at the bottom, is filled with plaister passed through a wide sieve.

When the plaister is half-dry, the frame is set up perpendicularly, and left till it is quite dry, then it is taken out by taking the frame to pieces.

In this kind of mosaic the ground is the most important part.

Now, in order to the preparation of this sifted gypsum, which is to be applied on this ground, it should be dissolved and boiled in the best English glue, and mixed with the colour that it is to be of; then the whole is to be worked up together in the usual consistence of plaister, and then taken and spread on the ground five or six inches thick.

Observe, that if the work is such that mouldings are required, they are to be formed with gouges and other proper instruments.

It is on this plaister, thus coloured like marble or precious stone, and which is to serve as a ground to a work, either of lapis, agate, alabaster, or the like, that the design to be represented is drawn, having first been pounced or calked.

To hollow or impress the design, you must use the same instruments that sculptors do, the ground whereon you are to work not being much less hard than marble itself.

The cavities being thus made in the ground, are to be filled up with the same gypsum boiled in glue, only differently coloured, and thus are the different colours of the original represented.

In order that the necessary colours and tints may be ready at hand, quantities of the gypsum must be tempered with the several colours in pots.

After the design has been thus filled and rendered visible, by half-polishing it with brick and soft stone, it is to be gone over again, cutting such plates as are either to be weaker or more shadowed, and filling them with gypsum; which work is repeated till all the colours being added one after the other, represent the original perfectly.

When the work is finished, it is scoured with soft stone, sand, and water; after that, with a pumice-stone; and, in the last place, polished with a wooden mullet and emery.

Then, lastly, it is smeared over with oil, and rubbed a long time with the palm of the hand, which gives it a lustre no ways inferior to that of natural marble.

If you would only make a variegated table, or other work, of several colours, without mosaic figures, the process is somewhat different.

Then you are to prepare separately, in bowls, as many colours as nature shews in the marble which you would imitate; and after you have incorporated these with gypsum and glue-water, take a trowelful of each and dispose them in a trough without any order; then, without mingling them, and only by cutting or crossing the gypsum of each trowel once with each of the rest, you will give them the appearance of beautiful natural marble. Of these you may make tables, or lay them in a mould, according to the nature of the work.

Elydoric painting.

This new method of painting was invented by M. Vincent, of Montpetit. It is little known. It takes its name from two Greek words, expressing oil and water, both these liquids being employed in its execution.

Its principal advantages are, that the artist is able to add to the mellowness of oil-painting, the freshness of water-colours, and the high finishing of miniature, in such a manner that the work appears like a large picture seen through a diminishing glass.

The following is the manner of proceeding: A piece of very fine linen or white taffety is sized with starch in the most equal manner possible; or pieces of glass about two inches square, the angles of which are blunted in order that the cloth may be without wrinkles.

When these pieces of cloth are sufficiently dry, a layer of white lead finely ground in oil of pinks or poppies (the whitest that can be procured) is applied on them with a knife. To this layer, when dry enough to admit of scraping, more may be added if necessary.

As it is of the greatest importance for the preservation of this kind of painting, that the layers are purged of oil, in order that they may imbibe the colours laid on them, it is necessary that their surface is made very smooth, and is very dry and hard.

The artist is next provided with a circle of copper, nearly two inches in diameter, and one-fourth of an inch in height, extremely thin, and painted on the inside with black. This circle is employed to contain the water on the surface of the picture.

Water distilled from rain or snow is preferable to any other; ordinary water, on account of the salts which it contains, being pernicious to this mode of painting.

The colours, also, must be ground between two Oriental agates, most carefully preserved from dust; and mixed with oil of poppies, or any other siccative oil, which has been extracted without fire, and limpid as water.

All the colours being ground, are placed in a small heap, on a piece of glass covered with distilled water, in a tin box.

The materials being thus prepared, the subject to be painted is faintly traced with a black-lead pencil on one of the pieces of cloth above-mentioned.

The tints are formed on the pallet from the little heaps under the water, and the pallet placed as usual in the left hand.

The picture is held between the thumb and fore finger, supported by the middle, and the necessary pencils between the third and little fingers. The hand rests on the back of a chair, to give a full liberty of bringing the work near, or removing it from, the eye.

The pencils are cleaned with essence of rectified turpentine.

After having made the rough draught with the colours still fresh, the circle of copper which ought to surround the picture is fitted exactly to the surface.

The distilled water is poured within this circle till it rises to the height of one-eighth of an inch, and the eye is held perpendicular over the object. The third finger of the right hand must rest on the internal right angle of the picture.

The artist retouches his work, adding colour and softening as he finds requisite.

As soon as the oil swims on the top, the water is poured off, and the picture carefully covered with a watch-glass, and dried in a box by a gentle heat.

When it is dry enough to be scraped nearly smooth with a knife, the artist repeats the same method till he is satisfied with his work.

It is at this period that the advantage of this new method particularly shews itself for the purpose of finishing; as the water poured on the picture discovers every fault of the pencil, and gives the power of correcting and perfecting with certainty.

When the work is finished, it is put under a crystal, from which the external air is excluded, and it is then dried by means of a gentle heat.

HISTORY OF PAINTING.

Rise, progress, and decline of the art among the antients.

As far as history reaches back into past ages, it presents us with manifest proofs of the antiquity of painting and the other arts of design. The first writers of history were in no little degree indebted to those arts for their best materials and surest vouchers in compiling their records: painting, sculpture, and other monuments, having been employed in the most antient times to preserve the memory of facts, and likewise to represent religious and philosophical opinions.

It is natural to imagine that a certain rude way of delineating objects has in all countries preceded the more artificial communication of the thoughts by letters, and hence we hear of the picture-writing of the Mexicans, and the hieroglyphic symbols of Egypt.

Pliny expressly says that the art of painting was unknown in the times described by Homer, the most antient of authors, in the Iliad; but he acknowledges that sculpture was in use at the siege of Troy, from whence it is evident that design, which is the basis and essential part of painting, was even then well understood. Although the name of the art is not to be found in the writings of Homer, yet the art itself is there plainly described, as it consists in design and colouring. We can, therefore, hardly doubt that painting was practised even at that early period; at least, Homer himself must be allowed by every one who reads his lively descriptions of carvings, statues, sculptures, tapestries, and picturesque ornaments of all kinds, to have had very perfect ideas of all the arts of design, not only of statuary and sculpture, but of painting.

But the earliest date of painting appears to have been in Persia, India, and China, if we give credit to the writers of those countries. Neither the Persians, however, nor the Chinese, appear to have at any time attained to excellence in painting. The former, as well as the Arabians, had, at one period, some knowledge of mosaic, and their carpets, worked with various figures, were in high estimation in the time of Alexander the Great; but all such productions are of an inferior class, as they must necessarily be copied from other works. Painting, among the modern Persians, is still in the same low degree.

The Chinese paintings have little other merit than the brightness of their colours. The pictures of the Chinese artists are totally deficient in drawing and perspective.

In India, painting appears to have been confined in the earliest times to the representation of monstrous forms, connected with the superstition of the country. The paintings of Thibet are said to be remarkable for the fineness of the penciling, but to have no other merit. Some of the idols are painted in imitation of relievo, but are wholly destitute of beauty.

In Egypt, according to the accounts given by Plato, painting had been practised for several thousand years before his time, but we do not know with what degree of progress. The monuments of Egyptian painting, says Winckelman, with which we are best acquainted, are the chests of their mummies, which have endured so long that they appear to be secure from the injuries of time. That learned antiquarian gives the following account of the method of painting used on these chests:

"White, made of white lead, is first laid on as a ground, and the outlines of the figure are traced on this ground with black. The colours afterwards used are four in number, namely, blue, red, yellow, and green, and these are laid on without any mixture or shading. The red and blue prevail most, and seem to have been prepared in the coarsest manner. The light is formed by leaving the white-lead ground, where it is necessary, in the same manner as white paper is treated in drawings."

In the travels of Norden in Upper Egypt, there is a description of some colossal figures, coloured in the same manner as the mummies. The colours are laid on a ground prepared in the manner of fresco, and they are said to have retained their freshness for many thousand years.

The painting of the chests of mummies, of earthen-ware, and of ornaments on their barges, appears to have been the chief employment of the Egyptian artists. Pliny relates that they painted also on the precious metals, but in what manner they exercised this latter branch of art is unknown.

This style of Egyptian painting is supposed to have continued till the reign of the Ptolemies.

In antient Etruria, now called Tuscany, the arts flourished at a very early period. Pliny says that painting was carried to great perfection in Italy before the foundation of Rome; and it appears that even in his time the painters of Etruria were held in great esteem.

The only Etrurian paintings which are now remaining were found in the tomb of the Tarquins. They consist of long painted frizes, and pilasters adorned with large figures which occupied the whole space from the base to the cornice. These paintings are on a ground of thick mortar, and many of them in a high state of preservation.

Winckelman is of opinion, that in Campania also the arts had been introduced by the colonies of Greeks who settled at Naples and Nola; but considers as purely Campanian works some medals of Capua and Teanum, whither the Greeks had not reached, and praises the beauty of several. The authority, however, of these medals is questioned.

There have been discovered also, says the learned abbé, a great number of painted Campanian vases, which, for design, are worthy of a place in the works of Raffael, and give us a high idea of the perfection of antient art.

But it is in Greece that the history of painting is first deserving of particular attention. The Greeks have, with most singular diligence, preserved the names of their artists from the earliest introduction of the arts amongst them. Ardices of Corinth, and Telephanes and Crato of Sicyon, are noticed at a period when painting had advanced no farther than the mere circumscription of shadows by single lines. To this mode of design they gave the name of sciographia. Those artists taught something of the effect of light and shade, and of course gave an appearance of roundness to the object represented. This step of art was first called graphice. To these succeeded the monochromatists, a numerous list; the first of whom was Cleophantes the Corinthian, who filled up his outline with a single colour, every where of equal force, and thence gave the name of monochroms (or objects of one colour) to his paintings.

Cimon Cleonæus invented the art of varying the attitudes of his figures, distinguishing the joints and muscles, and imitating the folds of draperies. But the highest encomium given of him by Ælian, is that he somewhat improved the rude art of his time.

The antient schools were those of Sicyon, Rhodes, Corinth, and Athens. Pliny mentions that the authority of Eupompus, an artist of Sicyon, was of so great weight that, whereas before him there were only two schools, the Asiatic and the Grecian, they were from his time divided into three, the Attic, Sicyonian, and Ionic.

Aglaophon and Polygnotus of Thasos, who lived about 420 years before Christ, were the first painters of eminence. Polygnotus is said to have been the first who gave a pleasing air to the draperies and head-dresses of his female figures, and to have opened the mouth so far as to shew the beauty of the teeth. Aristotle speaks of him as excellent in expression. But the art of painting may be still considered to have been in an inferior state till the time of Timanthes, Parrhasius, and Zeuxis, who flourished about the period of the Peloponnesian war.

In the contest between the two latter of these great painters, Zeuxis declared himself to be overcome, because a cluster of grapes, painted by him, had only deceived the birds, but he was himself deceived by a curtain painted by his rival. The principal works of Zeuxis, according to Pliny, were his Penelope, in which he appeared to have expressed the manners of that princess; a Jupiter surrounded by the gods; the infant Hercules strangling the serpents in the presence of Amphitryon and Alcmene; Helen; and Marsyas bound by Apollo. Lucian also gives an account of a picture by Zeuxis, representing male and female centaurs; in describing which, after speaking of the composition itself, he proceeds to notice the execution of the work: and praises particularly the truth and delicacy of the drawing, the perfect blending of the colours, the skilful shading, and the scientific observance of proportion and harmony throughout the whole performance.

Parrhasius was esteemed superior to others in correctness of outline and softness of colouring. Timanthes is chiefly celebrated for expression, and, in particular, for his picture of the sacrifice of Iphigenia; in which he covered the face of Agamemnon with a mantle, because he thought it impossible to represent any expression adequate to the feelings of his situation.

The fame of these great artists was surpassed by the class of painters who immediately succeeded them. Protogenes, Pamphilus, Melanthius, Antiphilus, Theon, Euphranor, and, finally, Apelles, carried the art of painting to the utmost perfection which it has ever attained. These were chiefly eminent in separate provinces of art. Euphranor united a great skill in various branches, and Apelles eclipsed all other painters in his powers of giving elegance and grace to his figures.

From the time of these pre-eminent masters, painting gradually declined in Greece; and, the Romans becoming masters of the whole country, the arts sunk into insipidity and insignificance.

The undisputed and unrivalled excellence of the Greek schools appears to have consisted in drawing and expression. None of their greatest works remaining to our time, we can only take the accounts of historians respecting their powers of colouring; but it is evident that they were capable of making very nice distinctions in this branch of art, from the comparison made between two pictures of Theseus, painted by different artists, in one of which the hero was said to appear as if he had been fed on roses, and in the other on flesh.

It is still more particularly doubtful whether the antients possessed the knowledge of chiaro-scuro in so eminent a degree as it has since been shewn in the works of the Lombard and Flemish schools. The present remains of antient paintings do not certainly warrant any conclusion in their favour, although many passages in their historians tend to make us believe them skilled in this point; and, as the works that remain are undoubtedly executed by inferior artists, their authority may be thought of little weight against the general testimony on the contrary side.

The character of the antient school of art is thus given by a Greek writer:

"The paintings of the antients," says Dionysius of Halicarnassus, "were at first simple and unvaried in their colouring, but correct in their drawing, and distinguished by their elegance. Those which succeeded, less correct in their drawing, were more finished; more varied in their light and shades, trusting their effect to the multitude of their colours."

Roman art. We have already seen that before the foundation of Rome the arts were cultivated in Etruria. Pliny also mentions some paintings at Ardeæ, Lanuvium, and Cære, older than Rome, but it is uncertain by what artists these were executed. As long as the Romans employed artists of other countries, they were indifferent to the cultivation of the arts; but towards the year of Rome 450, and 303 years before Christ, one of the Fabii, a patrician family in Rome, thought it no discredit to employ himself in painting. He painted the temple of the goddess Salus, and assumed the name of Fabius Pictor, or the painter. His works remained till the temple itself was destroyed by fire in the reign of Claudius.

The example of Fabius did not excite imitation. More than a century elapsed before the tragic poet Pacuvius followed his example, and painted the temple of Hercules. Turpilius, a Roman knight, was also a painter, contemporary with Pacuvius. Painting did not come into great repute till the time of Messala, who, as well as Lucius Scipio, painted representations of his own victories. Few names of Roman painters, even in the time of Augustus, are mentioned by writers. The arts, however, flourished in high reputation under many of the emperors, particularly from the time of Nerva to Antoninus; and Nero is said to have prided himself on his skill in painting. A colossal painting of 120 feet in height was executed by his orders, and was afterwards destroyed by lightning. This was the only work which is particularly mentioned by antient authors to have been painted on cloth.

In the time of Claudius and Nero, the arts had considerably degenerated, and in the decline and fall of the Roman empire they were neglected and lost for many centuries.

The best authority to be consulted on the state of Grecian and Roman painting, is the relation of Pliny in his 35th book of natural history; where the reader will find a complete list of the Greek and Roman painters, and of their works, arranged in their due classes of merit.

Ælian, Pausanias, Quinctilian, Velleius Paterculus, and Cicero, may also be referred to for instructive accounts of various works of the Greek masters.

Of the methods of painting, and colours employed by the antients.

The paintings of the antient artists were either moveable, or on the ceilings or compartments of buildings. According to Pliny, the most eminent painters were employed on moveable pictures. The latter were either on fir-wood, larch, box-wood, or canvas, as in the instance of the colossal picture mentioned above, and sometimes on marble. When they employed wood, they laid on first a white ground. Among the antiquities of Herculaneum are four paintings on white marble.

Their immoveable paintings on walls were either in fresco, or on the dry stucco in distemper. Indeed, all the antient paintings may be reduced to, first, fresco-painting; secondly, water-colour or distemper-painting; and thirdly, encaustic painting.

The antient fresco-paintings appear to have been always on a white stucco-ground. The outlines of the antient paintings on fresco, were probably done at once, as appears from the depth of the incision, and the boldness and freedom of the design.

In general, the antients painted on a dry ground, even in their buildings, as appears from the Herculaneum antiquities, most of which are executed in this manner. At Rome and Naples, the first (deepest) coat is of true Puzzolana (of the same nature with the terras now used in mortar, required to keep out wet), about one finger thick; the next of ground marble, or alabaster, and sometimes of pure lime or stucco, in thickness about one-third of the former. Upon this they appear to have laid a coat of black, and then another of red paint; on which last the subject itself was executed. Such seems to have been their method of painting on walls; but in their moveable pictures, and in the performances of their first artists, and where effect of shade and light was necessary, they doubtless used white.

The colours employed, they seem to have mixed up with size: this appears to have made the colours so durable and adhesive, that the ancient paintings lately found, bear washing with a soft cloth and water, and sometimes even diluted aquafortis is employed to clean their paintings in fresco. Pliny says, that glue dissolved in vinegar, and then dried, is not again soluble.

What the encaustic painting of the antients was, has been much disputed. From the works of Vitruvius and Pliny, it appears evidently that it was of three kinds:

First, where a picture painted in the common way, was covered with a varnish of wax melted, diluted with a little oil, and laid on warm with a brush;

Secondly, where the colours themselves were mixed up with melted wax, and the mixture used while warm; and

Thirdly, where a painting was executed on ivory by means of the cestrum or viriculum.

Some experiments on this last method by Mr. Colebrook may be found in the Phil. Trans. vol. 51 and more particular directions in Muntz's treatise on encaustic painting. See Encaustic.

It appears from antient writings of the best authority, that in the earliest and purest times of this art, the painters used few colours, perhaps not more than four. But no certain conclusion can be drawn, that the more early among the great painters of the antients, such as Apollodorus, Zeuxis, Timanthes, &c. had no more colours than four to use, merely because they did not use them. On the contrary, it may be conjectured with some degree of probability, from their chasteness in design, and from the complaints Pliny makes of the gaudy taste of the Roman painters, that the Greeks in general were designedly chaste in their colouring, and not so merely from necessity.

Of white colouring substances, the antients had white lead variously prepared, a white from calcined egg-shells, and a preparation from cretaceous and argillaceous earths. The moderns, in addition, have magistery of bismuth, little used; and ought to have the calces of tin and zinc.

Of blacks, the antients had preparations similar to lamp, ivory, blue, and Frankfort black; also to Indian ink, and common writing ink; and they used what we do not, the precipitate of the black-dyers' vats.

The antients possessed a species of vermilion, or fine cinnabar, a coarser cinnabar, red lead; various earths burnt and unburnt, apparently similar to our red ochre; Venetian red, Indian red, Spanish brown, burnt terra di Sienna, and scarlet ochre; they had also a substance alike in colour and in name to our dragon's-blood. See Colours.

The yellow pigments of the antients were generally the same with our orpiments, king's yellow, Naples' yellow, &c. They did not possess turbeth mineral, mineral yellow, or gamboge; nor do they appear to have known of gall-stone as a pigment.

Of blue paints they had preparations from the lapis syanus, and lapis armenus. Indigo they had, and perhaps bice and smalt; for they made blue glass, but whether from some ore of cobalt or of wolfram must be uncertain; they had not Prussian blue, verditer, nor litmus, which we have. We do not use the blue precipitate of the dyers' vats, nor mountain blue, which they certainly employed.

Of green colours they had verdigris, terra vert, and malachite, or mountain green. The latter is not in use among us. Sap green, green verditer, and Scheeld's green, appear to have been known to them: like us, they procured as many tints as they pleased, from blue and yellow vegetables.

We have no original purple in use: that from gold, by means of tin, though very good when well prepared, is too dear perhaps, and unnecessary. Their purple was a tinged earth. Their orange of Sandarac, (red orpiment) we also possess. Hence there does not appear to have been any great want of pigments, or any material difference between the colours they used, and such as we generally employ. Perhaps the full effect of colouring may be obtained without the use of exceeding brilliant pigments, depending chiefly on the proportion and opposition of tints.

The antients could not know any thing about the spirit varnishes, distillation being a modern invention; but they were undoubtedly acquainted with the use of the better oil varnishes, that is, with the use and effect of resinous gums, dissolved in boiling inspissated oils.

One of the best preserved mummies in the British Museum, has an astonishing brightness of colours on the outside of the coffin. Thousands of years have not impaired them; they are as fresh as if they had been laid on yesterday.

From an accurate observation of one of those mummies belonging to the university of Cambridge, it appeared that the varnish which covered the colours could not be dissolved, nor in the least affected by common water, and that it equally resisted the dissolving powers of the strongest spirits; hence it is reasonable to conclude, that the coffins of the mummies were not covered with size, whites of eggs, simple gums, or any preparation of wax, but with a fine transparent oil-varnish. It was discovered at the same time, the colours themselves were not prepared or mixed with oil; for where the external glossy skin was damaged, broken, or rubbed off, even common water would wash the colours away, and affect the chalk ground under them.

Pliny has described the general and particular effects of the varnish of Apelles, under the name of atrament, so distinctly, that nobody can mistake the thing, or the mixture he is speaking of. He has mentioned the shining glossy skin of the varnish, which excites the brightness of the colours, and preserves them against dust; he observed, that this skin was laid on so thin, that it could not be discerned at any distance; nor was he less accurate in reporting the particular effects of that mixture which Apelles made use of; it harmonized, and lowered the tone of the brightest florid colours in an imperceptible manner, and the whole appeared as if it had been seen through isinglass. The chemists and connoisseurs are fully of opinion that no liquid substance or mixture of any kind is fit to produce these effects besides the oil-varnishes; and if there are not, Apelles and the Greeks were certainly acquainted with these varnishes: a fact, which might be strongly urged in behalf of their knowledge of colours.

The black outlines of the figures of the most ancient Greek paintings yet extant, that is, on Etruscan vases, are so sharp, so thick, and drawn in so easy and masterly a manner, that one cannot help looking upon them as having been drawn in oil-colours. Had they been in distemper or water-colours on the red clay ground on which they are applied, they would have been imbibed and soaked into it. Our china and enamel painters, prepare and apply their colours with spike or other liquid oils; and the Greek masters seem to have done the same, unless they should appear to have burnt their vases before they painted them, or to have used a mixture of dissolved wax or gum for giving a body to their colours, which might have answered the same end as oils. And this is the more probable, as there is some reason to believe, that these vases went through two different fires, that of baking them, and that of smelting or burning-in their colours.

The Greek and Roman paintings that have been preserved or discovered at Rome and Herculaneum do not countenance the supposition of oil-colours. On the other hand, Vitruvius, who has left us so many valuable notices of the antient arts, acquaints us that there was a kind of painting, which absolutely required a mixture of oil.

From these observations, the evidence which the antients have given us in behalf of themselves, and of their knowledge of oil-painting, may be summed up in few words.

Their having been acquainted with the white chalk ground which many modern masters use for oil-painting on boards, proves no more than that the antients might have done the same.

The oil-varnishes used by the Egyptians and Apelles might have brought them to the discovery of oil-painting; but as it appears both from mummies, and from the works of Pliny, that their colours were not prepared and mixed with that varnish, and as it is plain rather that this varnish was externally laid over the finished pictures, no other conclusion can be drawn, except that they were within sight of the discovery, and that it is a matter of wonder that they should not have laid hold of it.

The outlines of the old Greek or Etruscan vases are merely fallacious appearances.

The old Greek and Roman paintings on walls and stones are either painted in distemper or fresco, or they have not been sufficiently examined.

The oil used in the coarser wax and wall paintings, proves at most, that experiments had been tried with oils; but we have no direct proofs of oil-painting having been understood or used by the Egyptians, Greeks, or Romans; and however great their skill or ingenuity, they might very well have been within sight and reach of the discovery, and nevertheless have missed it.

Rise and progress of painting among the moderns.

Italy. The revival of painting in Italy was owing to Giovanni Cimabue, born at Florence in the year 1240 He acquired his first instructions from some inferior Greek painters then employed in that city, and laid the foundation of the art in his own country.

His immediate followers were Giotto and his scholars, whose manner, like that of their master, was dry and hard; but the admiration bestowed on their works excited a general emulation, and they were succeeded by Masolini and Masaccio, the latter of whom began to advance the art by giving a superior air to his figures. Ghirlandaio added a greater knowledge of distribution in the subjects of his pictures, as well as greater correctness of design.

Andrea Castagna was the first Florentine who painted in oil. But Lionarda da Vinci, and Michael Angelo Buonaroti, were the glory of the Florentine art. Lionardi, possessing a fine imagination, and full of sensibility, entered into all the details of painting, and devoted himself to the expression of the affections of the soul. If, in this sublime branch of the art, he was afterwards surpassed by Raffaele, he could at least boast not only of excelling all the painters who went before him, but of having pursued and investigated a path which none of them had attempted to enter. His design is remarkable for purity, and the most diligent exactness of forms.

Michael Angelo delighted in seeking the great and the terrible, rather than the graceful and pleasing. Being well acquainted with every part of anatomy, he knew more accurately than any other artist in what manner to express the forms and joinings of the bones, and the office of every muscle, its origin and insertion. "In his figures," says Mengs, "the articulations of the muscles are so easy and free, that they appear to be made for the attitude in which he represents them." His style possessed a degree of grandeur beyond any other painter. He did not possess, in the opinion of Reynolds, so many delightful parts of the art as Raffaele, but those which he had acquired were of a more sublime nature.

He informs us in one of his letters (continues sir Joshua), that he modelled in clay, or in wax, all the figures which he intended to paint, a method familiar to the painters of that time.

Vasari has recorded that he painted but one picture in oil, and resolved never to paint another; saying it was an employment for women and children.

Michael Angelo was born at Castel Caprese in Tuscany in 1474, and died at the age of ninety. His principal work is the capella Sistina in the Vatican, which was painted by order of pope Julius the Second. It represents, in various compartments, the origin of the human race, and its progress to society; the empire of religion; and the last judgment.

The contemporary of Lionardo da Vinci, was Pietro Perugino, the master of Raffaelle Sanzio d'Urbino.

Raffaele was born in 1483, and was at an early age the pupil of Pietro. His first manner was that of his master; but endowed with a transcendant genius, after carefully studying, and uniting in himself, all the excellences of his predecessors and contemporaries, he formed a style more perfect than that of any painter who went before, or has succeeded him. He was sent for to Rome by pope Julius the Second, who employed him to paint several apartments of the Vatican palace.

It was fortunate for Raffaele, says Mengs, that he was born in what he terms the infancy of the art, and that he formed himself by copying nature, before he had access to the works of any great master. He began by studying, with great exactness, the simple truth in his figures; and thus habituated to imitate nature with precision, it was not difficult for him to carry the same accuracy into the superior style which he adopted, first on the sight of the works of the great Florentine masters, and afterwards in imitation of the antients.

Composition and expression are the chief excellences of Raffaele. He had too high an idea of painting to consider it as a mute art: he made it speak to the heart; and this could only be done in subjects which required expression. If Raffaele did not attain an excellence equal to the Greeks, he saw, at least, and imitated, whatever was most beautiful and expressive in nature. "The Grecians sailed majestically," says Mengs, "between earth and heaven; Raffaele walked with propriety on the earth."

At *Venice*, about the same time with Lionardo da Vinci, flourished the Bellinis and Mantegna. Giovanni Bellini contributed greatly to the progress of painting. He is accounted the founder of the Venetian school, by introducing the practice of oil-painting, which he managed very skilfully, and by teaching his scholars to paint after nature. He gave a noble air to his heads, and there is somewhat of harmony in his pictures; but his greatest glory is that he was the master of Giorgione and Titiano Vecelli, who carried the Venetian colouring to perfection.

Giorgione died in his 32d year, having excited the emulation of Titian, who soon greatly surpassed him.

Titian was instructed to copy nature in the most servile manner in the school of Bellini, but after seeing the works of Giorgione, he conceived the ideal excellence of colouring. The beauties of his works are to be found in the happy disposition of colours, both proper and local, an art which he carried to the extreme of skill. The artists in the Florentine and Roman schools had painted chiefly in fresco and distemper, and finished their large works from previous sketches; but as Titian painted in oil, and finished directly from the objects in nature, this practice, joined to his natural talents, gave him extraordinary advantages, and the greatest truth to his pictures.

He is not eminent in historical pictures alone, but also in landscape. In this province his scenes are well chosen, his trees are bold and varied in their forms, and their foliage admirably executed. He generally selected for his landscapes some singular appearance of nature.

In *Lombardy*, about the same period also, Bianchi, born at Modena, instructed in painting Antonio Allegri, better known by the name of Correggio. Correggio began, like the other painters of his time, to imitate nature alone, but soon enlarged his manner, and gave ease and grandeur to his designs. He painted chiefly in oil, a kind of painting susceptible of the greatest delicacy and sweetness, and he gave a pleasing and captivating tone to his pictures. His method was to lay his colours very thick on the brightest parts of his pictures, in order to make them capable of receiving afterwards the highest degree of light. He perceived that the reflections of light correspond with the colour of the body which reflects them, and on these principles founded his system of colouring.

A delicate taste in colours, a perfect knowledge of chiaro-scuro, the art of uniting light to light and shade to shade, together with that of detaching all objects from their ground, and an inimitable harmony of design, placed Correggio in the class of the greatest masters whom Italy has known.

From these great masters descended the schools of Florence, Rome, Venice, and Lombardy, in which the most distinguished painters were Fra Bartolomeo di San Marco, Andrea del Sarto, Giulio Romano, Vasari, Polydoro, Michael Angelo da Caravaggio, Tintoretto, Paolo Veronese, the Bassans, Pordenone, Parmigiano, and lastly, the Carraccis, who combining the merits of the various schools, became themselves the head of a school called the Bolognese school, from the place of their birth.

Ludovico Carracci was the master of the other two, Annibale and Agostino. He had studied the works of Titian and Paolo Veronese at Venice, those of Andrea del Sarto at Florence, those of Correggio at Parma, and those of Giulio Romano at Mantua; but he chiefly endeavoured to imitate the manner of Correggio.

Annibale studied equally Correggio and Titian, but he is principally esteemed for his knowledge of design. Agostino possessed a mind greatly cultivated by learning, and he devoted part of his time to poetry and music. These three painters often united their skill in the performance of the same picture, and their works are often confounded together, although the style of each is strongly different from the other two. Ludovico had less fire, but more gracefulness and grandeur; Agostino's conceptions were more spirited; and Annibale is characterized by boldness, by a more profound design, and a more powerful readiness of execution. "Ludovico," says sir Joshua Reynolds, "appears, in his best works, to approach the nearest to perfection. His unaffected breadth of light and shadow, the simplicity of colouring, and the solemn effect of that twilight which is diffused over his pictures, appear to correspond with grave and dignified subjects better than the more artificial brilliancy of sunshine, which enlightens the pictures of Titian.

The Carraccis established an academy at Bologna, which their zeal for the arts induced them at first to call l'Academia deè Desiderosi, but it was soon called by the name of the founders, because none more honourable could be given to it. In the schools of this academy were taught the art of modelling, perspective, and anatomy; lessons were given on the beauty of the proportions of nature, on the best manner of applying colours, and on the principles of light and shade. They held frequent meetings, to which men of general learning were admitted; but these meetings ceased on the departure of Annibale, when he went to Rome to paint the gallery of the cardinal Farnese.

The most eminent succeeding painters of the Bolognese school, were Guido, Lanfranco, Albano, and Guercino. Guido is distinguished by the gracefulness of his style, and Guercino by boldness of colour and effect.

In the Roman school, Pietro da Cortona succeeded to those great imitators of their predecessors and nature; and finding it difficult to rival them in that kind of painting, he applied himself principally to composition, and the arrangement of numerous groups. His contemporary and rival was Andrea Sacchi, followed by Carlo Maratti, who flourished at Rome about the middle of the 17th century, and aiming at extraordinary perfection, diligently studied the works of the greatest painters, and particularly Raffaele and the school of the Carracci. He is the last eminent painter of the Roman school. His best disciple was Francesco Imperiale, after whom Pompeo Battoni is the only one with whose works we are acquainted.

At Naples, in the early part of the 17th century, Guiseppe Ribera, called Spagnoletto, painted in the style of Caravaggio, and surpassed him in invention, design, and choice of subject. Luca Giordano was his disciple, who afterwards studied under Pietro da Cortona at Rome, and returning to Naples, became the founder of the Neapolitan school. Of this school Solimeni and Sebastian Conca are the principal ornaments.

During the fourteenth and fifteenth centuries, painting began to appear anew in Germany, France, Holland, and Flanders.

Germany. The names of Albert Durer, Kranach, Holbein, and Amberger, stood high at Nuremberg, Augsburg, Basil, and Weimar, in the beginning of the 16th century, but the capital of Vienna afforded no encouragement to painting till the reign of Rodolph the Second. The succeeding monarchs, principally from Ferdinand the Third to Leopold the First, were great promoters of the arts; but the perpetual wars in which they were involved, prevented the progress of refinement; and it was not till the total repulse of the Turks from the Austrian frontiers, under the last of these princes, that painting began to flourish at Vienna. The artists of the German school are numerous, but few of them have risen to eminence. Of those few, Albert Durer is the first in the order of time, and Mengs the latest.

Albert was born in 1471, and excelled in painting and engraving. His pictures were finished with great exactness, but his manner was dry and hard. His principal works were painted at Prague in the palace of the emperor Maximilian, by whom, as well as by Charles the Fifth, he was held in great esteem. Raffaele is said to have hung the prints of Albert Durer in his own apartment.

Holbein was nearly contemporary with Durer. He is known by a multitude of accurate portraits, and was likewise eminent for richness of invention, which he displayed in numerous designs for gravers, sculptors, and jewellers. His Dance of Death, painted in the town-hall of Basle, is universally celebrated. He is remarkable for having, like Turpilius, the Roman, performed all his works with his left hand.

Kneller, born at Lubeck, in the duchy of Holstein, received his first instructions from Rembrandt. He painted chiefly portraits, which were highly celebrated in England during the reigns of Charles the Second, James the Second, William the Third, Anne, and George the First.

Antonio Raffäel Mengs, one of the most scientific painters of any country, was educated in Germany; but painted chiefly at Rome, and at Madrid; to which latter capital he was invited by Charles the Third. He practised his art with an extreme diligence, which has deservedly rendered him eminent. His works possess many beauties of composition, and mechanical execution. His writings are too frequently metaphysical, but contain many excellent disquisitions on painting, calculated to inspire the artist with exalted ideas of his profession.

Holland and Flanders. The Dutch and Flemish schools are nearly as much distinguished by the number, as by the excellence of their artists.

In the former school, the precedence of fame in point of date, is given to Lucas van Leyden, born in 1494. He was a laborious competitor of Albert Durer, and resembles him in manner and style.

Polemberg, Ostade, Gerard Dow, Mieris, Wouvermans, Cuyp, Berghem, Vanderwerf, Van Huysum, Schalchen, Brower, Hemskirk, are amongst the eminent painters of the Dutch school; but they are all greatly surpassed by the truly astonishing genius of Rembrandt, many of whose works seem even to surpass nature in force and effect. His etchings also are highly and deservedly valued. It is not, however, to be omitted, that the singular merit of his original conceptions and compositions is counterbalanced by the grossness of his forms.

The honour of founding the Flemish school is attributed to John of Bruges; and the names of his successors are too many to admit of detail. Their works are to be found in every cabinet. The most illustrious masters of this school are Rubens and Vandyck.

To John of Bruges, better known by the name of John van Eyk, was for a long time attributed the invention of oil-painting; but he had only the honou of transmitting that method to Italy, where a picture painted by him, and sent to Alphonso, king of Naples, first divulged the discovery. Frans Floris is celebrated as the Raffaele of Flanders. De Vos, Segre, Diepenbech, Teniers, Jordaens, stand prominent in the catalogue of merit in the same school.

Rubens possessed a most fertile and extensive genius, and produced an immense number of works. This extraordinary painter distinguished himself equally in historical, portrait, and landscape painting; in animals, fruits, and flowers. He both invented and executed with the utmost facility. His drawing, although overcharged, is not without considerable merit. He had great knowledge of anatomy; but he was hurried away by the ardour of execution, and too often sacrificed form and correctness to splendour, and the magic charms of colour. He excelled in colouring, and chiaro-scuro. He studied principally in Lombardy, after the works of Titian, Paolo Veronese, and Tintoret, from whose excellences he formed rules for his own practice, from which he seldom deviated.

He was not only an eminent painter, but

an accomplished scholar, and rose to high employment in the service of his country, visiting several courts in the character of an ambassador.

Of the disciples of Rubens, Vandyck best comprehended all the rules and general maxims of his master; and even surpassed him in the delicacy of his colouring, particularly in portraits, in which he stands one of the highest masters of his art.

France. The French school or schools may be classed in three different æras, and characterized by as many different styles; two prior, and one modern, since the period of the late revolution. The artists of the former schools chiefly adopted the manners of the various painters whose works they studied or imitated. But Poussin, Vouet, Le Brun, and Le Sueur, are those masters who have given distinction to the French school in the province of history. The first and the last of these have been compared by the French to Raffaele, whose example Le Sueur in particular considered as his model. Poussin studied the antique statues with so great devotion, that his pictures frequently bear a strong resemblance to them. Le Brun's battles of Alexander are deservedly celebrated for their spirit, composition, and correct drawing. Gaspar Dughet (commonly called Gaspar Poussin, from his master's name, which he adopted), and Claude Gelée (called Claude Lorraine, from the place of his birth), are eminent examples of excellence in landscape. The latter appears to stand without a rival, or at least stood unrivalled in his time. Both these painters derived their professional knowledge, as well as their choice of subjects, from the fascinating and classic objects of imitation which they found in Italy, where they studied and flourished.

The arts which had been raised in France by the masters before-mentioned to very considerable dignity, sunk in the second school of Boucher and Vaulor to a state of imbecility and affectation. The reputation of a colourist was sought by exaggerated tints, and the hand of a master was conceived to consist in ostentatious penciling.

In a more recent period, and particularly since the revolution, a new style has been introduced into the arts. Vien was the first reformer of this class, and his example has been vigorously followed by David and his contemporaries. They have endeavoured to substitute a simple and rigid taste in the place of false and glittering manners. The attempt is laudable: the result will be judged of by posterity.

The comparative merits of those modern schools which have been hitherto mentioned, are thus given by Richardson:

"The painters of the Roman school were the best designers, and had a kind of greatness, but it was not antique. The Venetian and Lombard schools had excellent colourists and a certain grace, but entirely modern, especially those of Venice; but their drawing was generally incorrect, and their knowledge in history and the antique very little: and the Bolognese school is a sort of composition of the others. Even Annibale himself possessed not any part of painting in the perfection that is to be seen in those from whom his manner is composed; though, to make amends, he possessed more parts than perhaps any other master, and in a very high degree.

"The works of those of the German schools have a dryness and ungraceful stiffness not like what is seen amongst the old Florentines, that has something in it pleasing however; but this is odious, and as remote from the antique as Gothicism could carry it.

"The Flemings have been good colourists, and imitated nature as they conceived it; that is, instead of raising nature, they fell below it, though not so much as the Germans, nor in the same manner. Rubens himself lived and died a Fleming, though he would fain have been an Italian; but his imitators have caricatured his manner; that is, they have been more Rubens in his defects than he himself was, but without his excellences.

"The French, excepting some few of them (N. Poussin, Le Sueur, Sebastien Bourdon, &c.), as they have not the German stiffness, nor the Flemish ungracefulness, neither have they the Italian solidity; and in their airs of heads and manners, they are easily distinguished from the antique, how much soever they may have endeavoured to imitate it."

Spain. The art of painting began to flourish in Spain during the reigns of Charles the Fifth and Philip the Second. The style of painting, however, was not distinguished by great excellence until the works of Velasquez appeared. From the masterly imitation of nature displayed in his pictures, the school of the nation has been formed.

Zurbaran and Herrera are among the best painters before Velasquez; and Murillo for the most distinguished after him. The softness of tints and harmony of colour in the paintings of Murillo seem to enchant the eye.

In Russia the arts are at present cultivated with great energy, and with unremitting attention on the part of the government.

In America also, great establishments are forming at New York and Philadelphia, with the same view to the promotion of the arts.

It now only remains to speak of the art of painting in England, where it is at present making great advances towards excellence.

Painting has been cultivated in England at several periods with various success. We shall here give the account of it from Mr. West's letter in the third number of Academic Annals, published by the Royal Academy of London.

"Many sovereigns of this country have noticed and patronized the fine arts. Edward the Third caused several chapels to be embellished with painted glass and enamelled monuments, as well as with paintings on the walls, representing scriptural subjects, and others from the church legends, together with portraits of then existing characters of both sexes. The chapel of St. Stephen, Westminster, was the most conspicuous.

"Henry the Seventh gave patronage to many ingenious men, both in painting, sculpture, and architecture.

"Henry the Eighth followed the example of his father, in giving patronage to eminent men. He invited those of the greatest celebrity in painting in Italy, Germany, and Flanders, to visit his capital. Raffaele and Titian he wished to see at his court; and he endeavoured to draw them thither by the most splendid offers: but not succeeding in his desire, he procured several of their works; in particular the picture of St. George, by Raffaele, at present in the possession of the king of Spain, and the two pictures by Titian, now in the gallery of the marquis of Stafford; the subjects of which are, Diana and Acteon, and Diana and Calisto. He was more fortunate in his invitation to Holbein, at that time famous as a portrait painter, who resided in Henry's palace, and whose works were soon spread through the kingdom.

"Charles the First, more attached to the fine arts than any of his predecessors, formed a splendid collection of the works of the great Italian and Flemish masters. He invited to his court Rubens and Vandyck, and other painters of considerable eminence, from Flanders and Holland; and he gloried in counting among his natural subjects Inigo Jones, his architect, and Dobson, who rose to eminence in painting. These were the two first English artists who enjoyed the patronage of royal favour.

"Charles the Second was proud to follow the liberal example of his father, in bestowing rewards on ingenious artists. He patronized most of those who visited his court from Italy, Flanders, Germany, and Holland; of which the decorative paintings on the walls in Windsor-castle, and the palace of Hampton-court, by Verrio, and others, are evident proofs; beside many pictures from poetical subjects, by Gennari, as well as portraits by several painters of considerable eminence. The favours which this monarch showered on the arts, were, however, confined to foreign artists.

"Queen Anne was the first of our sovereigns who called into activity the British pencil, as the paintings in the cathedral of St. Paul's, and the hospital at Greenwich, by sir James Thornhill, and others under his direction, sufficiently evince. In architecture, sir Christopher Wren was equally distinguished by her favour.

"But to form the great epocha of patronage conferred by a British king on British subjects, in painting, sculpture, and architecture, was reserved for the reign of his present majesty, George the Third.

"In the year 1768, his majesty gave his royal sanction to a plan formed for the establishment of an academy of painting, sculpture, and architecture, of which he was graciously pleased to become the protector and patron.

"In the three branches of art which constitute that academy, he found many artists already formed: among others of considerable celebrity in painting, Reynolds, Wilson, Hayman, Gainsborough, Hoare, Danu, Mortimer, Barret, Sandby, Wright, Cotes, and West; in sculpture, Bacon, Nollekens, and Wilton; in architecture, Chambers, G. Dance, Stuart, T. Sandby, Gwyn, and the two Adams.

"At the same time, Strange, Woollett, Hall, Green, and Mac Ardell, shone with marked eminence among the engravers. The merits of our engravers, blended with the labours of the painter, opened a new avenue to fame. The harmonious softness of Strange; the united skill of Wilson and Woollett in landscape, as seen in the prints of Niobe, Phaeton, Ceyx, Celadon and Amelia, &c.;

the portraits in mezzotinto from sir Joshua Reynolds, by M'Ardell, Fisher, &c.; the successful combination of West with Earlom, Green, Woollett, Hall, &c. in historical works, as seen in the prints of Agrippina, Regulus, Hannibal, Wolfe, La Hogue, the Boyne, Penn, Cromwell, and the Restoration, &c. spread the celebrity of English works of art through the medium of engraving; and the circumstance of these prints rising to a higher price in every market throughout the continent than had ever been known in the annals of the arts, inspired those commercial views which afterwards produced the galleries of Shakspeare, under Boydell; the poets, under Macklin; historical, under Bowyer, &c. &c.; giving to this country a new source of commerce, highly beneficial to its interests, and unexampled in any other."

English school. To the list of painters mentioned by West, are to be added several who unfortunately experienced no royal patronage. Among these is Hogarth, whose unrivalled excellence in works of humour is principally known to us by the numerous engravings from his pictures.

Of the modern English school, sir Joshua Reynolds was the founder, and his works still remain its greatest glory. They not only give him the most distinguished rank among the artists of the present age, but the effects produced by them on the rising artists, as well as by the elevated principles inculcated in his discourses delivered at the Royal Academy, will secure his reputation as long as England shall pay respect to superior talents. The English taste appears to be formed on the great masters of the Italian and Flemish schools. Reynolds professed an admiration and preference of Michael Angelo, but his own works are in no point similar to that great master of design.

The names of Gainsborough and Wilson stand the highest in landscape painting.

The painters of this school have been distinguished as less rigid with regard to the forms and correctness of their drawing, than ambitious of striking and poignant effect. "Beauty," says the French Encyclopædia, "ought to be the characteristic of the English school, because the artists have it so frequently displayed before their eyes. If this beauty is not precisely similar to the antique, it is not inferior to it.

"The English school should also be distinguished for the truth of expression, because the liberty enjoyed in that country gives to every passion its natural and unbiassed operation."

The best accounts of painting and painters are to be found in the works of Lionardo da Vinci, Alberti, Lomazzo, and Bellori; and in the Lives of the Painters, by Vasari and Du Piles; Felibien's Entretiens sur les Vies des Peintres, and his other writings; the Discourses delivered by Reynolds in the Royal Academy of London; the various Treatises by Mengs; Richardson on Painting; and De Arte Graphicâ, by Du Fresnoy.

The later publications of Barry, Shee in his Rhymes on Art, and Howe in his Inquiry into the present State of the Arts in England, convey the most accurate information concerning the progress of painting in this country.

PAKFONG, or white copper, a metal composed of copper, nickel, and zinc. The zinc amounts to nearly one-half of the whole, and the proportions of copper and nickel are as 5 to 13. This compound metal is much used among the Chinese.

PALÆSTRA, in Grecian antiquity, a public building, where the youth exercised themselves in wrestling, running, playing at quoits, &c.

PALAMEDEA, a genus of birds belonging to the order of grallæ. The character of this genus is, the bill bends down at the point with a horn, or with a tuft of feathers erect near the base of it; the nostrils are oval; the toes are divided almost to their origin, with a small membrane between the bottoms of each.

There are two species; the first of which is the palamedea cornuta, or horned screamer. It is about the size of a turkey; in length about three feet four inches. The bill is two inches and a quarter long, and black; the upper mandible is a little gibbous at the base; the under shuts beneath it, as in the gallinaceous tribe: the nostrils are oval and pervious, and placed near the middle of the bill. From the crown of the head springs a slender horn of more than three inches in length, and pointed at the end: the irides are the colour of gold: the plumage on the head, neck, and upper part of the body, is black, margined with grey on the first, and downy: at the bend of the wing are two sharp horny spurs. The female, we are told, is very like the male.

It is remarked, that they are always met with in pairs; and if one dies, the other mourns to death for the loss. They frequent places near the water; make a large nest of mud, in the shape of an oven, upon the ground; and lay two eggs, the size of those of a goose. The young are brought up in the nest till able to shift for themselves. They have but one nest in the year, which is in January or February, except the first eggs are taken away, when they make a second in April or May. The young birds are frequently eaten by the natives, though the colour of the flesh is very dark; that of the old ones is tough and ill tasted. By some authors this species is said to feed on crabs and birds, such as pigeons, poultry, and even to attack sheep and goats; but this is denied by others, who say that its principal food is reptiles. The cornuta is a rare species. It is found in certain districts in Cayenne, Guiana, Surinam, and other parts of South America, chiefly in the marshes and wet savannas, and for the most part near the sea.

The second species of palamedea is the cristata, or crested screamer. This bird is about the size of a heron: the bill is short, bent like that of a bird of prey, and of a yellowish brown: the irides are gold-coloured: on the forehead, just above the bill, is a tuft of black feathers variegated with ash-colour: the head, neck, and body, are grey, mixed with rufous and brown, most inclining to the last on the wings and tail; the wings are not furnished with spurs; the legs pretty long, of a dull yellow; claws brown; the hind toe placed high up, so as not to touch the ground in walking. This bird inhabits Brazil.

PALATE. See Anatomy.

PALATINE COUNTIES, are those of Chester, Durham, and Lancaster. See Counties Palatine.

PALAVIA, a genus of the monadelphia polyandria class and order. The calyx is half five-cleft; style many-cleft; capsule many-seeded; cells in a ball on the central receptacle. There are two species, of no note.

PALE, in heraldry, one of the honourable ordinaries of an escutcheon, being the representation of a pale or stake placed upright, and comprehending the whole height of the coat from the top of the chief to the point. See Heraldry.

PALISADE, or Palisado, in fortification, an inclosure of stakes or piles driven into the ground, each six or seven inches square, and eight feet long, three whereof are hid under ground. Palisadoes are generally used to fortify the avenues of open forts, gorges, half-moons, the bottoms of ditches, the parapets of covert-ways, and in general all posts liable to surprize, and to which the access is easy. Palisadoes are usually planted perpendicularly, though some make an angle inclining towards the ground next the enemy, that the ropes cast over to tear them up may slip.

Palisades, *Turning*, are an invention of M. Coehorn, in order to preserve the palisades of the parapet of the covert-way from the besieger's shot. He orders them so, that as many of them as stand in the length of a rod, or in about ten feet, turn up and down like traps, so as not to be in sight of the enemy till they just bring on their attack, and yet are always ready to do the proper service of palisades.

PALISSE, in heraldry, a bearing like a range of palisades before a fortification, represented on a fesse, rising up a considerable height, and pointed at top, with the field appearing between them.

PALLADIUM. In the month of April, 1803, it was announced by a public notice, that a new noble metal called palladium was sold at Mr. Forster's, Gerard-street, Soho, London. Some of its properties are mentioned in the paper, but the name of the discoverer is concealed. Mr. Chenevix, suspecting imposition from the unusual manner in which the discovery was announced, made some experiments on it to discover its composition, and soon found that its properties could not be referred to any known metal. This induced him to purchase all that remained in the hands of the vender. It was sold at the rate of 25 grains per guinea.

It had been worked by art, and was offered for sale in thin laminæ. When polished, it had exactly the appearance of platinum. The laminæ were very flexible. The specific gravity varied from 10.972 to 11.482.

The effects of galvanic electricity on it were the same as on gold and silver. When exposed to the blowpipe, the side farthest removed from the flame became blue. A very violent heat is necessary to melt it. The button, by fusion, lost a little of its weight, but its specific gravity was increased from 10.972 to 11.871. It was harder than iron, and appeared chrystallized. The fracture was fibrous.

When strongly heated, if it is touched with sulphur it melts, and continues melting till the compound ceases to be red-hot. The sulphuret is brittle, and whiter than palladium. It was not altered by charcoal. It united with the different metals, and formed alloys; the properties of which have been described by Mr. Chenevix.

When exposed to the action of melted potass, it loses its brilliancy, and a little of its weight. Soda acts with less violence. When ammonia is kept over it for some days, it acquires a blue colour.

Sulphuric acid, when boiled upon palladium, acquires a fine red colour, and dissolves a portion of it; but its action is not very powerful. Nitric acid acts with much greater energy, and oxydizes and dissolves it, forming a very beautiful red solution. Muriatic acid, when long boiled upon it, becomes of a beautiful red colour. Nitro-muriatic acid attacks it with great violence, and forms a fine red solution.

The alkalies and earths throw down a fine orange powder from these solutions; and when ammonia is used, the supernatant liquid is sometimes of a fine greenish blue. Sulphat, nitrat, and muriat of potass and of ammonia, throw down orange precipitates, as they do from the solutions of platinum. Muriat of tin throws down a dark orange or brown precipitate from neutralized salts of palladium. Sulphat of iron throws down palladium in the metallic state. Prussiat of potass occasions an olive-coloured precipitate, and water containing sulphureted hydrogen gas a dark brown one. Fluoric, arsenic, phosphoric, oxalic, tartaric, citric acids, and their salts, precipitate some of the solutions of palladium, and form various compounds with it.

Such are the properties of palladium ascertained by Mr. Chenevix. They indicate a substance different from every other known metallic body. Still he considered the substance as a compound, and tried various ways of forming one similar. At last he suspected mercury and platinum as likely to be its constituents; and after various trials, hit upon the following mode of forming it, which succeeded:

One hundred parts of platinum, previously purified by solution in nitro-muriatic acid, and precipitation by sal ammoniac, were dissolved in nitro-muriatic acid. To the solution 200 grains of red oxide of mercury were added. These not saturating the excess of acid, he continued to add more till the acid was saturated. A solution of sulphat of iron was put into a long-necked matrass; the mixed solution of platinum and mercury was poured into it, and the matrass heated on a sand bath. A copious precipitate soon fell, and the inside of the matrass was coated with a thin metallic crust. This crust, collected and washed, was put into a charcoal crucible, and exposed to a violent heat; a button of metal was obtained, which possessed the properties of palladium. From the proportions employed, Mr. Chenevix concluded, that palladium is composed of two parts of platinum, and one of mercury.

The extraordinary consequences that follow from this experiment will occur at once to the reader. Here is a compound of two metals, which cannot be decomposed by art. And if we know one such compound, why may not many of the other supposed metals be such compounds?

We have here a compound containing mercury, one of the most volatile substances in nature, in such a state as to resist the most violent heat without quitting its combination: so that one of the most apparently whimsical of all the alchymistical opinions is here verified.

But the specific gravity of palladium is one of the most extraordinary circumstances. It is considerably less than that of the lightest of its component parts. The specific gravity of platinum cannot be stated at less than 22. The specific gravity of mercury may be stated at 13.5; but the actual specific gravity was only 11.2. So that an expansion amounting to more than a third of the whole has taken place.

The experiments of Mr. Chenevix were repeated by some of the eminent chemists in London; among others, by Dr. Wollaston and Mr. Tennant: but these gentlemen could not succeed in obtaining palladium. Hence doubts are still entertained by some concerning the composition of this substance. But the well-known precision of Mr. Chenevix, and the uncertainty which he has himself pointed out of succeeding in a few trials, ought to induce us to give him full credit. Dr. Thompson tried the experiment with all the precautions he could think of to ensure success. The metallic crust announced by Mr. Chenevix was formed; and upon heating it violently in a charcoal crucible, a button was obtained of a white colour, and very like platinum. It was very porous, and therefore though malleable, it soon broke under the hammer. Its specific gravity was only 11.126. But this was partly owing to its porousness. It was acted upon by the three mineral acids; but the action of neither of them was violent, and the solution, instead of red, was a dirty reddish-brown. He could detect no iron by the usual tests; but the solutions gave unequivocal marks of the presence of platinum. In short, the button was not platinum, but at the same time it was not palladium.

PALASSIA, a genus of the syngenesia polygamia frustranea class and order. The receptacle is chaffy; down none; seeds vertical; margin ciliated; calyx imbricate. There is one species, a shrubby plant of Lima.

PALLET, in heraldry, is nothing but a small pale.

PALLET. See WATCH.

PALM, a measure of length, about three inches.

PALPITATION. See MEDICINE.

PALSY. See MEDICINE.

PALY, or PALE, in heraldry, is when the shield is divided into four or more equal parts, by perpendicular lines falling from the top to the bottom.

PANARY FERMENTATION. See FERMENTATION.

PANAX, GINSENG, a genus of the diœcia order, in the polygamia class of plants. In the umbel the corolla is five-petalled; stamina five; hermaphrodite calyx five-toothed; superior styles two; berry two-seeded; male calyx entire. There are nine species of this plant: 1. Quinquefolia. 2. Trifolia. 3. Fruticosa. 4. Arborea. 5. Spinosa. 6. Aculeata. 7. Chrysophylla. 8. Simplex. 9. Attenuata.

Ginseng was formerly supposed to grow only in Chinese Tartary, affecting mountainous situations, shaded by close woods: but it has now been long known that this plant is also a native of North America, whence M. Sarrasin transmitted specimens of it to Paris in the year 1704; and the ginseng since discovered in Canada, Pennsylvania, and Virginia, by Lafiteau, Kalm, Bartram, and others, has been found to correspond exactly with the Tartarian species; and its roots are now regularly purchased by the Chinese.

The dried root of ginseng, as imported here, is scarcely the thickness of the little finger, about three or four inches long, frequently forked, transversely wrinkled, of a horny texture, and both internally and externally of a yellowish-white colour. On the top are commonly one or more little knots, which are the remains of the stalks of the preceding years, and from the number of which the age of the root is judged of. "To the taste it discovers a mucilaginous sweetness, approaching to that of liquorice, accompanied with some degree of bitterness, and a slight aromatic warmth, with little or no smell. It is far sweeter, and of a more grateful smell, than the roots of fennel, to which it has by some been supposed similar; and differs likewise remarkably from those roots in the nature and pharmaceutic properties of its active principles, the sweet matter of the ginseng being preserved entire in the watery as well as the spirituous extract, whereas that of fennel-roots is destroyed or dissipated in the inspissation of the watery tincture. The slight aromatic impregnation of the ginseng is likewise in good measure retained in the watery extract, and perfectly in the spirituous."

The Chinese ascribe extraordinary virtues to the root of ginseng; and have long considered it as a sovereign remedy in almost all diseases to which they are liable; having no confidence in any medicine unless in combination with it. It is observed by Jartoux, that the most eminent physicians in China have written volumes on the medicinal powers of this plant. We know, however, of no proofs of the efficacy of ginseng in Europe; and from its sensible qualities, we judge it to possess very little power as a medicine.

PANCRATIUM, a genus of the hexandria monogynia class of plants, the flower of which consists of six lanceolated petals; its nectarium is twelve-cleft; stamina placed on the nectary. There are ten species, beautiful flowering plants, with large bulbs.

PANCREAS. See ANATOMY.

PANDANUS, a genus of the diœcia monandria class and order. There is no calyx or corolla; male anther sessile; female stigmas two; fruit compound. There is one species.

PANDECTS, in the civil law, collections made by Justinian's order, of five hundred and thirty-four decisions of the antient lawyers, on so many questions occurring in the civil law; to which that emperor gave the force and authority of law, by an epistle prefixed to them. The pandects consist of fifty books, and make the first part of the body of the civil law. See CIVIL LAW.

PANEL, in law. See JURY.

PANICUM, a genus of the digynia order, in the triandria class of plants. The calyx is trivalved, the third valvule being very small. The species are in number seventy-nine, grasses of different countries.

PANNEL, in law. See PANEL. In the

Scotch law, pannel signifies the prisoner at the bar, or person who takes his trial before the court of justiciary, for some crime.

Pannel, in joinery, is a tympanum, or square piece of thin wood, sometimes carved, framed, or grooved in a larger piece, between two upright pieces and two cross pieces.

Pannel, in masonry, is one of the faces of a hewn stone.

PANORPA, a genus of insects of the order neuroptera: the generic character is, snout horny, cylindric, with two feelers; stemmata three; antennæ longer than thorax; tail of the male chelated or clawed. The most familiar species of this genus is the panorpa communis of Linnæus, an insect very frequently seen in meadows during the early part of summer. It is a longish-bodied fly, of moderate size, with four transparent wings elegantly variegated with deep-brown spots: the tail of the mail insect, which is generally carried in an upright position, is furnished with a forceps, somewhat in the manner of a lobster's claw.

The panorpa coa is a native of Greece and the islands of the Archipelago, and is an insect of a very peculiar appearance. It is considerably larger than the preceding, and is distinguished by having the lower wings so extremely narrow or slender as to resemble a pair of linear processes with an oval dilatation at the tip, while the upper wings are very large, oval, transparent, and beautifully variegated with yellowish-brown bars and spots. See Plate Nat. Hist. fig. 340.

PANTHER. See Felis.

PAPAVER, the *poppy*, a genus of the monogynia order, in the polyandria class of plants, and in the natural method ranking under the 27th order, rhœadæ. The corolla is tetrapetalous; the calyx diphyllous; the capsule bilocular, opening at the pores below a persisting stigma. There are nine species: 1. The somniferum, or somniferous common garden-poppy. There are of this a great many varieties, some of them extremely beautiful. The white officinal poppy is one of the varieties of this sort. It grows often to the height of five or six feet, having large flowers, both single and double, succeeded by capsules or heads as large as oranges, each containing about 8000 seeds.

We are told, that in the province of Bahar in the East Indies, the poppy-seeds are sown in the months of October and November, at about eight inches distance, and well watered till the plants are about half a foot high; when a compost of dung, nitrous earth, and ashes, is spread over the areas; and a little before the flowers appear, they are again watered profusely till the capsules are half grown, at which time the opium is collected, for when fully ripe they yield but little juice: two longitudinal incisions from below upwards, without penetrating the cavity, are made at sun-set for three or four successive evenings; in the morning the juice is scraped off with an iron scoop, and worked in an iron pot in the sun's heat, till it is of a consistence to be formed into thick cakes of about four pounds weight; these are covered over with the leaves of poppy, tobacco, or some other vegetable, to prevent their sticking together, and in this situation they are dried. See Narcotic Principle.

2. The rhæas, or wild globular-headed poppy, rises with an upright, hairy, multiflorous stalk, terminated by many red and other-coloured flowers in the varieties, succeeded by globular smooth capsules. This plant is common in corn-fields, and flowers in June and July. The capsules of this species, like those of the somniferum, contain a milky juice of a narcotic quality, but the quantity is very inconsiderable, and has not been applied to any medical purpose; but an extract prepared from them has been successfully employed as a sedative. The flowers have somewhat of the smell of opium, and a mucilaginous taste, accompanied with a slight degree of bitterness. A syrup of these flowers is directed in the London Pharmacopœia, which has been thought useful as an anodyne and pectoral, and is therefore prescribed in coughs and catarrhal affections; but it seems valued rather for the beauty of its colour than for its virtues as a medicine.

3. The cambricum, or Welsh poppy, has a perennial root, pinnated cut leaves, smooth, upright, multiflorous stalks, a foot and a half high, terminated by many large yellow flowers, succeeded by smooth capsules.

4. The orientalis, or oriental poppy, has a large, thick, perennial root; long, pinnated, sawed leaves; upright, rough, uniflorous stalks, terminated by one deep-red flower, succeeded by oval smooth capsules. The flowers appear in May.

PAPER, sheets of a thin matter, made of some vegetable substance.

Paper-Making. Under this word we cannot do better than by giving a concise view of the art of making paper.

The first instrument is called the duster, made in the form of a cylinder, four feet in diameter, and five feet in length. It is altogether covered with a wire net, and put in motion by its connection with some part of the machinery. A convenient quantity of rags before the selection are inclosed in the duster, and the rapidity of its motion separates the dust from them, and forces it through the wire. It is of considerable advantage to use the duster before selection, as it makes that operation less pernicious to the selectors.

The selection is then to be made; and it is found more convenient to have the tables for cutting off the knots and stitching, and for forming them into a proper shape, in the same place with the cutting-table. The surface both of these and of the cutting-table is composed of a wire net, which in every part of the operation allows the remaining dust and refuse of every kind to escape.

The rags, without any kind of putrefaction, are again carried from the cutting-table back to the duster, and from thence to an engine, where, in general, they are in the space of six hours reduced to the stuff proper for making paper. The hard and soft of the same quality are placed in different lots; but they can be reduced to stuff at the same time, provided the soft is put somewhat later into the engine.

The engine is that part of the mill which performs the whole action of reducing the rags to paste, or, as it may be termed, of trituration. The number of the engines depends on the extent of the paper-work, on the force of water, or on the construction of the machinery.

When the stuff is brought to perfection, it is conveyed into a general repository, which supplies the vat from which the sheets of paper are formed. This vat is made of wood; and generally about five feet in diameter, and two and a half in depth. It is kept in temperature by means of a grate introduced by a hole, and surrounded on the inside of the vat with a case of copper. For fuel to this grate, they use charcoal or wood; and frequently, to prevent smoke, the wall of the building comes in contact with one part of the vat, and the fire has no communication with the place where they make the paper.

Every vat is furnished on the upper part with planks inclosed inwards, and even railed in with wood, to prevent any of the stuff from running over in the operation. Across the vat is a plank which they call the trepan, pierced with holes at one of the extremities, and resting on the planks which surround the vat.

The forms or moulds are composed of wire cloth, and a moveable frame. It is with these that they fetch up the stuff from the vat, in order to form the sheets of paper. The sides of the form are made of oak, which is previously steeped in water, and otherwise prepared to prevent warping. The wire cloth is made larger than the sheet of paper, and the excess of it on all sides is covered with a moveable frame. This frame is necessary to retain the stuff of which the paper is made on the cloth; and it must be exactly adapted to the form, otherwise the edges of the paper will be ragged and badly finished. The wire cloth of the form is varied in proportion to the fineness of the paper and the nature of the stuff.

The felts are pieces of woollen cloth spread over every sheet of paper, and upon which the sheets are laid to detach them from the form, to prevent them from adhering together, to imbibe part of the water with which the stuff is charged, and to transmit the whole of it when placed under the action of the press. The two sides of the felt are differently raised: that of which the hair is longest is applied to the sheets which are laid down; and any alteration of this disposition would produce a change in the texture of the paper. The stuff of which the felts are made should be sufficiently strong, in order that it may be stretched exactly on the sheets without forming into folds; and, at the same time, sufficiently pliant to yield in every direction without injury to the wet paper. As the felts have to resist the reiterated efforts of the press, it appears necessary that the warp be very strong, of combed wool, and well twisted. On the other hand, as they have to imbibe a certain quantity of water, and to return it, it is necessary that the woof be of carded wool, and drawn out into a slack thread. These are the utensils, together with the press, which are used in the apartment where the sheets of paper are formed.

The vat being furnished with a sufficient quantity of stuff and of water, two instruments are employed to mix them; the one of which is a simple pole, and the other a pole armed with a piece of board, rounded and full of holes. This operation is repeated as often as the stuff falls to the bottom. In the principal writing-mills in England, they use for this purpose what is called a hog; which is a machine within the vat, that, by means of a small wheel on the outside, is made to turn constantly round, and keep the stuff in perpetual motion. When the stuff and water are properly mixed, it is easy to perceive whether the previous operations have been complete. When the stuff floats close, and in regular flakes, it is a proof that it has been well triturated; and the parts of the rags which have escaped the rollers also appear.

After this operation the workman takes one of the forms, furnished with its frame, by the middle of the short sides; and fixing the frame round the wire cloth with his thumbs, he plunges it obliquely four or five inches into the vat, beginning by the long side, which is nearest to him. After the immersion he raises it to a level: by these movements he fetches up on the form a sufficient quantity of stuff; and as soon as the form is raised, the water escapes through the wire cloth, and the superfluity of the stuff over the sides of the frame. The fibrous parts of the stuff arrange themselves regularly on the wire-cloth of the form, not only in proportion as the water escapes, but also as the workman favours this effect by gently shaking the form. Afterwards, having placed the form on a piece of board, the workman takes off the frame or deckle, and glides this form towards the coucher; who, having previously laid his felt, places it with his left hand in an inclined situation, on a plank fixed on the edge of the vat, and full of holes. During this operation the workman applies his frame, and begins a second sheet. The coucher seizes this instant, takes with his left hand the form, now sufficiently dry, and, having laid the sheet of paper upon the felt, returns the form by gliding it along the trepan of the vat.

They proceed in this manner, laying alternately a sheet and a felt, till they have made six quires of paper, which is called a post: and this they do with such swiftness, that, in many sorts of paper, two men make upwards of twenty posts in a day. When the last sheet of the post is covered with the last felt, the workmen about the vat unite together, and submit the whole heap to the action of the press. They begin at first to press it with a middling lever, and afterwards with a lever about fifteen feet in length. After this operation, another person separates the sheets of paper from the felts, laying them in a heap; and several of these heaps collected together are again put under the press.

The stuff which forms a sheet of paper is received, as we have already said, on a form made of wire cloth, which is more or less fine in proportion to the stuff, and surrounded with a wooden frame, and supported in the middle by many cross bars of wood. In consequence of this construction, it is easy to perceive, that the sheet of paper will take and preserve the impressions of all the pieces which compose the form, and of the empty spaces between them.

The traces of the wire cloth are evidently perceived on the side of the sheet which was attached to the form, and on the opposite side they form an assemblage of parallel and rounded risings. As in the paper which is most highly finished, the regularity of these impressions is still visible, it is evident that all the operations to which it is submitted have chiefly in view to soften these impressions without destroying them. It is of consequence, therefore, to attend to the combination of labour which operates on these impressions. The coucher, in turning the form on the felt, flattens a little the rounded eminences which are in relievo on one of the surfaces, and occasions at the same time the hollow places made by the wire cloth to be partly filled up. Meanwhile, the effort which is made in detaching the form, produces an infinite number of small hairs on every protuberant part of the sheet.

Under the action of the press, first with the felts and then without them, the perfecting of the grain of paper still goes on. The vestiges of the protuberances made by the wires are altogether flattened, and of consequence the hollows opposite to them disappear also; but the traces formed by the interstices of the wire, in consequence of their thickness, appear on both sides, and are rounded by the press.

The risings traced on each side of the paper, and which can be discovered by the eye on that which is most highly finished, form what is called the grain of paper. The different operations ought to soften, but not destroy it; which is effectually done by employing the hammer. This grain appears in the Dutch paper; which is a sufficient proof that though they have brought this part of the art to the greatest perfection, they have not employed hammers, but more simple and ingenious means. The grain of paper is often disfigured by the felts when they are too much used, or when the wool does not cover the thread. In this case, when the paper is submitted to the press, it takes the additional traces of the warp and the woof, and composes a surface extremely irregular.

The paper the grain of which is highly softened, is much fitter for the purposes of writing than that which is smoothed by the hammer: on the other hand, a coarse and unequal grain very much opposes the movements of the pen; as that which is beat renders them very uncertain. The art of making paper, therefore, should consist in preserving, and at the same time in highly softening, the grain: the Dutch have carried this to the highest perfection.

The exchange succeeds the operation last described. It is conducted in a hall contiguous to the vat, supplied with several presses, and with a long table. The workman arranges on this table the paper, newly fabricated, into heaps; each heap containing eight or ten of those last under the press, kept separate by a woollen felt. The press is large enough to receive two of them at once, placed the one at the other's side. When the compression is judged sufficient, the heaps of paper are carried back to the table, and the whole turned sheet by sheet, in such a manner that the surface of every sheet is exposed to a new one; and in this situation they are again brought under the press. It is in conducting these two operations sometimes to four or five times, or as often as the nature of the paper requires, that the perfection of the Dutch plan consists. If the stuff is fine, or the paper slender, the exchange is less frequently repeated. In this operation it is necessary to alter the situation of the heaps, with regard to one another, every time they are put under the press; and also, as the heaps are highest toward the middle, to place small pieces of felt at the extremities, in order to bring every part of them under an equal pressure. A single man with four or five presses may exchange all the paper produced by two vats, provided the previous pressing at the vats is well performed. The work of the exchange generally lasts about two days on a given quantity of paper.

When the paper has undergone these operations, it is not only softened in the surface, but better felted, and rendered more pliant in the interior parts of the stuff. In short, a great part of the water which it had imbibed in the operation of the vat is dissipated. By the felting of paper is understood the approximation of the fibres of the stuff, and their adhering more closely together. The paper is felted in proportion as the water escapes, and this effect is produced by the management and reiterated action of the press. Was it not for the gradual operation of the press, the paper would be porous, and composed of filaments adhering closely together. The superiority of the Dutch over the French paper, depends almost entirely on this operation.

If the sheets of paper are found to adhere together, it is a proof that the business of the press has been badly conducted. To avoid this inconveniency, it is necessary to bring down the press at first gently, and by degrees with greater force, and to raise it as suddenly as possible. By this means the water, which is impelled to the sides of the heaps, and which has not yet escaped, returns to the centre; the sheets are equally dry, and the operation is executed without difficulty.

According to the state of dryness in which the paper is found when it comes from the apartment of the vat, it is either pressed before or after the first exchange. The operation of the press should be reiterated, and managed with great care; otherwise, in the soft state of the paper, there is a danger that its grain and transparency are totally destroyed. Another essential principle to the success of the exchange is, that the grain of the paper is originally well raised. For this purpose the wire cloth of the Dutch forms is is composed of a rounder wire than that used in France, by which they gain the greatest degree of transparency, and are in no danger of destroying the grain. Besides this, the Dutch take care to proportion the wires even where the forms are equal to the thickness of the paper.

Almost every kind of paper is considerably improved by the exchange, and receives a degree of perfection which renders it more agreeable in the use. But it is necessary to observe at the same time, that all papers are not equally susceptible of this melioration; on the contrary, if the stuff is unequal, dry, or weakened by the destruction of the fine parts, it acquires nothing of that lustre and softness, and appearance of velvet, which the exchange gives to stuff properly prepared.

The sheds for drying the paper are in the neighbourhood of the paper-mill, and are furnished with a vast number of cords, on which they hang the sheets both before and after the sizing. The sheds are surrounded with moveable lattices, to admit a quantity of air sufficient for drying the paper. The cords of the shed are stretched as much as possible; and the paper, four or five sheets of it together, is placed on them by means of a wooden instrument resembling a pick-axe. The principal difficulty in drying the paper consists in gradually admitting the external air, and in preventing the cords from imbibing moisture. With regard to the first of these, the Dutch use very low sheds, and construct their lattices with great exactness. By this means the Dutch paper is dried equally, and is extremely supple before the sizing. They prevent the cords from imbibing the water by covering them with wax. In using such cords, the moisture does not continue in the line of contact between the paper and the cord, which prevents the sheet from stretching in that particular place by its weight, and from the folds which the moisture in the subsequent operations might occasion. The Dutch also employ cords of considerable thickness, and place fewer of them under the sheets; by which means they diminish the points of contact, and give a freer and more equal circulation to the air.

The size for paper is made of the shreds and parings got from tanners, curriers, and parchment-makers. All the putrefied parts and the lime are carefully separated from them, and they are inclosed into a kind of basket, and let down by a rope and pulley into the cauldron. This is a late invention, and serves two valuable purposes. It makes it easy to draw out the pieces of leather when the size is extracted from them by boiling, or easy to return them into the boiler if the operation is not complete. When the substance is sufficiently extracted, it is allowed to settle for some time; and it is twice filtred before it is put into the vessel into which they dip the paper.

Immediately before the operation, a certain quantity of alum is added to the size. The workman takes a handful of the sheets, smoothed and rendered as supple as possible, in his left hand, dips them into the vessel, and holds them separate with his right, that they may equally imbibe the size. After holding them above the vessel for a short space of time, he seizes on the other side with his right hand, and again dips them into the vessel. When he has finished ten or a dozen of these handfuls, they are submitted to the action of the press. The superfluous size is carried back to the vessel by means of a small pipe. The vessel in which the paper is sized is made of copper, and furnished with a grate, to give the size when necessary a due temperature; and a piece of thin board or felt is placed between every handful as they are laid on the table of the press.

The Dutch are very careful in sizing their paper, to have every sheet in the same handful of equal dryness; because it is found that the dry sheets imbibe the size more slowly than those which retain some degree of moisture. They begin by selecting the padges in the drying-house; and after having made them supple, and having destroyed the adherence between the sheets, they separate them into handfuls in proportion to the dryness, each of them containing that number which they can dip at one time. Besides this precaution, they take care to apply two sheets of brown paper of an equal size to every handful. This brown paper, firm, solid, and already sized, is of use to support the sheets.

As soon as the paper is sized, it is the practice at some paper-mills to carry it immediately to the drying-house, and hang it before it cools, sheet by sheet, on the cords. The paper, unless particular attention is paid to the lattices of the drying-house, is apt to dry too fast, whereby a great part of the size goes off in evaporation; or, if too slow, it falls to the ground. The Dutch drying-houses are the best to prevent these inconveniences: but the exchange after the sizing, which is generally practised in Holland, is the best remedy. They begin this operation on the handfuls of paper, either while they are still hot, or otherwise as they find it convenient. But, after the exchange, they are careful to allow the heaps to be altogether cold before they are submitted to the press. Without this precaution, the size would either be wholly squeezed out by the press of the exchange, or the surface of the paper become very irregular. It is of consequence that the paper, still warm from the sizing, grows gradually firm, under the operation of the exchange, in proportion as it cools. By this method it receives that varnish which is afterwards brought to perfection under the press, and in which the excellence of the paper either for writing or drawing chiefly consists. It is in consequence of the exchanging and pressing that the Dutch paper is soft and equal; and that the size penetrates into the body of it, and is extended equally over its surface.

The exchange after the sizing ought to be conducted with the greatest skill and attention, because the grain of the paper then receives impressions which can never be eradicated. When the sized paper is also exchanged, it is possible to hang more sheets together on the cords of the drying-house. The paper dries better in this condition, and the size is preserved without any sensible waste, because the sheets of paper mutually prevent the rapid operation of the external air. And as the size has already penetrated into the paper, and is fixed on the surface, the insensible progress of a well-conducted drying-house renders all the good effects more perfect in proportion as it is slowly dried.

If to these considerations is added the damage done to the paper in drying it immediately after the press of the sizing-room, whether it is done in raising the hairs by separating the sheets, or in cracking the surface, it is evident that the trouble of the second exchange is infinitely overpaid by the advantage.

When the paper is sufficiently dry, it is carried to the finishing-room, where it is pressed, selected, examined, folded, made up into quires, and finally into reams. It is here put twice under the press; first, when it is at its full size, and secondly, after it is folded.

The principal labour of this place consists in assorting the paper into different lots, according to its quality and faults; after which it is made up into quires. The person who does this must possess great skill, and be capable of great attention, because he acts as a check on those who separated the paper into different lots. He takes the sheets with his right hand, folds them, examines them, lays them over his left arm till he has the number requisite for a quire, brings the sides parallel to one another, and places them in heaps under the table. An expert workman, if proper care has been taken in assorting the lots, will finish in this manner near 6000 quires in a day.

The paper is afterwards collected into reams of 20 quires each, and for the last time put under the press, where it is continued for 10 or 12 hours, or as long as the demand of the paper-mill permits. We shall explain the structure of one of the best paper-mills now in use.

Plate Paper Mill, &c. figs. 1, 2, 3, explains the construction of an engine paper-mill. ABDE, fig 3, is a large vat of wood, lined with lead; on each side of it are bolted two pieces of wood, F,G; the piece E has a strong lever H jointed to it; the other end of this lever enters a mortise in the piece F, and has a screw fastened to it, which comes up through the top of the piece, where a nut *a* is put on it, by turning which the lever can be raised or lowered at pleasure. In the middle of each of the levers HH, is fixed a brass socket, in which the spindle of the cylinder I lies; and on the outer end of this spindle is fixed a pinion K, working into other cog wheels, connecting with the water-wheel, steam-engine, &c. which gives it motion. The cylinder is made of wood, and has a great number of steel cutters fixed into it, parallel to the axis. These cutters act against a similar set fixed into a block of wood L, fig. 2; this block goes through a hole in the side of the vat, and is kept in tight by a wedge, so that when the wedge is knocked out, the block can be taken out to sharpen the cutters: the ends of the cylinder work very close between the side of the vat, and a partition N in the middle of the vat, so that none of the rags can get through between them: the bottom of the vat is raised up at M, fig. 3. to the same lever with the axis of the cylinder, goes as near to its circumference as possible without touching, and then suddenly falls down to the block L. At the back of the vat a small leaden cistern O connects with it; through a hair sieve P is a crooked pipe, which brings clean water to the vat; the end of this pipe has a flannel bag tied over it, to catch any impurities which may be in the water.

Fig. 1. is a box which is put over the cylinder, and rests upon the edge of the vat, and the partition N; at each edge of this box is fixed a trough *bd*; when the box is put in its place, these connect with the top of the leaden pipes *ef*, fig. 3. on the side of the vat: on the edge of these troughs hair sieves *gg* are fixed; and before these boards, one of which is shewn at *h*, are slid in grooves in the sides of the box. The operation of the machine is as follows: The vat is filled with clean water, the box fig. 2. is put over the cylinder, and a quantity of rags is put into the vat. The cylinder being turned round with a velocity of 120 revolutions per minute in the direction of the arrow in fig. 2. draws the rags in between the cutters in the cylinder and the block L, and tears them to pieces; from the cylinder they go forwards into the vat, and turn slowly round in it till they come under the cylinder again. The great velocity of the cylinder throws the rags and water up against the sieves *g* in the box fig. 1.; the foul water runs through the sieve into the trough *bd*, and from thence into the pipes (*ef*), which convey it away, and the clean water is brought to the vat by the pipe P; when the foul water is wanted to be kept in

the boards are slid down before the sieve, as at *h*, fig. 1. which prevents the water going through the sieves. In larger mills two different engines are used; that into which the rags are first put is like fig. 3; the other one which is used to finish the rags is similar to it, but has much finer cutters, and the cylinder is let down much nearer the block L by the screw *a*.

The lower compartment of Plate Paper-making, represents one of the tables used in the manufactories in and near London, for printing the paper used for the hangings of rooms. A, is a square water-tight box, called the sieve, mounted upon legs; this box is about ¼ filled with water, mixed with paper-shavings, &c. and then another box B is put into it, so that it floats on the water; the bottom of this box is of parchment, and a frame covered with a piece of felt is laid upon it; the table D, where the printing is performed, has two pieces of wood *a* fixed upright in it; these have notches in them to receive the ends of a brass wire, which is put through the middle of the roll of paper *d*; the paper from this roll goes over the edge of the table, and is laid upon a horse, fig. 5. which has a roller on its top for the paper to lie on. On one part of the horse a number of small sticks *e*, a little longer than the width of the paper, are laid. The operation is conducted as follows: the workman takes a roll of paper (each of which is 12 yards long, and 22 inches wide) from the shelf F, under the table, and puts a brass wire through it, and lays its ends in the pieces *a*, as shewn in the figure 4.; he then pulls the end of the paper to the end of the table. In the mean time a boy, called the tier boy, who stands on the stool E, brushes the felt which lies in the sieve B over with the colour used in the printing; the workman then takes up the block (in which the device to be printed is cut as in wood cuts), by putting his hand through the strap nailed to the back of it, and presses its face upon the felt in the colour-sieve B: the water which is under causes the felt to touch the block in every part, and take colour equally over the surface of the block: he then removes the block, and lays it upon the paper near the end of the table; and takes up a mallet with a leaden head, called the mall, which has a small shelf *h*, in his right hand, and gives the block two blows on the back of it, to make the impression. He then puts down the mall, and lifts up the block (which his left hand never quitted), and turns round to take colour at the sieve: as he turns round to bring the block over the paper again, he takes hold of the edge of the paper with his right hand, and pulls it forward the proper distance to print again; in laying the block down, he guides it to its place with his right hand, and when it is laid he takes up the mall as before. In this manner he proceeds till the end of the paper touches the ground; the tier boy then goes and puts it over the horse, fig. 5. and returns to the sieve. When the middle of the paper nearly touches the ground, he goes again to the end of the paper, and pulls it straight over the horse, and lays it on the ground as in the figure. This operation he repeats as often as is necessary, till the pieces are finished: he then takes the poll, fig. 6. from the ground, and puts one of the sticks *e*, fig. 5. into the groove across its top. He then puts the paper on the sticks, and lifts them all together to the ceiling of the room, where he lodges the ends of the sticks upon a rack made for the purpose: he then takes down the pole, and puts up another stick in a different part, so as to hang up all the pieces in two or three loops to dry. In those prints which are very full, or in which there is much colour to lay on, the mall is not sufficient to give the impression: a lever is then used instead. Two of the legs of the table MN project some inches above it; between these, two bars P are bolted, the middle of which is strengthened by an upright post Q, whose end is fastened to the ceiling. The shelf *h* has a piece *m* put into it; the workman takes his colour, and places the block on the paper as before; but instead of taking the mall from the shelf *h*, he places the middle of the lever (the end of which was under the bar P, and the middle resting on the piece *m*) over the block, and presses his weight upon the outer end of the lever, which gives the impression: he then lifts up the lever, slides his right hand to the middle of it (keeping his left at the outer end), and returns the lever on to the piece *m*, then lifts up the block to take colour as before.

Paper, *Marbled*. See Marbling.

Paper-Office, an office in which all the public writings, matters of state and council, proclamations, letters, intelligences, negotiations abroad, and generally all dispatches that pass through the offices of the secretaries of state, are lodged, by way of library.

Paper-Office is also an office belonging to the court of king's bench.

PAPIER MACHE', is a substance made of cuttings of white or brown paper, boiled in water, and beaten in a mortar till they are reduced into a kind of paste; and then boiled with a solution of gum arabic or of size, to give tenacity to the paste, which is afterwards formed into different toys, &c. by pressing it into oiled moulds. When dry, it is covered with a mixture of size and lamp-black, and afterwards varnished.

PAPILIO, *butterfly*, a genus of insects of the order lepidoptera. The generic character is, antennæ thickening towards the extremity, commonly terminating in a knob or clavated tip; wings (when sitting) erect, and meeting upwards; flight diurnal.

The prodigious number of species, amounting to many hundreds, in this genus, renders it absolutely necessary to divide the whole into sections or sets, instituted from the habit or general appearance, and, in some degree, from the distribution of the colour on the wings. This division of the genus is conducted by Linnæus in a peculiarly elegant and instructive manner, being an attempt to combine, in some degree, natural and civil history, by attaching the memory of some illustrious antient name to an insect of a certain particular cast.

The first Linnæan division consists of the equites, distinguished by the shape of their upper wings, which are longer, if measured from their hinder angle to their anterior extremity, than from the same point to the base. Some of this division have filiform or sharpened antennæ, in which particular they resemble moths, but may generally be very clearly distinguished by their habit or general shape. The equites are either Troes (or Trojans), distinguished by having red or blood-coloured spots or patches on each side their breasts; or Achivi, Greeks, without red marks on the breast, of gayer colours in general than the former, and often having an eye-shaped spot at the inner corner of the lower wings.

The next division consists of the Heliconii. These are distinguished by the narrowness of their wings, which are also, in general, of a more transparent appearance than in the other divisions; their upper wings are also generally much more oblong than the lower, which are short in proportion.

The third division consists of the Danai, (from the sons and daughters of Danaus.) They are divided into danai candidi, or those in which the ground-colour of the wings is generally white; and the danai festivi, in which the ground-colour is never white, and in which a greater variety of colour occurs than in the candidi. The wings of the danai are of a somewhat rounder shape than those of the heliconii, or less stretched out.

The fourth section consists of the nymphales, and is distinguished by the edges of the wings being scolloped or indented: it is subdivided into the nymphales gemmati, in which eye-shaped spots are seen either on all the wings, or on the upper or lower pair only; and into the nymphales phalerati, in which no ocellated spots are visible on the wings, but, in general, a great variety of colours.

The fifth section contains the plebeii. These are, in general, smaller than the preceding kinds of butterflies: and are subdivided into plebeii urbicolæ, or those in which the wings are marked by semitransparent spots; and plebeii rurales, in which the spots or patches have no transparency.

The larvæ of butterflies are universally and emphatically known by the name of caterpillars, and are extremely various in their forms and colours, some being smooth, others beset with simple or ramified spines, &c. and some, especially those belonging to the division equites, are observed to protrude from their front, when disturbed, a pair of short tentacula or feelers, somewhat analogous to those of a snail.

The papilionaceous insects in general, soon after their enlargement from the chrysalis, and commonly during their first flight, discharge some drops of a red-coloured fluid, more or less intense in different species. This circumstance, exclusive of its analogy to the same process of nature in other animals, is peculiarly worthy of attention from the explanation which it affords of a phenomenon sometimes considered, both in antient and modern times, in the light of a prodigy; viz. the descent of red drops from the air; which has been called a shower of blood: an event recorded by several writers among the prodigies which took place after the death of the great dictator.

Among the equites troes, the papilio priamus should take the lead, not only from the corresponding dignity of the name, but from the exquisite appearance of the animal itself, which Linnæus considered as the most beautiful of the whole papilionaceous tribe.

This admirable species measures more than six inches from wing's end to wing's end: the upper wings are velvet-black, with a broad band of the most beautiful grass-green, and of a satiny lustre, drawn from the shoulder to the tip; and another on the lower part of the wing, following the shape of that part, and of a somewhat undulating appearance as it approaches the tip: the lower wings are of the same green colour, edged with velvet-black, and marked by four spots of that colour; while at the upper part of each, or at the part where the upper wings lap over, is a squarish orange-coloured spot: the thorax is black, with sprinklings of lucid green in the middle, and the abdomen is of a bright yellow, or gold-colour. On the under side of the animal the distribution of colours is somewhat different, the green being disposed in central patches on the upper wings, and the lower being marked by more numerous black as well as orange spots. The red or bloody spots on each side the thorax are not always to be seen on this the Trojan monarch. The papilio priamus is a very rare insect, and is a native of the island of Amboyna.

P. hector is very happily named, being of a deep or velvet-black colour, with the lower wings marked by numerous blood-red spots: the thorax is red on each side, and the upper wings have a pair of obscure, broken, whitish, transverse clouds or bars. It is a native of the East Indies. See Plate Nat. Hist. fig. 313.

Among the equites achivi, the P. menelaus may be considered as one of the most splendidly beautiful of the butterfly tribe. Its size is large, measuring, when expanded, about six inches; and its colour is the most brilliant silver-blue that imagination can conceive: changing, according to the variation of the light, into a deeper blue, and in some lights to a greenish cast: on the under side it is entirely brown, with numerous deeper and lighter undulations, and three large ocellated spots on each wing. It is a native of South America.

The P. machaon is an insect of great beauty, and may be considered as the only British species of papilio belonging to the tribe of equites.* It is commonly known among the English collectors by the title of the swallow-tailed butterfly, and is of a beautiful yellow, with black spots or patches along the upper edge of the superior wings: all the wings are bordered with a deep edging of black, decorated by a double row of crescent-shaped spots, of which the upper row is blue, and the lower yellow: the under wings are tailed, and are marked at the inner angle or tip with a round red spot bordered with blue and black. The caterpillar of this species feeds principally on fennel and other umbelliferous plants, and is sometimes found on rue. It is of a green colour, encircled with numerous black bands spotted with red, and is furnished on the top of the head with a pair of short tentacula of a red colour, which it occasionally protrudes from that part. In the month of July it changes into a yellowish-grey angular chrysalis, affixed to some convenient part of the plant, or other neighbouring substance, and from this chrysalis in the month of August proceeds the complete insect.

Of the division called heliconii the beautiful insect the papilio apollo is an example. It is a native of many parts of Europe, but has not yet been observed in our own country, and is somewhat larger than the common great cabbage-butterfly; of a white colour, with a slight semitransparency towards the tips of the wings, which are decorated with velvet-black spots; and on each of the lower wings are two most beautiful ocellated spots, consisting of a carmine-coloured circle with a white centre and black exterior border.

Of the division entitled danai candidi, the common large white butterfly, or P. brassica, is a familiar example: this insect is too well known to require particular description, and it may be only necessary to remind the reader that it proceeds from a yellowish caterpillar, freckled with blueish and black spots, and which changes during the autumn into a yellowish-grey chrysalis, affixed in a perpendicular direction to some wall, tree, or other object, some filaments being drawn across the thorax in order the more conveniently to secure its position. The fly appears in May and June, and is seen through all the summer.

Of the danai festivi the P. midamus may serve as an example; an elegant Asiatic species, of a black colour, with a varying blue lustre towards the tips of the upper wings, which are marked by many white spots, while the lower pair are streaked longitudinally with numerous white lines, and edged with a row of white specks.

Among the nymphales gemmati few can exceed in elegance the P. io, or peacock butterfly, a species by no means uncommon in our own country: the ground-colour of this insect is orange-brown, with black bars separated by yellow intermediate spaces on the upper edge of the superior wings, while at the tip of each is a most beautiful large eye-shaped spot, formed by a combination of black, brown, and blue, with the addition of whitish specks: on each of the lower wings is a still larger eye-shaped spot, consisting of a black central patch, varied with blue, and surrounded by a zone of pale brown, which is itself deeply bordered with black: all the wings are scolloped or denticulated. The caterpillar is black, with numerous white spots, and black ramified spines: it feeds principally on the nettle, changing to chrysalis in July, and the fly appearing in August.

P. jurtina is a species equally common, though far less beautiful. It is chiefly observed in meadows, and is of a brown colour, the upper wings having a much brighter or orange-ferruginous bar towards the tips, with a small, black, eye-shaped spot with a white centre: on the opposite or under side of the insect the same distribution of colours takes place.

Of the nymphales phalerati, few can surpass the common English species called P. atalanta, or the admirable butterfly: it is of the most intense velvet-black colour, with a rich carmine-coloured bar across the upper wings, which are spotted towards the tips with white; while the lower wings are black, with a deep border of carmine colour marked by a row of small black spots: the under surface of the wings also presents a most beautiful mixture of colours: the caterpillar is brown and spiny, feeds on nettles, and changes into a chrysalis in July, the fly appearing in August.

Of the last division, termed plebeii, may be adduced as an example a small English butterfly called P. malvæ, of a blackish or brown colour, with numerous whitish and semitransparent spots. It belongs to the plebeii urbicolæ.

To this division also belongs a very beautiful exotic species, a native of India, and of a most exquisite lucid blue colour, edged with black, and farther ornamented by having each of the lower wings tipped with two narrow black tail-shaped processes. It is the P. marsyas of Linnæus. See Plate Nat. Hist. figs. 311 and 313.

PAPISTS, persons professing the popish religion. By several statutes, if any English priest of the church of Rome, born in the dominions of the crown of England, came to England from beyond the seas, or tarried in England three days without conforming to the church, he was guilty of high treason; and they also incurred the guilt of high treason who were reconciled to the see of Rome, or procured others to be reconciled to it. By these laws also, papists were disabled from giving their children any education in their own religion. If they educated their children at home, for maintaining the schoolmaster, if he did not repair to church, or was not allowed by the bishop of the diocese, they were liable to forfeit 10*l.* a month, and the schoolmaster was liable to the forfeiture of 40*s.* a day: if they sent their children for education abroad, they were liable to forfeit 100*l.* and the children so sent were incapable of inheriting, purchasing, or enjoying, any lands, profits, goods, debts, legacies, or sums of money: saying mass was punishable by a forfeiture of 200 marks; and hearing it by a forfeiture of 100*l.*

But during the present reign the Roman Catholics have been in a great measure relieved from the restrictions formerly imposed on them. See 18 Geo. III. c. 60; and 31 Geo. III. c. 22.

PAPOPHORUM, a genus of the class and order triandria digynia. The calyx is two-valved, two-flowered; corolla two-valved, many-awned. There is one species, a grass of America.

PAPPUS, *down*. See BOTANY.

PAR, in commerce. See EXCHANGE.

PARABOLA, in geometry, a figure arising from the section of a cone, when cut by a plane parallel to one of its sides. See CONIC SECTIONS.

PARABOLIC CONOID, in geometry, a solid generated by the rotation of a parabola about its axis: its solidity is $= \frac{1}{2}$ of that of its circumscribing cylinder.

The circles conceived to be the elements of this figure, are in arithmetical proportion, decreasing towards the vertex.

A parabolic conoid is to a cylinder of the same base and height, as 1 to 2; and to a cone of the same base and height, as $1\frac{1}{2}$ to 1. See GAUGING.

PARABOLIC SPACE, the area contained between any entire ordinate and the curve of the incumbent parabola.

The parabolic space is to the rectangle of the semi-ordinate into the absciss, as 2 to 3; to a triangle inscribed on the ordinate as a base, it is as 4 to 3.

PARABOLOIDES, a name given to parabolas of the higher kind, which are algebraic curves.

PARACENTRIC MOTION, in astro-

* Unless we admit the papilio podalirius to be a British species also.

nomy, denotes so much as a revolving planet approaches nearer to, or recedes from, the sun, or centre of attraction.

PARADISE, *bird of*. See PARADISEA.

PARADISEA, in ornithology, a genus of birds belonging to the order of picæ. The beak is covered with a belt or collar of downy feathers at the base, and the feathers on the sides are very long.

"Birds of this genus (says Latham) have the bill slightly bending, the base covered with velvet-like feathers. The nostrils are small, and concealed by the feathers. The tail consists of ten feathers; the two middle ones, and sometimes more in several of the species, are very long, and webbed only at the base and tips. The legs and feet are very large and strong: they have three toes forward, one backward, and the middle connected to the outer one as far as the first joint. The whole of this genus have till lately been very imperfectly known; few cabinets possessing more than one species, viz. the greater, or what is called the common bird of Paradise; nor has any set of birds given rise to more fables, the various tales concerning which are to be found in every author; such as, their never touching the ground from their birth to death; living wholly on the dew; and being produced without legs. This last error is scarcely at this moment wholly eradicated. The circumstance which gave rise to it did not indeed at first proceed from an intention to deceive, but merely from accident. In the parts of the world which produce these birds, the natives made use of them as aigrets, and other ornaments of dress; and in course threw away the less brilliant parts. The whole trouble they were at on this occasion was merely to skin the bird, and, after pulling off the legs, coarser parts of the wings, &c. thrust a stick down the throat into the body, letting an inch or two hang out of the mouth, beyond the bill: on the bird's drying, the skin collapsed about the stick, which became fixed, and supported the whole. They had then no more to do than to put this end of it into a socket fitted to receive it, or fasten it in some manner to the turban, &c. By degrees these were imported into the other isles for the same uses, and afterwards were coveted by the Japanese, Chinese, and Persians, in whose countries they are frequently seen, as well as in many parts of India; the grandees of these last parts not only ornamenting themselves with these beautiful plumes, but adorning even their horses with the same."

Latham enumerates eight species, but suspects there may be more.

1. The largest bird of paradise is commonly two feet four inches in length; the head is small; the bill hard and long, of a pale colour. The head and back part of the neck are lemon-coloured, a little black about the eyes; about the neck the bird is of the brightest glossy emerald-green, soft like velvet, as is also the breast, which is black: the wings are large and chesnut-coloured: the back part of the body is covered with long, straight, narrow feathers, of a pale-brown colour, similar to the plumes of the ostrich. These feathers are spread when the bird is on the wing; for which reason he can keep very long in the air. On both sides of the belly are two tufts of stiff and shorter feathers, of a golden yellow, and shining. From the rump proceed two long stiff shafts, which are feathered on their extremities.

These birds are not found in Key, an island 50 Dutch miles east of Banda; but they are found at the Aroo islands, lying 15 Dutch miles farther east than Key, during the westerly or dry monsoon; and they return to New Guinea as soon as the easterly or wet monsoon sets in. They come always in a flock of 30 or 40, and are led by a bird which the inhabitants of Aroo call the king. This leader is black, with red spots; and constantly flies higher than the rest of the flock, which never forsake him, but settle when he settles; a circumstance that frequently proves their ruin when the king lights on the ground, whence they are not able to rise on account of the singular structure and disposition of their plumage. They are likewise unable to fly with the wind, which would ruin their loose plumage; but take their flight constantly against it, cautious not to venture out in hard-blowing weather, as a strong wind frequently obliges them to come to the ground. During their flight, they cry like starlings. Their note, however, approaches more to the croaking of ravens; which is heard very plainly when they are in distress from a fresh gale blowing on the back of their plumage. In Aroo, these birds settle on the highest trees, especially on the ficus benjamina of the hortus malabaricus, commonly called the waringa tree. The natives catch them with birdlime or in nooses, or shoot them with blunt arrows; but though some are still alive when they fall into their hands, the catchers kill them immediately, and sometimes cut the legs off; then they draw out the entrails, dry and fumigate the bodies with sulphur or smoke only, and sell them at Banda for half a rixdollar each; but at Aroo they may be bought for a spike-nail, or a piece of old iron. Flocks of these birds are often seen flying from one island to the other against the wind. In case they find the wind become too powerful, they fly straight up into the air, till they come to a place where it is less agitated, and then continue their flight. During the eastern monsoon, their tails are moulted, so that they have them only during four months of the western monsoon. See Plate Nat. Hist. fig. 315.

2. The smaller bird of Paradise is about 20 inches long. His beak is lead-coloured, and paler at the point. The eyes are small, and inclosed in black about the neck. The head and back of the neck are of a dirty yellow, the back of a greyish yellow, the breast and belly of a dusky colour, the wings small and chesnut-coloured. The long plumage is about a foot in length, and paler than in the large species; as in general the colours of this bird are less bright than the former. The two long feathers of the tail are constantly thrown away by the natives. This is in all respects like the greater sort; and they likewise follow a king or leader, who is, however, blacker, with a purplish cast, and finer in colour than the rest.

3 and 4. The large black bird of Paradise is brought without wings or legs for sale; so that no accurate description of it has yet been given. Its figure, when stuffed, is narrow and round, but stretched in length to the extent of four spans. The plumage on the head, neck, and belly, is black and velvet-like, with a hue of purple and gold, which appears very strong. The bill is blackish, and one inch in length. On both sides are two bunches of feathers, which have the appearance of wings, although they are very different, the wings being cut off by the natives. This plumage is soft, broad, similar to peacocks' feathers, with a greenish hue. Birds of this kind are brought only from one particular place of New Guinea. Besides the large black bird of Paradise, there is still another sort, whose plumage is equal in length, but thinner in body, black above, and without any remarkable gloss, not having those shining peacock-feathers which are found on the greater species. This wants likewise the three long-pointed feathers of the tail belonging to the larger black species.

5. The last species we shall mention is the king's bird. This creature is about seven inches long, and somewhat larger than a titmouse. Its head and eyes are small, the bill straight, the eyes included in circles of black plumage, the crown of the head is flame-coloured, the back of the neck blood-coloured, the neck and breast of a chesnut-colour with a ring of the brightest emerald-green. Its wings are in proportion strong, and the quill-feathers dark, with red shining plumes, spots, and stripes. The tail is straight, short, and brown. Two long naked black shafts project from the rump, at least a hand-breadth beyond the tail, having at their extremities semilunar twisted plumage, of the most glaring green colour above, and dusky below. The belly is white and green sprinkled; and on each side is a tuft of long plumage, feathered with a broad margin, being on one side green and on the other dusky. The back is blood-red and brown, shining like silk. The legs are in size like those of a lark, three fore-toes and one back-toe. This bird associates not with any of the other birds of Paradise; but flits solitary from bush to bush, wherever he sees red berries, without ever getting on tall trees.

PARADOX, in philosophy, a proposition seemingly absurd, as being contrary to some received opinion, but yet true in fact.

No science abounds more with paradoxes than geometry: thus, that a right line should continually approach to the hyperbola, and yet never reach it, is a true paradox; and in the same manner, a spiral may continually approach to a point, and yet not reach it, in any number of revolutions, however great.

PARALLACTIC, in general, something relating to the parallax of heavenly bodies. See PARALLAX.

The parallactic angle of a star, &c. is the difference of the angles CEA (Plate Miscell. fig. 179.), BTA, under which its true and apparent distance from the zenith is seen; or, which is the same thing, it is the angle TSE.

The sines of the parallactic angles ALT, AST (fig. 180.), at the same or equal distances, ZS, from the zenith, are in the reciprocal ratio of the distances TL and TS from the centre of the earth.

PARALLAX, in astronomy, denotes a change of the apparent place of any heavenly body, caused by being seen from different points of view; or it is the difference between the true and apparent distance of any heavenly body from the zenith.

Thus let AB (Plate Miscel. fig. 181.) be a quadrant of a great circle on the earth's surface, A the place of the spectator, and the point V in the heavens the vertex and zenith. Let VNH represent the starry firmament, AD the sensible horizon, in which suppose the star C to be seen, whose distance from the centre of the earth is TC. If this star was observed from the centre T, it would appear in the firmament in E, and elevated above the horizon by the arch DE: this point E is called the true place of the phænomenon or star. But an observer viewing it from the surface of the earth at A, will see it at D, which is called its visible or apparent place; and the arch DE, the distance between the true and visible place, is what astronomers call the parallax of the star, or other phænomena.

If the star rises higher above the horizon to M, its true place visible from the centre is P, and its apparent place N; whence its parallax will be the arch PN, which is less than the arch DE. The horizontal parallax, therefore, is the greatest; and the higher a star rises, the less is its parallax; and if it should come to the vertex or zenith, it would have no parallax at all: for when it is in Q, it is seen both from T and A in the same line TAV, and there is no difference between its true and apparent or visible place. Again, the farther a star is distant from the earth, so much the less is its parallax: thus the parallax of the star F is only GD, which is less than DE the parallax of C. Hence it is plain that the parallax is the difference of the distances of a star from the zenith when seen from the centre and from the surface of the earth: for the true distance of the star M from the zenith is the arch VP, and its apparent distance VN, the difference between which PN is the parallax.

These distances are measured by the angles VTM and VAM, but VAM — VTM = TMA. For the external angle VAM = ∠ ATM + ∠ AMT, the two inward and opposite angles; so that AMT measures the parallax, and upon that account is itself frequently called the parallax: and this is always the angle under which the semidiameter of the earth, AT, appears to an eye placed in the star; and therefore where this semidiameter is seen directly, there the parallax is greatest, viz. in the horizon. When the star rises higher, the sine of the parallax is always to the sine of the star's distance from the zenith, as the semidiameter of the earth to the distance of the star from the earth's centre: hence if the parallax of a star is known at any one distance from the zenith, we can find its parallax at any other distance.

If we have the distance of a star from the earth, we can easily find its parallax: for on the triangle TAC (fig. 181.) rectangular at A, having the semidiameter of the earth, and TC the distance of the star, the angle ACT, which is the horizontal parallax, is found by trigonometry; and, on the other hand, if we have this parallax, we can find the distance of the star; since in the same triangle, having AT, and the ∠ ACT, the distance TC may be easily found.

Astronomers, therefore, have invented several methods for finding the parallaxes of stars, in order thereby to discover their distances from the earth. However, the fixed stars are so remote as to have no sensible parallax; and even the sun, and all the primary planets, except Mars and Venus when in perigee, are at so great distances from the earth, that their parallax is too small to be observed. In the moon, indeed, the parallax is found to be very considerable, which in the horizon amounts to a degree or more, and may be found thus: In an eclipse of the moon, observe when both its horns are in the same vertical circle, and at that instant take the altitudes of both horns: the difference of these two altitudes being halved and added to the least, or subtracted from the greatest, gives nearly the visible or apparent altitude of the moon's centre; and the true altitude is nearly equal to the altitude of the centre of the shadow at that time. Now we know the altitude of the shadow, because we know the place of the sun in the ecliptic, and its depression under the horizon, which is equal to the altitude of the opposite point of the ecliptic in which is the centre of the shadow. And therefore having both the true altitude of the moon and the apparent altitude, the difference of these is the parallax required. But as the parallax of the moon increases as she approaches towards the earth, or the perigæum of her orbit, therefore astronomers have made tables, which shew the horizontal parallax for every degree of its anomaly.

The parallax always diminishes the altitude of a phænomenon, or makes it appear lower than it would do if viewed from the centre of the earth; and this change of the altitude may, according to the different situation of the ecliptic and equator in respect of the horizon of the spectator, cause a change of the latitude, longitude, declination, and right ascension of any phænomenon, which is called their parallax. The parallax, therefore, increases the right and oblique ascension; diminishes the descension; diminishes the northern declination and latitude in the eastern part, and increases them in the western; but increases the southern both in the eastern and western part; diminishes the longitude in the western part, and increases it in the eastern. Hence it appears, that the parallax has just opposite effects to refraction.

Parallax, *annual*, the change of the apparent place of a heavenly body, which is caused by being viewed from the earth in different parts of its orbit round the sun. The annual parallax of all the planets is found very considerable, but that of the fixed stars is imperceptible.

PARALLEL, in geometry, an appellation given to lines, surfaces, and bodies, every where equidistant from each other; and which, though infinitely produced, would never meet.

Parallel planes, are such planes as have all the perpendiculars drawn betwixt them equal to each other.

Parallel rays, in optics, are those which keep at an equal distance from the visible object to the eye, which is supposed to be infinitely remote from the object.

Parallel ruler, an instrument consisting of two wooden, brass, &c. rulers, equally broad every where; and so joined together by cross blades as to open to different intervals, accede and recede, and yet still retain their parallelism. See Instruments, *mathematical*.

The use of this instrument is obvious; for one of the rulers being applied to a given line, and the other withdrawn to a given point, a right line drawn by its edge through that point, is a parallel to the given line.

Parallels, or Parallel circles, in geography, called also parallels or circles of latitude, are lesser circles of the sphere conceived to be drawn from west to east, through all the points of the meridian, commencing from the equator to which they are parallel, and terminating with the poles. They are called parallels of latitude, because all places lying under the same parallel, have the same latitude.

Parallels *of latitude*, in astronomy, are lesser circles of the sphere parallel to the ecliptic, imagined to pass through every degree and minute of the colures. They are represented on the globe by the divisions on the quadrant of altitude, in its motion round the globe, when screwed over the pole of the ecliptic. See Globe.

Parallels *of altitude*, or Almucantars, are circles parallel to the horizon, imagined to pass through every degree and minute of the meridian between the horizon and zenith, having their poles in the zenith. They are represented on the globe by the divisions on the quadrant of altitude, in its motion about the body of the globe, when screwed to the zenith.

Parallels *of declination*, in astronomy, are the same with parallels of latitude in geography.

Parallel sphere, that situation of the sphere, wherein the equator coincides with the horizon, and the poles with the zenith and nadir. In this sphere all the parallels of the equator become parallels of the horizon, consequently no stars ever rise or set, but all turn round in circles parallel to the horizon; and the sun, when in the equinoctial, wheels round the horizon the whole day. After his rising to the elevated pole, he never sets for six months; and after his entering again on the other side of the line, never rises for six months longer.

This is the position of the sphere to such as live under the poles, and to whom the sun is never higher than 23° 30′.

Parallel sailing, in navigation, is the sailing under a parallel of latitude. See Navigation.

PARALLELEPIPED, or Parallelopiped, in geometry, a regular solid comprehended under six parallelograms, the opposite ones whereof are similar, parallel, and equal. See Geometry.

All parallelepipeds, prisms, cylinders, &c. whose bases and heights are equal, are themselves equal.

A diagonal plane divides a parallelepiped into two equal prisms; so that a triangular prism is half a parallelepiped upon the same base and of the same altitude.

All parallelepipeds, prisms, cylinders, &c. are in a ratio compounded of their bases and altitudes: wherefore, if their bases are equal, they are in proportion to their altitudes; and conversely.

All parallelepipeds, cylinders, cones, &c. are in a triplicate ratio of their homologous sides, and also of their altitudes.

Equal parallelepipeds, prisms, cones, cylinders, &c. reciprocate their bases and altitudes.

PARALLELISM *of the earth's axis.* See ASTRONOMY.

PARALLELOGRAM. See GEOMETRY.

PARALOGISM, in logic, a false reasoning, or a fault committed in demonstration, when a consequence is drawn from principles that are false; or, though true, are not proved; or when a proposition is passed over that should have been proved by the way.

PARALYSIS, *the palsy.* See MEDICINE.

PARAMECIUM, a genus of the order vermes infusoria, invisible to the naked eye, simple, pellucid, flattened, oblong. There are seven species. The P. aurelia is compressed, longitudinally plaited towards the fore-part, acute behind. It is found in ditch-water and infusions; membranaceous, four times as long as it is broad, the fore-part obtuse, hyaline; the hind part filled with molecules; the gold reaching from the middle to the tip.

PARAMETER, in conic sections, a constant line, otherwise called latus rectum. See CONIC SECTIONS.

The parameter is said to be constant, because in the parabola the rectangle under it and any abscis is always equal to the square of the corresponding semiordinate; and in the ellipsis and hyperbola, it is a third proportional to the conjugate and transverse axis.

Thus, if t and c are the two axes in the ellipse and hyperbola, and x and y an abscis and its ordinate in the parabola: it will be

$t : c :: c : p = \frac{c^2}{t}$ the parameter in the ellipse and hyperbola,

and $x : y :: y : p = \frac{y^2}{x}$ the parameter in the parabola.

PARAMOUNT, the supreme or highest lord of the fee. This seigniory of a lord paramount is frequently termed an honour, and not a manor; especially if it has belonged to an antient feudal baron, or has been at any time in the hands of the crown. 2 Black. 91.

PARAPET, in fortification, an elevation of earth designed for covering the soldiers from the enemy's cannon or small shot. The thickness of the parapet is from 18 to 20 feet; its height is six feet on the inside, and four or five on the outside. It is raised on the rampart, and has a slope above called the superior talus, and sometimes the glacis of the parapet. The exterior talus of the parapet is the slope facing the country: there is a banquette or two for the soldiers who defend the parapet to mount upon, that they may the better discover the country, fosse, and counterscarp, and fire as they find occasion.

Parapet of the covert way, or corridor, is what covers that way from the sight of the enemy, which renders it the most dangerous place for the besiegers, because of the neighbourhood of the faces, flanks, and curtains of the place.

PARAPET, is also a little wall raised breast-high on the banks of bridges, quays, or high buildings, to serve as a stay, and prevent people falling over.

PARAPHERNALIA, are the woman's apparel, jewels, and other things, which, in the life-time of her husband, she wore as the ornaments of her person, to be allowed by the discretion of the court, according to the quality of her and her husband. The husband cannot devise such ornaments and jewels of his wife; though, during his life, he has power to dispose of them. But if she continues in the use of them till his death, she shall afterwards retain them against his executors and administrators, legatees, and all other persons, except creditors where there is a deficiency of assets. 2 Black. 436.

PARAPLEGIA, or PARAPLEXIA, in medicine, a species of paralysis or palsy, usually succeeding an apoplexy. See MEDICINE.

PARASANG, an antient Persian measure, different at different times, and in different places; being sometimes 30, sometimes 40, and sometimes 50 stadia or furlongs.

PARASITES, or PARASITICAL PLANTS, in botany, such plants as are produced out of the trunk or branches of other plants, from whence they receive their nourishment, and will not grow upon the ground, as the misleto, &c.

PARCEL-MAKERS, two officers in the exchequer, who make parcels of the escheator's accounts, in which they charge them with every thing they have levied for the king's use, within the time of their office, and deliver the same to one of the auditors of the court, to make their accounts therewith.

PARCHMENT, in commerce, the skin of sheep or goats prepared after such a manner as to render it proper for writing upon, covering books, &c.

The manufacture of parchment is begun by the skinner, and finished by the parchment-maker. The skin having been stripped of its wool, and placed in the lime-pit, in the manner described under the article SHAMMY, the skinner stretches it on a kind of frame, and pares off the flesh with an iron instrument; this done, it is moistened with a rag, and powdered chalk being spread over it, the skinner takes a large pumice-stone, flat at bottom, and rubs over the skin, and thus scours off the flesh; he then goes over it again with the iron instrument, moistens it as before, and rubs it again with the pumice-stone without any chalk underneath: this smooths and softens the flesh-side very considerably. He then drains it again, by passing over it the iron instrument as before. The flesh-side being thus drained, by scraping off the moisture, he in the same manner passes the iron over the wool or hair side: then stretches it tight on a frame, and scrapes the flesh-side again: this finishes its draining; and the more it is drained, the whiter it becomes. The skinner now throws on more chalk, sweeping it over with a piece of lamb-skin that has the wool on, and this smooths it still farther. It is now left to dry, and when dried, taken off the frame by cutting it all round. The skin thus far prepared by the skinner, is taken out of his hands by the parchment-maker, who first, when it is dry, pares it on a summer (which is a calf-skin stretched in a frame) with a sharper instrument than that used by the skinner, and working with the arm from the top to the bottom of the skin, takes away about one-half of its thickness. The skin thus equally pared on the flesh-side, is again rendered smooth, by being rubbed with the pumice-stone, on a bench covered with a sack stuffed with flocks, which leaves the parchment in a condition fit for writing upon. The parings thus taken off the leather, are used in making glue, size, &c.

What is called vellum, is only parchment made of the skins of abortives, or at least sucking calves. This has a much finer grain, and is whiter and smoother than parchment; but is prepared in the same manner, except in not being passed through the lime-pit.

PARDON, is the remitting or forgiving a felony or other offence committed against the king.

Blackstone mentions the power of pardoning offences to be one of the greatest advantages of monarchy in general above every other form of government; and which cannot subsist in democracies. Its utility and necessity are defended by him on all those principles which do honour to human nature. See 4 Black. 396.

Pardons are either general or special; general as by act of parliament, of which, if they are without exceptions, the court must take notice ex officio; but if there are exceptions therein, the party must aver that he is none of the persons excepted. 3 Inst. 233.

Special pardons are either of course, as to persons convicted of manslaughter, or se defendendo, and by several statutes to those who shall discover their accomplices in several felonies; or of grace, which are by the king's charter, of which the court cannot take notice ex officio, but they must be pleaded. 3 Inst. 233.

A pardon may be conditional, that is, the king may extend his mercy upon what terms he pleases; and may annex to his bounty a condition either precedent or subsequent, on the performance whereof, the validity of the pardon will depend; and this by the common law. 2 Haw. 37.

All pardons must be under the great seal. The effect of a pardon is to make the offender a new man; to acquit him of all corporal penalties and forfeitures annexed to that offence; and to give him a new credit and capacity: but nothing but an act of parliament can restore or purify the blood after an attainder.

PAREGORICS. See PHARMACY.

PARENCHYMA *of plants*, that part of the plant that lies immediately below the epidermis. It is of a deep-green colour, very tender, and succulent. See PLANTS, *physiology of.*

PARENTHESIS, in grammar, certain intercalary words, inserted in a discourse, which interrupt the sense or thread, but seem necessary for the better understanding of the subject.

PARENTS AND CHILDREN. If parents run away, and leave their children at the charge of the parish, the churchwardens and overseers, by order of the justices, may seize the rents, goods, and chattels, of such parents, and dispose thereof towards their children's maintenance.

A parent may lawfully correct his child, being under age, in a reasonable manner; but the legal power of the father over the persons of his children, ceases at the age of 21. 1 Black. 452.

PARHELION. See OPTICS.

PARIAN CHRONICLE. See ARUNDELIAN MARBLES.

PARIAN MARBLE, in the natural history of the antients, the white marble used then, and to this day, for carving statues, &c. and called by us at this time statuary marble. Too many of the later writers have confounded all the white marbles under the name of the Parian; and among the workmen, this and all the other white marbles have the common name of alabasters; so that it is in general forgotten among them that there is such a thing as alabaster different from marble; which, however, is truly the case. Almost all the world also have confounded the Carrara marble with this, though they are really very different; the Carrara kind being of a finer structure and clearer white than the Parian, but less bright and splendid, harder to cut, and not capable of so glittering a polish. The true Parian marble has usually somewhat of a faint blueish tinge among the white, and often has blue veins in different parts of it.

PARIANA, a genus of the monœcia polyandria class and order. The male flowers in whorls, forming spikes; calyx two-valved; corolla two-valved, larger than the calyx; filaments 40. Female flowers solitary in each whorl; calyx two-valved; corolla two-valved; stigma two-seeded, three-cornered. There is one species, of no note.

PARIETALIA OSSA. See ANATOMY.

PARIETARIA, *pellitory of the wall*, a genus of the monœcia order, in the polygamia class of plants, and in the natural method ranking under the 53d order, scabridæ. The calyx of the hermaphrodite is quadrifid; there is no corolla; there are four stamina; one style; and one seed, superior and elongated. The female calyx is quadrifid; there is no corolla; nor are there any stamina. There is one style; and one seed, superior and elongated. There are 10 species, of which one, named the officinalis, is used in medicine. The plant has a cooling and diuretic quality. Three ounces of the juice taken internally, or a fomentation externally applied, have been found serviceable in the strangury. The plant laid upon heaps of corn infested with weevils, is said to drive away those destructive insects. See Plate Nat. Hist. fig. 316.

PARIS, *herb Paris*, or *truelove*, a genus of the trigynia order, in the octandria class of plants, and in the natural method ranking under the 11th order, sarmentaceæ. The calyx is tetraphyllous; there are four petals, narrow in proportion; the berry quadrilocular. There is but one species, growing naturally in woods and shady places in England. It has a single naked stem, greenish blossoms, and blueish-black berries. Though this plant has been reckoned of a poisonous nature, being ranked among the aconites, yet late authors attribute quite other properties to it, esteeming it to be a counter-poison, and good in malignant and pestilential fevers.

PARISH. In England there are 9913 parishes, of which 3845 are churches impropriate, and the rest are annexed to colleges or church dignities. In many of these parishes, on account of their large extent and the number of parishioners, there are several chapels of ease.

PARISH-OFFICERS, officers chosen annually to regulate and manage the concerns of the parish.

PARK, a piece of ground inclosed and stored with wild beasts of chase, which a man may have by prescription or the king's grant.

By 16 Geo. III. c. 30. if any person shall pull down or destroy the pale or wall of a park, he shall forfeit 30*l*.

PARK *of artillery*. See ARTILLERY, *park of*.

PARKINSONIA, so called in honour of the English botanist Parkinson, a genus of the monogynia order, in the decandria class of plants, and in the natural method it ranks under the 33d order, lomentaceæ. The calyx is quinquefid; there are five petals, all of them oval except the lowest, which is reniform; there is no style; the legumen moniliform, or like strung beads. We know but one species of this plant, which is very common in the Spanish West Indies, but has of late years been introduced into the English settlements, for the beauty and sweetness of its flowers. In the countries where it grows naturally, it rises to be a tree of 20 or more feet high, and bears long slender bunches of yellow flowers, which have a most agreeable sweet scent.

PARLIAMENT, is the legislative branch of the supreme power of Great Britain, consisting of the king, the lords spiritual and temporal, and the knights, citizens, burgesses, representatives of the commons of the realm, in parliament assembled.

The power and jurisdiction of parliament is so transcendant and absolute, that it cannot be confined, either for causes or persons, within any bounds. 4 Inst. 36.

The house of commons is a denomination given to the lower house of parliament. In a free state, every man, who is supposed a free agent, ought to be, in some measure, his own governor; and therefore a branch at least of the legislative power should reside in the whole body of the people. In elections for representatives for Great Britain, antiently, all the people had votes; but king Henry VI. to avoid tumults, first appointed that none should vote for knights but such as were freeholders, did reside in the county, and had forty shillings yearly revenue. In so large a state as ours, therefore, it is very wisely contrived, that the people should do that by their representatives which it is impracticable to perform in person; representatives chosen by a number of minute and separate districts, wherein all the voters are or may be easily distinguished. The counties are therefore represented by knights, elected by the proprietors of lands; the cities and boroughs are represented by citizens and burgesses, chosen by the mercantile or supposed trading interest of the nation.

The peculiar laws and customs of the house of commons, relate principally to the raising of taxes, and the elections of members to serve in parliament.

The method of making laws is nearly the same in both houses. In the house of commons, in order to bring in the bill, if the relief sought is of a private nature, it is first necessary to prefer a petition; which must be presented by a member, and usually set forth a grievance required to be remedied. This petition, when founded on facts of a disputable nature, is referred to a committee of members, who examine the matter alleged, and accordingly report it to the house; and then (or otherwise upon the mere petition), leave is given to bring in the bill. In public matters, the bill is brought in upon motion made to the house, without any petition.

If the bill begins in the house of lords, if of a private nature, it is referred to two judges, to make report. After the second reading, the bill is said to be committed, that is, referred to a committee; which is selected by the house, in matters of small importance; or upon a bill of consequence, the house resolves itself into a committee of the whole house. A committee of the whole house is composed of every member; and to form it the speaker quits the chair, and may consequently sit and debate upon the merits of it as a private member, another member being appointed chairman for the time. In these committees the bill is usually debated clause by clause, amendments made, and sometimes it is entirely new-modelled. Upon the third reading, further amendments are sometimes made; and if a new clause is added, it is done by tacking a separate piece of parchment on the bill, which is called a rider. 1 Black. 182.

The royal assent may be given two ways: 1. in person, when the king comes to the house of peers, in his crown and royal robes, and sending for the commons to the bar, the titles of all the bills that have passed both houses are read; and the king's answer is declared by the clerk of the parliament. If the king consents to a public bill, the clerk usually declares, *le roy le veut*, the king wills it so to be; if to a private bill, *soit fait comme il est desiré*, be it as it is desired. If the king refuses his assent, it is in the gentle language of, *le roy s'avisera*, the king will advise upon it. When a bill of supply is passed, it is carried up and presented to the king by the speaker of the house of commons; and the royal assent is thus expressed, *le roy remercie ses loyal sujets, accepte leur benevolence, et aussi le veut;* the king thanks his loyal subjects, accepts their benevolence, and also wills it so to be. By the stat. 33 Hen. VIII. c. 21., the king may give his assent by letters patent under his great seal, signed with his hand, and notified in his absence to both houses assembled together in the upper house. And when the bill has received the royal assent in either of these ways, it is then, and not before, a statute or act of parliament.

An act of parliament thus made is the exercise of the highest authority that this kingdom acknowledges upon the earth. It has power to bind every subject in the land, and the dominions thereunto belonging, nay even the king himself, if particularly named in it; and it cannot be altered, amended, dispensed with, suspended, or repealed, but in the same forms, and by the same authority, of parliament.

Adjournment is no more than a continuance of the session from one day to another, as the word itself signifies; and this is done by the authority of each house separately every day, or for a longer period; but the adjournment of one house is no adjournment of the other. 1 Black. 186.

Prorogation is the continuance of the parliament from one session to another, as an adjournment is a continuation of the session from day to day. And this is done by the royal authority, expressed either by the lord chancellor in his majesty's presence, or by commission from the crown, or frequently by proclamation; and by this, both houses are prorogued at the same time, it not being a prorogation of the house of lords or commons, but of the parliament. The session is never understood to be at an end until a prorogation; though unless some act is passed, or some judgment given in parliament, it is in truth no session at all. Id.

A dissolution is the civil death of the parliament; and this may be effected three ways: 1. By the king's will expressed either in person or representation; 2. By the demise of the crown; 3. By the length of time.

By the king's will; for as the king has the sole right of convening the parliament, so also it is a branch of the royal prerogative, that he may, whenever he pleases, prorogue the parliament for a time, or put a final period to its existence.

By the demise of the crown: this dissolution formerly happened immediately upon the death of the reigning sovereign; but the calling a new parliament immediately on the inauguration of the successor being found inconvenient, and dangers being apprehended from having no parliament in being, in case of a disputed succession, it was enacted by statutes 7 and 8 W. III. c. 15., and 6 Anne, c. 7., that the parliament in being shall continue for six months after the death of any king or queen, unless sooner prorogued or dissolved by the successor; that if the parliament is at the time of the king's death separated by adjournment or prorogation, it shall notwithstanding assemble immediately; and that if no parliament is then in being, the members of the last parliament shall assemble and be again a parliament.

Lastly, a parliament may be dissolved or expire by length of time.

The utmost extent of time that the same parliament was allowed to sit by the stat. of 6 W. c. 3. was three years; after the expiration of which, reckoning from the return of the first summons, the parliament was to have no longer continuance. But by stat. 1. Geo. I. c. 38. in order professedly to prevent the great and continued expences of frequent elections, and the violent heats and animosities consequent thereupon, and for the peace and security of the government just then recovering from the late rebellion, this term was prolonged to seven years. So that as our constitution now stands, the parliament must expire, or die a natural death, at the end of every seventh year, if not sooner dissolved by the royal prerogative. See ELECTION.

PARLIAMENT, *the high court of*, is the supreme court of the kingdom, not only for the making but also for the execution of laws, by the trial of great and enormous offenders, whether lords or commoners, in the method of parliamentary impeachment. An impeachment before the lords, by the commons of Great Britain in parliament, is a prosecution of the already known and established law, and has been frequently put in practice; being a presentment to the most high and supreme court of criminal jurisdiction by the most solemn grand inquest of the whole kingdom. A commoner cannot, however, be impeached before the lords for any capital offence, but only for high misdemeanors; a peer may be impeached for any crime. And they usually, in case of an impeachment of a peer for treason, address the crown to appoint a lord high steward, for the greater dignity and regularity of their proceedings; which high steward was formerly elected by the peers themselves, though he was generally commissioned by the king; but it has of late years been strenuously maintained, that the appointment of a high steward in such cases is not indispensably necessary, but the house may proceed without one. The articles of impeachment are a kind of bills of indictment, found by the house of commons, and afterwards tried by the lords; who are in cases of misdemeanors considered not only as their own peers, but as the peers of the whole nation.

PARNASSIA, *grass of Parnassia*, a genus of the tetragynia order, in the pentandria class of plants. The calyx is quinquepartite; there are five petals, and as many nectaria, heart-shaped, and ciliated with globular tops; the capsule quadrivalved. There is but one species, having a stalk about a foot high, angular, and often a little twisted, bearing a single white flower at top. The flowers are very beautifully streaked with yellow; so that though it is a common plant, growing naturally in moist pastures, it is frequently admitted into gardens.

PAROLE, a term signifying any thing done verbally or by word of mouth, in contradistinction to what is written; thus an agreement may be by parole. Evidence also may be divided into parole evidence and written evidence. A parole release is good to discharge a debt by simple contract. 2 Show. 417. The holder of a bill of exchange may authorize another to indorse his name upon it.

PAROLE EVIDENCE. See EVIDENCE.

PARONYCHIA, *whitlow*. See SURGERY.

PAROTIDES. See ANATOMY.

PAROXYSM. See MEDICINE.

PARRA, a genus of birds belonging to the order of grallæ; the characters of which are: the bill is tapering and a little obtuse; the nostrils are oval, and situated in the middle of the bill; the forehead is covered with fleshy caruncles, which are lobated; the wings are small and spinous. There are five species; of which the most remarkable is the chavaria, which is about the size of a domestic cock. The Indians in the neighbourhood of Carthagena, who breed large flocks of poultry that stray in the woods, and train up the chavaria to defend them against the numerous birds of prey, no one of which will dare to encounter it. It is never known to desert the flock, and it returns every evening to roost.

The parra Dominica is about the size of the lapwing. The bill is yellow, as are also the head and upper parts; the under are of a yellowish-white bordering on rose-colour: the legs are also yellow. This species inhabits several of the warmer parts of America and St. Domingo.

The parra Senegalla, is about the same size with the former. Its bill is also yellow, tipped with black; the forehead is covered with a yellow skin, the chin and throat are black, the head and upper parts of the body and lesser wing-coverts are grey-brown. The lower part of the belly, and the upper and under tail-coverts, are dirty white. At the bend of the wing is a black spur. It inhabits Senegal, and thence derives its name.

The parra jacana, or spur-winged water-hen, is about the size of the water-rail. The bill is in length about an inch and a quarter, of an orange-colour; and on the forehead is a membranous flap, half an inch long, and nearly as broad. On each side of the head also is another of the same, about a quarter of an inch broad; and both together they surround the base of the bill. The head, throat, neck, breast, and under-parts, are black; and sometimes the belly is mixed with white, &c. The birds of this species inhabit Brasil, Guiana, and Surinam; but are equally common at St. Domingo, where they frequent the marshy places, sides of ponds, and streams, and wade quite up to the thighs in the water. They are also generally seen in pairs, and when separated call each other continually till they join again. They are very shy, and most common in the rainy seasons in May and November. They are at all times very noisy; their cry sharp and shrill, and may be heard a great way off. This, as well as the other species, is called by the French chirurgien. The flesh is accounted pretty good.

The parra variabilis, or spur-winged water-hen, is about nine inches long. The bill is about 14 inches in length, and in colour is orange-yellow. On the forehead is a flap of red skin; the crown of the head is brown, marked with spots of a darker colour; the hind part of the neck is much the same, but of a deeper dye. On the forepart of the wing is a yellow spur, &c. The legs are furnished with long toes, as in all the others, the colour of which is blueish ash. This species inhabits Brasil, and is said to be pretty common about Carthagena, and in South America. There are five species in all.

PARRELS, in a ship, are frames made of trucks, ribs, and ropes, which having both their ends fastened to the yards, are so contrived as to go round about the masts, that the yards, by their means, may go up and down upon the masts: these also, with the breast-ropes, fasten the yards to the masts.

PARROT, and PARROQUET. See PSITTACUS.

PARSLEY. See APIUM.

PARSNEP. See PASTINACA.

PARSON, signifies the incumbent of a church. He is in himself a body corporate, in order to protect and defend the rights of the church by a perpetual succession. When a parson is instituted and inducted into a rectory, he is then, and not before, in full and complete possession. 1 Black. 391.

PART, in music, the name of each of the melodies of any harmonic composition, and which, when performed in union, form its harmony. Four is the fewest number of parts with which the chords necessary to elaborate harmony can be completely filled.

PARTERRE, in gardening, a level division of ground, which, for the most part, faces the south, and best front of a house; and is generally furnished with greens, flowers, &c.

PARTHENIUM, a genus of the pentandria order, in the monœcia class of plants, and in the natural method ranking under the 49th order, compositæ. The male calyx is common and pentaphyllous; the florets of the disk monopetalous. The female has five florets of the radius, each with two male florets behind it; the intermediate female superior; the seed is naked. There are two species.

This plant has been much neglected in Europe, having, on account of its smell, been banished from our parterres. It is therefore indebted for its culture to the distinguished rank it holds among the Chinese flowers. The skill of their florists, and their continual care, have brought it to so great perfection, that Europeans scarcely know it. They have, by their attention to its culture, procured more than 300 varieties of it, and every year produces a new one.

PARTI, Partie, Party, or Parted, in heraldry, is applied to a shield or escutcheon, denoting it divided or marked out into partitions. See Heraldry.

PARTICIPLE, in grammar, an adjective formed of a verb, so called because it participates partly of the properties of a noun, and partly of those of a verb.

PARTICLE, in grammar, a denomination for all those small words that tie or unite others together, or that express the modes or manners of words.

PARTIES, in law, signify the persons that are named in a deed or fine, viz. those that made the deed, or levied the fine, and also those to whom the same was made or levied. Here it is to be observed, that if an indenture was made between two parties, mentioned particularly in the beginning of the deed, and therein one of them grants to another that is not named at the beginning thereof, such person is no party to that deed, nor can take any thing thereby. The parties to a suit at law are the plaintiff and defendant, who carry on the suit.

PARTITION, in law, signifies a division of lands, &c. descended by common law or custom among coheirs or parceners, being two at least. Partition may also be made by joint tenants, and tenants in common, by assent, deed, or writ.

PARTNER If there are several joint partners, and a person has dealings generally with one of them in matters concerning their joint trade, whereby a debt becomes due to the said person, it shall charge them jointly and the survivors of them; but if the person only dealt with one of the partners upon a separate account, in that case the debt shall only affect that partner and his executors. If one or more of the joint traders become bankrupt, his or their proportions are only assignable by the commissioners, to be held in common with the rest who are not bankrupts. If one of two partners becomes a bankrupt, the commissioners cannot meddle with the interest of the other, for it is not affected with the bankruptcy of his companion. Payment to one of the partners, is payment to them all.

PARTRIDGE, in ornithology See Tetrao.

PARUS, or Titmouse, in ornithology, a genus belonging to the order of passeres. The bill is very entire, covered at the basis with hairs; the tongue is truncated and hairy. There are 14 species, of which the most remarkable are:

1. The cristatus, or crested titmouse, weighs 13 pennyweights; the bill is black, with a spot of the same colour above it; all the upper part of the body grey; the neck and under parts are white, with a faint tincture of red, which is deepest just below the wings. The legs are of a lead-colour. It erects its crown feathers into a crest. It inhabits the warm parts of North America, and frequents forest-trees, feeding upon insects.

2. The major, or great titmouse, has the head and throat black, the cheeks white, the back of a green colour, the belly yellowish-green, divided in the middle by a bed of black, which extends to the vent; the rump of a bluish-grey, the legs of a lead-colour, the toes divided to the very origin, and the back toe very large and strong. This species sometimes visits our gardens; but for the most part inhabits woods, where it builds in hollow trees, laying about ten eggs. It feeds on insects, which it finds in the bark of trees. In the spring they do a great deal of mischief by picking off the tender buds of the fruit trees. Like woodpeckers, they are perpetually running up and down the bodies of trees in quest of food. This bird has three cheerful notes, which it begins to utter in the month of February.

3. The caudatus, or long-tailed titmouse, is about five inches and a quarter in length, and seven inches in breadth. The bill is black, very thick and convex, differing from all others of this genus. The top of the head, from the bill to the hind part, is white, mixed with a few dark-grey feathers: this bed of white is entirely surrounded with a broad stroke of black, which, rising on each side of the upper mandible, passes over each eye, unites at the hind part of the head, and continues along the middle of the back to the rump. The feathers on each side of this black stroke are of a purplish red, as are those immediately incumbent on the tail. The tail is the longest in proportion to the bulk of any British bird, being in length three inches, the form not unlike that of a magpie, consisting of 12 feathers of unequal lengths, the middlemost the longest, those on each side growing gradually shorter. These birds are often seen passing through our gardens, going from one tree to another, as if in their road to some other place, never making any halt. They make their nests with great elegance, of an oval shape, and about eight inches deep, having near the upper end a hole for admission. The external materials are mosses and lichens curiously interwoven with wool. On the inside it is very warmly lined with a thick bed of feathers. The female lays from 10 to 17 eggs. The young follow their parents the whole winter, and from the slimness of their bodies and great length of tail, appear while flying like as many darts cutting the air.

4. The remiz, or small species of titmouse. It is called parus pendulinus, and is often found in Lithuania. Mr. Coxe, in his Travels through Poland, gives the following account of this little animal. "The wondrous structure of its pendant nest induced me to give an engraving of both that and the birds themselves. They are of the smallest species of titmice. The head is of a very pale bluish ash-colour; the forepart of the neck and the breast tinged with red; the belly white; wings black, back and rump of a yellowish rust-colour; quill feathers cinereous, with the exterior sides white; the tail rust-coloured. The male is singularly distinguished from the female by a pair of black-pointed whiskers. Its nest is in the shape of a long purse, which it forms with amazing art, by interweaving down, gossamer, and minute fibres, in a close and compact manner, and then lining the inside with down alone, so as to make a snug and warm lodge for its young brood. The entrance is at the side, small, and round, with its edge more strongly marked than the rest of this curious fabric: the bird, attentive to the preservation of its eggs or little ones from noxious animals, suspends it at the lesser end to the extremity of the slender twigs of a willow or some other tree over a river. Contrary to the custom of titmice, it lays only four or five eggs: possibly Providence hath ordained this scantiness of eggs to the remiz, because, by the singular instinct imparted to it, it is enabled to secure its young much more effectually from destruction than the other species, which are very prolific."

5. Macrocephalus, inhabits New Zealand. See Plate Nat. Hist. fig. 314.

PASPALUM, a genus of the triandria digynia class and order. The calyx is two-valved, orbicular; corolla of the same size; stigma pencilled. There are 15 species, all foreign grasses.

PASQUIN, a mutilated statue at Rome, in a corner of the palace of the Ursini: it takes its name from a cobler of that city called Pasquin, famous for his sneers and gibes, and who diverted himself with passing his jokes on all the people who went through that street. After his death, as they were digging up the pavement before his shop, they found in the earth the statue of an antient gladiator, well cut, but maimed, and half-spoiled: this they set up in the place where it was found, and by common consent named it Pasquin. Since that time all satires are attributed to that figure, and are either put into its mouth or pasted upon it, as if they were written by Pasquin redivivus; and these are addressed by Pasquin to Marforio, another statue at Rome. When Marforio is attacked, Pasquin comes to his assistance, and when Pasquin is attacked, Marforio assists him in his turn.

PASS, a straight, difficult, and narrow passage, which shuts up the entrance into a country. The first care of the general of an army is to seize the passes of the country into which he would carry the war, to fortify them, and take care that they are well guarded.

PASSAGE, or Passo, any phrase or short portion of any air, or other composition. Every member of a strain or movement is a passage.

Passage, *birds of*. See Migration.

PASSAGIO (Italian), a succession of sounds so connected in their melody and expression, as to form a member or phrase in the composition.

PASSANT. See Heraldry.

PASSERINA, in botany, a genus of the octandria monogynia class of plants, the flower of which is composed of a single petal, divided into four oval segments at the limb; the fruit is a coriaceous capsule, of an oval shape, with only one cell, and containing a single oval seed. There are 19 species.

PASSIFLORA, or Passion-flower, a genus of the pentandria order, in the gynandria class of plants, and in the natural method ranking under the 34th order, cucurbitaceæ. The calyx is pentaphyllous; there are five petals; the nectarium a crown; the berry is pedicellated. There are 36 diferent species, all of them natives of warm foreign countries, only one of which is sufficiently hardy to succeed well in the open ground here; all the others requiring the shelter of a greenhouse or stove, but chiefly the latter. The most remarkable are:

1. The cærulea, or blue-rayed common palmated passion-flower, with large spreading flowers, with whitish-green petals, and a blue radiated nectarium; succeeded by a large, oval, yellowish fruit. It is in flower from July until October; but the flowers are only of one day's duration, generally opening about 11 or 12 o'clock, and frequently in hot sunny weather burst open with elasticity, and continue fully expanded all that day; and the next they gradually close, assuming a decayed appearance, and never open any more.

2. The incarnata, or flesh-coloured Italian passion-flower, has leaves composed of three sawed lobes, each leaf attended by a twining tendril; and at the axillas long slender pedunculi, terminated each by one whitish flower, having a greenish calyx, and a reddish or purple radiated nectarium, surrounding the column of the fructification; which succeed to a large, round, fleshy fruit, ripening to a beautiful orange-colour.

3. The vespertilio, or bat's-wing passion-flower, has large, bilobate, or two-lobed leaves, the base roundish and glandular, the lobes acute, widely divaricated like a bat's wing, and dotted underneath; and axillary flowers, having white petals and rays.

4. Passiflora alata, one of the finest ornaments of our stoves.

As all the species are natives of warm climates, in this country they are mostly of a tender quality, except the first sort, which succeeds very well in the full ground, in a warm situation; only their young branches are sometimes killed in very severe winters; but plenty of new ones generally rise again in spring following; the others, denominated stove kinds, must always be retained in that repository.

PASSIONS, in painting: the passions are properly considered as subjects of painting, because being capable of representation by lines and colours, they fall within the province of that art, whose office it is to delineate all objects which can be expressed by those means. To represent the passions justly and fully, is however the utmost reach of the imitative art. The nicest accuracy is requisite, and the smallest deviation is frequently destructive of the whole effect intended to be produced.

Le Brun, a celebrated French painter, published a collection of heads, in which he gave examples of the appearances produced in the countenance by each distinct passion. But these examples are for the most part overcharged and gross. The student will find a much surer guide in the late publication of "The Anatomy of Painting," by Charles Bell, where the rules for delineating the passions are laid down with precision, by a fair demonstration of physical effects.

PASSPORT, or PASS, a licence or writing obtained from a prince or governor, granting liberty and safe conduct to pass through his territories without molestation. Passport also signifies a licence obtained for importing contraband goods, or for exporting and importing merchandise without paying the duties; these last licences are always given to ambassadors and other public ministers for their baggage, equipage, &c. If any person forges or counterfeits a passport, commonly called a Mediterranean pass, for any ship, or shall alter or erase any pass made out by the commissioners for executing the office of lord high admiral, or shall publish as true any forged, altered, or erased pass, knowing the same to be forged, &c. every such person being convicted in any part of his majesty's dominions where such offence may be committed, shall be guilty of felony without benefit of clergy, by 4 Geo. II. cap. 18. sect. 1.

PASTE, in the glass trade, a kind of coloured glass, made of calcined crystal, lead, and metallic preparations, so as to imitate the natural gems: for the manner of effecting which see GLASS.

PASTEBOARD. See PAPER.

PASTINACA, the *parsnip*, a genus of the digynia order, in the pentandria class of plants, and in the natural method ranking under the 45th order, umbellatæ. The fruit is an elliptical compressed plane; the petals are involuted and entire. There are only three species of this genus, the principal of which is the pastinaca sativa, or garden parsnip, which is an exceedingly fine esculent root. It is to be propagated by sowing the seeds in February or March, in a rich mellow soil, which must be deep dug, that the roots may be able to run deep without hindrance. It is a common practice to sow carrots at the same time upon the same ground with the parsnips; and if the carrots are designed to be drawn young there is no harm in it. The parsnips, when they are grown up a little, must be thinned to a foot distance, and carefully kept clear of weeds. They are finest tasted just at the season when the leaves are decayed; and such as are desirous to eat them in spring should have them taken up in autumn, and preserved in sand. They are useful for cattle.

PATEE, or PATTEE, in heraldry, a cross small in the centre, and widening to the extremes, which are very broad.

PATELLA. See ANATOMY.

PATELLA, or LIMPET, a genus of insects belonging to the order vermes testacea. The shells are of that class which is called univalves; they have no contour, and are in the form of little pointed cones. They are always attached to some hard body. Their summit is sometimes acute, sometimes obtuse, flatted, turned back, or perforated. The rock, or other hard body, to which they are always found adhering, serves as a kind of second or under shell to preserve them from injury; and for this reason Aldrovandus and Rondelet have classed them among the bivalves; but in this error they have not been followed by any other writer. The shells consist of carbonat of lime. But when exposed to a red-heat, they emit a smell like horn; and when dissolved in acids, a semi-liquid gelatinous matter was left behind. There are 36 species of this genus, which are principally distinguished by peculiarities in their shells. See Plate Nat. Hist. fig. 317.

PATENT, in general, denotes something that stands open or expanded: thus a leaf is said to be patent when it stands almost at right angles with the stalk.

PATENT, or *letters patent*, are writings sealed with the great seal of England, by which a man is authorized to do, or to enjoy, any thing, which of himself he could not do. They are called so by reason of their form; as being open, with their seal affixed, ready to be exhibited for the confirmation of the authority delegated by them.

PATHOLOGY, that part of medicine which explains the symptoms of diseases.

PATRON, in the canon and common law, is a person, who having the advowson of a parsonage, vicarage, or the like spiritual promotion, belonging to his manor, has, on that account, the gift and disposition of the benefice, and may present to it whenever it becomes vacant. The patron's right of disposing of a benefice originally arises either from the patron or his ancestors, &c. being the founders or builders of the church; from their having given lands for the maintenance thereof; or from the church's being built on their ground; and frequently from all three together. See ADVOWSON.

PAVEMENT. See PAVING.

PAVETTA, in botany, a genus of the tetrandria monogynia class of plants, with a monopetalous funnel-fashioned flower, and a monospermous berry. There are seven species, shrubs, natives of Africa, China, and the West Indies.

PAVILION. See ARCHITECTURE.

PAVILION, in heraldry, denotes a covering in form of a tent, which invests or wraps up the armories of divers kings and sovereigns, depending only on God and their sword.

PAVING, the construction of ground-floors, streets, or highways, in such a manner that they may be conveniently walked upon. In Britain the pavement of the grand streets, &c. is usually of flint or rubblestone; courts, stables, kitchens, halls, churches, &c. are paved with tiles, bricks, flags, or firestone; sometimes with a kind of freestone and ragstone. In some streets, as of Venice, the pavement is of brick: churches are sometimes paved with marble, and sometimes with mosaic work, as the church of St. Mark at Venice. In France the public roads, streets, courts, &c. are all paved with gres or grit, a kind of freestone. In Amsterdam, and the chief cities of Holland, they call their brick pavement the burgomasters' pavement, to distinguish it from the stone or flint pavement, which usually takes up the middle of the street, and which serves for carriages; the brick which borders it being destined for the passage of people on foot.

Pavements of freestone, flint, and flags, in streets, &c. are laid dry, that is, in a bed of sand; those of courts, stables, ground-rooms, &c. are laid in a mortar of lime and sand, or in lime and cement, especially if there are vaults or cellars underneath. Stonemasons, after laying a floor dry, especially of brick, spread a thin mortar over it; sweeping it backwards and forwards to fill up the joints. The several kinds of pavement are as various as the materials of which they are composed, and whence they derive the name by which they are distinguished: as,

1. Pebble-paving, which is done with

tones collected from the sea-beach, mostly brought from the islands of Guernsey and Jersey: they are very durable, indeed the most so of any stone used for this purpose. They are used of various sizes; but those which are from six to nine inches deep are esteemed the most serviceable. When they are about three inches deep they are denominated bolders or bowlers: these are used for paving court-yards, and other places not accustomed to receive carriages with heavy weights; and when laid in geometrical figures they have a very pleasing appearance.

2. Rag-paving was much used in London, but is very inferior to the pebbles; it is dug in the vicinity of Maidstone in Kent, from which it has the name of Kentish ragstone: there are squared stones of this material for paving coach-tracks and footways.

3. Purbeck pitchens, squared stones used in footways: they are brought from the island of Purbeck, and also frequently used in court-yards; they are in general from six to ten inches square, and about five inches deep.

4. Squared paving, for distinction by some called Scotch paving, because the first of the kind paved in the manner that has been and continues to be paved came from Scotland; the first was a clear close stone, called blue whynn, which is now disused because it has been found inferior to others since introduced in the order they are hereafter placed.

5. Granite, a hard material, brought also from Scotland, of a reddish colour, very superior to the blue whynn quarry, and at present very commonly used in London.

6. Guernsey, which is the best, and very much in use: it is the same stone with the pebble before spoken of, but broken with iron hammers, and squared to any dimensions required, of a prismoidal figure, set with its smallest base downwards. The whole of the foregoing paving should be bedded and paved in small gravel.

7. Purbeck paving, for footways, is in general got in large surfaces about two inches and a half thick; the blue sort is the hardest and the best of this kind of paving.

8. Yorkshire paving, is an exceeding good material for the same purpose; and is got of almost any dimensions of the same thickness as the Purbeck. This stone will not admit wet to pass through it, nor is it affected by the frost.

9. Ryegate, or firestone paving, is used for hearths, stoves, ovens, and such places as are liable to great heat, which does not affect the stone if kept dry.

10. Newcastle flags, are stones about two feet square, and one inch and a half or two inches thick: they answer very well for paving out-offices; they are somewhat like the Yorkshire.

11. Portland paving, with stone from the island of Portland: this is sometimes ornamented with black marble dots.

12. Swedland paving, is a black slate dug in Leicestershire, and looks well for paving halls, or in party-coloured paving.

13. Marble paving, is mostly variegated with different marbles, sometimes inlaid in mosaic.

14. Flat brick paving, done with brick laid in sand, mortar, or groute; as when liquid lime is poured into the joints.

15. Brick-on-edge paving, done with brick laid edgewise in the same manner. Bricks are also laid flat or edgewise in herring-bone. Bricks are also sometimes set endwise in sand, mortar, or groute. Paving is also performed with paving bricks; ten-inch tiles; foot tiles; clinkers for stables and outer-offices; and even with the bones of animals, for gardens, &c.

Pavements of churches, &c. frequently consist of stones of several colours; chiefly black and white, and of several forms, but chiefly squares and lozenges, artfully disposed. Indeed there needs no great variety of colours to make a surprising diversity of figures and arrangements. M. Truchet, in the Memoirs of the French Academy, has shewn by the rules of combination, that two square stones, divided diagonally into two colours, may be joined together chequerwise 64 different ways: which appears surprising enough, since two letters or figures can only be combined two ways.

The reason is, that letters only change their situation with regard to the first and second, the top and bottom remaining the same; but in the arrangement of these stones each admits of four several situations, in each whereof the other square may be changed 16 times, which gives 64 combinations.

Indeed, from a farther examination of these 64 combinations, he found there were only 32 different figures, each figure being repeated twice in the same situation, though in a different combination; so that the two differed from each other only by the transposition of the dark and light parts.

PAULICIANS, christians of the seventh century, disciples of one Constantine, a native of Armenia, and a favourer of the errors of Manes; who, as the name Manichees was become odious to all nations, gave those of his sect the title of Paulicians, on pretence that they followed only the doctrine of St. Paul.

PAULINIA, a genus of the trigynia order, in the octandria class of plants, and in the natural method ranking under the 23d order, trihilatæ. Its characters are these: the flower has a permanent empalement, composed of four small oval leaves; it has four oblong oval petals, twice the size of the empalement; and eight short stamina with a turbinated germen, having three short slender styles, crowned by spreading stigmas; the germen turns to a large three-cornered capsule with three cells, each containing one almost oval seed. There are 17 species, natives of the West Indies.

PAULIONISTS, in church history, christians of the third century, disciples of Paul Samosatensis, bishop of Antioch, who denied Christ's divinity, maintaining that when we call him the Son of God, we do not thereby mean that he is really and truly God; but only that he was so perfect a man, and so superior in virtue to all others, that he has this name given him by way of eminence.

PAVO, the *peacock*, in ornithology, a genus belonging to the order of gallinæ. The head is covered with feathers which bend backwards; the feathers of the tail are very long, and beautifully variegated with eyes of different colours. Latham enumerates eight species. The most remarkable are,

1. The cristatus, or common peacock, which is about the size of a common turkey; the length from the tip of the bill to the end of the tail being three feet eight inches. On the crown there is a sort of crest, composed of 24 feathers, which are not webbed except at the ends, which are gilded green. See Plate Nat. Hist. fig. 318. The female is rather less than the male.

This bird, now so common in Europe, is of Eastern origin, being a native of India. They are found wild in the islands of Ceylon and Java in the East Indies, and at St. Helena, at Barbuda, and other West India islands. They are not natural to China; but they are found in many places of Asia and Africa. They are, however, no where so large or so fine as in India, in the neighbourhood of the Ganges, whence, by degrees, they have spread into all parts, increasing in a wild state in the warmer climes, but wanting some care in the colder regions. In ours this bird does not come to its full plumage till the third year. The female lays five or six greyish white eggs; in hot climates 20, the size of those of a turkey. These, if let alone, she lays in some secret place, at a distance from her usual resort, to prevent their being broken by the male, which he is apt to do if he finds them. The time of sitting is from 27 to 30 days. The young may be fed with curd, chopped leeks, barley-meal, &c. moistened; and are fond of grasshoppers and some other insects. In five or six months they will feed as the old ones, on wheat and barley, with what else they can pick up in the circuit of their confinement. They are caught in India by carrying lights to the trees where they roost, and having painted representations of the bird presented to them at the same time; when they put out the neck to look at the figure, the sportsman slips a noose over the head, and secures his game. In most ages they have been esteemed as a salutary food. Hortensius gave the example at Rome, where it was carried to the highest luxury, and sold dear; and a young pea-fowl is thought a dainty even in the present times.

2. The pavo bicalcaratus is larger than the common pheasant. The feathers on the crown of the head are sufficiently long to form a crest, of a dull-brown colour. The neck is bright brown, striated across with dusky brown: the upper parts of the back, scapulars, and wing-coverts, are dull-brown, dotted with paler brown and yellowish; besides which each feather is marked near the end with a roundish large spot of a gilded purple colour, changing into blue and green in different lights; the lower part of the back and rump are dotted with white; all the under parts are brown, striated transversely with black. The female is a third smaller than the male. This species is of Chinese origin; and some of them have been brought from China to England alive.

3. The pavo tibetanus is about the size of a pintado, being about two feet and nearly two inches long. The head, neck, and under parts, are ash-coloured, marked with blackish lines: the wing-coverts, back, and rump, are grey, with small white dots; besides which, on the wing-coverts and back are large round spots of a fine blue, changing in different lights to violet and green gold. This species inhabits the kingdom of Thibet. The Chinese give it the name of chin-tchien-khi.

PAUPER, in law. See FORMA PAUPERIS.

PAUSE, in music, a mark or character, consisting of a curve drawn over a dot, and signifying that the note or the rest, over which it is placed, is to be continued beyond the regular time. The exact length of the pause is not dictated by any stated rule, but left to the judgment, taste, and feeling of the performer; who sometimes is licensed by the words ad libitum, to introduce extempore embellishments.

PAUSUS, a genus of insects, of the order coleoptera. The generic character is: antennæ of two joints, the upper very large, inflated, moveable, and hooked; head stretched forwards; wing-sheaths flexile, deflected, truncated.

1. Pausus microcephalus. The head is uncommonly small; the thorax broader than the head, and very uneven, the two parts being entirely separated by a transverse furrow. This rare insect is a native of Banana island, and Sierra Leone in Africa. Its colour is a blackish brown. It is represented on the Plate, both in its natural size, and considerably magnified.

The 2d species, or pausus sphærocerus, is thus described by Dr. Afzelius. "There was a house building for the governor, on an eminence at the south end of Free-town, in Sierra Leone. I had not resided there many days, when one evening, having just lighted my candle, and begun to write, I observed something dropping from the cieling before me upon the table, which, from its singular appearance, attracted my particular attention. It remained for a little while quite immoveable, as if stunned or frightened, but began soon to crawl very slowly and steadily. I then caught it, put it into a box, and left it confined there for a day or two. One evening, going to look at it, and happening to stand between the light and the box, so that my shadow fell upon the insect, I observed, to my great astonishment, the globes of the antennæ, like two lanthorns, spreading a dim phosphoric light. This singular phenomenon raised my curiosity, and, after having examined it several times that night, I resolved to repeat my researches the following day. But the animal being exhausted, died before the morning, and the light disappeared; and afterwards, not being able to find any more specimens, I was prevented from ascertaining the fact by reiterated experiments at different times."

PAWLE, in a ship, a small piece of iron bolted to one end of the beams of the deck, close to the capstan; but yet so easily, as that it can turn about. Its use is, to stop the capstan from turning back, by being made to catch hold of the whelps: they therefore say, heave a pawle; that is, heave a little more, for the pawle to get hold of the whelps: and this they call pawling the capstan.

PAWN, a pledge lodged for the security of the payment of a sum of money borrowed. As the party that pawns the goods has a general property therein, they cannot be forfeited by the person that has them in pawn, for any offence of his; neither can they be taken in execution for his debt: on the other hand, where goods are repawned for money, if after judgment is obtained against the pawner for debt, the goods in the pawnee's hands are not liable to execution until such time as the money lent is paid to the pawnee. He that borrows money on a pawn is to have again the pledge, when he repays the same, or he may bring an action for detaining it; and his very tender of the money revests the special property in him. Likewise it has been held, that where a broker refuses, on tendering the money, to redeliver the goods, he thereupon shall be indicted. In case goods are pawned for lent money, and no day fixed for their redemption, they are said to be redeemable at any time during the pawner's life; and though they may not be redeemed after his death, they may after the death of the pawnee. Where the pawn is redeemable on a certain day, it must be strictly observed, or upon failure of payment it may be sold. Also it is the common practice of the brokers, when no day is fixed for redemption, not to stay longer than a year for their money, at the expiration of which time they usually sell the goods. See also 39 and 40 Geo. III. c. 99.

PAY, in the sea language. The seamen say, pay more cable, when they mean to let out more cable.

PAYING, among seamen. When the seams of a ship are laid over with a coat of hot pitch, it is called paying her; and when this is done with canvas, parcelling: also when, after she is graved, and the soil burned off, a new coat of tallow and soap, or one of train-oil, rosin, and brimstone boiled together, is put on her, that is also called paying of a ship.

PAYMENT, is the consideration or purchase-money for goods, and may be made by the buyer giving to the seller the price agreed upon, either by bill or note, or by money. Where a day certain is appointed for payment, the party bound shall be allowed till the last moment of the day to pay it in, if it is an inland bill. 4 T. R. 173.

Payment of money before the day is, in law, payment at the day; for it cannot, in presumption of law, be any prejudice to him to whom the payment is made, to have his money before the time; and it appears by the party's receipt of it, that it is for his own advantage to receive it then. 5 Co. 117.

PEACE, in law, signifies a quiet and harmless behaviour towards the king and his people. The king, by his office and dignity royal, is the principal conservator of the peace within all his dominions, and may give authority to any other to see the peace kept, and to punish such as break it: hence it is usually called the king's peace. All the great officers of state are generally conservators of the peace throughout the kingdom, and may commit all breakers of it, or bind them in recognizance to keep it. Also the sheriff, coroner, constables, and tithingmen, are conservators of the peace within their own jurisdiction; and may apprehend all breakers of the peace, and commit them till they find sureties to keep the peace. 1 Black. 350.

PEACE, *justices of the*, are persons appointed by the king's commission to attend to the peace of the county where they dwell. They were called guardians of the peace till the 36th year of Edw. III. c. 12, where they are called justices.

A justice of the peace must, before he acts, take the oath of office, which is always done at the general quarter sessions for the county, by virtue of a dedimus potestatem out of chancery.

Sheriffs, coroners, attorneys, and proctors, may not act as justices of the peace.

The power, office, and duty of this magistrate, extends to an almost infinite number of instances, specified in some hundreds of acts of parliament, and every year accumulating.

The commission of the peace does not determine by the demise of the king, nor until six months after, unless sooner determined by the successor: but before his demise, the king may determine it, or may put out any particular person; which is most commonly done by a new commission, leaving out such person's name.

Justices of the peace can only be appointed by the king's special commission, and such commission must be in his name; but it is not requisite that there should be a special suit or application to, or warrant from, the king for the granting thereof, which is only requisite for such as are of a particular nature; as constituting the mayor of such a town, and his successors, perpetual justices of the peace within their liberties, &c. which commissions are neither revocable by the king, nor determinable by his demise, as the common commission of the peace is, which is made of course by the lord chancellor, according to his discretion. 1 Lev. 219.

The form of the commission of the peace, as it is at this day, was, according to Hawkins, settled by the judges about the 23 Eliz. 4 Inst. 471.

Qualifications. On renewing the commission of the peace (which generally happens when any person is newly brought into the same), a writ of dedimus potestatem is issued out of chancery to take the oath of him who is newly inserted, which is usually in a schedule annexed; and to certify the same into that court at such a day as the writ commands. Unto which oath are usually annexed the oaths of allegiance and supremacy. Lamb. 53.

Jurisdiction. It seems now to be settled, that justices of the peace have no power to hear and determine felonies, unless they are authorized so to do by the express words of their commissions; and that their jurisdictions to hear and determine murder, manslaughter, and other felonies and trespasses, is by force of the word assignavimus in their commission, which gives them, or two of them (whereof one is of the quorum), power to hear and determine felonies, &c. 2 Haw. P. C. 38. And hence it has been lately adjudged, that the caption of an indictment of trespass before justices of the peace, without adding, necnon ad diversas felonias, &c. assignat, is naught. Trin. 7 G. I. in B. R. But though justices of the peace, by force of their commission, have authority to hear and determine murder and manslaughter, yet they seldom exercise a jurisdiction herein, or in any other offences in which clergy is taken away, for two reasons: 1. By reason of the monition and clause in their commission, viz. in cases of difficulty to expect the presence of the justices of assize. 2. By the direction of the statute of 1 and 2 P. and M. c. 13, which directs justices of the peace, in case of manslaughter and other felonies, to take the examination of the prisoner, and the information of the fact, and put the same in writing; and then to bail the prisoner if there is cause, and to certify the same with the bail at the next general gaol-delivery; and therefore in cases of great moment they bind over the prosecutors, and bail the party, if bailable, to the next general gaol-delivery; but in smaller matters, as petty larceny, and in some other cases, they bind over to the sessions; but this is only in point of discretion and convenience, not because they have not jurisdiction of the crime.

As to inferior offences, the jurisdiction herein given to justices of the peace by particular statutes, is so various, and extends to such a multiplicity of cases, that it would be endless to endeavour to enumerate them. 6 Mod. 128. It has been held, that not only assaults and batteries, but libels, barratry, and common night-walking, and haunting bawdy-houses, and such like offences, which have a direct tendency to cause breaches of the peace, are cognizable by justices of the peace, as trespasses within the proper and natural meaning of the word. 1 Lev. 139.

Duty. Justices of the peace are to hold their sessions four times in the year, viz. the first week after Michaelmas, the Epiphany, Easter, and St. Thomas. They are justices of record; for none but justices of record can take a recognizance of the peace. Every justice of the peace has a separate power, and may do all acts concerning his office apart and by himself, and even may commit a fellow-justice upon treason, felony, or breach of the peace; and this is the antient power which conservators of the peace had at common law. By several statutes justices may act, in many cases, where their commission does not reach; the statutes themselves being a sufficient commission. Wood, Inst. 79, 80.

Justices of the peace are authorized to do all things appertaining to their office, so far as they relate to the laws for the relief, maintenance, and settlement of the poor; for passing and punishing vagrants; for repair of the highways; or to any other laws concerning parochial taxes, levies, or rates; notwithstanding they are rated or chargeable with the rates, with any place affected by such their acts. Provided that this shall not empower any justice for any county at large to act in the determination of any appeal to the quarter-sessions of such county, from any order, matter, or thing, relating to any such parish, township, or place, where such justice is so charged or chargeable. 16 Geo. II. c. 18.

The power of justices is ministerial, when they are commanded to do any thing by a superior authority, as the court of B. R. &c. In all other cases they act as judges; but they must proceed according to their commission, &c. Where a statute requires an act to be done by two justices, it is an established rule, that if the act is of a judicial nature, or the result of discretion, the two justices must be present to concert and join in it, otherwise it will be void; as in the orders of removal and filiation, the appointment of overseers, and the allowance of the indenture of a parish apprentice; but where the act is merely ministerial, they may act separately, as in the allowance of a poor-rate. This is the only act of two justices which has been construed to be ministerial; and the propriety of this construction has been justly questioned. 4 Durnf. & East, 386.

If a justice of the peace does not observe the form of proceeding directed by a statute, it is coram non judice, and void; but if he acts according to the direction of the statutes, neither the justices in sessions, nor B. R. can reverse what he has done. Jones, 170.

Where a justice shall exceed his authority in granting a warrant, the officer must execute it, and he is indemnified for so doing; but if it is in a case wherein he has no jurisdiction, or in a matter whereof he has no cognizance, the officer ought not to execute such warrant; for the officer is bound to take notice of the authority and jurisdiction of the justice. 10 Co. 76.

Justices acting improperly. If a justice of the peace will not, on complaint to him made, execute his office, or if he shall misbehave in his office, the party grieved may move the court of king's bench for an information, and afterwards may apply to the court of chancery to put him out of the commission. But the most usual way of compelling justices to execute their office, in any case, is by writ of mandamus out of the court of king's bench.

Where the plaintiff in an action against a justice, shall obtain a verdict, and the judge shall, in open court, certify on the back of the record, that the injury for which such action was brought, was wilfully and maliciously committed, the plaintiff shall have double costs. 24 G. II. c. 44. And if a justice of peace acts improperly, knowingly, information shall be granted. 27 G. III.

No justice shall be liable to be punished both ways, that is, criminally and civilly; but before the court will grant an information, they will require the party to relinquish his civil action, if any such is commenced: and even in the case of an indictment, and though the indictment is actually found, the attorney-general, on application made to him, will grant a noli prosequi upon such indictment, if it appears to him that the prosecutor is determined to carry on a civil action at the same time. Bur. 719.

If any action shall be brought against a justice for any thing done by virtue of his office, he may plead the general issue, and give the special matter in evidence; and if he recovers he shall have double costs. 7 Jac. c. 5. Such action shall not be laid but in the county where the fact was committed. 21 Jac. c. 12. And no suit shall be commenced against a justice of the peace till after one month's notice. And unless it is proved upon the trial that such notice was given, the justice shall have a verdict and costs. And no action shall be brought against any constable or other officer, or any person acting by his order and in his aid, for any thing done in obedience to the warrant of a justice, till demand has been made, or left at the usual place of his abode, by the party or by his attorney, in writing, signed by the party demanding the same, of the perusal and copy of such warrant, and the same has been refused or neglected for six days after such demand. And no action shall be brought against any justice for any thing done in the execution of his office, unless commenced within six months after the act committed. 24 G. II. c. 44.

PEACH, in botany. See AMYGDALUS.

PEACOCK. See PAVO.

PEAK OF DERBYSHIRE, a chain of very high mountains in the county of Derby in England, famous for the mines they contain, and for their remarkable caverns. The most remarkable of these are Pool's-hole and Elden-hole. The former is a cave at the foot of a high hill called Coitmoss, so narrow at the entrance that passengers are obliged to creep on all-fours; but it soon opens to a considerable height, extending to above a quarter of a mile, with a roof somewhat resembling that of an antient cathedral. By the petrifying water continually dropping in many parts of the cave, are formed a variety of curious figures, and representations of the works both of nature and art. There is a column here as clear as alabaster, which is called "the queen of Scots' pillar," because queen Mary is said to have proceeded thus far when she visited the cavern. It seems, the curiosity of that princess had led her thus far into the dark abode, and indeed there are few travellers who care to venture farther; but others, determined to see the end of all, have gone beyond it. After sliding down the rock a little way, is found the dreary cavity turned upwards: following its course, and climbing from crag to crag, the traveller arrives at a great height, till the rock, closing over his head on all sides, puts an end to any further subterraneous journey. Just at turning to descend, the attention is caught by a chasm, in which is seen a candle glimmering at a vast depth underneath. The guides say, that the light is at a place near Mary queen of Scots' pillar, and no less than 80 yards below. It appears frightfully deep indeed to look down; but perhaps does not measure any thing like what it is said to do. If a pistol is fired by the queen of Scots' pillar, it will make a report as loud as a cannon. Near the extremity there is a hollow in the roof, called "the needle's eye;" in which if a candle is placed, it will represent a star in the firmament to those who are below. At a little distance from this cave are two small clear streams, consisting of hot and cold water, so near each other, that the finger and thumb of the same hand may be put, the one into the hot water, and the other into the cold.

Elden-hole is a dreadful chasm in the side of a mountain; which, before the latter part of the last century, was thought to be altogether unfathomable. In the time of queen Elizabeth a poor man was let down into it for 200 yards; but he was drawn up in a frenzy, and soon after died. In 1682 it was examined by captain Collins, and in 1699 by captain Sturmy, who published their accounts in the Philosophical Transactions. The latter descended by ropes fixed at the top of an old lead-ore pit, four fathoms almost perpendicular, and thence three fathoms more obliquely, between two great rocks. At the bottom of this he found an entrance into a very spacious cavern, whence he descended along with a miner for 25 fathoms perpendicular. At last they came to a great river or water, which he found to be twenty fathoms broad and eight fathoms deep. The miner who accompanied him, insisted that this water ebbed and flowed with the sea; but the captain disproved this assertion, by remaining in the place from three hours flood to two hours ebb, during which time there was no alteration in the height of the water. As they walked by the side of this water, they observed a hollow in the rock some feet above them. The miner went into this place, which was the mouth of another cavern; and walked for about 70 paces in it, till he just lost sight of the captain. He then called to him, that he had found a rich mine, but immediately after came running out, and crying that he had seen an evil spirit; nor could any persuasions induce him to return. The floor of these caverns is a kind of white stone enamelled with lead ore, and the roofs are encrusted with shining spar. On his return from this subterraneous journey, captain Sturmy was seized with a violent head-ache, which, after continuing four days, terminated in a fever, of which he died in a short time.

Several years ago this cavern was visited by the late Mr. James Ferguson, who tells us, that it consists of two hollows one over another; but that the mouth of the lowermost is now stopped up by planks of timber laid across it, on which is a heap of stones thrown in at the upper mouth, with a design to fill up the cavern entirely; which, however, will probably be never accomplished, on account of its vast size.

PEAR, in botany. See Pyrus.

PEARCH, in ichthyology. See Perca.

PEARL, in natural history, a hard, white, shining body, usually roundish, found in various kinds of testaceous fishes.

Pearls, though esteemed of the number of gems by our jewellers, and highly valued, not only at this time, but in all ages, proceed only from a distemper in the creature that produces them, analogous to the bezoars and other stony concretions in several animals of other kinds.

The fish in which the largest and finest pearls are usually produced, is the East Indian pearl-oyster, as it is commonly called. Besides this shell there are many others that are found to produce pearls; as the common oyster, the muscle, and several others, the pearls of which are often very good; but those of the true Indian berberi, or pearl-oyster, are in general superior to all. The small or seed-pearls, also called ounce-pearls, from their being sold by the ounce and not by tale, are vastly the most numerous and common; but, as in diamonds, among the multitudes of small ones, there are smaller numbers and larger found, so in pearls there are larger and larger kinds; but as they increase in size, they are proportionably less frequent; and this is one reason of their great price. We have Scotch pearls frequently as large as a little tare, some as big as a large pea, and some few of the size of a horse-bean; but these are usually of a bad shape, and of little value in proportion to their weight. Philip II. of Spain had a pearl perfect in its shape and colour, and of the size of a pigeon's egg. The finest, and what is called the true shape of the pearl, is a perfect round; but if pearls of a considerable size are of the shape of a pear, as is not unfrequently the case, they are not less valued, as they serve for ear-rings and other ornaments. Their colour ought to be a pure white; and that not a dead and lifeless, but a clear and brilliant one: they must be perfectly free from any foulness, spot, or stain; and their surfaces must be naturally smooth and glossy; for they bring their natural polish with them, which art is not able to improve.

All pearls are formed of the matter of the shell, and consist of a number of coats spread with perfect regularity one over another, in the manner of the several coats of an onion, or like the several strata of the stones found in the bladders or stomachs of animals, only much thinner.

The manner of fishing for pearls in the East Indies is this: There are two seasons for pearl-fishing; the first is in March and April, and the last in August and September; and the more rain there falls in the year, the more plentiful are these fisheries. At the beginning of the season there are sometimes 250 barks on the banks: the larger barks have two divers, and the smaller one. As soon as barks arrive at the place where the fish lie, and have cast anchor, each diver binds a stone, six inches thick and a foot long, under his body, which serves him as a ballast, prevents his being driven away by the motion of the water, and enables him to walk more steadily under the waves. They also tie another very heavy stone to one foot, by which they are very speedily sent to the bottom of the sea: and as the oysters are usually firmly fastened to the rocks, they arm their hands with leather mittens, to prevent their being wounded in pulling them violently off; but this task some perform with an iron rake. In the last place, each diver carries down with him a large net, in the manner of a sack, tied to his neck by a long cord, the other end of which is fastened to the side of the bark. This net is to hold the oysters gathered from the rock; and the cord is to pull up the diver when his bag is full, or when he wants air. In this equipage he sometimes precipitates himself sixty feet under water; and as he has no time to lose, he no sooner arrives at the bottom, than he begins to run from side to side, tearing up all the oysters he meets with, and cramming them into his budget.

At whatever depth the divers are, the light is so great, that they easily see whatever passes in the sea; and, to their great consternation, sometimes perceive monstrous fishes, from which all their address in mudding the water, &c. will not save them, but they unhappily become their prey: and of all the dangers of the fishery this is one of the greatest and most usual. The best divers will keep under water near half an hour, and the rest do not stay less than a quarter. During this time they hold their breath, without the use of oils or any other liquors; only acquiring the habit by long practice. When they find themselves straitened, they pull the rope to which the bag is fastened, and hold fast by it with both hands; when those in the bark, taking the signal, heave them up into the air, and unload them of their fish; which is sometimes 500 oysters, and sometimes not above 50. Some of the divers need a moment's respite to recover breath; others jump in again instantly, continuing this violent exercise without intermission for several hours.

On the shore they unload their barks, and lay their oysters in an infinite number of little pits dug in the sand four or five feet square, raising heaps of sand over them to the height of a man; and in this condition they are left till the rain, wind, and sun, have obliged them to open, which soon kills them: upon this the flesh rots and dries; and the pearls, thus disengaged, fall into the pit on their taking out the shells. After clearing the pits of the grosser filth, they sift the sand several times, in order to find the pearl; but, whatever care they take, they always lose a great many. After cleaning and drying the pearls, they are passed through a kind of sieve, according to their sizes; the smallest are then sold as seed pearls, and the rest put up to auction, and sold to the highest bidder. See also Mya: and for the composition of the pearl, see the next article.

Mother-of-Pearl, is the shell not of the pearl oyster, but of another sea-fish of the oyster kind. This shell on the inside is extremely smooth, and of the whiteness and water of pearl itself; and it has the same lustre on the outside, after the first laminæ or scales have been cleared off with aquafortis, and the lapidary's mill. Mother-of-pearl is used in inlaid works, and in several toys, as snuff-boxes, &c.

Mother-of-pearl shells, when exposed to a red heat, crackle, blacken, and emit a strong fetid odour. They exfoliate, and become grey and white; when immersed in acids, they effervesce. The acids take up only the lime, and leave a number of thin membranaceous substances, which still retain the form of the shell. From Mr. Hatchett's experiments we learn, that these membranes have the properties of coagulated albumen. Mother-of-pearl shells then are composed of alternate layers of coagulated albumen and carbonat of lime, beginning with the epidermis, and ending with the last-formed membrane. The animals which inhabit these shells increase their habitation by the addition of a stratum of carbonat of lime, secured by a new membrane; and as every additional stratum exceeds in extent that which was previously formed, the shell becomes stronger as it becomes larger.

Though this in general is the structure of the mother-of-pearl shells, yet there is a considerable difference between the proportion of the component parts, and the consistency of the albuminous part. Some of them, as the common oyster-shell, approach nearly to the patellæ, the albuminous portion being small, and its consistence nearly gelatinous; while others, as the haliotis iris, the turbo olearius, the real mother-of-pearl, and a species of fresh-water muscle analysed by Hatchett, the membranes are distinct, thin, compact, and semitransparent. Mother-of-pearl contains

66	carbonat of lime
34	membrane
100.	

The pearl which is formed in some of these shells (see the preceding article) resembles them exactly in its structure and composition. It is a beautiful substance of a blueish-white colour, iridescent, and brilliant. It is composed of concentric and alternate cost a of thin membrane and carbonat of lime. Their iridescence is obviously the consequence of the lamellated structure.

Mr. Hatchett found that what is called the bone of the cuttle-fish is exactly similar to mother-of-pearl shells in its composition.

From the comparative analysis of shells and bones Mr. Hatchett was induced to compare them together, and has shewn that porcelanous shells bear a striking resemblance to enamel of teeth, while mother-of-pearl shells bear the same resemblance to the substance of teeth or bone: with this difference, that in enamel and bone the earthy salt is phosphat of lime, whereas in shells it is pure carbonat of lime.

PEARLS, *artificial*. Attempts have been made to take out stains from pearls, and to render the foul opaque-coloured ones equal in lustre to the Oriental. Abundance of processes are given for this purpose in books of secrets and travels; but they are very far from answering what is expected from them. Pearls may be cleaned indeed from any external foulnesses by washing and rubbing them with a little Venice soap and warm water, or with ground rice and salt, with starch and powder-blue, plaister of Paris, coral, white vitriol and tartar, cuttle-bone, pumice-stone, and other similar substances; but a stain that reaches deep into the substance of pearls is impossible to be taken out. Nor can a number of small pearls be united into a mass similar to an entire natural one, as some pretend.

There are, however, methods of making artificial pearls, in such a manner as to be with difficulty distinguished from the best Oriental. The ingredient used for this purpose was long kept a secret; but it is now discovered to be a fine silver-like substance found upon the under side of the scales of the blay or bleak. The scales, taken off in the usual manner, are washed and rubbed with fresh parcels of fair water, and the several liquors suffered to settle: the water being then poured off, the pearly matter remains at the bottom, of the consistence of oil, called by the French essence d'orient. A little of this is dropped into a hollow bead of blueish glass, and shaken about so as to line the internal surface; after which the cavity is filled up with wax, to give solidity and weight. Pearls made in this manner are distinguishable from the natural only by their having fewer blemishes.

PEAT, a well-known inflammable substance, used in many parts of the world as fuel. There are two species.

It consists, according to Kirwan, of clay mixed with calcareous earths and pyrites; sometimes also it contains common salt. While soft it is formed into oblong pieces for fuel, after the pyritaceous and stony matters are separated. By distillation it yields water, acid, oil, and ammonia; the ashes containing a small proportion of fixed alkali; and being either white or red, according to the proportion of pyrites contained in the substance.

The oil which is obtained from peat has a very pungent taste, and an empyreumatic smell, less fetid than that of animal substances, but more so than that of mineral bitumens: it congeals in the cold into a pitchy mass, which liquefies in a small heat: it readily catches fire from a candle, but burns less vehemently than other oils, and immediately goes out upon removing the external flame: it dissolves almost totally in rectified spirit of wine into a dark brownish-red liquor.

It is evident that peat will vary as to composition, according to situation and circumstance; and in almost every place will be found somewhat different. The following is an account of the peat found near Newbury in Berkshire: It is a composition of the branches, twigs, leaves, and roots of trees, with grass, straw, and plants, particularly moss, which, having lain long in water, is formed in a mass so soft as to be cut through with a sharp spade. The colour is a blackish brown, and it is used in many places for firing. There is a stratum of this peat on each side of the Kennet, near Newbury in Berks, which is from about a quarter to half a mile wide, and many miles long. The depth below the surface of the ground is from one foot to eight. Great numbers of entire trees are found lying irregularly in the true peat. They are chiefly oaks, alders, willows, and firs, and appear to have been torn up by the roots: many horses' heads, and bones of several kinds of deer; the horns of the antelope, the heads and tusks of boars, and the heads of beavers, are also found in it. Not many years ago an urn of a light-brown colour, large enough to hold about a gallon, was found in the peat-pit in Speen moor, near Newbury, at about 10 feet from the river, and four feet below the level of the neighbouring ground. Just over the spot where the urn was found, an artificial hill was raised about eight feet high; and as this hill consisted both of peat and earth, it is evident that the peat was older than the urn. From the side of the river several semicircular ridges are drawn round the hill, with trenches between them. The urn was broken to shivers by the peat-diggers who found it, so that it could not be critically examined; nor can it be known whether any thing was contained in it.

The ashes, properly burnt, are advantageously used for a manure. See HUSBANDRY.

There are many low grounds, which, nearly on a level with small rivers, and sometimes even below it, are alternately covered with earth and left by their waters, or admit them in such a manner as to be continually fermented by them. These grounds producing an enormous quantity of plants crowded together, incessantly growing, and annually accumulating layer upon layer, their soil becomes loaded to a greater or less depth with remains of vegetables, or herbaceous stalks, interwoven with each other in all directions, of a black and coaly colour, and of a disagreeable or even fetid smell, which indicate a considerably advanced stage of vegetable decomposition.

These remains, still solid and combustible, are known by the name of turf or peat; and the place from which they are taken are called bogs. Though peat consists of coherent masses, belonging to a much larger mass of one single piece of a subterranean deposit, yet by separating the filaments which compose their texture, we may distinguish several of the plants which have contributed to their formation. They are separable into long, soft, brown, or black stalks, sometimes indeed of a blueish or violet colour, which have lost the natural consistence of the plants to which they belonged, and are manifestly altered in their texture as well as in their nature.

When turf is heated in an apparatus for distillation, we obtain from it a yellow or reddish fetid water, an extremely stinking oil, carbonate of ammonia, and carbonated hydrogen gas of a very disagreeable smell. The residuum is a coal, frequently pyrophoric, from which some salts may be extracted after incineration; particularly muriates and sulphates of soda and potass, mixed with phosphate of lime, calcareous sulphate, and oxides of iron and manganese. Every person knows the manner in which turf burns in fire-places and furnaces, the ill smell it emits, and the reddish ferruginous ashes it leaves. Attempts have been made with some success to divest it of these inconveniences, by half-burning it in close vessels, so as to char it like wood. This process has certainly its advantage. It must be mentioned, however, that this charcoal is inferior to that commonly made from wood; and that it is liable to take fire from the combined action of air and water, so that it ought to be kept for use in close places well secured.

Peat therefore is in reality the residuum of plants or herbs half-decomposed, half-burned, reduced almost to the state of charcoal, analogous in its nature to fossil wood, which is equally carbonaceous. It is used as fuel, where there is no other. It may be very useful in forges: its ashes are employed as manure. By lixiviation, salts of use in the arts may be obtained from it. There are some bogs which are found to contain likewise sulphuret of iron, or pyrites. This compound, so combustible in moist air, heats them when they are exposed to it, and even occasions them to take fire. Some of them, such as those in the environs of Beauvais, are even capable of furnishing by lixiviation sulphate of iron, which is formed in them by exposure to the air. There is no doubt that most peats may be employed for obtaining from them by distillation an oil analogous to tar, as Becher proposed in 1683.

PEBBLES, the name of a genus of fossils, distinguished from the flints by having a variety of colours. These are defined to be stones composed of a crystalline matter debased by earths of various kinds in the same species; and then subject to veins, clouds, and other variegations, usually formed by incrustation round a central nucleus, but sometimes the effect of a simple concretion; and veined like the agates, by the disposition which the motion of the fluid they were formed in gave their differently-coloured substances.

The variety of pebbles is so great, that a hasty describer would be apt to make almost as many species as he saw specimens. A careful examination will teach us, however, to distinguish them into a certain number of essentially different species, to which all the rest may be referred as accidental varieties. When we find the same colours, or those resulting from a mixture of the same, such as nature frequently makes in a number of stones, we shall easily be able to determine that these are all of them the same species, though of different appearances; and this whether the matter is disposed of in one or two, or in 20 crusts, laid regularly round a nucleus; or thrown irregularly, without a nucleus, into irregular lines; or, lastly, if blended into an uniform mass.

These are the three states in which every pebble is found; for if it has been naturally and regularly formed by incrustation round a certain nucleus, we find that always the same in the same species, and the crusts not less regular and certain. If the whole has been more hastily formed, and the result only of one simple concretion, if that has happened while its different substances were all moist and thin, they have blended together and made a mixed mass of the joint colour of them all. But if they have been something harder when this has happened, and too far concreted to diffuse wholly among one another, they are found thrown together into irregular veins. These are the natural differences of all the pebbles; and having regard to these in their several variegations, all the known pebbles may be reduced to 34 species.

Such pebbles as are found in strata near the surface of the earth, are much more brittle than those which lie in deeper strata; and the more clear and transparent the sand is which is found among pebbles, the more beautiful the pebbles are generally observed to be.

PENCHBLENDE, one of the ores of uranium. See URANIUM.

PECORA, in zoology, the fifth order of the class mammalia, in the Linnæan system: they are thus distinguished; fore-teeth upper, none; lower, cutting, many; feet hoofed, cloven; food herbs, which they pluck; chew the cud; stomachs four; the paunch to macerate and ruminate the food; the bonnet, reticulate, to receive it; the omasus, or maniples of numerous folds, to digest it; and the abomasus or caille, fasciate, to give it acescency, and prevent putrefaction. In this order there are eight genera, viz. the antelope, bos, camelopardalis, camelus, capra, cervus, moschus, and ovis.

PECTEN, the *scallop*; a genus of shellfish, the characters of which are these: the animal is a tethys; the shell bivalve and unequal; the hinge toothless, having a small ovated hollow. This shell-fish is one of the spinners, having the power of spinning threads like the muscles; but they are much shorter and coarser than even those of that fish, so that they can never be wrought into any kind of work like the longer and finer threads of the pinna marina. The use of the threads which are spun by the scallop is, to fix the creature to any solid body near its shell. All these proceed, as in the muscle, from one common trunk. It is an evident proof that the fish has a power of fixing itself at pleasure to any solid body by means of these threads, that after storms the scallops are often found tossed upon rocks, where there were none the day before; and yet these are fixed by their threads, as well as those which had remained ever so long in their place. They form their threads in the very same manner with the muscle; only their organ which serves for spinning is shorter, and has a wider hollow, whence the threads are necessarily thicker and shorter.

The pectens, such as the sole pecten, the ducal-mantle pecten, the knotted, and others, seem to be in general inhabitants of the Indian seas; some of them frequent those of Africa, and the South seas. The most remarkable species is the maximus or great scallop, being the same with what Barbut calls the ducal-mantle pecten. It has fourteen rays, very prominent and broad, and striated both above and below. They are rugged, and imbricated with scales. They grow to a large size, are found in beds by themselves, are dredged up, and barrelled for sale. The antients say that they have a power of removing themselves from place to place by vast springs or leaps. This fish was used both by the Greeks and Latins as a food. When dressed with pepper and cummin, it was taken medicinally. The scallop was commonly worn by pilgrims on their hat, or the cape of their coat, as a mark that they had crossed the sea in their way to the Holy Land, or some distant object of devotion.

PECTIS, a genus of the class and order syngenesia polygamia superflua. The cal. is five-leaved, cylindric; florets in the ray five; down awned; recept. naked. There are four species, annuals of the West Indies.

PECULIAR, in the canon law, signifies a particular parish or church that has jurisdiction within itself for granting probates of wills, and administrations, exempt from the ordinary or bishop's courts. The king's chapel is a royal peculiar, exempt from all spiritual jurisdiction, and reserved to the visitation and immediate government of the king himself. There is likewise the archbishop's peculiar; for it is an antient privilege of the see of Canterbury, that wherever any manors or advowsons belong to it, they forthwith become exempt from the ordinary, and are reputed peculiars; there are fifty-seven such peculiars in the see of Canterbury. Besides these, there are some peculiars belonging to deans, chapters, and prebendaries, which are only exempted from the jurisdiction of the archdeacon; these are derived from the bishop, who may visit them, and to whom there lies an appeal.

PEDALS. See ORGAN.

PEDALIUM, a genus of the class and order didynamia angiospermia. The cal. is five-parted; the cor. five-cleft; nect. subaceous; seeds two. There is one species, an annual of the East Indies.

PEDESTAL. See ARCHITECTURE.

PEDICELLARIA, a genus of insects, of the order vermes mollusca: the generic character is, body soft and seated on a rigid peduncle; aperture single. There are three species. The P. tridens inhabits the north seas, among the spines of echini: nect. smooth, hyaline, sometimes reddish; lobes of the head sometimes four, and three times as long as the neck, rarely unarmed with awn; peduncle reddish, and three times as long as the neck. See Plate Nat. Hist. fig. 319.

PEDICULARIS, *red-rattle*, or *lousewort*, a genus of the didynamia angiospermia class of plants, the corolla whereof consists of a single ringent petal; the tube is oblong and gibbous; the upper lip galeated, erect, compressed, and emarginated; the under one is patent, plane, semitrifid, and obtuse; the fruit is a roundish acuminated capsule; the seeds are numerous, roundish, compressed and covered. There are 19 species. This plant is of a cooling and drying nature, whence it is recommended in fistulas and other sinous ulcers. It also stops hæmorrhages and the menses.

PEDICULUS, louse, a genus of insects of the order aptera: the generic character is, legs six, formed for walking; mouth furnished with an exsertile piercer; antennæ the length of the thorax; abdomen depressed, sublobated.

This is a very numerous genus of insects, far more remarkable for variety than elegance of appearance. Of these strange and unpleasing animals some infest the bodies of quadrupeds, others of birds, and some even those of insects themselves. It must, however, be here observed, that many small insects, infesting other animals, have been often referred to the genus pediculus, which in reality belong to those of acarus, monoculus, &c. &c.

The pediculus humanus, or common louse, is so well known as to render any particular description unnecessary. As a species, it is distinguished by its pale livid colour, and lobated, oval abdomen. It is produced from a small oval egg, properly called by the name of a nit, which is fastened or agglutinated by its smaller end to the hair on which it is deposited. From this egg proceeds the insect, complete in all its parts, and differing only from the parent animal in its smaller size. Such diminutive specimens are far preferable, for microscopic observation, to the full-grown insects, shewing in a more distinct manner the disposition of the viscera, muscles, &c. &c. When thus examined by the microscope, the principal appearances are as follow, viz. The trunk or proboscis, which is generally concealed in its sheath or tube, is of a very sharp form, and is furnished towards its upper part with a few reversed aculei or prickles; the eyes are large, smooth, and black: the stomach and intestines, which possess the greater part of the abdominal cavity, afford an extremely distinct and curious view of the peristaltic motion; while the ramifications of the tracheæ, or respiratory tubes, appear dispersed in an elegant manner throughout various parts of the animal, and are particularly observable towards their orifices on the sides of the abdomen; the legs are each terminated by a double claw, not greatly unlike that of a lobster, but of a much sharper form; and the whole animal is every where covered by a strong granulated skin. It is affirmed by Lewenhoek, that the male is furnished at the extremity of the abdomen with a sting, and that it is this extremity which causes the chief irritation suffered from these animals; the suction of the proboscis hardly seeming to have caused any perceptible pain on the skin of his hand. The male is readily distinguished from the female by having the tail or tip of the abdomen rounded; in the female it is forked or bifid. The same accurate observer (Lewenhoek), being desirous of learning the proportion and time of the increasing of these insects, placed two females in a black silk stocking, which he wore day and night for that purpose. He found that in six days, one of them had laid fifty eggs, and upon dissecting it, he found as many more in the ovary; he therefore concluded that in twelve days it would have laid a hundred eggs; these eggs, hatching in six days, which he found to be their natural time, would probably produce fifty males and as many females; and these females coming to their full growth in eighteen days, might each of them be supposed, after twelve days more, to lay also a hundred eggs; which in six days farther (the time required to hatch them) might produce a younger brood of five thousand; so that in eight weeks a louse might see five thousand of its own descendants.

The louse, in all ages enumerated among the pests of mankind, has been sometimes represented as the mere punishment of personal negligence, and sometimes commemorated as one of the most humiliating concomitants of degraded pride; since, exclusive of the memorable and impressive descriptions on this subject in the sacred writings, we meet with various examples of characters of no small degree of eminence who have suffered from the attacks of this odious insect. The disorder, however, commonly termed phthiriasis, is probably more owing to want of attention during the first stages of its appearance, than to any real constitutional cause in the patient; it being entirely contrary to the nature of this insect to get under the cuticle, as commonly supposed; and utterly inconceivable that a complaint merely external should be able to resist mercurial or other preparations outwardly used; there can be little doubt that such cases, whenever they occur, would be effectually removed by a proper application of a dilute solution of mercury sublimate. We must even venture to express our doubts whether a real and genuine phthiriasis, considered as a primary disease, has ever appeared. Notwithstanding this, we are told by Pliny that Pherecydes Sirius, Sylla the dictator, and others, have died of this disorder.

The insects of this genus found on quadrupeds and birds, may be considered as almost equalling the number of the animals themselves; since few of either division exist without one or more species peculiar to themselves.

PEDIGREE. See Descent.

PEDIMENT. See Architecture.

PEDOMETER, or Podometer, foot-measurer, or way-wiser; a mechanical instrument, in form of a watch, and consisting of various wheels and teeth; which, by means of a chain, or string, fastened to a man's foot, or to the wheel of a chariot, advance a notch each step, or each revolution of the wheel; by which it numbers the paces or revolutions, and so the distance from one place to another.

Plate Pedometer, &c. figs. 1, 2, 3, explains one of Spencer and Perkins's pedometers or way-wisers, which when worked in the pocket ascertains the number of steps made by the wearer. The external appearance, fig. 1. is somewhat like that of a watch: in the place of the watch-chain is a brass lever A, figs. 1 and 3, one end of which is bent into a hook; the other has a hole *a* through it, as shewn in fig. 2, and has a cleft cut in it through the hole; through this hole a wire passes, which wire is fixed between the two studs *b b*, figs. 1 and 2, so as to turn round freely; it also goes through the two arms of the piece B, fig. 2, and is made fast to them so that they turn with it the arm *x*, which is higher than the other, and has a narrow opening cut in it, into which is jointed a piece of steel D by a pin through its top; the end of the lever A has two small screws in it so as to close up the hole *a*, and pinch the wire which passes through the hole tight. When the lever A is moved backwards and forwards, it turns the wire by friction, and moves the piece B up or down till it is stopped by its leaf *d* coming either against the under side of the dial, or against the back of the case, as shewn in fig. 3.; the lever then slips round the pin. When the piece B is moved up or down, it pushes or pulls the piece D in or out of the case: the end of this is in two branches *ef*; the latter ends in the plain point, the other is bent into a hook; these branches take on each side of a small racket wheel, in fig. 3, which has 10 teeth. When the lever A is moved so as to draw back the piece D, the hook *e* takes one of the teeth of the racket wheel *n*, and moves it round one tooth: at the same time the point *f* slips over the sloping side the opposite tooth, and when the piece D is pushed in, it also moves the wheel round one tooth in the same direction as while the hoof *e* slips over the teeth ready for the next movement. The racket *m* has a pinion of 6 teeth on its under side, which tacks into a wheel *n* of 60 teeth; on the spindle of this wheel (which projects through the dial), is fastened the long hand *i*, fig. 1. As the wheel *m* makes one revolution for ten strokes of the lever A, and its pinion has one-tenth of the number of teeth in the wheel *n*, it is evident that 100 strokes of the lever will be required for one revolution of the wheel *n*, and hand *i*. The wheel *n* has a pinion of six leaves on it, which gives motion to a wheel *o* of 60 teeth, which turns *r* of 60 teeth, on whose arbour the hand *t*, fig. 1. is fastened: the wheel *o* has a pinion of 6 leaves on the under side of it, which moves a wheel *y* of 72 teeth, which carries the hand *s*, fig. 1.; by this arrangement the hand *t* will turn once round for 1000 strokes of the lever A; its dial is divided into 10 each, answering to 100, or 1 revolution of the hand *i*. The index *s* will turn round once for 1200 strokes of the lever; and its circle is divided into 12 parts, each of which denotes one revolution of the hand *t*, or 100 strokes of the lever; the hands are not fastened to their spindle, but can be turned round to set them all to O when it is going to be used. The best method of placing the machine, is with a case upon the thigh, the lever A brought towards the button of the waistband, and if possible, the joints of the lever over the joints of the thigh; that the lever being over the belly is at rest, while the motion of the thigh moves the case part of the machine at every step. Set all the hands to O; and when 100 paces are walked, the long hand will have made one revolution, and the hand will move to the figure 1, and so on as before described. Persons of middle stature are found to make about 1000 paces in a mile; but it is best to walk a mile several times, observing each time by the machine, the number of paces each time, and the average of these will serve to calculate by.

PEEK, in the sea-language, is a word used in various senses. Thus the anchor is said to be a-peek, when the ship being about to weigh, comes over her anchor in such a manner that the cable hangs perpendicularly between the hawse and the anchor. To heave a-peek, is to bring the peek so that the anchor may hang a-peek. A ship is said to ride a-peek, when lying with her main and fore-yards hoisted up, one end of her yards is brought down to the shrouds, and the other raised up on end; which is chiefly done when she lies in rivers, lest other ships falling foul of the yards should break them. Riding a broad peek, denotes much the same, excepting that the yards are only raised to half the height. Peek is also used for a room in the hold, extending from the bits forward to the stem: in this room men of war keep their powder, and merchantmen their victuals.

PEERS, in our common law, are those who are impannelled in an inquest upon any man, for the convicting or clearing him of any offence, for which he is called in question; and the reason is, because the course and custom of our nation is, to try every man in such a case by his equals, or peers.

Peers *of the realm*, are the nobility of the kingdom, and lords of parliament; who are divided into dukes, marquises, earls, viscounts, and barons; and the reason why they are called peers is, because notwithstanding there is a distinction of dignities in our nobility, yet in all public actions they are equal, as in their votes of parliament, and in passing upon the trial of any nobleman.

It seems clearly, that the right of peerage was originally territorial; that is, annexed to lands, houses, castles, &c.; the proprietors and possessors of which were, in right of those estates, allowed to be peers of the realm, and were summoned in parliament to do suit and service to their sovereign; and, when the land was alienated, the dignity passed with its appendant. Thus the bishops still sit in the house of lords, in right of succession to certain ancient baronies annexed, or supposed to be annexed, to their episcopal lands. But afterwards, as alienations grew frequent, the dignity of peerage was confined to the lineage of the party ennobled; and instead of territorial, became personal. Actual proof of a tenure by barony became no longer necessary to constitute a lord of parliament; but the record of the writ of summons to him, or his ancestors, was admitted as a sufficient evidence of the tenure.

Peers are now created either by writ, or patent; for those who claim by prescription must suppose either a writ or patent made to their ancestors, though by length of time it may be lost. The creation by writ or the king's letter, is a summons to attend the house of peers, by the style and title of that barony which the king is pleased to confer; that by patents is a royal grant to a subject, of any dignity and degree of peerage. The creation by writ, is the more antient way; but a man is not ennobled by it unless he actually takes his seat in the house of lords; and therefore the most usual, because the surest way, is to grant the dignity by patent, which ensures to a man and his heirs, according to the limitations thereof, though he never himself makes use of it. 1 Black. 399.

In criminal cases, a nobleman is tried by his peers. Peers shall have the benefit of clergy for the first offence of felony without being burned in the hand.

PEERESS, a woman who is noble by descent, creation or marriage. If a peeress by descent or creation, marries a person under the degree of nobility, she still continues noble; but if she obtains that dignity only by marriage, she loses it, on her afterwards marrying a commoner; yet, by the curtesy of England, she retains the title of her nobility. No peeress can be arrested for debt or trespass; for though on account of their sex, peeresses cannot sit in the house of lords, yet they enjoy the privileges of peers, and therefore all peeresses by birth are to be tried by their peers.

PEGANUM, *wild-rue*, or *harmel*, a genus of the dodecandria monogynia class of plants, the flower of which consists of five oval petals; and its fruit is a trilocular capsule containing a great many small seeds. There are two species.

This herb is said to have an inebriating and soporific quality.

PEGASUS, in astronomy, a constellation of the northern hemisphere, in form of a flying horse; said by different authors to contain 19, 20, and 93 stars.

Pegasus is also a genus of fishes of the order nantes: the generic character is, snout elongated, mouth beneath; pectoral fins large, ventral single-rayed; body depressed, mailed, with the abdomen divided into bony segments.

Pegasus draco, dragon pegasus. The principal species of this genus, the pegasus draco, is a small fish of about the length of three or four inches, and is remarkable for the size of its pectoral fins, which are supposed to enable it, like the exocœti and some other fishes, to support itself for some moments in the air, while it springs occasionally over the surface of the water: the thorax or superior part of the body is of a broad, slightly flattened, squarish form, and is marked both above and beneath by several radiated shields or bony tubercles of considerable size; from each side of the abdomen springs a lengthened cirrus, which may be considered as supplying the place of a ventral fin; from the thorax the body decreases suddenly in diameter, and is marked into several divisions or transverse segments; the tail is small and slightly rounded; the pectoral fins, as before observed, are large in proportion to the size of the animal, and of a rounded shape, with a kind of scalloped or indented outline; the eyes are large and protuberant, and the snout of a subconical form, but with a slight dilatation towards the tip, so as to appear spatule-shaped when viewed from above; the colour of the whole animal is whitish, with a slight cast of pale brown. It is a native of the Indian seas. See Plate Nat. Hist. fig. 320.

2. Pegasus volans: length about three inches; snout much elongated; on the head a rhomboidal depression, and behind it two deep subpentagonal cavities; last joints of the body, next the tail, pointed on each side. Native of the Indian seas.

3. Pegasus natans: length three or four inches; shape much more slender than that of the P. volans; colour yellowish-brown, whitish beneath. Native of the Indian seas.

PELAGIANS, a Christian sect who appeared before the latter part of the fourth, or the beginning of the fifth century. Pelagius, the author of this sect, was born in Wales, and his name was Morgan, which in the Welsh language signfies sea-born; whence he had his Latin name Pelagius. St. Austin gives him the character of a very pious man, and a Christian of no vulgar rank: according to the same father, he travelled to Rome, where he associated himself with persons of the greatest learning and figure, and wrote his commentaries on St. Paul's espistles, and his letters to Melania and Demetrius; but being charged with heresy, he left Rome, and went into Africa, and thence to Jerusalem, where he settled. He died somewhere in the East, but where is uncertain. He was charged with maintaining the following doctrines: 1. That Adam was by nature mortal, and whether he had sinned or not, would certainly have died. 2. That the consequences of Adam's sin were confined to his own person. 3. That new-born infants are in the same condition with Adam before the fall. 4. That the law qualified men for the kingdom of heaven, and was founded upon equal promises with the gospel. 5. That the general resurrection of the dead does not follow in virtue of our Saviour's resurrection. 6. That the grace of God is given according to our merits. 7. That this grace is not granted for the performance of every moral act; the liberty of the will, and information in points of duty, being sufficient, &c. Pelagius's sentiments were condemned by several councils in Africa, and by a synod at Antioch.

There was also a sect of semi-pelagians; who, with the orthodox, allowed of original sin; but denied that the liberty of the will could be so far impaired thereby, that men could not of themselves do something which might induce God to afford his grace to one more than another; and as to election, they held, that it depended on our perseverance; God choosing only such to eternal life, as continued stedfast in the faith.

PELECOIDES, in geometry, a figure in form of a hatchet: such is the figure BCDA, (see Plate Miscel. fig. 182.) contained under the two inverted quadrantal arcs AB and AD, and the semicircle BCD. The area of the pelecoides is demonstrated to be equal to the square AC, and that again to the parallelogram EB. It is equal to the square AC, because it wants of the square on the left hand the two segments AB and AC, which are equal to the two segments BC and CD, by which it exceeds on the right hand.

PELICAN, in chemistry, a kind of double glass vessel, used in distilling liquors by circulation: it consists of a cucurbit and alembic head, with two tubes bending into the cucurbit again.

PELICANUS, in ornithology, a genus belonging to the order of anseres. The bill is straight, without teeth, and crooked at the point; the face is naked; and the feet are palmated. See Plate Nat. Hist. fig. 321. Mr. Latham enumerates no less than 30 different species of this genus, besides varieties. The most remarkable seem to be these that follow:

1. The carbo, or cormorant, sometimes exceeds seven pounds in weight; the length three feet four; the extent four feet two; the bill dusky, five inches long, destitute of nostrils; the base of the lower mandible is covered with a naked yellow skin, that extends under the chin, and forms a sort of pouch; a loose skin of the same colour reaches from the upper mandible round the eyes and angles of the mouth; the head and neck are of a sooty blackness, but under the chin of the male the feathers are white; and the head in that sex is adorned with a short, loose, pendant crest; in some the crest and hind part of the head are streaked with white. The coverts of the wings, the scapulars, and the back, are of a deep green, edged with black, and glossed with blue; the quill-feathers and tail dusky; the legs are short, strong, and black; the middle claw serrated on the inside; the irides are of a light ash-colour.

The birds occupy the highest parts of the cliffs that impend over the sea: they make their nests of sticks, sea-tang, grass, &c. and lay six or seven white eggs of an oblong form. In winter they disperse along the shores, and visit the fresh waters, where they make great havock among the fish. They are remarkably voracious, having a most sudden digestion, promoted by the infinite quantity of small worms that fill their intestines. The cormorant has the rankest and most disagreeable smell of any bird, even when alive. Its form is disagreeable, its voice hoarse and croaking, and its qualities base. These birds, however, have been trained to fish, as falcons to fowl. Whitelock tells us, that he had a cast of them manned like hawks, and which would come to hand. He took much pleasure in them; and relates, that the best he had was one presented him by Mr. Wood, master of the cormorants to Charles I. It is well known that the Chinese make great use of these birds, or a congenerous sort, in fishing; and that not for amusement, but profit.

2. The graculus, or shag, is much inferior in size to the cormorant; the length is 27 inches; the breadth three feet six; the weight three pounds and three quarters. The bill is about four inches long, and more slender than that of the preceding; the head is adorned with a crest two inches long, pointing backward; the whole plumage of the upper part of this bird is of a fine and very shining green; the edge of the feathers a purplish black; but the lower part of the back, the head, and the neck, wholly green; the belly is dusky; the tail of a dusky hue, tinged with green; the legs are black, and like those of the cormorant. Both these kinds agree in their manners, and breed in the same places; and what is very strange in web-footed birds, will perch and build in trees; both swim with their head quite erect, and are very difficult to be shot; for, like the grebes and divers, as soon as they see the flash of a gun, they pop under water, and never rise but at a considerable distance.

3. The bassanus, gannet, or solan goose, weighs seven pounds; the length is three feet one inch; the breadth six feet two inches. The bill is six inches long, straight almost to the point where it inclines down; and the sides are irregularly jagged, that it

may hold its prey with more security; it has no nostrils, but in their place a long furrow, that reaches almost to the end of the bill; the whole is of a dirty white, tinged with ash-colour.

From the corner of the mouth is a narrow slip of black bare skin, that extends to the hind part of the head; beneath the chin is another, that, like the pouch of the pelican, is dilatable, and of size sufficient to contain five or six entire herrings; which in the breeding season it carries at once to its mate or its young.

The young birds, during the first year, differ greatly in colour from the old ones; being of a dusky hue, speckled with numerous triangular white spots; and at that time resemble in colour the speckled diver. Each bird, if left undisturbed, would only lay one egg in the year; but if that is taken away, they will lay another; if that is also taken, then a third, but never more that season. The egg is white, and rather less than that of the common goose; the nest is large, and formed of any thing the bird finds floating on the water, such as grass, sea-plants, shavings, &c. These birds frequent the isle of Alisa, in the frith of Clyde; the rocks adjacent to St. Kilda; the Stalks of Souliskerry, near the Orkneys; the Skelig isles off the coasts of Kerry, Ireland; and the Bass isle in the frith of Forth: the multitudes that inhabit these islands are prodigious.

4. The sulla, or booby, is somewhat less than a goose. The colours of the body are brown and white; but varied so in different individuals, that they cannot be described by them. Their wings are very long; their legs and feet pale yellow, shaped like those of cormorants. They frequent the Bahama islands, where they breed all months in the year, laying one, two, or three eggs on the bare rock. While young, they are covered with a white down, and continue so till they are almost ready to fly. They feed on fish like the rest of this genus; but have a very troublesome enemy in the man-of-war bird, which lives on the spoils obtained from other sea-birds, particularly the booby. As soon as this rapacious enemy perceives that the booby has taken a fish, he flies furiously at him, upon which the former dives to avoid the blow; but as he cannot swallow his prey below water, he is soon obliged to come up again with the fish in his bill as before, when he suffers a new assault; nor does his enemy cease to persecute him till he lets go the fish, which the other immediately carries off.

5. The aquilus, or man-of-war bird, is in the body about the size of a large fowl; in length three feet, and in breadth fourteen. The bill is slender, five inches long, and much curved at the point; the colour is dusky; from the under mandible hangs a large membranaceous bag attached some way down the throat, as in the pelican, and applied to the same uses; the colour of this is a fine deep red, sprinkled on the sides with a few scattered feathers; the whole plumage is brownish black, except the wing-coverts, which have a rufous tinge; the tail is long and much forked; the outer feathers are eighteen inches or more in length, the middle ones from seven to eight; the legs are small, all the toes are webbed together, and the webs are deeply indented; the colour of them is dusky red.

The frigate-pelican, or man-of-war bird, as it is by some called, is chiefly, if not wholly, met with between the tropics, and ever out at sea, being only seen on the wing. Sometimes it soars so high in the air as to be scarcely visible, yet at other times approaches the surface of the sea, where, hovering at some distance, the moment he spies a fish he darts down on it with the utmost rapidity, and seldom without success, flying upwards again as quick as he descended. It is also seen to attack gulls and other birds which have caught a fish, when it obliges them to disgorge it, and then takes care to seize it before it falls into the water.

6. The onocrotalus, or pelican of Asia, Africa, and America; though Linnæus thinks that the pelican of America may possibly be a distinct variety. This creature, in Africa, is much larger in the body than a swan, and somewhat of the same shape and colour. Its four toes are all webbed together, and in some measure resemble those of a swan; but that singularity in which it differs from all other birds is in the bill, and the great pouch underneath. This enormous bill is 15 inches from the point to the opening of the mouth, which is a good way back behind the eyes. At the base the bill is somewhat greenish, but varies towards the end, being of a reddish blue. It is very thick in the beginning, but tapers off to the end, where it hooks downwards. The under chap is still more extraordinary; for to the lower edges of it hangs a bag, reaching the whole length of the bill to the neck, which is said to be capable of containing 15 quarts of water. This bag the bird has the power of wrinkling up into the hollow of the under chap; but by opening the bill, and putting the hand down into the bag, it may be distended at pleasure. The first thing the pelican does in fishing is, to fill up the bag; and then it returns to digest its burden at leisure. Tertre affirms, that it will hide as many fish as will serve 60 hungry men at a meal.

This pelican was once also known in Europe, particularly in Russia; but it seems to have deserted our coasts. This is the bird of which so many fabulous accounts have been propagated; such as its feeding its young with its own blood, and its carrying water into the desert for them in its great reservoir. But the absurdity of the first account answers itself; and as for the latter, the pelican uses its bag for very different purposes than that of filling it with water.

The pelican feeds her young with fish macerated for some time in her bag, and when they cry, flies off for a new supply. Labat tells us, that he took two of these when very young, and tied them by the leg to a post stuck in the ground, where he had the pleasure of seeing the old one for several days come to feed them, remaining with them the greatest part of the day, and spending the night on the branch of a tree that hung over them. By these means they were all three become so familiar, that they suffered themselves to be handled; and the young ones very kindly accepted whatever fish he offered them. These they always put first into their bag, and then swallowed at their leisure.

It seems, however, that they are but disagreeable and useless domestics; their gluttony can scarcely be satisfied; their flesh smells very rancid, and tastes a thousand times worse than it smells. The native Americans kill vast numbers; not to eat, for they are not fit even for the banquet of a savage, but to convert their large bags into purses and tobacco-pouches. They bestow no small pains in dressing the skin with salt and ashes, rubbing it well with oil, and then forming it to their purpose. It thus becomes so soft and pliant, that the Spanish women sometimes adorn it with gold and embroidery, to make work-bags of.

PELLICLE, among physicians, &c. denotes a thin film, or fragment of a membrane.

When any liquor is evaporated in a gentle heat, till a pellicle arises at top, it is called an evaporation to a pellicle; wherein there is just liquor enough left, to keep the salts in fusion.

PELTARIA, a genus of the siliculosa order, in the tetradynamia class of plants; and in the natural method ranking under the 39th order, siliquosæ. The silicula is entire, and nearly orbiculated, compressed plane, and not opening. There are two species, herbs of the Cape.

PELVIS, in anatomy, the lower part of the cavity of the abdomen, thus called from its resemblance to a bason, or ewer, in Latin called pelvis. See Anatomy.

PEN, *fountain*, is a pen made of silver, brass, &c. contrived to contain a considerable quantity of ink, and let it flow out by gentle degrees, so as to supply the writer a long time without being under the necessity of taking fresh ink. The fountain-pen is composed of several pieces, as in the plate, where the middle piece F carries the pen, which is screwed into the inside of a little pipe, which again is soldered to another pipe of the same bigness as the lid G; in which lid is soldered a male screw, for screwing on the cover, as also for stopping a little hole at the place, and hindering the ink from passing through it. At the other end of the piece F is a little pipe, on the outside of which the top-cover H may be screwed; In the cover there goes a port-crayon, which is to be screwed into the last-mentioned pipe, in order to stop the end of the pipe, into which the ink is to be poured by a funnel. To use the pen, the cover G must be taken off, and the pen a little shaken, to make the ink run more freely.

PENANCE, in our canon law, is an ecclesiastical punishment chiefly adjudged to the sin of fornication. The punishment is thus described by the canons: the delinquent is to stand in the church porch on some Sunday, bare-headed and barefoot, in a white sheet, with a white wand in his hand, bewailing himself, and begging every one to pray for him; then he is to enter the church, and falling down, is to kiss the ground; and at last is to be placed on an eminence in the middle of the church, over against the minister, who is to declare the foulness of his crime which is odious to God, and scandalous to the congregation. If the crime is not notorious, the canons allow the punishment to be commuted at the party's request for a pecuniary mulct, for the benefit of the poor, &c.

PENÆA, a plant of the tetrandria monogynia class, with a monopetalous campaniform flower; and a quadragonal capsule for its fruit, containing four cells, with two oblong seeds in each. There are nine species. This plant has been erroneously supposed to have produced the sarcocolla of the shops.

PENDANT, an ornament hanging at the ear, frequently consisting of diamonds, pearls, and other precious stones.

PENDANTS, in heraldry, parts hanging down from the label, to the number of three, four, five, or six at most, resembling the drops in the Doric frieze.

PENDANTS of a ship, are those streamers or long colours which are split and divided into two parts ending in points, and hung at the head of masts, or at the yard-arm ends.

PENDULUM, in mechanics, any heavy body, so suspended as that it may swing backwards and forwards, about some fixed point, by the force of gravity.

These alternate ascents and descents of the pendulum, are called its oscillations, or vibrations; each complete oscillation being the descent from the highest point on one side, down to the lowest point of the arch, and so on, up to the highest point on the other side. The point round which the pendulum moves, or vibrates, is called its centre of motion, or point of suspension; and a right line drawn through the centre of motion, parallel to the horizon, and perpendicular to the plane in which the pendulum moves, is called the axis of oscillation. There is also a certain point within every pendulum, into which, if all the matter that composes the pendulum were collected, or condensed as into a point, the times in which the vibrations would be performed, would not be altered by such condensation; and this point is called centre of oscillation. The length of the pendulum is usually estimated by the distance of this point below the centre of motion; being always near the bottom of the pendulum; but in a cylinder, or any other uniform prism or rod, it is at the distance of one third from the bottom, or two thirds from and below the centre of motion.

The length of a pendulum, so measured to its centre of oscillation, that it will perform each vibration in a second of time, thence called the second's pendulum, has, in the latitude of London been generally taken at $39\frac{2}{10}$ or $39\frac{1}{5}$ inches; but by some very ingenious and accurate experiments, the late celebrated Mr. George Graham found the true length to be $39\frac{128}{1000}$, inches, or $39\frac{1}{8}$ inches very nearly.

The length of the pendulum vibrating seconds at Paris, was found by Varin, Des Hays, De Glos, and Godin, to be $440\frac{5}{6}$ lines; by Picard $440\frac{1}{2}$ lines; and by Mairan $440\frac{17}{30}$ lines.

Galileo was the first who made use of a heavy body annexed to a thread, and suspended by it, for measuring time, in his experiments and observations. But according to Sturmius, it was Riccioli who first observed the isochronism of pendulums, and made use of them in measuring time. After him, Tycho, Langrene, Wendeline, Mersenne, Kircher, and others, observed the same thing; though it is said, without any intimation of what had been done by Riccioli. But it was the celebrated Huygens who first demonstrated the principles and properties of pendulums, and probably the first who applied them to clocks. He demonstrated, that if the centre of motion was perfectly fixed and immoveable, and all manner of friction, and resistance of the air, &c. removed, then a pendulum, once set in motion, would for ever continue to vibrate without any decrease of motion, and that all its vibrations would be perfectly isochronal, or performed in the same time. Hence the pendulum has universally been considered as the best chronometer or measurer of time. And as all pendulums of the same length perform their vibrations in the same time, without regard to their different weights, it has been suggested, by means of them, to establish an universal standard for all countries.

Pendulums are either simple or compound; and each of these may be considered either in theory, or as in practical mechanics among artisans.

A simple pendulum, in theory, consists of a single weight, as A, Plate Miscel. fig. 183. considered as a point, and an inflexible right line AC, supposed void of gravity or weight, and suspended from a fixed point or centre, C, about which it moves.

A compound pendulum, in theory, is a pendulum consisting of several weights moveable about one common centre of motion, but connected together so as to retain the same distance both from one another, and from the centre about which they vibrate.

The doctrine and laws of pendulums. 1. A pendulum raised to B, through the arc of the circle AB, will fall and rise again, through an equal arc, to a point equally high, as D; and thence will fall to A, and again rise to B; and thus continue rising and falling perpetually. For it is the same thing, whether the body falls down the inside of the curve BAD, by the force of gravity, or is retained in it by the action of the string; for they will both have the same effect; and it is otherwise known, from the oblique descents of bodies, that the body will descend and ascend along the curve in the manner above described.

Experience also confirms this theory, in any finite number of oscillations. But if they are supposed infinitely continued, a difference will arise. For the resistance of the air, and the friction and rigidity of the string about the centre C, will take off part of the force acquired in falling; whence it happens that it will not rise precisely to the same point from whence it fell.

Thus, the ascent continually diminishing the oscillation, this will be at last stopped, and the pendulum will hang at rest in its natural direction, which is perpendicular to the horizon.

Now, as to the real time of oscillation in a circular arc BAD; it is demonstrated by mathematicians, that if $p = 3.1416$, denote the circumference of a circle whose diameter is 1; $g = 16\frac{1}{12}$ feet, or 193 inches, the space a heavy body falls in the first second of time; and $r = CA$, the length of the pendulum, also $a = AE$, the height of the arch of vibration; then the time of each oscillation in the arc BAD, will be equal to $p\sqrt{\frac{r}{2g}} \times$ into the infinite series

$$1 + \frac{1^2a}{2^2d} + \frac{1^2 . 3^2a^2}{2^2 . 4^2d^2} + \frac{1^2 . 3^2 . 5^2a^3}{2^2 . 4^2 . 6^2d^3}$$ &c. where $d = 2r$ is the diameter of the arc described, or twice the length of the pendulum.

And here, when the arc is a small one, as in the case of the vibrating pendulum of a clock, all the terms of this series after the 2d may be omitted, on account of their smallness; and then the time of a whole vibration will be nearly equal to $p\sqrt{\frac{r}{2g}} \times (1 + \frac{a}{8r})$. So that the times of vibration of a pendulum in different small arcs of the same circle, are as $8r + a$; or 8 times the radius, added to the versed sine of the semi-arc.

And farther, if D denotes the number of degrees in the semi-arc AB, whose versed sine is a, then the quantity last mentioned, for the time of a whole vibration, is changed to $p\sqrt{\frac{r}{2g}} \times (1 + \frac{D^2}{52524})$. And therefore the times of vibration in different small arcs, are as $52524 + D^2$, or as the number 52524 added to the square of the number of degrees in the semi-arc AB.

2. Let CB be a semicycloid, having its base EC parallel to the horizon, and its vertex B downwards; and let CD be the other half of the cycloid, in a similar position to the former. Suppose a pendulum-string, of the same length with the curve of each semicycloid BC, or CD, having its end fixed in C, and the thread applied all the way close to the cycloidal curve BC, and consequently the body or pendulum-weight coinciding with the point B. If now the body is let go from B, it will descend by its own gravity, and in descending it will unwind the string from off the arch BC, as at the position CGH; and the ball G will describe a semicycloid BHA, equal and similar to BGC, when it has arrived at the lowest point A; after which, it will continue its motion, and ascend, by another equal and similar semicycloid AKD, to the same height D, as it fell from at B, the string now wrapping itself upon the other arch CID. From D it will descend again, and pass along the whole cycloid DAB, to the point B; and thus perform continual successive oscillations between B and D, in the curve of a cycloid; as it before oscillated in the curve of a circle, in the former case.

This contrivance to make the pendulum oscillate in the curve of a cycloid, is the invention of the celebrated Huygens, to make the pendulum perform all its vibrations in equal times, whether the arch, or extent of the vibration, is great or small; which is not the case in a circle, where the larger arcs take a longer time to run through them than the smaller ones do, as is well known both from theory and practice.

The chief properties of the cycloidal pendulum then, as demonstrated by Huygens, are the following: 1st. That the time of an oscillation in all arcs, whether larger or smaller, is always the same quantity, viz. whether the body begins to descend from the point B, and describes the semiarch BA; or that it begins at H, and describes the arch HA; or that it sets out from any other point; as it will still descend to the lowest point A in exactly the same time. And it is farther proved, that the time of a whole vibration through any double arc BAD, or HAK, &c. is in proportion to the time in which a heavy body will freely fall, by the force of gravity, through a space equal to $\frac{1}{2}$AC, half the length of the pendulum, as the circumference of a circle is to its diameter. So that, if $g = 16\frac{1}{12}$ feet denotes the space a heavy body falls in the first second of time, $p = 3.1416$ the circumference of a circle whose diameter is 1, and $r = AC$ the length of the pendulum; then, because, by the nature of descents by gravity, $\surd g : \surd \frac{1}{2}r :: 1'' : \surd \frac{r}{2g}$, that is, the time in which a body will fall through $\frac{1}{2}r$, or half the length of the pendulum; therefore, by the above proportion, as $1 : p :: \surd \frac{a}{2g} : p\surd \frac{r}{2g}$, which is the time of an entire oscillation in the cycloid.

And this conclusion is abundantly confirmed by experience. For example: if we consider the time of a vibration as 1 second, to find the length of the pendulum that will so oscillate in 1 second; this will give the equation $p\surd \frac{r}{2g} = 1$; which reduced, gives $r = \frac{2g}{p^2} = \frac{386}{3.1416^2}$ inches $= 39.11$, or $39\frac{1}{9}$ inches, for the length of the second's pendulum; which the best experiments shew to be about $39\frac{1}{8}$ inches.

3. Hence also, we have a method of determining, from the experiment the length of a pendulum, the space a heavy body will fall perpendicularly through in a given time; for, since $p\surd \frac{r}{2g} = 1$, therefore, by reduction, $g = \frac{1}{2}p^2 r$ is the space a body will fall through in the first second of time, when r denotes the length of the second's pendulum; and as constant experience shews that this length is nearly $39\frac{1}{8}$ inches, in the latitude of London, in this case g, or $\frac{1}{2}p^2 r$, becomes $\frac{1}{2} \times 3.1416^2 \times 39\frac{1}{8} = 193.07$ inches $= 16\frac{1}{12}$ feet, very nearly, for the space a body will fall in the first second of time, in the latitude of London: a fact which has been abundantly confirmed by experiments made there. And in the same manner, Mr. Huygens found the same space fallen through at Paris, to be 15 French feet.

The whole doctrine of pendulums oscillating between two semicycloids, both in theory and practice, was delivered by that author, in his Horologium Oscillatorium, sive Demonstrationes de Motu Pendulorum. And every thing that regards the motion of pendulums has since been demonstrated in different ways, and particularly by Newton, who has given an admirable theory on the subject, in his Principia, where he has extended to epicycloids the properties demonstrated by Huygens of the cycloids.

4. As the cycloid may be considered as coinciding in A, with any small arc of a circle described from the centre C, passing through A, where it is known the two curves have the same radius and curvature; therefore the time in the small arc of such a circle, will be nearly equal to the time in the cycloid; so that the times in very small circular arcs are equal, because these small arcs may be considered as portions of the cycloid, as well as of the circle. And this is one great reason why the pendulums of clocks are made to oscillate in as small arcs as possible, viz. that their oscillations may be the nearer to a constant equality.

This may also be deduced from a comparison of the times of vibration in the circle, and in the cycloid, as laid down in the foregoing articles. It has there been shewn, that the times of vibration in the circle and cycloid are thus, viz.

time in the circle nearly $p\surd \frac{r}{2g} \times (1 + \frac{a}{8r})$,

time in the cycloidal arc $p\surd \frac{r}{2g}$; where it is evident that the former always exceeds the latter in the ratio of $1 + \frac{a}{8r}$ to 1; but this ratio always approaches nearer to an equality, as the arc, or as its versed sine a, is smaller; till at length, when it is very small, the term $\frac{a}{8r}$ may be omitted, and then the times of vibration become both the same quantity, viz. $p\surd \frac{r}{2g}$.

Farther, by the same comparison, it appears, that the time lost in each second, or in each vibration of the seconds pendulum, by vibrating in a circle, instead of a cycloid, is $\frac{a}{8r}$, or $\frac{D^2}{52524}$; and consequently the time lost in a whole day of 24 hours, is $\frac{5}{3}D^2$ nearly. In like manner, the seconds lost per day by vibrating in the arc of Δ degrees, is $\frac{5}{3}\Delta^2$. Therefore, if the pendulum keeps true time in one of these arcs, the seconds lost or gained per day, by vibrating in the other, will be $\frac{5}{3}(D^2 - \Delta^2)$. So, for example, if a pendulum measures true time in an arc of 3 degrees, on each side of the lowest point, it will lose $11\frac{2}{3}$ seconds a day by vibrating 4 degrees; and $26\frac{2}{3}$ seconds a day by vibrating 5 degrees; and so on.

5. The action of gravity is less in those parts of the earth where the oscillations of the same pendulum are slower, and greater where these are swifter; for the time of oscillation is reciprocally proportional to $\surd g$. And it being found by experiment, that the oscillations of the same pendulum are slower near the equator, than in places farther from it; it follows that the force of gravity is less there; and consequently the parts about the equator are higher or farther from the centre, than the other parts; and the shape of the earth is not a true sphere, but somewhat like an oblate spheroid, flatted at the poles, and raised gradually towards the equator. And hence also the times of the vibration of the same pendulum, in different latitudes, afford a method of determining the true figure of the earth, and the proportion between its axis and the equatorial diameter.

Thus, M. Richer found by an experiment made in the island of Cayenne, about 4 degrees from the equator, that a pendulum 3 feet $8\frac{3}{5}$ lines long, which at Paris vibrated seconds, required to be shortened a line and a quarter to make it vibrate seconds. And many other observations have confirmed the same principle. See Newton's Principia, lib. iii. prop. 20. By comparing the different observations of the French astronomers, Newton apprehends that 2 lines may be considered as the length a second's pendulum ought to be decreased at the equator.

From some observations made by Mr. Campbell, in 1731, in Black-river, in Jamaica, 18° north latitude, it is collected, that if the length of a simple pendulum that swings seconds in London, is 39.126 English inches, the length of one at the equator would be 39.00, and at the poles 39.206.

And hence Mr. Emerson has computed the following Table, shewing the length of a pendulum that swings seconds at every 5th degree of latitude, as also the length of the degree of latitude there, in English miles.

Degrees of Latitude.	Length of Pendulum.	Length of the Degree.
	inches.	miles.
0	39.027	68.723
5	39 029	68.730
10	39.032	68.750
15	39.036	68.783
20	39.044	68.830
25	39.057	68.882
30	39.070	68.950
35	39.084	69.020
40	39.097	69.097
45	39.111	69.176
50	39.126	69.256
55	39.142	69.330
60	39.158	69 401
65	39.168	69 467
70	39.177	69.522
75	39.185	69.568
80	39.191	69.601
85	39.195	69.620
90	39.197	69.628

6. If two pendulums vibrate in similar arcs, the times of vibration are in the sub-duplicate ratio of their lengths. And the lengths of pendulums vibrating in similar arcs, are in the duplicate ratio of the times of a vibration directly; or in the reciprocal duplicate ratio of the number of oscillations made in any one and the same time. For, the time of vibration t being as $p\surd \frac{r}{2g}$, where p and g are constant or given, therefore t is as $\surd r$, and r as t^2. Hence therefore the length of a half-second pendulum will be $\frac{1}{4}r$, or $\frac{39\frac{1}{8}}{4} = 9.781$ inches; and the length of the quarter-second pendulum will be $\frac{1}{16}r = \frac{39\frac{1}{8}}{16} = 2.445$ inches; and so of others.

7. The foregoing laws, &c. of the motion of pendulums, cannot strictly hold good, unless the thread that sustains the ball is void of weight, and the gravity of the whole ball is collected into a point. In practice, therefore, a very fine thread, and a small ball, but of a very heavy matter, are to be used. But a thick thread, and a bulky ball, disturb the motion very much; for in that case, the simple pendulum becomes a compound one; it being much the same thing, as if several weights were applied to the same inflexible rod in several places.

8. Mr. Krafft, in the new Petersburgh Memoirs, vols. 6 and 7, has given the result of many experiments upon pendulums, made in different parts of Russia, with deductions from them, from whence he derives this theorem: if x is the length of a pendulum that swings seconds in any given latitude l, and in a temperature of 10 degrees of Reaumur's thermometer, then will the length of that pendulum, for that latitude, be thus expressed, viz.

$x = (439{\cdot}178 + 2{\cdot}321 + \sin.^2 l)$ lines of a French foot. And this expression agrees very nearly, not only with all the experiments made on the pendulum in Russia, but also with those of Mr. Graham, and those of Mr. Lyons in 79° 50′ north latitude, where he found its length to be 441·38 lines.

Pendulum, *simple*, in mechanics, an expression commonly used among artists, to distinguish such pendulums as have no provision for correcting the effects of heat and cold, from those that have such provision. Also simple pendulum, and detached pendulum, are terms sometimes used to denote such pendulums as are not connected with any clock, or clockwork.

Pendulum, *compound*, in mechanics, is a pendulum whose rod is composed of two or more wires or bars of metal. These, by undergoing different degrees of expansion and contraction, when exposed to the same heat or cold, have the difference of expansion or contraction made to act in such a manner as to preserve constantly the same distance between the point of suspension and centre of oscillation, although exposed to very different and various degrees of heat or cold. There are a great variety of constructions for this purpose; but they may be all reduced to the gridiron, the mercurial, and the lever pendulum.

It may be just observed by the way, that the vulgar method of remedying the inconvenience arising from the extension and contraction of the rods of common pendulums, is by supplying the bob, or small ball, with a screw at the lower end; by which means the pendulum is at any time made longer or shorter, as the ball is screwed downwards or upwards, and thus the time of its vibration is kept continually the same.

The gridiron pendulum was the invention of Mr. John Harrison, a very ingenious artist, and celebrated for his invention of the watch for finding the difference of longitude at sea, about the year 1725, and of several other timekeepers and watches since that time; for all which he received the parliamentary reward of between 20,000 and 30,000 pounds. It consists of five rods of steel, and four of brass, placed in an alternate order, the middle rod being of steel, by which the pendulum-ball is suspended; these rods of brass and steel, thus placed in an alternate order, are so connected with each other at their ends, that while the expansion of the steel rods has a tendency to lengthen the pendulum, the expansion of the brass rods, acting upwards, tends to shorten it. And thus, when the length of the brass and steel rods is duly proportioned, their expansions and contractions will exactly balance and correct each other, and so preserve the pendulum invariably of the same length. The simplicity of this ingenious contrivance is much in its favour; and the difficulty of adjustment seems the only objection to it. See Longitude.

Mr. Harrison, in his first machine for measuring time at sea, applied this combination of wires of brass and steel, to prevent any alterations by heat or cold; and in the machines or clocks he has made for this purpose, a like method of guarding against the irregularities arising from this cause is used.

The mercurial pendulum was the invention of the ingenious Mr. Graham, in consequence of several experiments relating to the materials of which pendulums might be formed, in 1715. Its rod is made of brass, and branched towards its lower end, so as to embrace a cylindric glass vessel 13 or 14 inches long, and about two inches diameter; which being filled about twelve inches deep with mercury, forms the weight or ball of the pendulum. If upon trial the expansion of the rod is found too great for that of the mercury, more mercury must be poured into the vessel; if the expansion of the mercury exceeds that of the rod, so as to occasion the clock to go fast with heat, some mercury must be taken out of the vessel, so as to shorten the column. And thus may the expansion and contraction of the quicksilver in the glass be made exactly to balance the expansion and contraction of the pendulum-rod, so as to preserve the distance of the centre of oscillation from the point of suspension invariably the same.

Mr. Graham made a clock of this sort, and compared it with one of the best of the common sort, for three years together; when he found the errors of his own but about one-eighth part of those of the latter.

Mr. John Ellicott also, in the year 1738, constructed a pendulum on the same principle, but differing from Mr. Graham's in many particulars. The rod of Mr. Ellicott's pendulum was composed of two bars only; the one of brass, and the other of steel. It had two levers, each sustaining its half of the ball or weight; with a spring under the lower part of the ball to relieve the levers from a considerable part of its weight, and so to render their motion more smooth and easy. The one lever in Mr. Graham's construction was above the ball; whereas both the levers in Mr. Ellicott's were within the ball, and each lever had an adjusting screw, to lengthen or shorten the lever, so as to render the adjustment the more perfect.

Notwithstanding the great ingenuity displayed by these very eminent artists on this construction, it must farther be observed, in the history of improvements of this nature, that Mr. Cumming, another eminent artist, has given, in his Essays on the Principles of Clock and Watch Work, an ample description, with plates, of a construction of a pendulum with levers, in which it seems he has united the properties of Mr. Graham's and Mr. Ellicott's, without being liable to any of the defects of either. The rod of this pendulum is composed of one flat bar of brass, and two of steel; he uses three levers within the ball of the pendulum; and, among many other ingenious contrivances for the more accurate adjusting of this pendulum to mean time, it is provided with a small ball and screw below the principal ball or weight, one entire revolution of which on its screw will only alter the rate of the clock's going one second per day; and its circumference is divided into 30, one of which divisions will therefore alter its rate of going one second in a month.

Pendulum-clock, is a clock having its motion regulated by the vibration of a pendulum.

It is controverted between Galileo and Huygens, which of the two first applied the pendulum to a clock.

After Huygens had discovered, that the vibration made in arcs of a cycloid, however unequal they might be in extent, were all equal in time; he soon perceived, that a pendulum applied to a clock, so as to make it describe arcs of a cycloid, would rectify the otherwise unavoidable irregularities of the motion of the clock; since, though the several causes of those irregularities should occasion the pendulum to make greater or smaller vibrations, yet, by virtue of the cycloid, it would still make them perfectly equal in point of time; and the motion of the clock governed by it, would therefore be preserved perfectly equable. But the difficulty was, how to make the pendulum describe arcs of a cycloid; for naturally the pendulum, being tied to a fixed point, can only describe circular arcs about it.

Here Mr. Huygens contrived to fix the iron rod or wire, which bears the ball or weight at the top, to a silken thread, placed between two cycloidal cheeks, or two little arcs of a cycloid, made of metal. Hence the motion of vibration, applying successively from one of those arcs to the other, the thread, which is extremely flexible, easily assumes the figure of them, and by that means causes the ball or weight at the bottom to describe a just cycloidal arc.

This is doubtless one of the most ingenious and useful inventions many ages have produced; by means of which it has been asserted there have been clocks that would not vary a single second in several days; and the same invention also gave rise to the whole doctrine of involute and evolute curves, with the radius and degree of curvature, &c.

It is true, the pendulum is still liable to its irregularities, how minute soever they may be. The silken thread by which it was suspended, shortens in moist weather, and lengthens in dry; by which means the length of the whole pendulum, and consequently the times of the vibrations, are somewhat varied.

To obviate this inconvenience, M. De la Hire, instead of a silken thread, used a little fine spring; which was not indeed subject to shorten and lengthen, from those causes; yet he found it grew stiffer in cold weather, and then made its vibrations faster than in warm: to which also we may add its expansion and contraction by heat and cold. He therefore had recourse to a stiff wire or rod, firm from one end to the other. Indeed, by this means he renounced the advantages of the cycloid; but he found, as he says, by experience, that the vibrations in circular arcs are performed in times as equal, provided they are not of too great extent, as those in cycloids. But the experiments of sir Jonas Moore, and others, have demonstrated the contrary.

The ordinary causes of the irregularities of pendulums Dr. Derham ascribes to the alterations in the gravity and temperature of the air, which increase and diminish the weight of the ball, and by that means make the vibrations greater and less; an accession of weight in the ball being found by experiment to accelerate the motion of the pendulum; for a weight of six pounds added to the ball, Dr. Derham found made his clock gain thirteen seconds every day.

A general remedy against the inconveniences of pendulums, is to make them long, the ball heavy, and to vibrate but in small arcs. These are the usual means employed in England; the cycloidal cheeks being generally neglected.

Pendulum-clocks resting against the same rail have been found to influence each other's motion. See the Philos. Trans. numb. 453, sects. 5 and 6, where Mr. Ellicott has given a curious and exact account of this phenomenon.

Pendulum, *royal*, a name used among us for a clock, whose pendulum swings seconds, and goes eight days without winding up; shewing the hour, minute, and second. The numbers in such a piece are thus calculated: First cast up the seconds in twelve hours, which are the beats in one turn of the great wheel; and they will be found to be $43200 = 12 \times 60 \times 60$. The swing-wheel must be 30, to swing 60 seconds in one of its revolutions; now let the half of 43200, viz. 21600, be divided by 30, and the quotient will be 720, which must be separated into quotients. The first of these must be 12, for the great wheel, which moves round once in 12 hours. Now 720 divided by 12, gives 60; which may also be conveniently broken into two quotients, as 10 and 6, or 12 and 5, or 8 and $7\frac{1}{2}$, which last is most convenient; and if the pinions are all taken 8, the work will stand thus:

$$\begin{array}{l} 8\ )\ 96\ (\ 12 \\ 8\ )\ 64\ (\ \ 8 \\ 8\ )\ 60\ (\ 7\tfrac{1}{2} \\ \hline \qquad\quad 30 \end{array}$$

According to this computation, the great wheel will go round once in 12 hours, to shew the hour; the next wheel once in an hour, to shew the minutes; and the swing-wheel once in a minute, to shew the seconds. See CLOCKWORK.

PENEA, in botany, a genus of the monogynia order, in the tetrandria class of plants; and in the natural method ranking with those of which the order is doubtful. The calyx is diphyllous; the corolla campanulated; the style quadrangular; the capsule tetragonal, quadrilocular, and octospermous.

PENELOPE, a genus of birds of the order of gallinæ. The characters of which are: the beak is bare at the base; the head is covered with feathers; the neck is quite bare; the tail consists of twelve principal feathers; and the feet are for the most part bare. Linnæus, in the Systema Naturæ, enumerates six species: 1. Penelope meleagris satyra, or horned pheasant. Latham calls it the horned turkey. This species is larger than a fowl, and smaller than a turkey. The colour of the bill is brown; the nostrils, forehead, and space round the eyes are covered with slender black hairy feathers; the top of the head is red. Behind each eye there is a fleshy callous blue substance like a horn, which tends backward. On the forepart of the neck and throat there is a loose flap, of a fine blue colour, marked with orange spots, the lower part of which is beset with a few hairs; down the middle it is somewhat looser than on the sides, being wrinkled. The breast and upper part of the back are of a full red colour. The neck and breast are inclined to yellow; the other parts of the plumage and tail are of a rufous brown, marked all over with white spots encompassed with black. The legs are somewhat white, and furnished with a spur behind each. It is a native of Bengal.

2. The penelope meleagris cristata, is about the size of a fowl, being about two feet six inches long. The bill is two inches long, and of a black colour; the sides of the head are covered with a naked purplish blue skin, in which the eyes are placed: beneath the throat for an inch and a half, the skin is loose, of a fine red colour, and covered only with a few hairs. The top of the head is furnished with long feathers, which the bird can erect as a crest at pleasure; the general colour of the plumage is brownish black, glossed over with copper in some lights; but the wing-coverts have a greenish and violet gloss. They inhabit Brasil and Guiana, where they are often made tame. They frequently make a noise not unlike the word jacu. Their flesh is much esteemed.

3. Penelope crax cumanensis, called by Latham, &c. yacou. It is bigger than a common fowl. The bill is black; the head feathers are long, pointed, and form a crest, which can be erected at pleasure. It has a naked membrane, or kind of wattle, of a dull black colour. The blue skin comes forward on the bill, but is not liable to change colour like that of the turkey. The plumage has not much variation; it is chiefly brown, with some white markings on the neck, breast, wing-coverts, and belly. This species inhabits Cayenne, but is a very rare bird, being met with only in the inner parts, or about the Amazons' country. Those seen at Cayenne are mostly tame ones, for it is a familiar bird, and will breed in that state, and mix with other poultry. It makes the nest on the ground, and hatches the young there, but is at other times mostly seen on trees. It frequently erects the crest, when pleased, or taken notice of, and likewise spreads the tail upright like a fan, in the manner of the turkey.

4. The pipile, or as it is called, crax pipile, is black in the belly, and the back brown stained with black. The flesh on the neck is of a green colour. It is about the bigness of the former, and has a hissing noise. The head is partly black and partly white, and is adorned with a short crest. The space about the eyes, which are black, is white; the feet are red. It inhabits Guiana.

5. The marail is about the size of a fowl, and shaped somewhat like it. The space round the eyes is bare, and of a pale red; the chin, throat, and forepart of the neck, are scarcely covered with feathers; but the throat itself is bare, and the membrane elongated to half an inch or more; both this and the skin round the eyes change colour, and become deeper and thicker, when the bird is irritated. The head feathers are longish, so as to appear like a crest when raised up, which the bird often does when agitated; at which time it also erects those of the whole body, and so disfigures itself as to be scarcely known: the general colour of the plumage is a greenish black. This species is common in the woods of Guiana, at a distance from the sea. The female makes her nest on some low bushy tree, as near the trunk as possible, and lays three or four eggs. When the young are hatched, they descend with the mother after ten or twelve days. The mother acts as other fowls, scratching on the ground like a hen, and brooding the young, which quit their nurse the moment they can shift for themselves. They have two broods in a year; one in December or January, the other in May or June. The best time of finding these birds is morning or evening, being then met with on such trees whose fruit they feed on, and are discovered by some of it falling to the ground. The young birds are easily tamed, and seldom forsake the places where they have been brought up; they need not be housed as they prefer the roosting on tall trees to any other place. Their flesh is much esteemed.

6. The vociferating penelope. The bill of this bird is of a greenish colour: the back is brown, the breast green, and the belly of a whitish brown. Latham calls it the crying curassow. It is about the bigness of a crow.

PENGUIN, in ornithology. See ALCA.

PENNANTIC, a genus of the polygamia diœcia class and order. There is no calyx; the corolla is five-petalled; stamina five: perianthum three-sided, two-celled. There is one species, a herb of New Zealand.

PENNATULA, or SEA-PEN, a genus of zoophyte, which,* though it swims about freely in the sea, approaches near to the gorgonia. This genus has a bone along the middle of the inside, which is its chief support; and this bone receives the supply of its osseous matter by the same polype-mouths that furnish it with nourishment. Linnæus reckons seven species. It is certainly an animal, and as such is free or locomotive. Its body generally expands into processes on the upper parts, and these processes or branches are furnished with rows of tubular denticles; they have a polype-head proceeding from each tube.

The sea-pen is not a coralline, but distinguished from it by this specific difference; corals, corallines, alcyonia, and all that order of beings, adhere firmly by their bases to submarine substances, but the sea-pen either swims about in the water or floats upon the surface.

Its general appearance greatly resembles that of a quill-feather of a bird's wing; it is about four inches long, and of a reddish colour; along the back there is a groove from the quill part to the extremity of the feathered part, as there is in a pen; the feathered part consists of fins proceeding from the stem. The fins move the animal backward and forward in the water, and are furnished with suckers or mouths armed with filaments.

Dr. Boadsch of Prague had an opportunity of observing one of these animals alive in the water, and he gives the following account of what he saw: "A portion of the stem contracted, and became of a strong purple colour, so as to have the appearance of a ligature round it; this apparent ligature, or zone, moved upwards and downwards successively through the whole length of the stem, as well the feathered as the naked part; it began at the bottom, and moving upwards to the other extremity, it there disappeared, and at the same instant appeared again at the bottom, and ascended as before; but as it ascended through the feathered or pinnated part, it became paler." When this zone is much constricted, the trunk above it swells, and acquires the form of an onion; the constriction of the trunk gives the colour to the zone, for the intermediate parts are paler in proportion as the zone becomes deeper. The end of the naked trunk is sometimes curved like a hook; and at its extremity there is a sinus or chink, which grows deeper while the purple ring is ascending, and shallower as it is coming down. The fins have four motions, upward and downward, and backward and forward, from right to left, and from left to right. The fleshy filaments, or claws, move in all directions; and with the cylindrical part from which they proceed are sometimes protruded from the fins, and sometimes hidden with them.

Upon dissecting this animal the following phenomena were discovered: When the trunk was opened lengthwise, a saltish liquor flowed out of it, so viscid as to hang down an inch. The whole trunk of the stem was found to be hollow, the outward membrane being very strong, and about the tenth part of an inch thick; within this membrane appeared another much thinner; and between these two membranes, in the pinnated part of the trunk, innumerable little yellowish eggs, about the size of a white poppy-seed, were seen floating in a whitish liquor; about three parts of the cavity within the inner membrane is filled by a kind of yellowish bone; this bone is about two inches and a half long, and one twentieth of an inch thick; in the middle it is square, but towards the ends it grows round and very taper, that end being finest which is next the pinnated part of the trunk. This bone is covered in its whole length with a clear yellowish skin, which at each end runs out into a ligament; one is inserted in the top of the pinnated trunk, and the other in the top of the naked trunk; by the help of the upper ligament the end of the bone is either bent into an arch, or disposed in a straight line. The fins are composed of two skins; the outward one is strong and leathery, and covered over with an infinite number of crimson streaks; the inner skin is thin and transparent; the suckers are also in the same manner composed of two skins, but the outward skin is something softer. Both the fins and suckers are hollow, so that the cavity of the suckers may communicate with those of the fins, as the cavity of the fins does with that of the trunk. Dr. Shaw, in the History of Algiers, says, that these animals are so luminous in the water, that in the night the fishermen discover fishes swimming about in various depths of the sea by the light they give. From this extraordinary quality, Linnæus calls this species of the sea-pen pennatula phosphorea; and remarks, after giving the synonyms of other authors, habitat in oceano fundum illuminans.

There are other kinds of sea-pens, or species of this animal, which have not a resemblance to a pen.

PENNY, formerly a silver, but now a copper coin.

The penny was the first silver coin struck in England by our Saxon ancestors, being the 240th part of their pound, and its true weight was about $22\frac{1}{2}$ grains troy.

In Etheldred's time, the penny was the 20th part of the troy ounce, and equal in weight to our threepence; which value it retained till the time of Edward the Third.

Till the time of king Edward the First, the penny was struck with a cross so deeply sunk in it, that it might, on occasion, be easily broken, and parted into two halves, thence called halfpence; or into four, thence called fourthings, or farthings. But that prince coined it without the cross; instead of which he struck round halfpence and farthings: though there are said to be instances of such round halfpence having been made in the reign of Henry the First, if not also in those of the two Williams.

Edward the First also reduced the weight of the penny to a standard; ordering that it should weigh 32 grains of wheat, taken out of the middle of the ear. This penny was called the penny sterling; and 20 of them were to weigh an ounce, whence the penny became a weight as well as a coin.

By the 9th of Edward the Third, it was diminished to the 26th part of the troy ounce; by the 2d of Henry the Sixth it was the 32nd part; by the 5th of Edward the Fourth, it became the 40th, and also by the 36th of Henry the Eighth, and afterwards the 45th; but by the 2nd of Elizabeth, 60 pence were coined out of the ounce, and during her reign 62, which last proportion is still observed in our times.

Penny-weight, a troy weight, being the 20th part of an ounce, containing 24 grains; each grain weighing a grain of wheat gathered out of the middle of the ear, well dried. The name took its rise from its being actually the weight of one of our ancient silver pennies. See Penny.

PENTAGON, in geometry, a figure of five sides and five angles.

If the five sides are equal, the angles are so too, and the figure is called a regular pentagon; such is ABCDE (Plate Miscel. fig. 184), inscribed in the circle.

The most considerable property of a pentagon is, that one of its sides DE, is equal in power to the sides of a hexagon and a decagon, inscribed in the same circle ABCDE; that is, the square of the side DE, is equal to the sum of the squares of the sides dE and Eb.

The area of a pentagon, like that of any other polygon, may be obtained by resolving it into triangles. See the articles Triangle and Polygon.

Pappus has also demonstrated, that twelve regular pentagons contain more than twenty triangles inscribed in the same circle.

The dodecahedron, which is the fourth regular solid, consists of twelve pentagons.

In fortification, pentagon denotes a fort with five bastions.

PENTAGRAPH, or Parallelogram, an instrument whereby designs of any kind may be copied in what proportion you please, without being skilled in drawing.

A pentagraph is composed of 4 bars, ABDE, Plate Pedometer, &c. fig. 4, usually of brass; the bar A is jointed to B at b about the middle, and at a it is connected with E: the bar B is the same length as A; and at d is jointed to the bar D, whose end is connected with the end of E; these four bars form a parallelogram: thus, ba = D, and bd = E. To the other end of the bar A, a tube F is soldered, through which a pointed brass rod e, called the tracer, is put; the end of the bar B has a slider G upon it, which has a tube similar to F; another slider I of the same kind is mounted on the bar D. These sliders have screws, by which they can be fixed at any distance. Under each of the joints of the base, a small tube is fixed, in the bottom of which is a small castor as H, which makes the instrument run easily on the table. When the instrument is used, the two sliders GI must be set exactly in a line with the tube F; when it is required to make a copy of a drawing of the same size, the sliders must be set so that from F to I is the same distance as from I to G; the tube I must then have a wire put through it, whose lowest end is fast screwed to a heavy leaden weight, L; this must have three sharp points in the under side, so that when it is set on the table it may not be liable to move; then if a design or drawing is laid under the tube F, and the point of the tracer drawn over the lines of it, the point of the pencil at G will describe a similar figure. If the drawing is to be reduced to one-half of the size, the weight must be put to the slider G, and the pencil into I, without moving either slider; then the distance from the tracer to the fixed point or weight L, is twice the distance of the pencil to the weight. The rule for setting the sliders for any proportion is, as the distance between the tracer e and the fixed point L, is to the distance between the pencil G and the same, so is the length of any line described by the tracer, to the length of the line at the same time described by the pencil. To avoid the trouble of measuring these distances each time, the bars B and D are divided into ten or twenty of the most common proportions, by which divisions the sliders are to be fixed.

The construction of one of the sliders is shewn in fig. 5: where M is a piece of brass, to one corner of which a tube g is soldered; an opening of the same width as the bar is cut in this, and a cover N is screwed on with two screws: this cover has a screw with a mill-head through it, by which the slider is fixed. A piece of brass O, a little bent, is put between the bar and the under side of the cover, and whose elasticity prevents the slider moving too freely when the screw is slack, and defends the bar from being scratched by the ends of the screw when it is fixed.

Fig. 6, describes the method of making the joints of the rods: P is the end of one bar, which has a steel spindle p screwed fast to it; the other bar o has a cock v, screwed on, whose upper end projects over the tube t, and has a hole through it, just over the hole in the tube. The ends of the spindle P are put between the holes in the cock and the hole in the tube; if the spindles are well fitted, this joint is very steady, and without any shake. The lower end of the tube t has a hole drilled in it, into which the spindle W of the castor is put; the castor is kept from falling out of the tube, by the point of a small screw going through the side of the tube t, which takes into a notch cut round in the top of the spindle w. When the machine is used, a fine line, RR, is put through rings in the cocks bd, and tied to the pencil; the other end has a loop to be hooked over the thumb of the operator, by pulling which he can raise the pencil at D, when he does not wish it to mark.

PENTAMETER, in antient poetry, a kind of verse consisting of five feet, or metres, whence the name.

PENTANDRIA, in botany, one of Linnæus's class of plants, the fifth in order; the characters of which are, that all the plants comprehended in it have hermaphrodite flowers, with five stamina or male parts in each; they are subdivided into orders, which are denominated monogynia, digynia, trigynia, &c. according as there are one, two, three, &c. pistils, or female parts, in each flower.

PENTAPETES, a genus of the dodecandria order, in the monadelphia class of plants, and in the natural method ranking under the 37th order, columniferæ. The calyx is double; the stamina are 15 in number, of which five are castrated and long; the capsule quinquelocular and polyspermous. There is but one species known in the gardens of this country, viz. the phœnicia, with halbert-pointed, spear-shaped, sawed leaves. It is an annual plant, a native of India.

PENTHORUM, a genus of the pentagynia order, in the pentandria class of plants. The calyx is quinquefid; there are either five petals or none; the capsule is five-pointed and quinquelocular. There is one species.

PENTSLEMON, a genus of the didynamia angiospermia class and order. The calyx is five-leaved; the corolla bilabiate, ventricose; rudiment of a 5th stamen, bearded above; capsules two-celled. There are 2 species.

PENUMBRA, in astronomy, a partial shade observed between the perfect shadow and the full light in an eclipse.

It arises from the magnitude of the sun's body; for were he only a luminous point, the shadow would be all perfect; but by reason of the diameter of the sun, it happens that a place which is not illuminated by the whole body of the sun, does yet receive rays from a part thereof. See ECLIPSE.

PEPLIS, a genus of the monogynia order, in the hexandria class of plants, and in the natural method ranking under the 17th order, calycanthemæ. The perianthium is campanulated; the mouth cleft in 12 parts; there are six petals inserted into the calyx; the capsule is bilocular. There are 2 species, creeping plants.

PEPPER. See PIPER.

PERAMBULATOR, in surveying, an instrument for measuring distances, called also pedometer, way-wiser, and surveying wheel.

Plate Perambulator, &c. figs. 1, 2, and 3, represent a perambulator; AA, fig. 1, is a wheel of mahogany, tired with iron, and made very strong; its circumference must be exactly ninety-nine inches, or half a pole. This is placed so as to turn round in an opening cut in the piece BD, which forms the frame. In the arm B, a groove is cut from the centre of the wheel to the dial *b*; the end of the spindle comes through the wood into this groove, and has a small crown-wheel of eight teeth upon it. This works another wheel of eight teeth fixed on a long spindle, which conveys motion from the wheel beneath to the dial *b*. The groove containing this spindle has a slip of wood screwed over it, to keep out dirt, &c.; and the end of this spindle has a square hole in it, into which is put the square end of the spindle *a* (fig. 2). This has an endless screw *d* upon it, which works a worm-wheel *e* of twenty-four teeth, having a pinion of twelve beneath it: and below this has a wheel *f* of thirty-six. The pinion works the wheel *g* of forty; and the wheel *f* turns the pinion *h* of twelve, whose spindle carries the short hand of the dial (fig. 3). The arbour of the wheel *g* comes up through the dial, and has the hand F fig. 3 on it; as also a pinion of eight, which turns *g* of sixty-four. In the arbor of the wheel *h*, is a pinion *i* of six, taking into *k* of seventy-two; this is here supposed to be half broken away, to shew the wheels beneath. The spindle of this is hollow, and is put over the arbor of the wheel *g*; and carries the hand G fig. 3. HHHH are four pillars, by which the two plates forming the frame for the wheels are held together. The wheel *g* (fig. 2) is not fixed fast to its spindle, but is held between a brass plate *l* and another beneath; the friction of these causes the wheel to turn the hand, and at the same time leaves the hand at liberty to be set without moving the wheels. The plate *l* has a pin *n* fixed in it; which pin takes against a projecting part of the handle of the hammer *m*, so as to lift it up when the plate is turned, and let the spring *p* through *w* against the bell K.

When any distance is to be measured by this machine, the operator takes hold of the handle, and wheels it along in as straight a line as he can. The circumference of the wheel being ninety-nine inches (or half a pole), and the two wheels in the piece being equal, the screw *d* (fig. 2) will turn once in each turn of the great wheel, or twice for every pole the machine is wheeled. This screw must be so cut that the great wheel must turn twenty-four times for one turn of the wheel *e*, and also the wheel *f* on the same spindle as this must turn a pinion *h* of one-third of its number of teeth. The short hand on the dial which it carries will for every revolution require eight turns of the great wheel, = four poles, = one chain. The circle is divided into 100 parts, each = one link. The pinion of twelve on the arbor of the wheel *e*, turning once for twenty-four turns of the great wheel, makes the wheel *g* require for each revolution eighty turns of the great wheel, or for the machine to be wheeled ten chains (or turns of the short hand) = 40 poles (as the circle of its hand is divided), = one furlong: and at each revolution of this wheel, the hammer *m* will strike the bell K. The pinion of eight on the arbor of the wheel *g*, works *h* of sixty-four; and its pinion *i* turns K of seventy-two; the result of which will be, that the hand on the spindle of *k* will require for each revolution 7680 turns of the great wheel, or for the machine to be wheeled 3840 poles, = 960 chains or turns of the short hand, = 96 furlongs or turns of the hand F and strokes on the bell, = twelve miles as the dial is divided.

The use of this instrument is obvious from its construction. Its proper office is in the surveying of roads and large distances, where a great deal of expedition, and not much accuracy, is required. It is evident, that driving it along, and observing the hands, has the same effect as dragging the chain, and taking account of the chains and links.

Its advantages are, its handiness and expedition; its contrivance is such, that it may be fitted to the wheel of a coach, in which state it performs its office, and measures the road without any trouble.

PERCA, PERCH, a genus of fishes of the order thoracici; the generic character is, teeth sharp, incurvate; gill-covers triphyllous, scaly, serrated; dorsal fin spiny on the fore part; scales (in most species) hard and rough.

1. Perca fluviatilis, common perch. The perch is an inhabitant of clear rivers and lakes throughout almost all parts of Europe, arriving sometimes to a very large size, and to the weight of eight, nine, or ten pounds; its general size, however, is far smaller, usually measuring from six to fifteen inches in length, and weighing from two ounces to four pounds. The colour of the perch is brownish-olive, sometimes accompanied by a slight gilded tinge on the sides, and commonly marked by five or six moderately broad, blackish, transverse, semidecurrent bars; the dorsal fin is of a pale violet-brown, marked at the back of the spiny part by a roundish black spot accompanied by a smaller one; the rest of the fins, with the tail, are red.

The perch usually spawns in the early part of the spring, depositing a kind of extended bands of gluten, throughout which are disposed the ova in a sort of reticular direction. It is of a gregarious disposition, and is fond of frequenting deep holes in rivers which flow with a gentle current; it is extremely voracious, and bites eagerly at a bait; it is tenacious of life, and may be carried to the distance of sixty miles in dry straw, and yet survive the journey. It is one of those fishes which were held in repute at the tables of the antient Romans, and is in general esteem at the present day, being considered as firm and delicate. In some of the northern regions a species of isinglass is prepared from the skin.

2. Perca lucioperca, sandre perch. General length from one to two feet, but said sometimes to arrive at four feet; shape longer than in the preceding species, having something of the habit of a pike, the head being rather produced, and the mouth furnished with large teeth: general colour silvery grey, deepest on the back, and with a pretty strong tinge of blue on the head and gill-covers; sides of the back marked by pretty numerous, slightly decurrent, blackish bands; dorsal fins, by numerous dusky spots; pectoral fins, reddish; the rest dusky. Native of clear rivers and lakes in the middle parts of Europe, and highly esteemed for the table: in general manners said to resemble the common perch, but to be far less tenacious of life.

3. Perca cernua, ruffe perch. Length about six inches; shape more slender than that of the common perch; head rather large, and somewhat flattened; teeth small; colour subolivaceous, with numerous dusky spots disposed over the body, dorsal, pectoral fins, and tail; abdomen whitish; native of many parts of Europe; chiefly frequenting clear rivers, assembling in large shoals, and keeping in the deepest part of the water. There are about forty species of this genus. See Plate Nat. Hist. figs. 323, 324.

PERCH, in land-measuring, a rod or pole of $16\frac{1}{2}$ feet in length, of which 40 in length and 4 in breadth make an acre of ground. But, by the customs of several counties, there is a difference in this measure. In Staffordshire it is 24 feet; and in the forest of Sherwood 25 feet, the foot being there 18 inches long; and in Herefordshire a perch of ditching is 21 feet, the perch of walling $16\frac{1}{2}$ feet, and a pole of denshiered ground is 12 feet, &c.

PERCUSSION, in mechanics, the impression a body makes in falling or striking upon another, or the shock of two bodies in motion.

Percussion is either direct or oblique; direct, when the impulse is given in a line perpendicular to the point of contact; and oblique, when it is given in a line oblique to the point of contact.

The ratio which an oblique stroke bears to a perpendicular one, is as the sine of the angle of incidence to the radius. Thus, let *ab* (Plate Miscel. fig. 185) be the side of any body on which an oblique force falls, with the direction *da*; draw *dc* at right angles to *db*, a perpendicular let fall from *d* to the body to be moved, and make *ad* the radius of a circle; it is plain that the oblique force *da*, by the laws of composition and resolution of motions, will be resolved into the two forces *dc* and *bd*; of which *dc*, being parallel to *ab*, has no energy or force to move that body; and consequently, *db* expresses all the power of the stroke or impulse on the body to be moved. But *db* is the right sine of the angle of incidence *dab*; wherefore the oblique force *da*, to one falling perpendicularly, is as the sine of the angle of incidence to the radius.

Percussion, *centre of*, is that part or point of a pendulous body, which will make the greatest impression on an obstacle that is opposed to it whilst vibrating; for if the obstacle is opposed to it at different distances from the point of suspension, the stroke or percussion will not be equally powerful, and it will soon appear that this centre of percussion does not coincide with the centre of gravity.

The force of percussion is the same as the momentum, or quantity of motion, and is represented by the product arising from the mass or quantity of matter moved, multiplied by the velocity of its motion; and that without any regard to the time or duration of action; for its action is considered totally independant of time, or but as for an instant, or an infinitely small time.

This consideration will enable us to resolve a question that has been greatly canvassed among philosophers and mathematicians, viz. what is the relation between the force of percussion and mere pressure or weight? For we hence infer, that the former force is infinitely, or incomparably, greater than the latter. For, let M denote any mass, body, or weight, having no motion or velocity, but simply its pressure; then will that pressure or force be denoted by M itself, if it is considered as acting for some certain finite assignable time; but, considered as a force of percussion, that is, as acting but for an infinitely small time, its velocity being 0, or nothing, its percussive force will be $0 \times M$, that is 0, or nothing; and is therefore less than any the smallest percussive force whatever. Again, let us consider the two forces, viz. of percussion and pressure, with respect to the effects they produce. Now the intensity of any force is very well measured and estimated by the effect it produces in a given time: but the effect of the pressure M, in 0 time, or an infinitely small time, is nothing at all; that is, it will not, in an infinitely small time, produce, for example, any motion, either in itself, or in any other body; its intensity, therefore, as its effect, is infinitely less than any the smallest force of percussion. It is true, indeed, that we see motion and other considerable effects produced by mere pressure, and to counteract which it will require the opposition of some considerable percussive force; but then it must be observed, that the former has been an infinitely longer time than the latter in producing its effect; and it is no wonder in mathematics that an infinite number of infinitely small quantities makes up a finite one. It has therefore only been for want of considering the circumstance of time, that any question could have arisen on this head. Hence the two forces are related to each other, only as a surface is to a solid or body; by the motion of the surface through an infinite number of points, or through a finite right line, a solid or body is generated; and by the action of the pressure for an infinite number of moments, or for some finite time, a quantity equal to a given percussive force is generated; but the surface itself is infinitely less than any solid, and the pressure infinitely less than any percussive force. This point may be easily illustrated by some familiar instances, which prove at least the enormous disproportion between the two forces, if not also their absolute incomparability. And first, the blow of a small hammer, upon the head of a nail, will drive the nail into a board; when it is hard to conceive any weight so great as will produce a like effect, *i. e.* that will sink the nail as far into the board, at least unless it is left to act for a very considerable time; and even after the greatest weight has been laid as a pressure on the head of the nail, and has sunk it as far as it can as to sense, by remaining for a long time there without producing any farther sensible effect; let the weight be removed from the head of the nail, and instead of it, let it be struck a small blow with a hammer, and the nail will immediately sink farther into the wood. Again, it is also well known, that a ship-carpenter, with a blow of his mallet, will drive a wedge in below the greatest ship whatever, lying aground, and so overcome her weight, and lift her up. Lastly, let us consider a man with a club to strike a small ball, upwards or in any other direction; it is evident that the ball will acquire a certain determinate velocity by the blow, suppose that of 10 feet per second or minute, or any other time whatever; now it is a law, universally allowed in the communication of motion, that when different bodies are struck with equal forces, the velocities communicated are reciprocally as the weights of the bodies that are struck; that is, that a double body, or weight, will acquire half the velocity from an equal blow; a body ten times as great, one-tenth of the velocity; a body 100 times as great, the 100th part of the velocity; a body a million times as great, the millionth part of the velocity, and so on, without end; from whence it follows, that there is no body or weight, how great soever, but will acquire some finite degree of velocity, and be overcome, by any given small finite blow, or percussion.

In percussion, we distinguish at least three several sorts of bodies; the perfectly hard, the perfectly soft, and the perfectly elastic. The two former are considered as utterly void of elasticity; having no force to separate or throw them off from each other again, after collision; and therefore either remaining at rest, or elseproceeding uniformly forward together as one body or mass of matter.

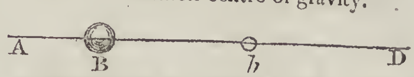
The laws of percussion therefore to be considered, are of two kinds; those for elastic, and those for non-elastic bodies.

The one only general principle for determining the motions of bodies from percussion, and which belongs equally to both the sorts of bodies, *i. e.* both the elastic and non-elastic, is this; viz. that there exists in the bodies the same momentum, or quantity of motion, estimated in any one and the same direction, both before the stroke and after it. And this principle is the immediate result of the third law of nature or motion, that reaction is equal to action, and in a contrary direction; from whence it happens, that whatever motion is communicated to one body by the action of another, exactly the same motion does this latter lose in the same direction, or exactly the same does the former communicate to the latter in the contrary direction.

From this general principle too it results, that no alteration takes place in the common centre of gravity of bodies by their actions upon another; but that the said common centre of gravity perseveres in the same state, whether of rest or of uniform motion, both before and after the shock of bodies.

Now, from either of these two laws, viz. that of the preservation of the same quantity of motion, in one and the same direction, and that of the preservation of the same state of the centre of gravity, both before and after the shock, all the circumstances of the motions of both the kinds of bodies after collision may be made out; in conjunction with their own peculiar and separate constitutions, namely, that of the one sort being elastic, and the other non-elastic.

The effects of these different constitutions, here alluded to, are these: that non-elastic bodies, on their shock, will adhere together, and either remain at rest, or else move together as one mass with a common velocity; or if elastic, they will separate after the shock, with the very same relative velocity with which they met and shocked. The former of these consequences is evident, viz. that non-elastic bodies keep together as one mass after they meet; because there exists no power to separate them, and without a cause there can be no effect. And the latter consequence results immediately from the very definition and essence of elasticity itself, being a power always equal to the force of compression or shock; and which restoring force therefore, acting the contrary way, will generate the same relative velocity between the bodies, or the same quantity of matter, as before the shock, and the same motion also of their common centre of gravity.



To apply now the general principle to the determination of the motions of bodies after their shock; let B and *b* be any two bodies, and V and *v* their respective velocities, estimated in the direction AD; which quantities V and *v* will be both positive if the bodies both move towards D, but one of them as *v* will be negative if the body *b* moves towards A, and *v* will be $= 0$ if the body *b* is at rest. Hence then, BV is the momentum of B towards D, and also *bv* is the momentum of *b* towards D, whose sum is $BV + bv$, which is the whole quantity of motion in the direction AD, and which momentum must also be preserved after the shock.

Now, if the bodies have no elasticity, they will move together as one mass $B + b$ after they meet, with some common velocity, which call y, in the direction AD: therefore the momentum in that direction after the shock, being the product of the mass and velocity, will be $(B + b) \times y$. But the momenta, in the same direction, before and after the impact, are equal, that is, $BV + bv = (B + b)\,y$; from which equation any one of the quantities may be determined when the rest are given. So, if we would find the common velocity after the stroke, it will be $y = \frac{BV + bv}{B + b}$, equal to the sum of the momenta divided by the sum of the bodies; which is also equal to the velocity of the common centre of gravity of the two bodies, both before and after the collision. The signs of the terms, in this value of y, will be all positive, as above, when the bodies move both the same way AD; but one term bv must be made negative when the motion of b is the contrary way; and that term will be absent or nothing, when b is at rest before the shock.

Again, for the case of elastic bodies, which will separate after the stroke, with certain velocities, x and z, viz. x the velocity of B, and z the velocity of b after the collision, both estimated in the direction AD, which quantities will be either positive, or negative, or nothing, according to the circumstances of the masses B and b, with those of their celerities before the stroke. Hence then, Bx and bz are the separate momenta after the shock, and $Bx + bz$ their sum, which must be equal to the sum $BV + bv$ in the same direction before the stroke: also $z - x$ is the relative velocity with which the bodies separate after the blow, and which must be equal to $V - v$, the same with which they meet; or, which is the same thing, that $V + x = v + z$; that is, the sum of the two velocities of the one body, is equal to the sum of the velocities of the other, taken before and after the stroke; which is another notable theorem. Hence then, for determining the two unknown quantities x and z, there are these two equations, viz.

$$BV + bv = Bx + bz,$$
and $$V - v = z - x;$$
or $$V + x = v + z;$$

the resolution of which equations gives those two velocities as below,

$$\text{viz. } x = \frac{2bv + (B - b)V}{B + b},$$

$$\text{and } z = \frac{2BV - (B - b)v}{B + b}.$$

From these general values of the velocities, which are to be understood in the direction AD, any particular cases may easily be drawn. As, if the two bodies B and b are equal, then $B - b = 0$ and $B + b = 2B$, and the two velocities in that case become, after impulse, $x = v$, and $z = V$, the very same as they were before, but changed to the contrary bodies, i. e. the bodies have taken each other's velocity that it had before, and with the same sign also. So that, if the equal bodies were before both moving the same way, or towards D, they will do the same after, but with interchanged velocities. But if they before moved contrary ways, B towards D, and b towards A, they will rebound contrary ways, B back towards A, and b towards D, each with the other's velocity. And, lastly, if one body, as b, was at rest before the stroke, then the other B will be at rest after it, and b will go on with the motion that B had before. And thus may any other particular cases be deduced from the first general values of x and z.

PERDICIUM, a genus of the class and order syngenesia polygamia superflua. The corollets are bilabiate; down simple; receptacle naked. There are six species.

PERENNIAL, in botany, is applied to those plants whose roots will abide many years, whether they retain their leaves in winter or not; those which retain their leaves are called evergreens; but such as cast their leaves, are called deciduous.

PERGALESIA, a genus of the pentandria digynia class and order. Contorted nect. surrounding the genitals with five-sagittated cups; corolla salver-shaped. There are five species, twining plants of the Cape, &c.

PERIANTHIUM. See BOTANY.

PERICARDIUM. See ANATOMY.

PERICARPIUM, among botanists, a covering or case for the seeds of plants. See BOTANY.

PERICRANIUM. See ANATOMY.

PERIGÆUM, PERIGEE. See ASTRONOMY.

PERIHELIUM. See ASTRONOMY.

PERILLA, a genus of the class and order didynamia gymnospermia. The calyx uppermost; segment very short; stamina distant; styles two, connected. There is one species, an annual of the East Indies.

PERIMETER, in geometry, the bounds or limits of any figure or body. The perimeters of surfaces or figures are lines, those of bodies are surfaces. In circular figures, instead of perimeter, we say circumference, or periphery.

PERINÆUM, or PERINEUM. See ANATOMY.

PERIOD, in astronomy, the time taken up by a star or planet in making a revolution round the sun; or the duration of its course till it returns to the same point of its orbit. See ASTRONOMY.

PERIOD. See CHRONOLOGY.

PERIOD, in grammar, denotes a small compass of discourse, containing a perfect sentence, and distinguished at the end by a point, or full stop, thus (.); and its members or divisions marked by commas, colons, &c.

PERIŒCI. See GEOGRAPHY.

PERIOSTEUM. See ANATOMY.

PERIPHERY, in geometry, the circumference of a circle, ellipsis, or any other regular curvilinear figure. See CIRCLE, &c.

PERIPLOCA, *Virginian silk*, a genus of the digynia order, in the pentandria class of plants; and in the natural method ranking under the 30th order, contortæ. The nectarium surrounds the genitals, and sends out five filaments. There are 13 species, some of which are natives of warm climates: one, however, is sufficiently hardy for this climate. The periploca is a fine climbing plant, that will wind itself with its ligneous branches about whatever tree, hedge, pale, or pole, is near it, and will arise, by the assistance of such support, to the height of above 30 feet; and where no tree or support is at hand to wind about, it will knit or entangle itself together in a most complicated manner. The stalks of the older branches, which are most woody, are covered with a dark-brown bark, whilst the younger shoots are more mottled with the different colours of brown and grey, and the ends of the youngest shoots are often of a light green. The leaves are the greatest ornament to this plant, for they are large, and of a shining green colour on their upper surface, and cause a variety by exhibiting their under surface of a hoary cast. Their figure is oblong, or rather more inclined to the shape of a spear, as their ends are pointed, and they stand opposite, by pairs, on short footstalks. Their flowers afford pleasure to the curious examiner of nature. Each of them singly has a star-like appearance; for, though it is composed of one petal only, yet the rim is divided into segments, which expand in such a manner as to form that figure. Their inside is hairy, as is also the nectarium which surrounds the petal. The propagation of this climber is very easy; for, if the cuttings are planted in a light moist soil, in the autumn or in the spring, they will readily strike root.

PERIPNEUMONY. See MEDICINE.

PERIPTERE. See ARCHITECTURE.

PERISCII. See GEOGRAPHY.

PERISTALTIC. See PHYSIOLOGY.

PERISTYLE. See ARCHITECTURE.

PERITONÆUM. See ANATOMY.

PERITROCHIUM. See MECHANICS.

PERJURY, is a crime committed when a lawful oath is administered, by any one who has authority, to a person in any judicial proceeding, who swears wilfully, absolutely, and falsely, in a matter material to the issue or cause in question, by his own act, or by the subornation of others. To constitute perjury, it is essential that the oath is wilfully taken; that it is in a judicial proceeding, or some other public proceeding of a similar nature: the oath must be taken before persons lawfully authorized to administer it, and also by a person sworn to depose the truth; it must also be taken absolutely and directly, and upon something material to the point in issue. It is not material whether the false oath is credited or not; or whether the party in whose prejudice it was taken, was in the event damaged by it; for the prosecution is not grounded upon the damage, but on the abuse of public justice. By stat. 5 Eliz. c. 9, persons guilty of perjury, or subornation of perjury, are to be punished with one year's imprisonment, and stand in the pillory where the offence was committed. This offence is also punished by transportation.

PERIWINKLE. See TURBO.

PERMUTATION *of quantities*, in algebra. See COMBINATION.

PERORATION. See RHETORIC.

PEROTIS, a genus of the digynia order, in the triandria class of plants, and in the natural method ranking under the fourth order, gramina. There is no calyx; the corolla consists of a bivalvular glume; the valves are oblong, acute, somewhat unequal, and terminating in a sharp beard. There are two species, natives of the East Indies.

PEROXIDE, in chemistry, denotes the maximum of oxidizement. See OXIDE.

PERPENDICULAR. See GEOMETRY.

PERPENDICULAR *to a parabola*, is a right line cutting the parabola in the point in which any other right line touches it, and is also itself perpendicular to that tangent.

PERPETUITY, in annuities, the number of years purchase to be given for an annuity which is to continue for ever. It is found by dividing 100*l*. by the rate of interest, and, consequently, is, at the most usual rates, as follows:

At 3 per cent.	33,3333
$3\frac{1}{2}$	28,5714
4	25,0000
$4\frac{1}{2}$	22,2222
5	20,0000
6	16,6666
	14,2857

These are the number of years purchase to be given for a perpetual annuity, on the supposition that it is receivable yearly; but as annuities are much more commonly receivable half-yearly, and the interest of money is likewise usually paid half-yearly, the perpetuity under these circumstances will be greater or less than the above, as the periods at which the annuity is payable are more or less frequent than those at which the rate of interest is supposed payable. Example at 4 per cent. interest:

Interest payable.	Annuity payable. Yearly.	Half-yearly.
Yearly,	25,000000	25,247548
Half-yearly,	24,752475	25,000000
Quarterly,	24,628109	24,875621

PERPETUITY is, where if all that have interest join in the conveyance, yet they cannot bar or pass the estate; for, if by concurrence of all having interest, the estate may be barred, it is no perpetuity. 1 Chan. Ca. 213.

PERRON. See ARCHITECTURE.

PERRY, a drink made of pears, in the same manner as cyder is made from apples. See CYDER.

PERSECUTION, is any pain or affliction which a person designedly inflicts upon another; and, in a more restrained sense, the sufferings of Christians on account of their religion. Historians usually reckon ten general persecutions, the first of which was under the emperor Nero, thirty-one years after our Lord's ascension; when that emperor having set fire to the city of Rome, threw the odium of that execrable action on the Christians, who under that pretence were wrapped up in the skins of wild beasts, and worried and devoured by dogs; others were crucified, and others burnt alive. The second was under Domitian, in the year 95. In this persecution St. John the apostle was sent to the isle of Patmos, in order to be employed in digging in the mines. The third began in the third year of Trajan, in the year 100, and was carried on with great violence for several years. The fourth was under Antoninus the philosopher, when the Christians were banished from their houses, forbidden to shew their heads, reproached, beaten, hurried from place to place, plundered, imprisoned, and stoned. The fifth began in the year 197, under the emperor Severus. The sixth began with the reign of the emperor Maximinus in 235. The seventh, which was the most dreadful persecution that had ever been known in the church, began in the year 250, in the reign of the emperor Decius, when the Christians were in all places driven from their habitations, stripped of their estates, tormented with racks, &c. The eighth began in the year 257, in the fourth year of the reign of the emperor Valerian. The ninth was under the emperor Aurelian, A. D. 274, but this was very inconsiderable; and the tenth began in the nineteenth year of Dioclesian, A. D. 303. In this dreadful persecution, which lasted ten years, houses filled with Christians were set on fire, and whole droves were tied together with ropes, and thrown into the sea.

PERSEUS, in astronomy, a constellation of the northern hemisphere, which, according to the catalogues of Ptolemy and Tycho, contains twenty-nine stars; but in the Britannic catalogue sixty-seven.

PERSIAN WHEEL, an engine, or wheel, turned by a rivulet, or other stream of water, and fitted with open boxes at its cogs, to raise water for the overflowing of lands, or other purposes. See HYDRAULICS.

It may be made of any size, according to the height the water is to be raised to, and the strength of the stream by which it is turned. This wheel is placed so that its bottom only is immersed in the stream, wherein the open boxes at its cogs are all filled one after another with water, which is raised with them to the upper part of the wheel's circuit, and then naturally empties itself into a trough which carries it to the land.

PERSICARIA, *arsmart.* See POLYGONUM.

PERSON, in grammar, a term applied to such nouns or pronouns, as being either prefixed or understood, are the nominatives in all inflections of a verb; or it is the agent or patient in all finite and personal verbs.

PERSONAL GOODS. See CHATTELS.

PERSONATE, is the representing a person by a fictitious or assumed character, so as to pass for the person represented. Personating bail, is by stat. 21 Jac. I. c. 26, a capital felony. By various other statutes, personating seamen entitled to wages, prize-money, &c. is also a capital felony.

PERSOONIA, a genus of the class and order tetrandria monogynia. There is no calyx; petals four; glands four, at the base of the germ; stigma blunt; drupe one-seeded.

PERSPECTIVE, is the art of drawing the picture or representation of any visible object on a plane surface, in such manner as it would appear on some transparent surface, interposed between an object and the eye of an observer. Hence it is the foundation of true painting, and is so far necessary in regulating the practical designs of an artist, that, without a knowledge of the principles thereof, he works at random, in not keeping to the nicety of measures and proportions. It has geometry for its foundation, and, consequently, truth for its support. It consists in determining and fixing the geometric situation of points in a picture, which points connected, produce lines, and lines (straight and curvilineal) constitute the first principles of a picture, the grand outline and structure which the painter is to dress with light and shade. Hence it is perceivable that the mathematician directs the outlines, but does not finish the piece; and, on the other hand, the painter cannot make a sure beginning without the mathematician's rules.

We do not mean to say that these rules are to be applied to the minute inflections or curvatures of every leafy subject of a landscape, or to all the smaller hollows and prominences of objects, or the muscular roundness and softness of living creatures; for these, as well as some other of the minutiæ of art, are to be determined by the eye, and drawn by a steady hand. A landscape-painter may study nature in the inmost recesses of a forest, and there store his mind with models of trees, shrubs, and foliage, and by such means he may become qualified to make a random picture of an individual shrub, or a group of trees; but if he would go further and represent a true protraiture of an avenue of these subjects, he must study the perspective diminution of the most remote parts thereof, as well as their relative positions, or his proposed picture will become an anamorphosis. He may give a tolerable direct view of one side of a building, but he can do no more; if he would give the representation of more than one side he must have recourse to the principles of perspective.

The practical rules of perspective are in great measure applied to the delineation of architectural bodies, and other right-lined figures; and a knowledge of the general laws of this science is sure to inform the judgment of the manner in which lines should run, whereto they should tend, and where terminate, so as to produce the desired effect.

Perspective is employed both in representing the ichnographies and the scenographics of objects; and the former is frequently found to be a necessary foundation of the latter.

We mean not to enter into an elaborate history of perspective, and say who it was that first discovered the properties of lines, which, when posited in certain order, would aid the representation of solid bodies, but rather proceed immediately to the practical rules, after premising that all the practical geometry necessary in this art has been elucidated in our preceding volume under that head, to which we refer the student.

The drawing-board, covered with a sheet of paper, may be termed the perspective plane, whereon the objects are to be delineated. See Plate Perspective, fig. 1.

Parallel to the bottom of this plane let a pencil-line be drawn, mark it AB, and call it the ground-line.

At about a third part, or somewhat more, of the height of the intended picture, or principal figure in the picture, draw (with the help of a T square) a pencil-line parallel to the ground-line, mark it *ho*, and call it the horizontal line. The height of this line will be variable, as the ground on which the observer stands may be higher or lower from the base of the principal figure; but, in general, when the draughtsman can choose his station, the height we have prescribed will be found the most convenient.

On that part of the ground-line which the eye is supposed opposite to in drawing any picture, draw another pencil-line perpendicular thereto, as at C, crossing the horizontal line at D. This point D is called the point of sight, being the spot which the eye is immediately opposite to, both in lateral and perpendicular position.

The ground-line, and its perpendicular, may be divided into scales of equal parts, whereof CD may be supposed five feet, the height of the eye.

The distance of the eye from the principal object must be set off in the horizontal line, both ways from the point of sight D. The choosing a proper distance is so essential a requisite, that, without a due observance thereof, a faithful representation of a picturesque object cannot be attained.

The most favourable point of distance seems to be that which is a mean between the diagonal of an upper quarter of the picture (as DG) set off from D to the perpendicular DE, continued as at *x*, and the length of the picture set off from G to the perpendicular, as at *y*; and the mean of the distance will be found at *z*, which will be somewhat about four times the height of the eye. This distance must be set off on the horizontal line also, as before mentioned, on one or both sides of the point of sight.

These requisites being laid down on the drawing-board, we may proceed to examples of finding the true positions of points and lines on the picture, from their ichnography, drawn out of, and below, the base line.

Suppose the pentagon ABDEF (fig. 2.) was to be represented by the rules of perspective on the transparent plane VP, placed perpendicularly on the horizontal plane HR; dotted lines are imagined to pass from the eye C to each point of the pentagon, as CA, CB, CD, &c. which are supposed in their passage through the plane PV, to leave their traces or vestigia in the points *a*, *b*, *d*, &c. on the plane, and thereby to delineate the pentagon *abdef*; which, as it strikes the eye by the same rays that the original pentagon ABDEF does, will be a true perspective representation of it.

The business of perspective, therefore, is to lay down geometrical rules for finding the points *abdef* upon the plane; and hence, also, we have a mechanical method of delineating any object very accurately.

Perspective is either employed in representing the ichnographics, or ground-plots of objects; or the scenographics, or representations of the objects themselves.

But before we give any examples of either, it will be proper to explain some technical terms in regard to perspective in general; and, first, the horizontal line is that supposed to be drawn parallel to the horizon through the eye of the spectator; or rather it is a line which separates the heaven from the earth, and which limits the sight. Thus, A, B, fig. 3, are two pillars below the horizontal line CD, by reason the eye is elevated above them; in fig. 4, they are said to be equal with it; and in fig. 5, raised above it. Thus, according to the different points in view, the objects will be either higher or lower than the horizontal line. The point of sight, A, fig. 6, is that which makes the central ray on the horizontal line; or, it is the point where all the other visual rays, D, D, unite. The points of distance, C, C, are points set off in the horizontal line at equal distances on each side of the point of sight, A; and, in the same figure, BB represents the base line, or fundamental line; EE is the abridgment of the square, of which D, D, are the sides; F, F, the diagonal lines, which go to the points of distance C, C. Accidental points, are those where the objects end: these may be cast negligently, because neither drawn to the point of sight, nor to those of distance, but meeting each other in the horizontal line. For example, two pieces of square timber, G and H, fig. 7, make the points I, I, I, I, on the horizontal line; but go not to the point of sight K, nor to the points of distance C, C: these accidental points serve likewise for casements, doors, windows, tables, chairs, &c. The point of direct view, or of the front, is when we have the object directly before us; in which case, it shews only the foreside; and, if below the horizon, a little of the top, but nothing of the sides, unless the object is polygonous. The point of oblique view, is when we see an object aside of us, and as it were aslant, or with the corner of the eye; the eye, however, being all the while opposite to the point of sight; in which case, we see the object laterally, and it presents to us two sides or faces. The practice is the same in the side-points, as in the front-points; a point of sight, points of distance, &c. being laid down in the one as well as in the other.

We shall now give some examples, by which it will appear that the whole practice of perspective is built upon the foundation already laid down. Thus, to find the perspective appearance of a triangle, ABC, fig. 8, between the eye and the triangle draw the line DE, which is called the fundamental line; from 2 draw 2 V, representing the perpendicular distance of the eye above the fundamental line, be it what it will; and through V draw, at right angles to 2 V, HH parallel to DE: then will the plane DHHE represent the transparent plane, on which the perspective representation is to be made. Next, to find the perspective points of the angles of the triangle, let fall perpendiculars A 1, C 2, B3, from the angles to the fundamental DE: set off these perpendiculars upon the fundamental opposite to the point of distance H, to B, A, C; from 1, 2, 3, draw lines to the principal point V; and from the points A, B, and C, on the fundamental line, draw the right lines AH, BH, CH, to the point of distance H; which is so called, because the spectator ought to be so far removed from the figure or painting, as it is distant from the principal point V. The points *a*, *b*, and *c*, where the visual lines V 1, V 2, V 3 intersect the lines of distance AC, BH, CH, will be the angular points of the triangle *abc*, the true representation of ABC.

By proceeding in this manner with the angular points of any right-lined figure, whether regular or irregular, it will be very easy to represent it in perspective; however, in practice, several compendious methods will occur to every artist. Again, if the scenographic appearance of any solid was to be represented, suppose of a triangular prism, whose base is the triangle *mno*, fig. 9, you need only find the upper surface of it, in the same manner as you found the lower, or base; and then joining the corresponding points by right lines, you will have the true representation of the solid in perspective. So that the work is the same as before; only you take a new fundamental line, as much higher than the former, as is the altitude of that solid whose scenographic representation you would delineate.

But there is still a more commodious way, which is this: having found, as above, the base or ichnographic plane *mno*, let perpendiculars be erected to the fundamental line from the three angular points, which will express the altitudes of those points. But because these altitudes, though equal in the body or solid itself, will appear unequal in the scenographic view, the farthest off appearing less than those nearer the eye, their true proportional heights may be thus determined. Any where in the fundamental line, let AB be erected perpendicularly, and equal to the true altitude; or, if the figure has different altitudes, let them be transferred into the perpendicular AB; and from the points A and B, and from all the points of intermediate altitudes, if there are any such, draw right lines to the point of sight V: those lines, AV, BV, will constitute a triangle with AB, within which all the points of altitude will be contained. Through the points *o*, *n*, *m*, draw parallels to the fundamental line; and from the points *a*, *a*, &c. erect perpendiculars to those parallels; and the points where they intersect the lines AV, BV, as in *a*, *a*, *b*, *b*, &c. will determine the apparent height of the solid in that scenographic position to the eye in V.

Parallel perspective is where the picture is supposed to be so situated, as to be parallel to the side of the principal object in the picture, as a building for instance. Then the lines on those sides of the building that are parallel to each other, continue parallel on the picture, and do not vanish into any point; while the lines at right angles to the former, vanish into the centre of the picture. This will be exemplified in fig. 10.

The picture being supposed to stand parallel to the side of the house ABCD, the lines AB, DC, which in nature are parallel to each, must be made parallel in the perspective representation. But the lines BE, CF, which in nature are at right angles to AB and DC, and consequently also to the picture, tend towards a point; and this point G, towards which they tend, is the centre of the picture.

Oblique perspective, is when the plane of the picture is supposed to stand oblique to the sides of the objects represented, in which case the representations of the lines upon those sides will not be parallel among themselves, but will tend towards their vanishing point. This kind of perspective is shewn in fig. 11.

A bird's-eye view, is a view supposed to be taken in the air, looking down upon the object, and differs from the usual way of drawing perspective views, in supposing the horizontal line to be raised much higher.

When an object is to be drawn in perspective, all its parts must be measured, so that we may be able to lay them down from a scale of equal parts.

Having determined whether it is to be parallel or oblique perspective, the first thing to be drawn is the horizontal line, which is to be put parallel to the bottom of the drawing, and as high above it as the height of a man's head, or five feet six inches, as HG, fig. 10, which is five feet six inches above the bottom of the house. Next, determine on the centre of the picture G, which must be placed so as to leave convenient room for the representation. Fix on C the nearest corner of the object, and draw the perpendicular CB: lay off CD equal to the length of the building, and draw DA and AB. From C, the nearest corner, draw CG, to the centre of the picture. CG now contains the line which represents the bottom of the end of the house; but this is an indefinite representation, of which we do not yet know the exact length. The method of determining this is as follows: Continue the line DC to I, and make CI equal to the width of the house. From G, the centre of the picture, lay off GK equal to the distance of the picture, the choosing of which must be regulated by taste. Draw IK, cutting CG in F; then is CF the exact width of the house in perspective, which was equal to CI. To find the middle of this end of the house, you cannot divide it by your compasses, because the farthest half will appear less than the nearer; but if you divide CI into two equal parts in L, and draw LK, it will cut CF into two equal parts perspectively. Or it may be found more simply thus: having drawn the lines BE and CF to the centre of the picture, draw the diagonals EC, BF, crossing each other in M, and raise the perpendicular MN, which is in the middle of the gable-end.

To find the height of the gable, lay its actual height above BE, upon the corner line BC continued, as BO, and draw OG; this crossing the perpendicular MN, gives N the point of the gable. The top of the chimney must be drawn in the same manner, by laying its real height, taken from a scale, on OP; and drawing PG, lay off L*m* and L*n*, each equal to half the width, and draw from these points to the distance-point K; this will cut the bottom of the house CF, in the points *o* and *p*; from these draw perpendiculars, which will give the perspective width of the chimney. To obtain its thickness, lay off PQ equal to its thickness, and draw QG; then drawing from *a* the line *ab*, you obtain the exact width of the chimney. From *b* draw *bc*, and from *d* draw *dc*. The other end of the gable may be drawn by two different methods. The first is by supposing the front of the house transparent, and drawing the other end as if seen through it, in the same manner as the end we have described, by laying its width from D to R, and drawing to the distance-point K. By raising the perpendicular in the middle, you will meet the ridge-line from the other gable in *d*. The other method is as follows: Through the centre of the picture G draw the line ST, upwards and downwards, and perpendicular to the horizontal line. Then continue the line of the roof B*d* till it meets ST in S. From A draw AS, which will give the other gable, and S will be the vanishing-point for all lines parallel to B*d* and A*d*; if NE is continued in like manner, it will give T for its vanishing-point. The doors and windows on the side ABCD are laid down from a scale, because that side being parallel to the picture, does not vary from its geometrical delineation, except shewing the thickness of the reveals, or edges of the doors and windows. If there had been any windows in the side BEFC, they would be drawn in perspective by the same method that was used for finding the width of the house and the middle of the end, viz. by laying off the actual dimensions from C upon CI, and drawing from these points to the distance-point K, which would transfer these divisions to the bottom of the house CF, and then perpendiculars might be drawn upwards.

This practice is farther explained by the following rule:

To divide a line in perspective which is parallel to the horizon, and which tends to a vanishing-point, into any number of equal parts; or to divide it into any required proportion.

Let AB be the line going to its vanishing-point C, fig. 12; and first let it be required to divide that line into six equal parts. Let CD be the horizontal line, and AE the ground-line, drawn parallel to it. Lay off, at pleasure, CD for the distance of the picture, if C is the centre of tne picture. Draw a line from D, touching the end B of the line to be divided: draw DBE, cutting the ground-line in E. Then AE represents the actual dimensions of the line AB, which is seen in perspective. (Here it may be observed, that this gives a rule also for finding the real length of any line which tends to a vanishing-point.) Divide AE into the same number of equal parts into which you proposed to divide the given line AB; as A1, 1 2, 2 3, &c. Then from these different divisions draw lines to D, cutting the line AB in *a*, *b*, *c*, *d*, &c. which will represent the required number of equal parts, but diminishing in size as they are farther removed from the eye. If it is wished to divide the line AB into any number of unequal parts, or to lay off doors, windows, &c. upon it, the line AE, found as before, must be divided in the required propoıtion, and lines drawn from those to D will give the required divisions on AB, from which perpendiculars may be drawn for the doors, windows, &c.

To draw a circle in perspective.

The perspective representation of every circle is a regular ellipsis, when the eye is without the circle; which may be demonstrated by considering that the rays from the circumference of the circle to the eye, form an oblique cone. But it is well known to those who are acquainted with conic sections, that every section of a cone, whether right or oblique, is a true ellipsis, except in one case only, which is, when the section is taken subcontrary to its base, a situation which happens so rarely in drawings that it may be disregarded altogether, and the section of a cone, or the perspective of a circle, in all cases considered as a perfect ellipsis.

The most correct and easy method of drawing an ellipsis is, to find the transverse and conjugate axes; the curve may then be completed by a trammel, or by hand. But as it is very difficult to find the transverse and conjugate axes of the ellipses which are the perspective representations of circles, recourse is generally had to another method of obtaining the curve. The circle is circumscribed by a square, as KLMN, in fig. 13, and the diagonals and the lines across the centre, and parallel to the sides, are drawn; also the lines *al*, *cd*, are drawn parallel to the sides, through the points where the circle is cut by the diagonals. This square, with all these lines drawn across it, is now put in perspective as follows: Draw AB for the horizontal line, and fix B for the centre of the picture, and AB for the distance of the picture. Make DC equal to the width of the square, and draw CB, DB; draw CA to the distance-point A, cutting off DG, equal to the depth of the square; then draw GF parallel to DC, which completes the perspective of the square; also draw the diagonal DF. Take now the distances M*a*, *c*N; and transfer them to D*x*, *o*C; from these points *x* and *o*, draw lines to the vanishing-point B, cutting the diagonals of the square. The points in this reticulated square in perspective, which correspond to those in the square KLMN, where the circle passes through, must now be observed, and a curve traced through them with a steady hand it will be the perspective required. Even in this process, it is of considerable use to know that the curve you are tracing is a regular ellipsis: for though you cannot easily ascertain the axes exactly, yet you may very nearly; and the eye very soon discovers whether the curve which has been drawn is that of a regular ellipsis or not.

Upon the same principle exactly, the row of arches, fig. 14, is drawn. The width of the arches and piers is obtained in the same manner as was shewn in fig. 12, viz. by laying their dimensions upon the ground-line AB, and drawing lines to the distance-point. The curves of the arches are then found by drawing the lines which correspond to those in half the square, fig. 13, in the same manner as described above for the circle.

Fig. 15 shews the appearance of circles drawn upon a cylinder, when HI is the horizontal line. The circle drawn on the cylinder at that place, is seen exactly edgeways, and appears only as a straight line; that next above it is seen a little underneath; the next still more; and so on, as they rise higher, appearing like so many ellipses of the same transverse diameter, but whose conjugate diameters continually increase in length, as they rise above the horizontal line. On the contrary, you see the under sides of the circles drawn below the horizontal lines; but they observe the same law, being so many ellipses, whose conjugate diameters vary in the same proportion. A little reflection on this simple example, will enable those who draw to avoid many ridiculous mistakes which are sometimes committed; such as shewing the two ends of a cask, or the top and bottom of a cylinder, at the same time.

Fig. 11 shews the method of drawing a building, or other object, in oblique perspective. AB is the horizontal line, and CD the ground-line, parallel to it as before. Here neither of the sides of the house is parallel to the picture, but each goes to its respective vanishing-point. Having fixed on the nearest corner E, draw EB, at pleasure, for one side, and choose any point F for the centre of the picture; then, to find the other side, lay off FG equal to the distance of the picture, which, as before, depends upon taste only; draw BG, and GA perpendicular to BG, cutting the horizontal line in A, the other vanishing-point. Draw now EA for the other side. To cut off the several widths of the two sides of the house, which as yet are only drawn to an indefinite extent, two distance-points must be laid down, viz. one for each vanishing-point. To do this, extend the compasses from B to G, and lay the distance taken in it from B to H, which will give H for the distance-point of B, and which is to cut off all the divisions on the side EB. Also extend the compasses from AG, and lay down AI. I is the distance-point of A, and is used for transferring all divisions upon the side EA from the ground-line GE. These points and lines being adjusted, the process is not much different from parallel perspective; only here equal divisions on each side of the building, as doors, windows, diminish as they recede in the same way as on the side BEFC, fig. 10. Lay the real length of the side EL, taken from the same scale used for laying down the horizontal line, and lay it down on the ground-line, from E to C, and draw CI, cutting off EL for the perspective length of the building. For the other side of the house, lay its width down in the same manner, from E to D, and draw DH, cutting off EN for the perspective width. Raise the perpendiculars EM, LK, and NO, for the three angles of the house. Lay the height of the building upon the corner that comes to the ground-line, as EM, and draw MK and MO to their several vanishing-points. Also lay all the heights of the doors and windows, and other divisions, upon EM, and draw them to the vanishing-points A and B. To lay down the widths of the doors and windows, put their actual widths upon CE, and draw from them to the distance-point I, which cuts off all divisions upon the side LE, and then raise the perpendiculars. The gable-end is found exactly in the same manner as has been described, only taking care to use the proper distance-point H. The manner of finding the width of the chimney is different. Lay off *ba* for the height of the chimney above the top of the gable, and draw *ac* parallel to the horizontal line; then put *ac* equal to the actual thickness of the chimney, and draw *ad* to the vanishing-point A; draw also *cd* to the distance-point I, cutting off *ad* in *d*: then having drawn *ef* from the nearest corner of the chimney, which was found as in fig. 10, draw *df* to the vanishing-point B, cutting off *ef* for the exact perspective width.

Fig. 16 represents the method of finding the perspective of a circle in oblique perspective. AB is the horizontal line, C the centre of the picture, and D, E, the distance-points. The process is exactly the same as that just described; the several divisions of the reticulated square in fig. 13, being laid upon the ground-line FG, and from these, lines are drawn to the distance-points. The perspective of the square is then drawn with all the lines across it, and the curve traced through the different points.

By drawing these examples frequently over, to a large scale, and reflecting upon them with attention, the student will become familiar with their use; and as they include the cases which most frequently occur, he will necessarily find great benefit from the knowledge of them.

The practical part of perspective, is only the application of these rules to the actual description of objects. But, as this part is purely mathematical, its assistance towards drawing is alone what can be performed by rule and compass, and can therefore strictly serve only for finding the images of points, of which they are composed; and, as these are infinite, it is endless to find them all by the strict rules; whence it becomes necessary after a sufficient number of them are found, to complete the image by the help of drawing, to the better effecting of which these points serve as a guide. Thus, when a circle is to be described, the practical rules serve to find a sufficient number of points in the circumference; which, being neatly joined by hand, will perfect the image, so that, in strictness, nothing in this image is found by mathematical rules, save the few particular points; the rest owes its being to the hand of the drawer.

Thus also, if any complicated figure is proposed, it may not be easy to apply the practical rules to the description of every minute part; but by inclosing that figure in a regular one, properly subdivided and reduced into perspective, that will serve as a help, whereby a person skilled in drawing, may with ease describe the object proposed. Upon the whole, where the boundaries of the proposed objects consist of straight lines and plane surfaces, they may be described directly by the rules of perspective; but when they are curvilinear, either in their sides or surfaces, the practical rules can only serve for the description of such right-lined cases as may conveniently inclose the objects, and which will enable the designer to draw them within those known bounds with a sufficient degree of exactness.

It is therefore in vain to seek, by the practical rules of perspective, to describe all the little hollows and prominences of objects, the different light and shade of their parts, or their smaller windings and turnings; the infinite variety of the folds in drapery; of the boughs and leaves of trees, or the features and limbs of men and animals; much less to give them that roundness and softness, that force and spirit, that easiness and freedom of posture, that expression and grace, which are requisite to a good picture. Perspective must content itself with its peculiar province of exhibiting a kind of rough draught to serve as a ground-work, and to ascertain the general proportions and places of the objects, according to their supposed situations; leaving the rest to be finished, beautified, and ornamented, by a hand skilful in drawing.

It is true, perspective is of most use where it is most wanted, and where a deviation from its rules would be the most observable; as in describing all regular figures, pieces of architecture, and other objects of that sort, where the particular tendency of the several lines is most remarkable; the rule and compass in such cases being much more exact than any description made by hand: but still the figure, described by the perspective rules, will need many helps from drawing; the capitals, and other ornaments of pillars, and their entablatures, the strength of light and shade, the apparent roundness and protuberance of the several parts, must owe their beauty and finishing to the designer's hand; but, with regard to such objects as have no constant and certain determinate shape or size, such as clouds, hills, trees, rivers, uneven grounds, and the like, there is a much larger latitude allowable, provided the general bulk, or usual natural shape of those objects, are in some measure observed, so as not to make them appear unnatural or monstrous. See DRAWING.

But, although the strict practical rules of perspective are in a great measure confined to the description of right-lined figures, yet the knowledge of the general laws of that science is of great and necessary use to inform the judgment, after what manner the images of any proposed lines should run, which way they should tend, and where terminate; and thereby enables it the better to determine what appearance any objects ought to put on, according to their different situations and distances; it accustoms the eye to judge with greater certainty of the relations between real objects and their perspective descriptions, and the hand to draw the same accordingly, and directs the judgment readily to discover any considerable error therein which might otherwise escape notice. Besides that, when the ground, or general plan, and the principal parts of a picture, are first laid down according to the rules, every thing else will more naturally fall in with them, and every remarkable deviation from the just rules will be the more readily perceived, and the easier avoided or rectified; so that although it may be infinitely tedious, or absolutely impracticable, to describe every minute part of a picture by the strict mechanical rules, yet the employing them, where they can be the most commodiously used, will give the picture in general such a look, as will guide the artist in drawing the other parts without any obvious inconsistency.

We shall, therefore, give such rules as are of most general use in the practice of perspective. 1. Let every line which in the object or geometrical figure is straight, perpendicular or parallel to its base, be so also in its scenographic delineation. 2. Let the lines, which in the object return at right angles from the fore-right side, be drawn scenographically from the visual point. 3. Let all straight lines, which in the object return from the fore-right side, run in a scenographic figure into the horizontal line. 4. Let the object you intend to delineate, standing on your right hand, be placed also on the right hand of the visual point; and that on the left hand, on the left hand of the same point; and that which is just before, in the middle of it. 5. Let those lines which are (in the object) equidistant to the returning line, be drawn in the scenographic figure, from that point found in the horizon. 6. In setting off the altitude of columns, pedestals, and the like, measure the height from the base-line upward, in the front or fore-right side; and a visual ray down that point in the front shall limit the altitude of the column or pillar, all the way behind the fore-right side, or orthographic appearance, even to the visual point. This rule you must observe in all figures, as well where there is a front or fore-right side, as where there is none. 7. In delineating ovals, circles, arches, crosses, spirals, and cross arches, or any other figure in the roof of any room, first draw it ichnographically; and so with perpendiculars from the most eminent points thereof, carry it up into the ceiling; from which several points carry on the figure. 8. The centre in any scenographic regular figure, is found by drawing cross lines from opposite angles: for the point where the diagonals cross, is the centre. 9. A ground-plane of squares is alike, both above and below the horizontal line; only the more it is distant above or beneath the horizon, the squares will be so much the larger or wider. 10. In drawing a perspective figure, where many lines come together, you may, for the directing of your eye, draw the diagonals in red: the visual lines in black; the perpendiculars in green, or other different colour from that which you intend the figure shall be of. 11. Having considered the height, distance, and position of the figure, and drawn it accordingly, with side or angle against the base, raise perpendiculars from the several angles or designed points, from the figure to the base; and transfer the length of each perpendicular, from the place where it touches the base, to the base on the side opposite to the point of distance; so will the diametrals drawn to the perpendiculars in the base, by intersection with the diagonals, drawn to the several transferred distances, give the angles of the figures, and so lines drawn from point to point will circumscribe the scenographic figure. 12. If in a landscape there are any standing waters, as rivers, ponds, and the like, place the horizontal line level with the farthest sight or appearance of it. 13. If there are any houses, or the like, in the picture, consider their position, that you may find from what point in the horizontal lines to draw the front and sides thereof. 14. In describing things at a great distance, observe the proportion both in magnitude and distance, in draught, which appears from the object to the eye. 15. In colouring and shadowing of every thing, you must do the same in your picture, which you observe with your eye, especially in objects lying near; but, according as the distance grows greater and greater, so the colours must be fainter and fainter, till at last they lose themselves in a darkish sky-colour. 16. The catoptrics are best seen in a common looking-glass, or other polished matter, where, if the glass is exactly flat, the object is exactly like its original: but, if the glass is not flat, the resemblance alters from the original; and that more or less, according as the glass differs from an exact plane. 17. In drawing catoptric figures, the surface of the glass is to be considered, upon which you mean to have the reflection: for which you must make a particular ichnographical draught or projection, which on the glass must appear to be a plane full of squares; on which projection transfer what shall be drawn on a plane, divided into the same number of like squares, where though the draught may appear very confused, yet the reflection of it on the glass will be very regular, proportional, and regularly composed. 18. The dioptric, or broken beam, may be seen in a tube through a crystal or glass which has its surface cut into many others, whereby the rays of the object are broken. For to the flat of the crystal, or water, the rays run straight; but then they break and make an angle, which also by the refracted beams is made and continued on the other side of the same flat. 19. When these faces on a crystal are returned towards a plane placed directly before it, they separate themselves at a good distance on the plane, because they are all directed to various far-distant places of the same.

Perspective plane, is the glass or other transparent surface, PV, (Plate Perspective, fig. 2.) supposed to be placed between the eye and the object, perpendicularly to the horizon. It is sometimes called the section, table, or glass.

PERSPIRATION. There seems to be something thrown out from the blood during its circulation in the arteries, at least through those vessels which are near the surface of the body: for it is a fact, that certain substances are constantly emitted from the skins of animals. These substances are known in general by the name of perspirable matter, or perspiration. They have a great resemblance to what is emitted in the lungs; which renders it probable that both excretions are owing to the same cause, namely, to the decomposition produced in the blood by the effects of respiration. Many experiments have been made to ascertain the quantity of matter perspired through the skin. For the first set, and not the least remarkable, we are indebted to Sanctorius, who continued them for no less than thirty years. He ascertained his own weight, and the weight of his food; and whatever weight he lost over and above that of his excrements, he ascribed to perspiration. A similar set of experiments was afterwards made in France by Dodart; in England by Keil; in Ireland by Bryan Robertson and Rye; and in Carolina by Lining. The result of all these experiments has been collected by Haller; but it gives us no precise estimate of the amount of the transpiration, since these philosophers have not distinguished between what is lost by the skin and by the lungs. Lavoisier and Seguin alone have attempted to ascertain the amount of the matter perspired through the skin. A bag composed of varnished silk, and perfectly air-tight, was procured, within which Seguin, who was usually the subject of experiment, was enclosed, and the bag was closed exactly over his head. There was a slit in the bag opposite to his mouth, and the edges of this slit were accurately cemented round the mouth by means of a mixture of turpentine and pitch. Thus every thing emitted by the body was retained in the bag, except what made its escape from the lungs by respiration. By weighing himself in a delicate balance at the commencement of the experiment, and again after he had continued for some time in the bag, the quantity of matter carried off by respiration was ascertained. By weighing himself without this varnished covering, and repeating the operation after the same interval of time had elapsed as in the former experiment, he ascertained the loss of weight occasioned by perspiration and respiration. By subtracting from this sum the loss of weight indicated by the first experiment, he obtained the quantity of matter which made its escape by perspiration in a given time. The following facts were ascertained by these experiments: 1. The maximum of matter perspired in a minute amounted to 26.25 grains troy; the minimum to 9 grains: which gives 17.63 grains at a medium in the minute, or 52.82 ounces in the 24 hours. This quantity differs less than might have been expected from the result of former experiments made by Dodart, Keil, Rye, &c. 2. The quantity perspired is increased by drink, but not by solid food. 3. Perspiration is at its minimum immediately after a repast. It reaches its maximum during digestion. See Digestion.

The quantity of matter perspired differs very considerably according to circumstances. It has been shewn to be greatest in hot weather, and in hot climates, and after great exercise; and its relation to the quantity of urine has been long known. When the matter perspired is great, the quantity of urine is small, and vice versa.

To ascertain the substance thus emitted by perspiration is a difficult task, because it passes off invisibly, and in small quantities at a time. It has, notwithstanding, been ascertained that water, carbon, and an oily matter, are emitted; and that an acid supposed to be the phosphoric, phosphat of lime, and even urea, are sometimes emitted through the skin.

1. The most accurate experiments on this matter that have been made are those of Mr. Cruikshank. He put his hand into a glass vessel, and luted its mouth at his wrist by means of a bladder. The interior surface of the vessel became gradually dim, and drops of water trickled down. By keeping his hand in this manner for an hour, he collected thirty grains of a liquid, which possessed all the properties of pure water. On repeating the same experiment at nine in the evening (thermometer 62°), he collected only 12 grains. The mean of these is 21 grains. But as the hand is more exposed than the trunk of the body, it is reasonable to suppose that the perspiration from it is greater than that from the hand. Let us therefore take 30 grains per hour as the mean; and let us suppose, with Mr. Cruikshank, that the hand is $\frac{1}{60}$th of the surface of the body. The perspiration in an hour would amount to 1880 grains, and in 24 hours to 43,200 grains, or 7 pounds 6 ounces troy. This is almost double the quantity ascertained by Lavoisier and Seguin. Hence we may conclude that more matter is perspired through the hand than the other parts of the body, provided Mr. Cruikshank's estimate of the ratio between the surface of the hand and body is not erroneous.

He repeated the experiment again after hard exercise, and collected in an hour 48 grains of water. He found also, that this aqueous vapour pervaded his stocking without difficulty; and that it made its way through a shamoy-leather glove, and even through a leather boot, though in a much smaller quantity than when the leg wanted that covering.

It is not difficult to see why the quantity of watery vapour diminishes with cold. When the surface of the body is exposed to a cold temperature, the capacity of the cutaneous vessels diminishes, and consequently the quantity which flows through them must decrease.

When the temperature, on the other hand, is much increased, either by being exposed to a hot atmosphere, or by violent exercise, the perspired vapour not only increases in quantity, but even appears in a liquid form. This is known by the name of sweat. In what manner sweat is produced, is not at present known; but we can see a very important service which it performs to the animal. No sooner is it thrown upon the surface of the skin than it begins to evaporate. But the change into vapour requires heat; accordingly a quantity of heat is absorbed, and the temperature of the animal is lowered. This is the reason that animals can endure to remain for some time in a much higher temperature without injury, than could have been supposed.

The experiments of Tillet, and the still more decisive experiments of Fordyce and his associates, are well known. These gentlemen remained a considerable time in a temperature exceeding the boiling-point of water.

2. Besides water, it cannot be doubted that carbon is also emitted from the skin; but in what state, the experiments hitherto made do not enable us to decide. Mr. Cruikshank found that the air of the glass vessel in which his hand and foot had been confined for an hour contained carbonic acid gas; for a candle burned dimly in it, and it rendered lime-water turbid. And Mr. Jurine found that air which had remained for some time in contact with the skin, consisted almost entirely of carbonic acid gas. The same conclusion may be drawn from the experiments of Ingenhousz and Milly. Trousset has lately observed that air was separated copiously from a patient of his while bathing.

Now it is evident that the carbonic acid gas which appeared during Mr. Cruikshank's experiment, did not previously exist in the glass vessel; consequently it must have either been transmitted ready-formed through the skin, or formed during the experiment by the absorption of oxygen gas, and the consequent emission of carbonic acid gas. The experiments of Mr. Jurine do not allow us to suppose the first of these to be true; for he found that the quantity of air allowed to remain in contact with the skin did not increase. Consequently the appearance of the carbonic acid gas must be owing either to the emission of carbon, which forms carbonic acid gas by combining with the oxygen gas of the air, or to the absorption of oxygen gas, and the subsequent emission of carbonic acid gas; precisely in the same manner, and for the same reason, that these substances are emitted by the lungs. The last is the more probable opinion; but the experiments hitherto made do not enable us to decide.

3. Besides water and carbon, or carbonic acid gas, the skin emits also a particular odorous substance. That every animal has a peculiar smell, is well known: the dog can discover his master, and even trace him to a distance by the scent. A dog, chained some hours after his master had set out on a journey of some hundred miles, followed his footsteps by the smell, and found him on the third day in the midst of a crowd. But it is needless to multiply instances of this fact; they are too well known to every one. Now this smell must be owing to some peculiar matter which is constantly emitted; and this matter must differ somewhat either in quantity or some other property, as we see that the dog easily distinguishes the individual by means of it. Mr. Cruikshank has made it probable that this matter is an oily substance; or at least that there is an oily substance emitted by the skin. He wore repeatedly, night and day for a month, the same vest of fleecy hosiery during the hottest part of the summer. At the end of this time he always found an oily substance accumulated in considerable masses on the nap of the inner surface of the vest, in the form of black tears. When rubbed on paper, it makes it transparent, and hardens on it like grease. It burns with a white flame, and leaves behind it a charry residuum.

4. Berthollet has observed the perspiration acid; and he has concluded that the acid which is present is the phosphoric: but that has not been proved. Fourcroy and Vauquelin have ascertained that the scurf which collects upon the skins of horses consists chiefly of phosphat of lime, and urea is even sometimes mixed with it. It is well known that the sweat has a salt taste; but hitherto it has not been analysed, though it probably differs from the transpiration.

It has been supposed that the skin has the property of absorbing moisture from the air; but this opinion has not been confirmed by experiments, but rather the contrary.

The chief arguments in favour of the absorption of the skin, have been drawn from the quantity of moisture discharged by urine being, in some cases, not only greater than the whole drink of the patient, but even the whole of his drink and food. But it ought to be remembered that, in diabetes, the disease here alluded to, the weight of the body is continually diminishing, and therefore part of it must be constantly thrown off. Besides, it is scarcely possible in that disease to get an accurate account of the food swallowed by the patients; and in those cases where very accurate accounts have been kept, and where deception was not so much practised, the urine was found to exceed the quantity of drink. In a case of diabetes, related with much accuracy by Dr. Gerard, the patient was bathed regularly during the early part of the disease in warm water, and afterwards in cold water: he was weighed before and after bathing, and no sensible difference was ever found in his weight. Consequently, in that case, the quantity absorbed, if any, must have been very small.

It is well known that thirst is much alleviated by cold bathing. By this plan captain Bligh kept his men cool and in good health during their very extraordinary voyage across the South Sea. This has been considered as owing to the absorption of water by the skin. But Dr. Currie had a patient who was wasting fast for want of nourishment, a tumour in the œsophagus preventing the possibility of taking food, and whose thirst was always alleviated by bathing; yet no sensible increase of weight, but rather the contrary, was perceived after bathing. It does not appear then, that in either of these cases water was absorbed. The allaying of thirst by the cold bathing may indeed easily be accounted for, by the lessening of the temperature, and the prevention of perspiration.

Further, Seguin has shewn that the skin does not absorb water during bathing, by a still more complete experiment: he dissolved some mercurial salt in water, and found that the mercury produced no effect upon a person that bathed in the water, provided no part of the cuticle was injured; but upon rubbing off a portion of the cuticle, the mercurial solution was absorbed, and the effects of the mercury became evident upon the body. Hence it follows irresistibly, that water, at least in the state of water, is not absorbed by the skin when the body is plunged into it, unless the cuticle is first removed.

This may perhaps be considered as a complete proof that no such thing as absorption is performed by the skin; and that therefore the appearance of carbonic acid gas, which takes place when air is confined around the skin, must be owing to the emission of carbon. But it ought to be considered, that although the skin cannot absorb water, this is no proof that it cannot absorb other substances; particularly that it cannot absorb oxygen gas, which is very different from water. It is well known that water will not pass through bladders, at least for some time: yet Dr. Priestley found that venous blood acquired the colour of arterial blood from oxygen gas, as readily when these substances were separated by a bladder, as when they were in actual contact. He found, too, that when gases were confined in bladders, they gradually lost their properties. It is clear from these facts, that oxygen gas can pervade bladders; and if it can pervade them, why may it not also pervade the cuticle? Nay, further, we know from the experiments of Cruikshank, that the vapour perspired passes through leather, even when prepared so as to keep out moisture, at least for a certain time. It is possible, then, that water, when in the state of vapour, or when dissolved in air, may be absorbed, although water, while in the state of water, may be incapable of pervading the cuticle. The experiments, therefore, which have hitherto been made upon the absorption of the skin, are insufficient to prove that air and vapour cannot pervade the cuticle, provided there are any facts to render the contrary supposition probable.

Now that there are such facts, cannot be denied. We shall not indeed produce the experiment of Van Mons as a fact of that kind, because it is liable to objections, and at best is very indecisive. Having a patient under his care who, from a wound in the throat, was incapable for several days of taking any nourishment, he kept him alive during that time, by applying to the skin in different parts of the body, several times a day, a sponge dipt in wine or strong soup. A fact mentioned by Dr. Watson is much more important, and much more decisive. A lad at Newmarket, who had been almost starved in order to bring him down to such a weight as would qualify him for running a horse-race, was weighed in the morning of the race-day; he was weighed again an hour after, and was found to have gained 30 ounces of weight; yet in the interval he had only taken half a glass of wine. Here absorption must have taken place, either by the skin, or lungs, or both. The difficulties in either case are the same; and whatever renders absorption by one probable, will equally strengthen the probability that absorption takes place by the other. See Physiology.

PERULA, a genus of the class and order dioecia polyandria. There is one species, a tree of New Grenada.

PETAL, among botanists, an appellation given to the flower-leaves, in opposition to the folia, or common leaves of the plant. See Botany.

PETALOMA, a genus of the decandria monogynia class and order: the calyx is goblet-shaped, five-toothed; petals five; stamina on margin of calyx; berry one-celled, seeds one or four. There are two species, trees of Jamaica and Guiana.

PETARD, in the art of war, a metalline engine, somewhat resembling a high-crowned hat. The petard may be considered as a piece of ordnance; it is made of copper mixed with brass, or of lead with tin: its charge is from five to six pounds of powder, which reaches to within three fingers'-breadth of the mouth; the vacancy is filled with tow, and stopped with a wooden tompion, the mouth being strongly bound up with cloth tied very tight with ropes. It is covered up with a madrier, or wooden plank, that has a cavity to receive the mouth of the petard, and fastened down with ropes.

Its use is in a clandestine attack to break down gates, bridges, barriers, &c. to which it is hung; and this it does by means of the wooden plank. It is also used in countermines to break through the enemy's galleries, and give their mines vent. The invention of petards is ascribed to the French Huguenots, in 1579, who with them took Cahors, as d'Aubigné tells us.

PETECHIÆ. See Medicine.

PETER-PENCE, an antient tax of a penny on each house, paid to the pope. It was called Peter-pence, because collected on the day of St. Peter ad vincula, and sent to Rome; whence it was also called Rome-scot, and Rome-penny.

PETESIA, a genus of the tetrandria monogynia class and order: the corolla is one-petalled, funnel-form, stigma bifid, berry many-seeded. There are three species, shrubs of South America and the West Indies.

PETIOLE, in botany, the slender stalk that supports the leaves of a plant.

PETTIA, a genus of the class and order tetrandria monogynia: the calyx is four-toothed, inferior; corolla four-parted, drupe with a two-celled nut. There is one species, a small tree of St. Domingo.

PETITIO PRINCIPII, in logic, the taking a thing for true, and drawing conclusions from it as such, when it is really false, or at least wants to be proved, before any inferences can be deduced from it.

PETITION. No petition to the king, or to either house of parliament, for any alteration in church or state, shall be signed by above twenty persons, unless the matter thereof is approved by three justices of the peace, or the major part of the grand jury in the country; and in London by the lord mayor, aldermen, and common council: nor shall any petition be presented by more than ten persons at a time.

PETITION IN CHANCERY, a request in writing, directed to the lord chancellor or master of the rolls, shewing some matter or cause, whereupon the petitioner prays somewhat to be granted him.

PETIVERIA, a genus of the tetragynia order, in the hexandria class of plants, and in the natural method ranking under the 12th order, holoraceæ. The calyx is tetraphyllous; there is no corolla; and but one seed, with reflexed awns at the top. There are two species (Guinea hen-weed), herbs of the West Indies.

PETREA, in botany, a genus of the didynamia angiosperima class of plants, with a monopetalous flower, divided into five rounded segments at the limb. There is one species, a shrub of South America.

PETRIFACTION, in natural history, denotes the conversion of wood, bones, and other substances, principally animal or vegetable, into stone. These bodies are more or less altered from their original state, according to the different substances they have lain buried among in the earth; some of them having suffered very little change, and others being so highly impregnated with crystalline, sparry, pyritical, or other extraneous matter, as to appear mere masses of stone, or lumps of the matter of the common pyrites; but they are generally of the external dimensions, and retain more or less of the internal figure, of the bodies into the pores of which this matter has made its way. The animal substances thus found petrified are chiefly sea-shells; the teeth, bony palates, and bones of fish; the bones of land-animals, &c. These are found variously altered, by the insinuation of stony and mineral matter into their pores; and the substance of some of them is found to be wholly gone, there being only stony, sparry, or other remaining matter deposited in the shape and form of the original matter, which has gradually wasted away, and these may be regarded as the true petrifactions.

Respecting the manner in which petrifaction is accomplished, we know but little. It has been thought by many philosophers, that this was one of the rare processes of nature; and accordingly such places as have afforded a view of it, have been looked upon as great curiosities. However, it is now discovered, that petrifaction is exceedingly common; and that every kind of water carries with it some earthy particles, which being precipitated from it, become stone of a greater or lesser degree of hardness; and this quality is most remarkable in those waters which are much impregnated with selenetic matter. Of late, it has also been found by some observations on a petrifaction in East Lothian in Scotland, that iron contributes greatly to the process: and this it may do by its precipitation of any aluminous earth which happens to be dissolved in the water by means of an acid; for iron has the property of precipitating this earth, though it cannot precipitate the calcareous kind. The calcareous kinds of earth, however, by being soluble in water without any acid, must contribute very much to the process of petrifaction, as they are capable of a great degree of hardness by means only of being joined with carbonic acid, on which depends the solidity of our common cement or mortar used in building houses.

The name petrifaction belongs only, as we have seen, to bodies of vegetable or animal origin; and in order to determine their class and genus, or even species, it is necessary that their texture, their primitive form, and in some measure their organization, are still discernible. Thus we ought not to place the stony kernels moulded in the cavity of some shell, or other organized body, in the rank of petrifactions properly so called.

Petrifactions of the vegetable kingdom are almost all either gravelly or siliceous; and are found in gulleys, trenches, &c. Those which strike fire with steel are principally found in sandy fissures; those which effervesce in acids are generally of animal origin, and are found in the horizontal beds of calcareous earth, and sometimes in beds of clay or gravel; in which case the nature of the petrifaction is different. As to the substances which are found in gypsum, they seldom undergo any alteration, either with respect to figure or composition, and they are very rare.

A petrified substance, strictly speaking, is nothing more than the skeleton, or perhaps image, of a body which has once had life, either animal or vegetable, combined with some mineral. Thus petrified wood is no longer wood, properly speaking. When wood is buried in certain places, lapidific fluids, extremely divided and sometimes coloured, insinuate themselves into its pores, and fill them up. These fluids are afterwards moulded and condensed. The solid part of the wood is decomposed and reduced into powder, which is expelled without the mass by aqueous filtrations. In this manner, the places which were formerly occupied by the wood are now left empty in the form of pores. This operation of nature produces no apparent difference either of the size or of the shape; but it occasions, both at the surface and in the inside, a change of substance, and the ligneous texture is inverted; that is to say, that which was pore in the natural wood, becomes solid in that which is petrified; and that which was solid or full in the first state, becomes porous in the second. In this way, says M. Musard, petrified wood is much less extended in pores than solid parts, and at the same time forms a body much more dense and heavy than the first. As the pores communicate from the circumference to the centre, the petrifaction ought to begin at the centre, and end with the circumference of the organic body subjected to the action of the lapidific fluids.

In proportion to the tenderness and bad quality of wood, it imbibes the greater quantity of water; therefore this sort will unquestionably petrify more easily than that which is hard. It is thought that all the petrified wood so often found in Hungary, has been originally soft, such as firs or poplars. Suppose a piece of wood buried in the earth; if it is very dry, it will suck up the moisture which surrounds it like a spunge. This moisture, by penetrating it, will dilate all the parts of which it is composed. The trachiæ, or air-vessels, will be filled first; and then the lymphatic vessels, and those which contain the succus proprius, as they are likewise empty. The water which forms this moisture keeps in solution a greater or a less quantity of earth; and this earth, detached, and carried along in its course, is reduced to such an attenuated state, that it escapes our eyes, and keeps itself suspended, whether by the medium of fixed air or by the motion of the water. Such is the lapidific fluid. Upon evaporation, or the departure of the menstruum, this earth, sand, or metal, again appears in the form of precipitate or sediment in the cavities of the vessels, which by degrees are filled with it. This earth is there moulded with exactness: the lapse of time, the simultaneous and partial attraction of the particles, make them adhere to one another; the lateral suction of the surrounding fibres, the obstruction of the moulds, and the hardening of the moulded earth, become general; and there consists nothing but an earthy substance which prevents the sinking of the neighbouring parts. If the deposit is formed of a matter in general pretty pure, it preserves a whiter and clearer colour than the rest of the wood; and as the concentric layers are only perceptible and distinct in the wood, because the vessels are there more apparent on account of their size, the little earthy cylinders, in the state of petrified wood, must be there a little larger, and consequently must represent exactly the turnings and separations of these layers. At the place of the utriculi, globules are observed, of which the shapes are as various as the moulds wherein they are formed. The anastomoses of the proper and lymphatic vessels form, besides, points of support or reunion for this stony substance.

With regard to holes formed by worms in any bits of wood, before they had been buried in the earth, the lapidific fluid, in penetrating these great cavities, deposits there as easily the earthy sediment, which is exactly moulded in them. These vermiform cylinders are somewhat less in bulk than the holes in which they are found, which is owing to the retreat of the more refined earth, and to its drying up.

Let any one represent to himself this collection of little cylinders, vertical, horizontal, inclined in different directions, the stony masses of utriculi and of anastomoses, and he will have an idea of the stony substance which forms the ground-work of petrifaction. Hitherto not a single ligneous part is destroyed; they are all existing, but surrounded on every side with earthy deposits; and that body which, during life, was composed of solid and of empty parts, is now entirely solid: its destruction and decomposition do not take place till after the formation of these little deposits. In proportion as the water abandons them, it penetrates the ligneous substance, and destroys it insensibly. The woody fibres being decomposed, form in their turn voids and interstices, and there remains in the whole piece nothing but little stony cylinders. But in proportion as these woody fibres disappear, the surrounding moisture, loaded with earth in the state of dissolution, does not fail to penetrate the piece of wood, and to remain in its new cavities. The new deposit assumes exactly the form of decomposed fibres; it envelops in its turn the little cylinders which were formed in their cavities, and ends by incorporating with them. We may suppose here, that in proportion as it decomposes, there is a reaction of the ligneous part against the lapidific fluid: from this reaction a colour arises which stains more or less the new deposit; and this colour will make it easily distinguishable from that which has been laid in the inside of the vessels. In all petrified wood this shade is generally perceptible.

We have then, says M. Mongez, four distinct epochs in the process by which nature converts a piece of wood into stone, or, to speak more justly, by which she substitutes a stony deposit in its place: 1. Perfect vegetable wood, that is to say, wood composed of solid and of empty parts, of ligneous fibres, and of vessels 2. Wood having its vessels obstructed and choked up by an earthy deposit, while its solid parts remain unaltered. 3. The solid parts attacked and decomposed, forming new cavities betwixt the stony cylinders, which remain in the same state, and which support the whole mass. 4. These new cavities filled with new deposits, which incorporate with the cylinders, and compose nothing else but one general earthy mass, representing exactly the piece of wood.

Among the petrifactions of vegetables called dendrolites, are found parts of shrubs, stems, roots, portions of the trunk, some fruits, &c. We must not, however, confound the impressions of mosses, ferns, and leaves, nor incrustrations, with petrifactions.

Among the petrifactions of animals, we find shells, crustaceous animals, polyparii, some worms, the bony parts of fishes and of amphibious animals, few or no real insects, rarely birds and quadrupeds, together with the bony portions of the human body. The cornua ammonis are petrified serpents; and with regard to figured and accidental bodies, these are lusus naturæ.

In order, says M. Bertrand, in his Dictionnaire des Fossiles, that a body should become petrified, it is necessary that it is, 1. Capable of preservation under ground. 2. That it is sheltered from the air and running water (the ruins of Herculaneum prove that bodies which have no connection with free air preserve themselves untouched and entire). 3. That it is secured from corrosive exhalations. 4. That it is in a place where there are vapours or liquids, loaded eithher with metallic or stony particles in a state of dissolution, and which, without destroying the body, penetrate it, impregnate it, and unite with it in proportion as its parts are dissipated by evaporation.

It is a question of great importance among naturalists, to know the time which nature employs in petrifying bodies of an ordinary size. It was the wish of the late emperor, duke of Lorraine, that some means should be taken for determining this question. M. le chevalier de Baillu, director of the cabinet of natural history of his imperial majesty, and some other naturalists, had, several years before, the idea of making a research which might throw some light upon it. His imperial majesty being informed by the unanimous observations of modern historians and geographers, that certain pillars which are actually seen in the Danube in Gervia, near Belgrade, are remains of the bridge which Trajan constructed over that river, presumed that these pillars having been preserved for so many ages must be petrified, and that they would furnish some information with regard to the time which nature employs in changing wood into stone. The emperor thinking this hope well founded, and wishing to satisfy his curiosity, ordered his ambassador at the court of Constantinople to ask permission to take up from the Danube one of the pillars of Trajan's bridge. The petition was granted, and one of the pillars was accordingly taken up; from which it appeared that the petrifaction had only advanced three-fourths of an inch in the space of 1500 years. There are, however, certain waters in which the transmutation is more readily accomplished. Petrifactions appear to be formed more slowly in earths that are porous and in a slight degree moist than in water itself.

When the foundations of the city of Quebec in Canada were dug up, a petrified savage was found among the last beds to which they proceeded. Although there was no idea of the time at which this man had been buried under the ruins, it is however true, that his quiver and arrows were still well preserved. In digging a lead-mine in Derbyshire in 1744, a human skeleton was found among stags' horns. It is impossible to say how many ages this carcase had lain there. In 1695 the entire skeleton of an elephant was dug up near Tonna, in Thuringia. Some time before this epoch the petrified skeleton of a crocodile was found in the mines of that country. We might cite another fact equally curious which happened at the beginning of the last century. John Munte, curate of Slægarp in Scania, and several of his parishioners, wishing to procure turf from a drained marshy soil, found, some feet below ground, an entire cart with the skeletons of the horses and carter. It is presumed that there had formerly been a lake in that place, and that the carter attempting to pass over on the ice, had by that means probably perished. In fine, wood partly fossil, and partly coaly, has been found at a great depth, in the clay of which tile was made for the abbey of Fontenay. It is but very lately that fossil wood was discovered at the depth of 75 feet in a well betwixt Issi and Vauvres, near Paris. This wood was in sand betwixt a bed of clay and pyrites, and water was found four feet lower than the pyrites. M. de Laumont, inspector-general of the mines, says that in the lead-mine at Pontpéan, near Rennes, is a fissure, perhaps the only one of its kind. In that fissure, sea-shells, rounded pebbles, and an entire beech, have been found 240 feet deep. This beech was laid horizontally in the direction of the fissure. Its bark was converted into pyrites, the sap-wood into jet, and the centre into coal.

A great many pieces of petrified wood are found in different counties of France and Savoy. In Cobourg in Saxony, and in the mountains of Misnia, trees of a considerable thickness have been taken from the earth, which were entirely changed into a very fine agate, as also their branches and their roots. In sawing them, the annual circles of their growth have been distinguished. Pieces have been taken up, on which it was distinctly seen that they had been gnawed by worms; others bear visible marks of the hatchet. In fine, pieces have been found which were petrified at one end, while the other still remained in the state of wood fit for being burned. It appears then that petrified wood is a great deal less rare in nature than is commonly imagined.

Mr. Kirwan observes on the subject of petrifications, 1. Those of shells are found on or near the surface of the earth; those of fish deeper; and those of wood deeper still. Shells in substance are found in vast quantities, and at considerable depths. 2. The substances most susceptible of petrifaction are those which most resist the putrefactive process; of which kind are shells, the harder kinds of wood, &c.; while the softer parts of animals, which easily putrefy, are seldom met with in a petrified state. 3. They are most commonly found in strata of marl, chalk, limestone, or clay; seldom in sandstone, still more seldom in gypsum; and never in gneiss, granite, basaltes, or schoerl. Sometimes they are found in pyrites, and ores of iron, copper, and silver; consisting almost always of that kind of earth or other mineral which surrounds them; sometimes of silex, agate, or carnelian. 4. They are found in climates where the animals themselves could not have existed. 5. Those found in slate or clay are compressed and flattened.

The different species of petrifactions, according to Cronstedt, are,

I. Terræ larvatæ; extraneous bodies changed into a limy substance, or calcareous changes. These are, 1. Loose or friable. 2. Indurated. The former are of a chalky nature, in form of vegetables or animals; the second filled with solid limestone in the same forms. Some are found entirely changed into a calcareous spar.

On these petrifactions Cronstedt observes, that shells and corals are composed of limy matter even when still inhabited by their animals, but they are classed among the petrifactions as soon as the calcareous particles have obtained a new arrangement: for example, when they have become sparry, filled with calcareous earth either hardened or loose, or when they lie in the strata of the earth. "These (says he) form the greatest part of the fossil collections which are so industriously made, often without any regard to the principal and only use they can be of, viz. that of enriching zoology. Mineralogists are satisfied with seeing the possibility of the changes the limestone undergoes in regard to its particles; and also with receiving some insight into the alteration which the earth has been subject to from the state of the strata which are now found in it." The calcined shells, where the petrifactions are of a limy or chalky nature, answer extremely well as a manure; but the indurated kind serve only for making grottoes. Gypseous petrifactions are extremely rare: however, Chardin informs us that he had seen a lizard inclosed in a stone of that kind in Persia.

II. Larvæ, or bodies changed into a flinty substance. These are all indurated, and are of the following species: 1. Carnelians in form of shells from the river Tomm in Siberia. 2. Agate in form of wood; a piece of which is said to be in the collection of the count de Tessin. 3. Coralloids of white flint (millepora) found in Sweden. 4. Wood of yellow flint found in Italy, in Turkey near Adrianople, and produced by the waters of Lough-neah in Ireland.

III. Larvæ argillaceæ; where the bodies appear to be changed into clay. These are found either loose and friable, or indurated. Of the former kind is a piece of porcelain clay met with in a certain collection, with all the marks of the root of a tree upon it. Of the latter kind is the osteocolla; which is said to be the roots of the poplar-tree changed, and not to consist of any calcareous substance. A sort of fossil ivory, with all the properties of clay, is said likewise to be found in some places.

IV. Larvæ insalitæ; where the substances are impregnated with great quantities of salts. Human bodies have been twice found impregnated with vitriol of iron in the mine of Fahlun, in the province of Dalarne in Sweden. One of them was kept for several years in a glass-case, but at last began to moulder and fall to pieces. Turf and roots of trees are likewise found in water strongly impregnated with vitriol. They do not flame, but look like a coal in a strong fire; neither do they decay in the air.

V. Bodies penetrated by mineral inflammable substances. 1. By pit-coal, such as wood; whence some have imagined coal to have been originally produced from wood. Some of these substances are fully saturated with the coaly matter; others not. Among the former Cronstedt reckons jet; among the latter the substance called mumia vegetablis; which is of a loose texture, resembling amber, and may be used as such. 2. Those penetrated by asphaltum or rock-oil. The only example of these given by our author is a kind of turf in the province of Skone in Sweden. The Egyptian mummies, he observes, cannot have any place among this species, as they are impregnated artificially with asphaltum, in a manner similar to what happens naturally with the wood and coaly matter in the last species. 3. Those impregnated with sulphur which has dissolved iron, or with pyrites. Human bodies, bivalve and univalve shells, and insects, have been all found in this state; and the last are found in the alum state at Andrarum, in the province of Skone in Sweden.

VI. Larvæ metalliferæ; where the bodies are impregnated with metals. These are, 1. Covered with native silver; which is found on the surface of shells in England. 2. Where the metal is mineralised with copper and sulphur. Of this kind is the fahlertz or grey silver-ore, in the shape of ears of corn, and supposed to be vegetables, found in argillaceous slate at Frankenberg and Tahlitteren in Hesse. 3. Larvæ cupriferæ, where the bodies are impregnated with copper. To this species principally belong the turquoise or Turkey stones, improperly so called; being ivory and bones of the elephant, or other animals, impregnated with copper. At Simore in Languedoc there are bones of animals dug up, which, during calcination, assume a blue colour; but according to Cronstedt, it is not probable that these owe their colour to copper. 3. With mineralised copper. Of these our author gives two examples. One is, where the copper is mineralised with sulphur and iron, forming a yellow marcasitical ore. With this some shells are impregnated, which lie upon a bed of loadstone in Norway. Other petrifactions of this kind are found in the form of fish in different parts of Germany. The other kind is where the copper is impregnated with sulphur and silver. Of this kind is the grey silver-ore, like ears of corn, found in the slate-quarries at Hesse. 4. Larvæ ferriferæ, with iron in form of a calx, which has assumed the place or shape of extraneous bodies. These are either loose or indurated. Of the loose kind are some roots of trees found at the lake Langelma in Finland. The indurated kinds are even exemplified in some wood found at Orbissan in Bohemia. 5. Where the iron is mineralised, as in the pyritaceous larvæ already described.

VII. Where the bodies are tending to decomposition, or in a way of destruction. Among these, our author enumerates mould and turf, &c.

PETROCARYA, a genus of the class and order heptandria monogynia. The calyx is five-cleft, turbinate; corolla five-petalled; filaments twenty-four; drupe inclining, and two-celled nut. There are two species, trees of Guiana.

PETROLEUM. See Bitumen.

PETROMYZON, the *lamprey*, a genus of fishes belonging to the class of amphibia nantes. It has seven spiracula at the side of the neck, no gills, a fistula on the top of the head, and no breast or belly fins. There are eight species, distinguished by peculiarities in their back fins.

1. The marinus, or sea-lamprey, is sometimes found so large as to weigh four or five pounds. It greatly resembles the eel in shape, but its body is larger, and its snout longer, narrower, and sharper at the termination. The opening of the throat is very wide; each jaw is furnished with a single row of very small teeth; in the middle of the palate are situated one or two other teeth, which are longer, stronger, and moveable towards the inside of the throat.

The lamprey is an inhabitant of the ocean, ascending rivers chiefly during the latter part of winter and the early months of spring; and after a residence of a few months in fresh water, again returning to the sea: it is viviparous, and the young are observed to be of slow growth; contrary to the assertions of some writers, who have supposed the lamprey to be a short-lived fish. When in motion this fish is observed to swim with considerable vigour and rapidity, but it is more commonly seen attached by the mouth to some large stone or other substance, the body hanging at rest, or obeying the motion of the current: so strong is the power of adhesion exerted by this animal, that a stone of the weight of more than twelve pounds may be raised without forcing the fish to forego its hold. The general habits of the lamprey seem pretty much to resemble those of the eel, and it is supposed to live principally on worms and young fish. Like the eel it is remarkably tenacious of life; the several parts, when cut in pieces, will long continue to move; and the head will strongly attach itself for several hours to a stone, though by far the greater part of the body is cut away from it.

Among the cartilaginous fishes none is so destitute of all appearance of real bone as the lamprey, in which the spine itself is no other than a mere soft cartilage, without any processes or protuberances whatsoever. Among other particulars in its anatomy, it is remarkable that the heart, instead of being inclosed in a soft pericardium, as in other animals, is guarded by a strong cartilaginous one: the liver, which is of an oblong form, is of a fine grass-green colour, somewhat deeper in the female fish, and may be used for the purpose of a pigment.

A vulgar error, arising from inattentive inspection, and total ignorance of the nature of the animal, is said sometimes to prevail, viz. that the lamprey is furnished with nine eyes on each side; this mistake appears to have excited unusual indignation in sir T. Brown.

As an article of food, the lamprey has for many ages maintained its credit as an exquisite dainty; and has uniformly made its appearance at the most splendid of our antient entertainments. The death of king Henry the First, it is well known, is attributed to a too luxurious indulgence in this his favorite dish. It still continues to be in high esteem; and we are told by Mr. Pennant that the city of Gloucester continues to send yearly, at Christmas, a present of a rich lamprey-pie to the king. It sometimes happens that lampreys at that season are so rare that a guinea is demanded for the price of a single fish. They are most in season during March, April, and May, and are observed to be much more firm when fresh-arrived from sea than when they have been a considerable time in fresh water. They are found in several of the British rivers, but that which is most celebrated for them is the Severn. In the mouths of some of the larger European rivers they are sometimes taken in such quantities that it is impossible to use them in their fresh state; they are therefore grilled and moderately salted, and afterwards barrelled up for sale, with the addition of vinegar and spices.

2. Petromyzon fluviatilis, lampern. This species is, according to Dr. Bloch, an inhabitant of the sea, and ascends in spring-time most of the European rivers, in which it is found much more frequently and plentifully than the great lamprey. With us it is found in great quantities in the Thames, the Severn, and the Dee. It is often potted with the larger lamprey, and is by some preferred to it, as being milder-tasted. Mr. Pennant informs us that vast quantities are taken about Mortlake, and sold to the Dutch, as baits for their cod and turbot fisheries. According to this author above four hundred and fifty thousand have been sold in a season, at forty shillings per thousand, and about a hundred thousand have been occasionally sent to Harwich for the same purpose. The Dutch, it is added, have the secret of preserving them till the time of the turbot-fishery. Great quantities, says Dr. Bloch, are taken in the march of Brandenburgh, and in Pomerania, Silesia, and Prussia; and after frying, are

packed in barrels by layers, between each of which is a layer of bay-leaves, and spices, sprinkled over with vinegar. In this state they are sent into many other parts of the German empire. In the river Bauster in Courland, great quantities are taken from beneath the ice with nets; they are much larger than those found elsewhere, and are packed in snow, and sent to any distance; and when put into cold water recover themselves. This species spawns in March and April, and is a prolific fish. It is so tenacious of life, that it will live many days out of water.

3. Petromyzon planeri, Planer's lamprey: length from five or six to ten inches; general resemblance that of the lampern: native of the rivers of Thuringia and other parts of the German empire. Like most of the genus, tenacious of life, living for the space of a quarter of an hour when immersed in spirits of wine, and moving with violence during the whole time. When thus killed in spirits, the mouth remains open, but when the fish dies in water it is shut.

4. Petromyzon branchialis, minute lamprey: inhabits the European rivers; in England more frequent in the Isis than elsewhere. Instead of concealing itself under stones, this species lodges itself among the mud, and is not observed to adhere to any other body like the rest of the genus: it is used as a bait for other fish. It seems to have been first distinctly described as an English species by Dr. Plot, in his History of Oxfordshire.

5. Petromyzon sanguisuga, leech lamprey. It seems in many points so nearly to resemble the common lamprey as to leave some suspicion of its being the young of that species; yet Mons. Noel seems convinced of its being specifically different. It is said to be found only at those times in which the shad (clupea alosa) is in the river. These fishes it persecutes, by fastening beneath their bellies, and sucking their blood with the avidity of a leech: its body being constantly found full of that fluid alone: they sometimes attack salmon in a similar way, but from the greater thickness of the skin in those fishes, are able to obtain but a small quantity of blood from them.

PETUNSE, in natural history, one of the two substances whereof the porcelain or China-ware is made. The petunse is a coarse kind of flint or pebble, the surface of which is not so smooth when broken as that of our common flint. See STONEWARE.

PEUCEDANUM, or SULPHURWORT, a genus of the digynia order, in the pentandria class of plants, and in the natural method ranking under the 45th order, umbellatæ. The fruit is lobated, striated on both sides, and surrounded by a membrane; the involucra are very short. There are 10 species, none of which have any remarkable properties excepting the officinale, or common hog's-fennel, growing naturally in the English salt marshes. The roots, when bruised, have a strong fetid scent like sulphur, and an acrid, bitterish, unctuous taste. Wounded in the spring they yield a considerable quantity of yellow juice, which dries into a gummy resin, and retains the strong smell of the root. The expressed juice was used by the antients in lethargic disorders.

PEWTER, a factitious metal, used in making domestic utensils, as plates, dishes, &c. See ZINC.

PEZIZA, cup-mushroom, a genus of the natural order of fungi, in the cryptogamia class of plants. The fungus is campanulated and sessile. Linnæus enumerates 11 species; Dr. Withering, 40 British species.

PHACA, a genus of the decandria order, in the diadelphia class of plants; and in the natural method ranking under the 32d order, papilionaceæ. The legumen is semibilocular. There are 11 species.

PHÆTHUSA, a genus of the class and order syngenesia polygamia superflua. The calyx is subcylindric, many-leaved; florets hermaphrodite; recept. chaffy; seeds vispid. There is one species, a tree of Virginia.

PHAETON, in ornithology, a genus of birds belonging to the order of anseres, the characters of which are: The bill is sharp, straight, and pointed; the nostrils are oblong, and the hinder toe is turned forward. There are two species, viz.

1. The demersus, or red-footed pinguin, has a thick, arched, red bill; the head, hind-part of the neck, and the back, of a dusky purplish hue, and breast and belly white; brown wings, with the tips of the feathers white; instead of a tail, a few black bristles; and red legs. It is found on Pinguin isle, near the Cape of Good Hope, is common all over the South Seas, and is about the size of a goose.

2. The ethereus, or tropic bird, is about the size of a partridge, and has very long wings. The bill is red, with an angle under the lower mandible. The eyes are encompassed with black, which ends in a point towards the back of the head. Three or four of the larger quill-feathers towards their ends are black, tipped with white; all the rest of the bird is white, except the back, which is variegated with curved lines of black. The legs and feet are of a vermilion red. The toes are webbed. The tail consists of two long straight narrow feathers, almost of equal breadth from their quills to their points.

The name tropic bird, given to this genus, arises from its being chiefly found within the tropical circles; but we are not to conclude that they never stray voluntarily, or are driven beyond them: for we have met with a few instances to prove the contrary. It is, however, so generally found within the tropical limits, that the sight of this bird alone is sufficient to inform the mariner of a very near approach to, if not his entrance therein. It has also been thought to portend the contiguity of land; but this has often proved fallacious, as it is not unfrequently found at very great distances from it. The flight of this bird is often to a prodigious height; but at other times it is seen along with the frigate-pelican, booby, and other birds, attending the flying-fishes at their rise from the water, driven from their native element into the air by their watery enemies, the shark, porpoise, albicore, bonito, and dolphin, which pursue them beneath, and prey upon them. These birds are sometimes observed to rest on the surface of the water, and have been now and then seen in calm weather upon the backs of the drowsy tortoises, supinely floating in the sea, so that they have been easily taken by the long-boat manned. On shore they will perch on trees, and are said to breed in the woods, on the ground beneath them. They have been met with in plenty on the islands of St. Helena, Ascension, Mauritius, New Holland, and various places in the South Seas; but in no place so numerous as at Palmerston island, where these birds, as well as the frigates, were in such plenty, that the trees were absolutely loaded with them, and so tame, that they suffered themselves to be taken off the boughs with the hand. At Otaheite, and in the Friendly isles, the natives give them the names of baingoo and toolaiee. Some ornithologists reckon two other species (perhaps varieties) of the tropic bird.

PHALÆNA, *moth*, a genus of insects of the order lepidoptera: the generic character is; antennæ setaceous, gradually lessening from base to tip; wings (when sitting) generally deflex (flight nocturnal). This genus, like that of papilio, containing a vast number of species, is divided into assortments, according to the different habits of the animals. These assortments are as follow, viz.

Attaci, or those in which the wings, when at rest, are spread out horizontally.

Bombyces, in which the wings are incumbent, and the antennæ pectinated.

Noctuæ, with incumbent wings and setaceous antennæ.

Geometræ, with wings horizontally spread out, nearly as in the attaci.

Tortrices, with very obtuse wings, curved on the exterior margin.

Pyralides, with wings converging into a deltoid and slightly furcated figure.

Tineæ, with wings convoluted into a cylinder.

Alucitæ, with wings divided into distinct plumes.

These distributions, like those of the genus papilio, are not strictly accurate, and must therefore be regarded with a proper degree of allowance.

In the first division or attaci ranks the most splendid, and largest, of all the phalænæ yet known, viz. the phalæna atlas, an insect so large that the extent of its wings measures not less than eight inches and a half; the ground-colour is a very fine deep orange-brown, and in the middle of each wing is a large subtriangular transparent spot or patch, resembling the appearance of a piece of Muscovy talc; each of these transparent parts is succeeded by a black border, and across all the wings run lighter and darker bars, exhibiting a very fine assortment of varying shades; the upper wings are slightly curved downwards at their tips in a falcated manner, and the lower wings are edged with a border of black spots on a pale buff-coloured ground; the antennæ are widely pectinated with a quadruple series of fibres, exhibiting a highly elegant appearance. This insect is a native of both the Indies, and occasionally varies both in size and colours.

Phalæna luna is an American species, of large size, and extremely beautiful; its colour is a most elegant pea-green, with a small yellowish eye-shaped spot with a transparent centre in the middle of each wing, and the lower wings are produced at the bottom into a long and broad tail or continuation: the ridge of the upper wings is broad, and of a fine purple-brown colour; the head and thorax yellowish white, and the body milk-white.

Of the European species of this division beyond comparison the finest is the phalæna junonia (ph. pavonia Lin.), a native of many parts of Germany, Italy, France, &c. but not yet observed in England. It measures about six inches in extent of wings, and is varied by a most beautiful assortment of the most sober colours, consisting of different shades of deep and light grey, black, brown, &c. On the middle of each wing is an eye-shaped spot, having the disk black, shaded on one side with blue, surrounded with red-brown, and the whole included by a circle of black. Lastly, all the wings are bordered by a deep edging of very pale brown, with a whiter line immediately adjoining to the darker part of the wing: the antennæ are finely pectinated. The caterpillar, which feeds on the apple, pear, &c. is hardly less beautiful than the insect itself: it is of a fine apple or yellowish-green colour, with each segment of the body ornamented by a row of upright prominences of a bright blue colour, with black radiated edges, and surrounded by long black filaments, each of which terminates in a clavated tip. This larva, when ready for its change, envelops itself in an oval web with a pointed extremity, and transforms itself into a large short chrysalis, out of which afterwards emerges the moth.

The phalæna pavonia minor, or smaller peacock-moth, is a native of England, and is commonly called the emperor moth. In every respect, except size, it so greatly resembles the former, that Linnæus chose to consider it as a permanent variety only of the same species. The larva and pupa are also of the same appearance with those of the preceding, but on a much smaller scale.

The bombyces constitute a very numerous tribe, of which the phalæna caja or great tiger-moth may serve as an example. This species is one of the larger English moths, and is of a fine pale cream-colour, with chocolate-brown bars and spots; the lower wings red, and black spots; the thorax chocolate-brown, with a red collar round the neck; and the body red, with black bars. The caterpillar is of a deep brown, with white specks; extremely hairy, and feeds on various plants. It changes into a chrysalis in June, and the fly appears in July.

Phalæna fuscicauda or the brown-tail moth is remarkable for the ravages which its caterpillar commits, by destroying the foliage of trees and hedges, and reducing them to a perfectly bare appearance. The moth itself is about a third part less than that of a silkworm, and is of a fine satiny white, except the hinder part of the body, which is of a deep brown. The caterpillar is brown, with ferruginous hairs, a row of white spots along each side, and two red spots on the lower part of the back: it is of a gregarious nature, vast numbers residing together under one common web: they are hatched early in autumn, from eggs laid by the parent moths, and immediately form for themselves a small web, and begin feeding on the foliage of the tree or shrub on which they were placed: they marshal themselves with great regularity for this purpose in rows, and at first devour only the upper pellicle and the green parenchyma of the leaves, and in the evening retire to their web. In about three weeks they cast their skin, and afterwards proceed to feed as before, enlarging their web from time to time, and forming it on all sides as strong and secure as possible. In this they remain the whole winter in a state of torpidity, till being enlivened by the warmth of the returning spring, they again issue from their covering, and being now grown stronger, begin to devour the whole substance of the leaves, instead of contenting themselves with the upper part as in their very young state. The destruction which they sometimes cause to the verdure of the country may be judged of by their ravages in the year 1782, when, according to the account of the ingenious Mr. Curtis, author of the Flora Londinensis, &c. in many parishes about London subscriptions were opened, and the poor people employed, to cut off and collect the webs at one shilling per bushel, which were burned, under the inspection of the church-wardens, overseers, or beadles, of the respective parishes. At the first onset of this business, Mr. Curtis assures us, he was informed that fourscore bushels were collected in one day in the parish of Clapham alone. When these caterpillars are arrived at full growth, which is usually about the beginning of June, each spins itself a separate web, in which it changes to a dark-brown chrysalis, out of which in the beginning of July proceeds the moth. The ravages of these insects in the current year, 1806, have been scarcely less than those above recorded.

But of all the moths of the tribe bombyx the phalæna mori, or silkworm moth, is by far the most important. This is a whitish moth, with a broad pale-brown bar across each of the upper wings. The caterpillar or larva, emphatically known by the title of the silkworm, is, when full grown, nearly three inches long, and of a yellowish-grey colour; on the upper part of the last joint of the body is a horn-like process, as in many of the sphinges. It feeds, as every one knows, on the leaves of the white mulberry, in defect of which may be substituted the black mulberry, and even, in some instances, the lettuce and a few other plants. The silkworm remains in its larva state about six weeks, changing its skin four times during that period, and, like other caterpillars, abstaining from food for some time before each change. When full-grown, the animal entirely ceases to feed, and begins to form itself a loose envelopement of silken fibres in some convenient spot which it has chosen for that purpose; and afterwards proceeds to enwrap itself in a much closer covering, forming an oval yellow silken case or ball, about the size of a pigeon's egg, in which it changes to a chrysalis, and after lying thus inclosed for the space of about fifteen days, gives birth to the moth. This however is always carefully prevented when the animals are reared for the purpose of commerce, the moth greatly injuring the silk of the ball by discharging a quantity of coloured fluid before it leaves the cell: the silk-balls are therefore exposed to such a degree of heat, as to kill the inclosed chrysalides, a few only being saved for the breed of the following year. The moth, when hatched, is a very short-lived animal, breeding soon after its exclusion; and when the females have laid their eggs, they, as well as the males, survive but a very short time.

The length of the silken fibre or thread drawn by the silkworm may be supposed to differ considerably in different silk-balls. According to Boyle, as quoted by Derham, a lady, on making the experiment, found the length of the ball to be considerably more than 300 yards, though the weight was only two grains and a half. The abbé La Pluche informs us, that of two balls one measured 924 feet, and the other 930. It may be proper to add, that the silk throughout its whole length is double, or composed of two conjoined or agglutinated filaments. See SILK MANUFACTURE.

In the next divison, or noctuæ, stands the beautiful phalæna nupta, a moderately large species, with the upper wings of a fine grey colour, elegantly clouded and varied with shades and lines of dark-brown, &c. and the under wings of a vivid crimson, with two broad transverse black bars; the body is grey, but white underneath. The caterpillar, which is of a pale flesh-coloured grey, is distinguished by a dorsal tubercle on the fore part of the body, and seeds chiefly on the willow; it changes to a chrysalis in July, and the moth appears in August and September. The division noctuæ, like that of bombyx, is extremely numerous.

As an example of the geometræ, we may adduce a very elegant moth often seen towards the middle of summer on the elder, and called phalæna sambucaria; it is moderately large, of a pale sulphur-colour, with angular wings, marked by a narrow transverse brown line or streak. It proceeds from a green caterpillar, which, like those of the rest of this section, walks in a peculiar manner, viz. by raising up the body at each progressive movement into the form of an arch or loop, the extremities nearly approaching each other. It changes in May and June into a black chrysalis, out of which in June or July proceeds the moth.

To this division also belongs that beautiful insect called the currant-bush moth, or phalæna grossulariata, so frequently seen in gardens in the month of July. It has somewhat the appearance of a butterfly, with rounded white wings, marked by numerous black spots; the upper pair being still farther decorated by a pair of deep-yellow bands: the body also is of a deep golden yellow, with black spots. The caterpillar is of similar colour, and the chrysalis black.

In the division tortrices, so named from the faculty which their caterpillars possess of rolling or twisting the leaves of the vegetables they inhabit, into a tubular form, stands the elegant phalæna prasinana, an inhabitant of the oak, and sometimes of the alder: the upper wings are of fine green, with two oblique yellow stripes; the lower wings pale or whitish. The caterpillar is of a yellowish-green, with white specks, and the end of the body orange-coloured.

In the division pyrales stands the phalæna farinalis, distinguished by the polished surface of its wings, which have a large glaucous-brown middle area or patch, while the remainder is marked by whitish streaks. This insect, when sitting, has an obtusely triangular outline, and the abdomen is turned up at the tip.

The division called tineæ, comprehends those moths which are in general of a small size, though often of very elegant colours. Of this tribe is the phalæna padella: it is of a pearly white colour, with very numerous black spots: its caterpillar is gregarious, appearing in great quantities on various sorts of fruit-trees during the decline of summer, and committing great ravages on the leaves: these caterpillars inhabit a common web, and usually move in large groupes together; their colour is a pale greyish yellow, with numerous black spots; each caterpillar, at the time of its change to chrysalis, envelops itself in a distinct oval web with pointed extremities; and many of these are stationed close to each other, hanging, in a perpendicular direction, from the internal roof of the general enclosing web; the chrysalis is blackish, and the moth appears in the month of September.

To this division also belong the moths emphatically so called, or cloth-moths. Of these the principal is the phalæna vestianella, which, in its caterpillar state, is very destructive to woollen cloths, the substance of which it devours, forming for itself a tubular case with open extremities, and generally approaching to the colour of the cloth on which it is nourished. This mischievous species changes into a chrysalis in April, and the moth, which is universally known, appears chiefly in May and June.

In the last division, called alucitæ, is one of the most elegant of the insect tribe, though not distinguished either by large size or lively colours. It is a small moth, of a snowy whiteness, and, at first view, catches the attention of the observer by the very remarkable aspect of its wings, which are divided into the most beautiful distinct plumes, two in each upper, and three in each under wing, and formed on a plan resembling that of the long wing-feathers of birds, viz. with a strong middle rib or shaft, and innumerable lateral fibres. This moth, which is the phalæna pentadactyla of Linnæus, appears chiefly in the month of August. Its caterpillar, which is yellowish-green, speckled with black, feeds on nettles, and changes into a blackish chrysalis enveloped in a white web.

Another very remarkable species of this division is the phalæna hexadactyla of Linnæus; each wing consisting of six distinct plumes. The insect is of a pale grey-brown colour, with several transverse lines or bars across the feathers, and exhibiting a very curious spectacle in the microscope. It chiefly makes its appearance in the month of September. This little moth is by the English collectors somewhat improperly called the twenty-plumed moth, the plumes being in reality twenty-four in number. See Plate Nat. Hist. figs. 325, 326, 327, 328.

PHALANGIUM, a genus of insects of the order aptera. The generic character is, legs eight; eyes two vertical, and two lateral; front furnished with cheliform antennæ; abdomen generally rounded.

Of all the insects in the order aptera, few perhaps will be found of a form more repulsive than that of the present genus; which, exclusive of its spider-like shape, is, in some species, armed with weapons resembling those of the genus aranea, but operating with greater malignity. The phalangia differ very much in size, some being very minute insects, while others are equal in magnitude to the larger kind of spiders.

The phalangium reniforme is one of the largest of the genus. This animal is a native of the hotter regions of the globe, being found in Africa and South America. It has the general appearance of a very large spider, with the thorax heart- (or rather kidney-) shaped, and the abdomen rounded: the legs are very long, and the palpi or claspers are strongly toothed on the inner side by several sharp-pointed curved processes: the first pair of legs have all the appearance of a pair of antennæ; far exceeding the rest in length, and being of a slender or filiform shape. The whole insect is of a deep chesnut-brown colour, with a yellowish cast on the abdomen. Its particular history seems to be little known, but there can be no doubt of its being of a predacious nature, living probably on the smaller insects.

Phalangium caudatum is, in general, of rather smaller size than the former, and of a lengthened shape, with shorter limbs in proportion: it is principally distinguished by the long setaceous process in which the abdomen terminates: the chelæ or claspers are large, and toothed on the inside towards the tips. The general colour of the animal is chesnut-brown. It is a native of the East Indies.

To this genus belong those well-known insects called long-legged, shepherd, or harvest spiders, being popularly considered as such, though differing very considerably from spiders properly so named. The most common insect of this kind is the phalangium opilio of Linnæus, which, during the autumn, may be observed in gardens, about walls, &c. It is remarkable for its plump, but flattish, orbicular body; and its extremely long and slender legs, which are generally so carried, that the body appears suspended or elevated to a considerable height above the surface on which the animal rests: the eyes are situated on the top of the head, and resemble two very minute glassy globules; the colour of the whole animal is a pale greyish-brown. This species preys on the smaller kind of insects in general.

Among the minute species of phalangium, the most remarkable is the phalangium cancroides of Linnæus, a very small insect, of a reddish-brown colour, and of slow motion, occasionally found among papers, dried plants, &c. &c. Its shape is obtusely oval, with a sharpened front, furnished with a pair of very long and large jointed claspers, which give the insect a very remarkable appearance; the body is very much depressed. This little insect has been occasionally referred to very different genera. It is a species which seems to vary considerably in size; those which are found in our own country rarely exceeding the length of the tenth of an inch, while in some parts of Europe it appears to arrive at twice that length. It is said by Linnæus, but probably on no just foundation, to introduce itself occasionally under the skin, and to excite a painful tumour; a circumstance which, considering the size of the animal, seems scarcely possible. It preys on smaller and weaker insects. See Plate Nat. Hist. fig. 329.

Phalangium. See Anthericum.

PHALANX, in Grecian antiquity, a square battalion, consisting of 8000 men, with their shields joined, and pikes crossing each other, so that it was next to impossible to break it.

PHALARIS, or Canary-grass, a genus of the trigynia order, in the triandria class of plants. The calyx is bivalved, carinated, and equal in length, containing the corolla. There are 12 species, of which the most remarkable are the canariensis, or manured canary-grass; and the arundinacea, or reed canary-grass. These are both natives of Britain. The first grows by the road-sides, and is frequently cultivated for the sake of the seeds, which are found to be the best food for the canary and other small birds. The second grows on the banks of rivers. It is used for thatching ricks or cottages, and endures much longer than straw. In Scandinavia they mow it twice a year, and their cattle eat it. There is a variety of this cultivated in our gardens with beautifully striped leaves. The stripes are generally green and white; but sometimes they have a purplish cast. This is commonly called painted lady-grass, ladies' tresses, or riband-grass.

PHALEUCIAN VERSE, in antient poetry, a kind of verse which consists of five feet, the first of which is a spondee, the second a dactyl, and the three last trochees: such is the following one of Martial:

1 2 3 4 5
Summam | nec metu | as di | em, nec | optes.

PHALLUS, the morel, a genus of the order of fungi, belonging to the cryptogamia class of plants. The fungus is reticulated above and smooth below. There are three species; the most remarkable are

1. The esculentus, or esculent morel, is a native of Britain, growing in woods, groves, meadows, pastures, &c. The substance, when recent, is wax-like and friable; the colour a whitish yellow, turning brownish in decay; the height of the whole fungus, about four or five inches. The stalk is thick and clumsy, somewhat tuberous at the base, and hollow in the middle. The pileus is either round or conical; at a medium about the size of an egg, often much larger; hollow within; its base united to the stalk; and its surface cellular, or latticed with irregular sinuses. The magnified seeds are oval. It is much esteemed at table both recent and dried, being commonly used as an ingredient to heighten the flavour of ragouts. We are informed by Gleditsch, that morels are observed to grow in the woods of Germany in the greatest plenty in the places where charcoal has been made. Hence the good women who collect them to sell, receiving a hint how to encourage their growth, have been accustomed to make fires in certain places of the woods, with heath, broom, vaccinium, and other materials, in order to obtain a more plentiful crop. This strange method of cultivating morels being however sometimes attended with dreadful consequences, large woods having been set on fire and destroyed by it, the magistrate thought fit to interpose his authority, and the practice is now interdicted.

2. The impudicus, stinking morel, or stink-horns, is also a native of Britain, and found in woods and on banks. It arises from the earth under a veil or volva, shaped exactly like a hen's egg, and of the same colour, having a long fibrous radicle at its base. This egg-like volva is composed of two coats or membranes, the space between which is full of a thick, viscid, transparent matter, which, when dry, glues the coats together, and shines like varnish. In the next stage of growth, the volva suddenly bursts into several lacerated permanent segments, from the centre of which arises an erect, white,

cellular, hollow stalk, about five or six inches high and one thick, of a wax-like friable substance, and most fetid cadaverous smell, conical at each end, the base inserted in a white, concave, membranaceous, turbinated cup, and the summit capped with a hollow, conical pileus, an inch long, having a reticulated cellular surface, its base detached from the stalk, and its summit umbilicated, the umbilicus sometimes perforated and sometimes closed. As soon as the volva bursts, the plant begins to diffuse its intolerable odours, which are so powerful and widely expanded, that the fungus may be readily discovered by the scent only, before it appears to the sight.

PHARMACY, is defined the art of preparing, compounding, and preserving medicinals.

The preservation of medicines merely consists in the application of rules for collecting vegetable, animal, and mineral productions, at certain seasons, or under particular circumstances, and of ensuring them against the injuries they would suffer by exposure to light, heat, air, moisture, &c. this, therefore, is the least extensive, and peculiar department of the pharmaceutic art. It is the preparation and composition of medicinals that constitute the principal objects of that science of which we are here to treat.

To prepare medicines, is to produce an artificial arrangement of their constituent principles, by which, either an essential change is effected in their nature, or their medicinal essence is preserved, while their form undergoes a new modification. The first of these effects is invariably the result of chemical action; the latter may be produced by mechanical and chemical agency, either singly or combined.

In the composition of medicines, no chemical union is, in any case, effected; for a change of principle is involved in the term chemical combination; whereas, by compounding medicines, we mean merely the mixing of them together for the purposes of increasing or diminishing, or otherwise modifying, their individual agency, of disguising their taste and odour, or of giving them a more convenient shape.

Pharmacy, then, has the materia medica for its objects, and for its instruments, the means by which mechanical or chemical change is operated upon the ingredients of which the materia medica is composed. The most orderly method, therefore, of considering this subject will be, first to describe the mode in which the component principles of substances are developed, separated and combined, to enumerate such principles, or give the analysis of medicinal articles; and secondly, to detail the individual processes of preparation, separation, and combination, with the general uses and average doses of medicines thus combined, separated, or prepared.

PART I.

Pharmaceutical operations, and general analysis of the different substances used in medicine.

Pulverization is a process too simple and common to require definition; it consists in reducing substances to powder, by beating, or forcibly overcoming the aggregative, in order to facilitate the agency of chemical attraction. In trituration, the same effect is produced by rubbing in place of beating the materials operated upon; when this last is carried to a certain extent, and assisted by the addition of a fluid which does not act chemically upon this material, the process is denominated levigation.

The above processes are facilitated by separating, from time to time, the coarser from the finer parts of the materials: hence the utility of sifting, or passing the powder over sieves with apertures of various diameters: hence likewise the pharmaceutical process of washing, or, as it is termed, elutriation, by which, although in a different mode, the same end is obtained as by sifting, the powder being agitated in a fluid which does not act upon it as a solvent, the larger particles immediately subside, from which the fluid suspending the smaller is poured off, and suffered to remain at rest until these last are all deposited.

Most of the metals are mechanically divided by the operation called granulation; this consists of first filing or beating the metal into fine leaves; or by melting it, and during its state of fusion, pouring it into water, which condenses the separate globules: this process is denominated granulation, on account of the metallic particles being separated in the form of small grains.

The above then are the principal of those mechanical operations which may be regarded as auxiliary or preliminary to such as more immediately promote chemical action, or tend to effect an essential change in bodies: of these last the primary and most important is solution.

Solution, like pulverization, appears at first sight to be a simple process; it is however, in fact, an example of chemical attraction exerted between the particles of a solid and of a fluid substance; and although the solvent or active power is in vulgar conception attributed to the latter, "the attraction whence the solution proceeds is reciprocal, and is not more exerted by the one than by the other." Solution, however, of bodies in water, differs from most cases of chemical combination, in scarcely effecting an actual change in the properties of such bodies. This process therefore may be regarded as, in some measure, an exception to the general law of chemical action. Solution is aided by mechanical division; it is accelerated by agitation, and in most instances proceeds with a rapidity proportionate to the degree of temperature to which the solvent and solvend are subjected; because, by pulverization, agitation, and heat, the power by which the minute particles of individual bodies are held together is weakened, and thus mutual attraction is expedited.

Solution is differently denominated, according to the nature either of the solvent or solvend, or the manner in which the process is effected.

When we have a combination of saline or earthy substances, part of which is only soluble in one, and part in another fluid, the one portion may be separated from the other by the application of its appropriate solvent: such mode of solution is denominated lixiviation, and the result obtained a ley. When a fluid is applied to any vegetable or animal matter, so as to dissolve or attract only part of its principles, the operation is called extraction. If solution is effected without artificial heat, we denominate the process maceration; if a moderate heat is employed, digestion. When boiling fluid is poured upon a substance, and the vessel covered till the solution cools, the operation is termed infusion; and decoction if the fluid is actually boiled upon the materials to be dissolved.

When we wish to obtain the solid matter that has been dissolved, the solution is exposed to heat, converted into vapour, and that part not capable by this degree, or mode of heat, of being volatilized or evaporated, is thus obtained in a solid form: this process is denominated evaporation. Many substances, especially of the saline class, when thus treated, after the evaporating process has been carried to a certain extent, concrete into hard masses, transparent, and of a regular form: such concretions are termed crystals, and the process which engenders them crystallization. Crystals are abundantly formed in nature by slow and spontaneous, in place of a hasty and artificial evaporation; indeed it has recently been argued, that every modification of material substances deserves to be regarded as a crystal. The figure which the body assumes as the result of crystallization is invariable and peculiar to itself. Hence the classification of crystals, according to their form, as into prismatic, rhomboidal, &c. External circumstances, however, often interfere with this regularity.

The transparency of crystals, which is essential to their existence, depends upon a certain quantity of water diffused through them, called therefore their water of crystallization; when this is expelled, by whatever means, the density, pellucidity, and figure of the crystal, are lost. When crystals are thus destroyed, in consequence of exposure to air, they are said to effloresce. When water is absorbed by a crystal, so that it loses its crystalline, and assumes a moist condition, it is said to deliquesce.

Precipitation is another mean by which a solid is separated from a fluid body. If to a solution is added a substance having a more powerful attraction to the fluid than the solvent, the latter will be disunited, and thrown down or precipitated in a solid form; or the added matter may enter into combination with the solvent itself, and produce a compound no longer soluble, which will consequently be in the same manner precipitated.

When from a given solution or mixture, the volatile rather than the fixed or solid matter is wished to be separated, the processes of distillation or sublimation are had recourse to: in the former, the materials are subjected to a given degree of heat in vessels formed so as to collect the vapour, and again condense or reduce it to fluidity; by the latter, the volatile matter is likewise separated, and again condensed, but the reduction is into the state not of fluidity but of solidity.

After solution, fusion is the next in importance of pharmaceutical processes. This operation is usually performed in vessels called crucibles, which are cups formed of black lead, of earthenware, or of some metal, to which heat is applied generally by a furnace. Fusion is employed in order to effect chemical combination among materials which are insoluble, at least in any fluid which does not interfere with their chemical relations. Heat, however, may be applied so as to promote union among bodies, though it is not so powerful as to produce fusion; as for example in calcination, by which, in consequence of exposing a metal to a high temperature, it attracts oxygen from the circumambient air. Deflagration is a process in some measure similar: this consists in mixing substances with which much oxygen is combined, by a feeble attractive power, with inflammable matter, and subjecting the mixture to heat; such substance attracts the oxygen from the matter with which it had previously been united, and thus becomes oxydated or deflagrated.

The above, then, are the chief processes of pharmacy; or those by which the principles of such substances as enter into the materia medica, are developed, combined, and separated. We now proceed to our proposed

Analysis of medicinal articles.

On this subject we shall be as brief as possible. A more ample analysis of the respective substances treated of, will be found under their names as they occur in alphabetical order.

In analysing the different productions of nature, we obtain a few substances which are incapable in our present state of knowledge of further decomposition. These substances are denominated *simple*. As, however, we have no means of ascertaining whether, at any period of decomposition, we have arrived at the ultimate particles of bodies, absolute simplicity can never be predicated of any substance; and by the term simple, we merely mean to express the homogeneousness of any substance, as it relates to our present state of chemical knowledge. See CHEMISTRY.

In the first order of simple substances, and those indeed which appear to prefer the highest claim to the character of simplicity, are the gases, oxygen, azote, and hydrogen; which are solid materials brought into a gaseous condition by caloric.

Of these, oxygen is the most important. Like other gases, it is elastic and invisible; it is a little heavier than common air. Its distinguishing properties or characteristics, are its power of supporting combustion and animal life. The compounds resulting from the union of oxygen with other materials form the most active medicinal agents.

Thus, for example, quicksilver, when in its metallic state, is scarcely possessed of any active properties in reference to the animal economy; on the contrary, when combined with oxygen, it constitutes one of the most powerful agents that are employed in medicine.

Oxygen constitutes nearly one-fourth of atmospheric air; united in a certain proportion with hydrogen, it forms water; and with certain inflammable substances, acids. Indeed the element derives its name from being the acidifying principle. Oxygen, however, unites with many substances without rendering them acid; such are the compounds which this element forms with the metals, as well as with large numbers of both vegetable and animal productions.

Azote, like oxygen, when pure and uncombined, always exists in a gaseous form; this constitutes the remaining three-fourths of the atmosphere. It is lighter than atmospheric air; it is unable to support respiration or combustion; and in the strictest sense it is not inflammable. Combined with oxygen, in a certain proportion, it forms, as just stated, atmospheric air; in that proportion in which the two elements are saturated, it constitutes the nitric acid; with a smaller proportion, the nitrous acid: and we may here observe, that the terminating syllables *ic* and *ous*, are used in all cases to denote the different degrees in which oxygen enters into the composition of acids. Thus sulphur, with a larger quantity of oxygen, so as to constitute it a more perfect acid, is called sulphur*ic*; with a smaller proportion of this principle, it is named sulphure*ous* acid.

Azote, with a certain quantity of oxygen, insufficient to create acidity, forms nitrous and nitrous-oxyd gases, the last of which has been but very recently discovered, and has been celebrated by its extraordinary powers on the animal frame.

Combined with hydrogen, in a given proportion, azote forms ammonia or volatile alkali.

Lastly, azote is an abundant principle in animal matter, and indeed chiefly occasions the variation in composition between this and vegetable substance.

Hydrogen, the last of the simple gases, is extremely light and inflammable; its most important compound is water, formed, as just stated, by its union in a certain proportion with oxygen. Water, it is almost unnecessary to observe, is one of the most important agents in pharmacy.

The next order of those substances which are considered as simple, are the three inflammable principles, carbon, sulphur, and phosphorus.

Carbon is the basis of common charcoal. In this substance, however, it is combined with some oxygen; and it has lately been demonstrated, that the diamond is the pure inflammable base of carbon. Combined with a larger quantity of oxygen, carbon constitutes the gaseous oxide of carbon; when actually saturated with oxygen, it forms the carbonic acid gas, or what was formerly called fixed air. Carbon, united with hydrogen and oxygen, forms several peculiar compounds, such as alcohol, ether, &c.

Sulphur, we have already said, in combination with oxygen, constitutes the sulphuric and sulphureous acids; the latter is extensively employed in chemistry and pharmacy.

Sulphur and hydrogen form a gaseous compound called sulphurated hydrogen, which is distinguished by a peculiar fœtor. Lastly, sulphur is a component principle of several animal, and of some few vegetable, substances.

Phosphorus has not been detected pure and uncombined. In the fossil kingdom, however, it is found combined both with several of the earths and metals; and it also enters into the composition of many animal and vegetable productions.

There are three acids, the muriatic, fluoric, and boracic, which, on account of their not having hitherto been decomposed, are regarded as simple, but which analogy leads us to suppose are constituted in the same manner with other acids, viz. by the union of their peculiar principle with oxygen: it is only the first of these that can be regarded as a pharmaceutic agent. It exists in abundance in sea-salt. When in a gaseous condition, it is remarkably pungent. It is capable of combining with a considerable portion of oxygen, so as to form the oxymuriatic acid, which acts with energy on inflammable substances.

Metals form the third order of simple substances. The distinguishing properties of these are opacity, brilliancy, ductility, fusibility, malleability, and superior specific gravity to that of any other substances. They are rendered active on the system by combination with oxygen or with acids; the most active of them, as we have already observed, being almost inert in a metallic state. Different metals are capable of combining with different quantities of oxygen; four of them, arsenic, molybdena, tungsten, and tin, may be so far oxygenated, as to pass into the form of acids.

The last order of simple substances is the earths. The characters of these are insipidity, infusibility, not being inflammable, and scarcely soluble, saving a specific gravity of less than five to one, and being capable of combination with acids to form neutral salts.

The principal earths are the silex, argil, magnesia, lime, barytes, and strontites. Of these the magnesia and lime are in the most common use as medicines; the argillaceous compounds are not unfrequently employed; and lately the barytic salts have been introduced into practice.

Alkalies bear some resemblance to the earths. They have a penetrating taste; they change the vegetable colours to a green; they powerfully attract water, unite with oils, and with the acids form neutral salts. They are three; potass, soda, and ammonia: the last has been proved to be compounded of azote and hydrogen, and it is probable that the others may ere long be demonstrated to be compound substances.

All the alkalies are employed in medicine; and they are likewise important agents in pharmacy. The names of the neutral salts which are formed by the union of acids with alkalies, earths, and metallic oxides, are chosen partly from the base and partly from the acid. All (for example) of the salts composed of the sulphuric acid, are denominated sulphats; as the sulphat of potass, of lime, &c. When the acid forming the union is less pure, or when it is the sulphureous, the resulting compounds are denominated sulphites; and this principle of nomenclature extends through the whole of saline compositions.

We now proceed to state the proximate and ultimate principles of the vegetable and animal productions of nature; or of those substances which result from organization, in contradistinction to those of inert matter. By the proximate principles of organic matter, we mean those by the combination and separation of which a compound body may be formed or divided. The ultimate principles are the elements of which an integral body may consist, whether more or less complex in its composition.

The proximate principles of vegetables, which substances are the most common objects of pharmacy, may be separated or ana lysed by mere exposure to heat: sometimes the atmospheric air is admitted in conjunction with heat; fermentation is often employed to separate the constituent principles of materials; lastly, nitric acid is much used in analysis, by which oxygen is communicated to the substance operated upon; and by the resulting compound, the nature of the acidifiable base is indicated.

Gum is one of the most abundant among the proximate principles of vegetables. It is glutinous, insipid, without odour, and soluble in water, constituting a viscid solution, denominated mucilage. It is insoluble in alcohol, ether, or oil. It does not absorb oxygen from the atmosphere; it is neither volatile nor fusible. At a temperature beyond the boiling point, but beneath that of ignition, gum is decomposed, and affords an impure acetous acid, ammonia, carbonic acid, and carbonated hydrogen gases; the residuum is charcoal with a certain quantity of lime.

The ultimate principles of gum are oxygen, hydrogen, carbon, azote, and lime. The medicinal qualities of gum are trivial. In pharmacy it is employed principally as a medium of mixture between oils and water.

Resin. This is another proximate principle existing in abundance in vegetable products. It is generally, but not always, united with gum. Resin is not soluble in water, but, unlike gum, is soluble in alcohol, ether, and oils. Resin does not absorb oxygen; when heated to ignition it burns; and is fusible by a heat nearly that of boiling water. When volatilized, however, it is invariably decomposed: its products are water, acetous acid, a burnt oil, and a charcoal residuum. Its ultimate principles are carbon, hydrogen, and oxygen.

Resins are much more active on the living system than gums. The virtues of many medicinal substances depend exclusively on their resinous part.

The extractive matter is another vegetable principle, which until lately was confounded with the gum and resin. This is equally soluble in water and in alcohol. It likewise, at a certain temperature, absorbs oxygen. It affords, upon being exposed to heat, empyreumatic acid and oil, and some ammonia. Its elements are carbon, hydrogen, oxygen, and azote.

This vegetable principle it is difficult to obtain pure and unmixed.

Oil. This is of two kinds, expressed or unctuous, and volatile or essential. These have some qualities in common, and others characteristic of each. Expressed oils are viscid, almost without taste or odour: they congeal by cold, and are insoluble either in water or alcohol. With alkalies they form soap. At a temperature of 212°, they are decomposed, and afford water and carbonic acid. Their ultimate principles are carbon, with a small proportion of hydrogen.

These oils are generally found in the seeds and fruits of vegetables, from which they are separated by mechanical pressure, or by boiling. Some of them have medicinal virtues, but they are commonly employed merely as lubricants.

Volatile or essential oils are quickly dissipated by the heat of boiling water, without suffering decomposition. They are more soluble in alcohol than in water. They slowly absorb oxygen, and are at length changed into resinous matter. They contain more hydrogen than the fixed oils.

Essential oil exists in abundance in the aromatic plants, and appears to constitute their aroma, although some chemists have supposed this last to be a peculiar and exclusive principle. It is usually extracted from the vegetable by distillation. As medicines, these oils are highly stimulant. The natural combination of essential oil and resin, which exists in some plants, constitutes balsam, which in some cases has also a peculiar acid in its composition.

Camphor. This is a distinct vegetable principle. It is insoluble in water, but is soluble in alcohol, oil, and ether. It evaporates even at the ordinary temperature of the atmosphere. When distilled, it is decomposed, and affords a pungent volatile oil, amounting to nearly one-third of its weight, while carbonic and hydrocarbonic acid gases escape, and a quantity of charcoal remains. Camphor then appears to contain a greater proportion of carbon and perhaps of oxygen than the essential oils. The medicinal powers of camphor are very considerable.

Wax is a solid, tenacious, and inflammable principle, holding nearly the same relation to expressed, that camphor does to essential, oil.

Fecula is an important principle in vegetables. It is, when existing separately, mild and insipid. It is not soluble in cold water. With boiling water, it forms a jelly. It is insoluble in alcohol. It is converted by certain processes into sugar. Fecula is composed of oxygen, carbon, and hydrogen. It is by far the most nutritious principle in vegetables.

Gluten. A thick fibrous substance found in the farina of some plants. It is insipid, elastic, insoluble in water, and but sparingly soluble in alcohol. Its prominent principle appears to be azote.

Albumen, like gluten, is named from its resemblance to a principle in animal matter. This is soluble in cold water, and coagulated by heat or alcohol. It affords much ammonia on exposure to heat.

Saccharine matter is generally found united with gum and extract. It is soluble in water, and in alcohol. It is converted by fermentation into alcohol; and this last, by a second stage of fermentation, becomes acetous acid. Saccharine matter consists of oxygen, carbon, and hydrogen.

The saline principle in vegetables is named their essential salt. Essential salts are either acids or neutrals.

The native vegetable acids which have been detected, are seven, viz. the malic, which is contained in apples, and other fruits, previous to their maturity. It is converted into the oxalic acid by the agency of nitrous acid.

The oxalic. This has the largest proportion of oxygen, of any native vegetable acid. It is soluble, and capable of crystallization. Its distinguishing property is its very strong attraction for lime.

The citric. This attracts the earths in general more forcibly than the alkalies.

The tartarous, which is extremely soluble in water, and crystallizable. It has been imagined to contain a larger portion of hydrogen than any other of the acids.

The acetous. This acid is more usually the produce of fermentation. It is however found native in the sap of the vine, &c. It yields upon decomposition a small portion of ammonia.

Benzoic acid is found in several balsams and gum-resins. This is soluble in boiling water, and upon cooling separates in white flakes.

The gallic is the last of the native vegetable acids. This has generally been supposed to constitute the principle of astringency in vegetables. It exists abundantly in gall-nuts, and other vegetable astringents. Its distinguishing property is its forcible attraction to the oxides of iron, with which it forms a precipitate of a very deep black. The gallic acid contains a large quantity of carbon, with some oxygen, and a very small quantity of hydrogen.

The tannin, or tanning principle, has been till lately confounded with the gallic acid. This principle is characterized by its faculty of combining with animal jelly, and forming a hard insoluble substance. Tannin is found in considerable quantity in vegetable astringents, and is usually united with the gallic acid.

Besides the above vegetable acids, several compounds exist in some vegetables, formed by the junction of sulphuric, nitric, muriatic, carbonic, and phosphoric acids, with the alkalies and earths.

The ligneous part, or fibre, of the vegetable, is enumerated among its proximate principles. This is in a manner the basis for the attachment of its other principles. It is insipid and insoluble. With nitrous acid it affords the malic and oxalic acids. It appears to be principally formed of carbon, combined with oxygen and hydrogen.

From the above enumeration of the proximate principles in vegetables, the utility of those pharmaceutical processes to which they are subjected, may with facility be perceived. These we need not again describe; but shall conclude the present section by a general notice of the principles of such animal substances as are medicinally employed. The number of articles which are received into the materia medica from the animal kingdom is comparatively small. Animal have the same general chemical characters with vegetable products. The principal difference is constituted by the superior disposition of the former to undergo the putrefactive process, and by their affording a larger quantity of ammonia or volatile alkali when decomposed by heat: these peculiarities appear to be principally derived, as above noticed, by the presence of azote in a much larger proportion in animal than in vegetable matter. This in decomposition unites with the hydrogen which animal substances likewise contain in abundance, and thus constitutes the ammonia. Animal substances contain likewise sulphur and phosphorus; and for the most part the carbon which enters into their composition is much inferior in quantity to what is found in vegetables.

The vegetable gluten and albumen we have already described as resembling the animal. Animal fat bears a considerable resemblance to vegetable oil. Gelatine is like mucilage or fecula. Milk contains a principle similar to the saccharine matter in the vegetable. A substance having an affinity to resin is found in several animal secretions; and the animal acids do not greatly differ from the vegetable compounds of the same class.

We now proceed to our detail of the individual processes in pharmacy. In so doing we shall pursue the plan adopted by Mr. Murray; of giving, not a translation of each separate process, both from the London and Edinburgh Pharmacopœias; but wherever the formula of the first differs in no essential point from the last, we shall confine ourselves to a statement of this last, and give at the head of the article the name by which it is distinguished in either. We have thus chosen the Edinburgh Pharmacopœia as in a manner the basis of the present article, and this merely on account of its more recent revision than that of the London, and the titles of medicines being made for the most part more conformable to the present improved condition of pharmaceutical chemistry. With the above-mentioned author, however, we shall point out when it occurs, "any important difference either in proportion, composition, or mode of conducting the process," in the directions of the two colleges, and at the end of each division add those preparations which are peculiar to the Pharmacopœia Londinensis.

While thus we shall make the article as brief as the subject will admit of, we shall at the same time, it is presumed, ensure the advantages of a treatise more in detail.

PART II.

THE PREPARATIONS AND COMPOSITIONS OF MEDICINES.

Simplicium quorundam medicamentorum præparationes.

Preparation of some simple medicines.

Carbonas calcis præparatus, prepared carbonat of lime, Ed. Creta præparata, Lond.

Carbonat of lime (whether the softer variety called chalk, or the harder, crab's-stones and crab's-eyes), being reduced to powder in an iron mortar, and levigated on a porphyry-stone, is to be put into a vessel of considerable size, and water poured upon it; after the vessel has been frequently agitated, the water is to be poured off loaded with a fine powder, which, when it has all subsided, is to be dried, and the coarser particles which the water could not suspend are to be again levigated and treated in the same manner.

These calcareous carbonates, which are all of the same nature, are used as antacids. Dose one or two drachms.

Carbonas ferri præparatus, prepared carbonat of iron, Ed. Ferri rubigo, Lond.

Purified iron filings to be frequently moistened with water, till they become rust, which is to be rubbed to a fine powder.

An active chalybeate. Dose from 10 to 20 grains.

Carbonas zinci impurus præparatus, prepared impure carbonate of zinc, Ed. Lapis calaminaris, Lond.

The preparation of impure carbonat of zinc roasted by those who make brass, is to be conducted in the same manner as the carbonat of lime.

This powder is the basis of the common cerate. It is sprinkled on the skin in the cutaneous inflammations of children.

Ferri limatura purificata, purified filings of iron, Ed.

A sieve being placed over the filings, a magnet is to be applied in order to attract the pure iron through its apertures upwards.

Ferri oxidum nigrum purificatum, purified black oxide of iron, Ed.

Let the scales of the black oxide of iron, found at the anvils of workmen, be treated with a magnet in the same manner; for the magnet attracts only the more small and pure scales, leaving those which are larger and less pure.

Oxidum zinci impurum præparatum, prepared impure oxide of zinc, Ed. Tutia, Lond.

To be prepared as the carbonat of lime.

Tutty is employed with the same intention as calamine.

Sulphas aluminæ exsiccatus, dried sulphat of argil, Ed. Alumen ustum, Lond.

Let sulphat of argil be melted in an earthen or iron vessel, and heat applied until the liquid ceases to boil.

This preparation is used as an escharotic.

Sulphur sublimatum lotum, washed sublimed sulphur, Ed. Flores sulphuris loti, Lond.

Take of sublimed sulphur one pound; water four pounds; boil the sulphur a little with the water, then pour the water off, and free the sulphur of acid by the affusion of cold water; lastly, dry the sulphur.

This perhaps is a superfluous process.

Sulphur præcipitatum, Lond.

Take of sulphurated kali (sulphuretum potassæ) six ounces; distilled water one pound and a half; diluted vitriolic (sulphuric) acid as much as necessary; boil the sulphurated kali in the distilled water until it is dissolved: filtre the liquor through paper, and add the diluted acid. Wash the precipitated powder until it becomes insipid.

This preparation of sulphur is from its whiteness useful in forming ointment.

Sulphuretum antimonii præparatum, prepared sulphuret of antimony, Ed. Antimonium præparatum, Lond.

To be prepared in the same manner as carbonate of lime.

Mel despumatum, clarified honey.

Liquify honey in a water-bath, and remove the scum.

Herbarum et florum exsiccatio, drying of herbs and flowers.

Herbs and flowers are to be dried with the gentle heat of a stove, or a common fire, in such a quantity that the exsiccation may be effected as speedily as possible; for in this manner their virtues are best preserved. The indication of this is their retaining their native colour. The leaves of hemlock, and other plants containing a subtle volatile oil, after being dried, are to be rubbed to powder, and preserved in glass-vessels well stopped.

Scilla maritima exsiccata, dried sea-quill, Ed. Scilla exsiccata, Lond.

Let the root of the sea-squill be cut transversely into thin slices, after its external covering has been removed, and dried by a gentle heat.

If when rendered friable, the squill retains its bitterness and acrimony, the drying process has been properly conducted. It is in this state that the squill is chiefly used in medicine. Dose from one to three grains.

Pulparum extractio, extraction of pulps, Ed. Pulparum præparatio, Lond.

Boil those fruits which afford pulp, if unripe or if ripe and dry, with a little water; then express the pulp through a hair-sieve, and gently boil it in an earthen vessel, stirring it frequently lest it burns, until it assumes the consistence of honey. The cassia fistula pulp is to be boiled from the bruised pod, and the water evaporated to a due consistence. When fruits are ripe and fresh, the pulp may be squeezed through a sieve without previous boiling.

The following preparations are only found in the London Pharmacopœia:

Ammoniaci purificatio, purification of gum ammoniac.

Boil impure ammoniac in water until it softens, and by a press strain it through a hempen bag: let the resinous matter have time to subside. Evaporate the water, mixing towards the end of the evaporation the resinous and gummy parts. Assafœtida and other similar gum-resins may be purified in the same way. Any gum also which melts easily, such as galbanum, may be purified by putting it into an ox-bladder and keeping it in boiling water, till it becomes so soft that it may be pressed through strong linen cloth, and freed from its impurities.

Styracis purificatio, purification of storax.

Having dissolved storax in alcohol, strain the liquor, and distil it with a gentle heat to a proper consistence.

Cornu cervi ustio, burning of hartshorn.

Burn pieces of hartshorn until they become white, then rub them to a very fine powder.

Millepedæ præparatio, preparation of millepedes.

Suspend these, inclosed in a thin linen bag, over proof spirit heated in a close vessel, that they may be killed by the vapour, and rendered friable.

Spongiæ ustio, burning of spunge.

Bruise spunge cut into small pieces; and when freed from strong matter, burn it in a close iron vessel until it becomes black and friable; then rub it into a fine powder.

Conservæ, conserves.

The conserves that are retained in the Ph. Ed. are the conserva corticis exterioris recentis fructus citri aurantii, radulâ abrasa; conserve of the outer rind of the orange, rasped by a grater, Ed. Conserva aurantii hispanionalis corticis exterioris, Lond. Conserva fructûs rosæ caninæ maturi, a seminibus eorumque pube sollicitè purgati, conserve of the fruit of dog-hips carefully freed from the seeds and included down, Ed. Conserva cynosbati, Lond.

Conserva rosæ gallicæ nondum explicitorum, conserve of the unblown petals of the red rose, Ed. Conserva rosæ rubræ, Lond.

In each of these the vegetable is to be beat into a pulp, and during the beating three times its weight of sugar to be gradually added.

In addition to the above, the London college retain conserva absinthii maritimi, conserve of sea-wormwood. Conserva lujulæ, conserve of wood-sorrel. Conserva ari, conserve of arum. Conserva pruni sylvestris, conserve of sloes. Conserva scillæ, conserve of squills.

Succi, juices.

Succus cochleariæ officinalis compositus, compound juice of scurvy-grass, Ed. Succus cochleariæ compositus, Lond.

Take of juice of scurvy-grass, juice of water-cresses expressed from recently gathered herbs, juice of the orange-fruit, of each two pounds; spirit of nutmeg half a pound: mix and let them stand until the impurities have subsided, then pour off the liquor.

This preparation is scarcely in use.

Succi inspissati, inspissated juices or extracts.

Succus spissatus aconiti napelli, inspissated juice of aconite or wolfsbane, Ed.

Bruise the fresh leaves, and press the juice strongly through a hempen bag; which reduce, by evaporation in open vessels heated by boiling water saturated with muriat of soda, to the consistence of thick honey. After the mass has cooled, it is to be kept in glazed earthen vessels, and moistened with alcohol.

A remedy chiefly employed in obstinate cases of chronic rheumatism. Dose from five to six or more grains.

In the same manner are to be prepared the four following:

Succus spissatus atropæ belladonnæ, inspissated juice of deadly-nightshade.

This has been used in convulsive disorders and in schirrus. Dose one grain, gradually increased.

Succus spissatus conii maculati, inspissated juice of hemlock, Ed. Succus spiss. cicutæ, Lond.

Recommended by Störk of Vienna in schirrus and cancer. Dose two grains, increased largely.

Succus spissatus hyoscyami nigri, inspissated juice of black henbane, Ed.

Dose one grain, increased.

Succus spissatus lactusæ virosæ, inspissated juice of strong-scented lettuce, Ed.

Principally used in Germany for dropsy. Dose four or five grains, largely increased.

Succus spissatus sambuci nigræ, inspissated juice or rob of elder, Ed. Succus spiss. baccæ sambuci, Lond.

Five pounds of elder-berry juice, and one pound of sugar, are to be gently boiled to the consistence of thick honey.

This is by no means an eligible preparation. It has been employed as a laxative, in the dose of half an ounce or more.

Succus spissatus momordicæ elaterii, inspissated juice of wild cucumber, Ed. Elaterium, Lond.

Cut the ripe fruit of the wild cucumber, and pass the expressed juice through a very fine hair sieve. Boil it a little, and set it aside for some hours, that the thick parts may subside. Pour off the thinner parts, and then separate the remainder by straining. The thicker part which remains is to be covered with a linen cloth, and dried by a gentle heat.

This preparation has been employed as a powerful cathartic. Dose one or two grains.

The additional preparations in the Ph. Lond. are, succus spissatus ribis nigri, inspissated juice of black currant; and succus spissatus limonis, inspissated juice of lemon.

Olea fixa, fixed oils.

Oleum amygdalæ communis, Ed. Ol. amygdalæ, Lond.

Take any quantity of fresh almonds, bruise them in a stone motrar, enclose the mass in a hempen bag, and express the oil by a press without heat.

In the same manner the oleum lini usitatissimi, oil of linseed, Ed.; ol. e semine lini, Lond. is to be expressed.

To the above, the London college add, ol. ricini, castor-oil; and ol. sinapeos, oil of mustard.

The former of these, however, is usually prepared by decoction, and is made in the West Indies.

Emulsiones, emulsions.

Emulsio amygdalæ communis, almond emulsion, Ed. Lac amygdalæ, Lond.

Take of sweet almonds (blanched) an ounce; water two pounds and a half; beat the almonds in a stone mortar, and gradually add the water, then strain.

This emulsion is employed freely as a demulcent.

Emulsio gummi mimosæ niloticæ, Arabic emulsion.

This is prepared in the same manner, adding while beating the almonds two ounces of gum-arabic mucilage.

Employed with the same intention as the above.

Emulsio camphorata, camphor emulsion.

Camphor one scruple, blanched sweet almonds two drachms, refined sugar one drachm, water six ounces; to be mixed in the same manner as the almond emulsion. Dose two ounces.

Infusa, infusions.

Infusum cinchonæ officinalis, infusion of Peruvian bark.

Take of Peruvian bark powdered one ounce; water one pound. Macerate for four-and-twenty hours, and then strain.

This contains only a small portion of the active principle of the bark. Dose two ounces.

Infusum digitalis purpureæ, infusion of foxglove.

Take of the dried leaves of foxglove one drachm; boiling water eight ounces; spirit of cinnamon one ounce. Macerate for four hours, and strain. Dose in dropsy half an ounce twice a day, gradually increased.

Infusum gentianæ luteæ compositum, compound infusion of gentian, Ed. Infus. gentianæ comp. Lond.

Take of gentian root half an ounce; dried orange-peel one drachm; coriander-seeds half a drachm; diluted alcohol four ounces; water one pound. Pour on first the alcohol, and after three hours the water; then macerate for twelve hours without heat, and strain.

An useful medicine in dyspepsia. Dose two ounces.

Infusum mimosæ catechu, infusion of catechu.

Take of extract of catechu two drachms and a half; cinnamon half a drachm; boiling water seven ounces; simple syrup one ounce. Macerate the extract and cinnamon with the water in a close vessel for two hours; then strain, and add the syrup.

Principally employed in diarrhœa. Dose one ounce.

Infusum rhei palmati, infusion of rhubarb.

Take of rhubarb root half an ounce; boiling water eight ounces; spirit of cinnamon one ounce. Macerate the root with the water in a closed vessel for twelve hours; then, the spirit being added, strain the liquor.

Employed as a mild cathartic. Dose two ounces.

Infusum rosæ gallicæ, infusion of red rose, Ed. Infus. rosæ, Lond.

Take of the dried petals of the rose two ounces; boiling water five pounds; sulphuric acid one drachm; refined sugar two ounces. Macerate the rose with the water in an earthen vessel (which is not glazed with lead) for twelve hours; then, having poured on the acid, strain the liquor and add the sugar.

Principally used as a mild astringent gargle.

Infusum tamarindæ indicæ cum cassia senna, infusion of tamarind and senna.

Take of the prepared fruit of the tamarind one ounce; senna-leaves one drachm; coriander-seeds half a drachm; unrefined sugar half an ounce; boiling water eight ounces. Macerate in a closed earthen vessel not glazed with lead, which is to be shaken frequently, and after four hours standing, the liquor is to be strained.

This is a mild and pleasant purgative. The whole of the above quantity may be taken at a time.

N. B. The infusum sennæ simplex of the Ph. Lond. is prepared from senna one ounce and a half; ginger one drachm; boiling water one pint; macerated for an hour and strained.

The infusum sennæ tartarisatum, is prepared from senna one ounce; coriander-seeds bruised half an ounce; acidulous tartrite of potass (crystals of tartar) two drachms; distilled water one pint: the crystals of tartar to be dissolved in the water by boiling, and the liquor while hot poured on the senna and coriander, the maceration being continued for an hour in a covered vessel, and when cold strained. Dose of each from two to eight ounces.

Potio carbonatis calcis, chalk potion, Ed. Mistura cretacea, Lond.

Take of prepared carbonate of lime an ounce; refined sugar half an ounce; mucilage of gum arabic two ounces. Rub them together, and gradually add two pounds and a half of water, and spirit of cinnamon two ounces.

An antacid. Dose one or two ounces.

The four following mixtures are found only in the Ph. Lond.

Mistura camphorata, camphorated mixture.

Take of camphor one drachm; a small quantity of rectified spirit of wine; refined sugar half an ounce; boiling distilled water one point. Rub the camphor first with the spirit, then with the sugar; add gradually the water, and strain the mixture.

Dose an ounce.

Mistura moschata, musk mixture.

Take of musk two scruples; powdered gum arabic, refined sugar, of each a drachm; rose-water six ounces. Rub the musk with the sugar, then with the gum, and gradually add the rose-water. Dose an ounce.

Lac ammoniaci, milk of gum ammoniac.

Take of gum ammoniac two drachms; distilled water half a pint. Triturate the gum with the water poured on gradually.

Dose from half an ounce to an ounce.

Lac assafœtidæ, milk of assafœtida.

Prepared in the same manner. Dose half an ounce or more.

Mucilago amyli, starch mucilage, Ed. Mucilago amyli, Lond.

Take of starch half an ounce; water one pound. Rub the starch, and add gradually the water; then boil them for a short time.

Principally employed as a vehicle for opium, &c. in enema.

Mucilago astragali tragacanthæ, mucilage of gum tragacanth, Ed. Mucilago tragacanthæ, Lond.

Take of tragacanth gum powdered an ounce; boiling water eight ounces. Macerate for twenty-four hours, and rub carefully the gum so that it may be dissolved; then strain it through linen.

Used chiefly in making troches.

Mucilago mimosæ niloticæ, mucilage of gum arabic, Ed. Mucilago gummi arabici, Lond.

Take of powdered gum arabic one part; boiling water one part. Digest with frequent shaking until the gum is dissolved; then strain through linen.

Employed principally as a demulcent, and as a vehicle for suspending oils, &c.

Mucilago seminum cydonii mali, Lond. mucilage of quince-seed.

Take of quince-seed one drachm; distilled water eight ounces. Boil with a gentle heat for ten minutes, and strain through linen.

This is seldom employed in medicine.

Aqua calcis, lime-water, Ed. Aq. calcis, Lond.

Take of lime recently prepared half a pound. Place it in an earthen vessel, and sprinkle it with four ounces of water, keeping the vessel covered while the lime becomes hot and pulverizes; then pour on twelve pounds of water, and by agitation mix it with the lime. This agitation is to be repeated after the lime has subsided, which is to be done about ten times, keeping the vessel closed to prevent the accession of air. Now let the water be strained through paper, interposing glass rods between the filtre and the funnel, that it may pass through as quickly as possible. It is to be kept in bottles well stopped.

Lime-water is used as a tonic and astringent. Dose from one to two pounds daily.

Decocta, decoctions.

Decoctum althææ officinalis, decoction of althæa, Ed.

Take of althæa-root dried four ounces; raisins freed from their seeds two ounces; water seven pounds. Boil down to five pounds; strain; put aside the strained liquor until the impurities have subsided, and pour off the clear liquor.

As a demulcent to be drunk ad libitum.

Decoctum anthemidis nobilis, decoction of camomile.

Take of dried camomile flowers an ounce; caraway-seeds half an ounce; water five pounds. Boil for a quarter of an hour, and strain.

The decoctum pro enemate, and decoctum pro fomento, of the London Ph. are similar to the above.

Decoctum cinchonæ officinalis, decoction of Peruvian bark, Ed. Decoctum cinchonæ, Lond.

Take of Peruvian bark in powder one ounce; water a pound and a half. Boil for ten minutes in a closed vessel, and while still hot strain. Dose two ounces.

Decoctum daphnes mezerei, decoction of mezereon, Ed.

Take of the mezereon-bark two drachms; of bruised liquorice-root half an ounce; water three pounds. Boil with a gentle heat down to two pounds, and strain.

This decoction has chiefly been given in cases of syphilis, either with or without mercury. Dose six or eight ounces.

Decoctum geoffrææ inermis, decoction of cabbage-tree bark, Ed.

Take of the cabbage-tree bark in powder an ounce; water two pounds. Boil gently to one pound, and strain.

This is sometimes given as an anthelmintic. Dose two ounces.

Decoctum guaiaci officinalis compositum, compound decoction of guaiac.

Take of the shavings of guaiac-wood three ounces; raisins two ounces; sassafras-root, liquorice-root, of each an ounce; water ten pounds. Boil the water with the guaiac and raisins with a gentle heat to five pounds, and towards the end of the decoction add the roots; then strain without expression.

It is chiefly given in chronic rheumatism. Dose two or three pints daily.

Decoctum ordei distichi, decoction of barley, Ed. Decoct. hordei, Lond.

Take of pearl-barley two ounces; water five pounds. First wash off with cold water the flour adhering to the barley; then boil the barley for a short time with about half a pound of water, to extract the colouring matter. Put the barley thus purified into five pounds of boiling water. Boil this to one half, and strain.

A common diluent in fever. In the Ph. Lond. a compound decoction is ordered with figs, raisins, and liquorice.

Decoctum polygalæ senegæ, decoction of seneka.

Take of seneka-root one ounce; water two pounds. Boil to sixteen ounces, and strain.

Dose two or three ounces.

Decoctum smilacis sarsaparillæ, decoction of sarsaparilla, Ed. Decoct. sarsaparillæ, Lon.

Take of cut sarsaparilla six ounces; water eight pounds. Digest for two hours in a heat of about 195°; then take out the root and bruise it, return it to the liquor, and boil it with a gentle fire to two pounds. Then express and strain.

Sarsaparilla in this form is employed in combination with mercury in syphilis.

The decoctions of the London, which are not in the Ed. Ph. are the following:

Decoctum cornu cervi, decoction of hartshorn.

Take of burnt and prepared hartshorn two ounces; gum arabic six drachms; distilled water three pounds. Boil, stirring constantly, down to two pounds, and strain.

This is a useless preparation.

Decoctum hellebori albi, decoction of white hellebore.

Take of white hellebore root in powder one ounce; distilled water two pints; rectified spirit of wine two ounces. Boil the water with the root to one pint, and when the liquor is cold, strain it and add the spirit.

This is principally employed as a wash in psora.

Decoctum sarsaparillæ compositum, compound decoction of sarsaparilla.

Take of sarsaparilla root slit and bruised six ounces; bark of sassafras root, shavings of guaiac wood, liquorice root bruised, of each one ounce; mezereon three drachms; distilled water ten pints. Macerate for six hours with a gentle heat; boil to five pints; towards the end of the boiling add the mezereon, and then strain.

An improvement upon the Lisbon diet-drink. Dose four or six ounces, three or four times a day.

Decoctum ulmi, decoction of elm.

Take of the elm bark, fresh bruised, four ounces; distilled water four pints. Boil to two pints, and strain.

This has been used in cutaneous affections.

Syrupi, syrups.

Syrupus simplex, common syrup.

Take of refined sugar, powdered, fifteen parts; water eight parts. Dissolve the sugar with a gentle heat, and boil it a short time, so as to form syrup.

Syrupus acidi acetosi, acidulous syrup.

Take of acetous acid two pounds and a half; refined sugar three pounds and a half. Boil so as to form syrup.

Syrupus althææ officinalis, syrup of althæa, Ed. Syr. althææ, Lond.

Take of fresh althæa root cut, one pound; water ten pounds; refined sugar four pounds. Boil the water with the root to one-half, and strain it by strong pressure. Put aside the strained liquor, that the impurities may subside; and to the purified liquor add the sugar: then boil, so as to form a syrup.

This is a superfluous preparation.

Syrupus amomi zinziberis, syrup of ginger, Ed. Syrupus ziniziberis, Lond.

Take of ginger root beaten three ounces; boiling water four pounds; refined sugar seven pounds and a half. Macerate the root in the water in a closed vessel for twenty-four hours: then to the strained liquor add the pounded sugar, so as to make a syrup.

This is a pleasant and useful syrup.

Syrupus citri aurantii, syrup of orange-peel, Ed. Syr. corticis aurantii, Lond.

Take of the fresh outer rind of the orange six ounces; boiling water three pounds;

refined sugar four pounds. Macerate the rind in the water for twelve hours; then to the strained liquor add the pounded sugar; and thus form a syrup, by applying a gentle heat.

This syrup, like the former, is grateful and aromatic.

Syrupus citri medicæ, syrup of lemon, Ed. Syr. limonis, Lond.

Take of the juice of lemons strained, after the impurities have subsided, three parts; refined sugar five parts. Dissolve the sugar so as to form a syrup.

This syrup is used to sweeten and acidulate mixtures.

Syrupus colchii autumnalis, syrup of colchium.

Take of the fresh root of colchium, sliced into small pieces, one ounce; acetous acid sixteen ounces; purified sugar twenty-six ounces. Macerate the root in the acid for two days, occasionally agitating the vessel: then strain it with a gentle pressure; to the strained liquor add the sugar, and boil it so as to form a syrup.

This has been given in dropsy, in the dose of from half an ounce to one ounce.

Syrupus dianthi caryophilli, syrup of clove July-flower, Ed. Syrup caryophilli rubri, Lond.

Take of the fresh petals of this flower, freed from the peels, one pound; boiling water four pounds; refined sugar seven pounds. Macerate the petals in the water for twelve hours; then, when the liquor is strained, add the pounded sugar, which is to be dissolved with a gentle heat, so as to form a syrup.

This syrup is of a deep red colour, and pleasant flavour.

Syrupus papaveris somniferi, syrup of white poppy. Syrup papaveris albi, Lond.

Take of the dried capsules of the white poppy, freed from the seeds, two pounds; boiling water thirty pounds; refined sugar four pounds. Macerate the sliced capsules in the water for twelve hours; then boil until only a third part of the liquor remains; then strain by strong pressure. Boil the strained liquor to one-half, and again strain: the sugar being then added boil a little, so as to form a syrup.

This syrup is given principally as an anodyne to children. Dose to a child a year old one drachm.

Syrupus rhamni cathartici, syrup of buckthorn, Ed. Syr. spinæ cervinæ, Lond.

Take of the clarified juice of ripe buckthorn-berries two parts; refined sugar one part. Boil so as to make syrup.

This is given as a cathartic. Dose an ounce to an ounce and a half.

Syrupus rosæ gallicæ, syrup of red rose.

Take the dried petals of the red rose seven ounces; boiling water five pounds; purified sugar six pounds. Macerate the petals in water for twelve hours; then boil them a little, and strain; to the strained liquor add the sugar, and again boil it, so as to make syrup.

This syrup is not in much use; it is very slightly astringent.

Syrupus rosæ centifoliæ, syrup of damask, or pale, rose, Ed. Syr. rosæ, Lond.

Take fresh petals of the pale rose one pound; boiling water four pounds; refined sugar three pounds. Macerate the petals in the water for twelve hours: having strained the liquor, add the sugar, and boil so as to form syrup.

A mild purgative given to infants, in the quantity of two or three tea-spoonfuls.

Syrupus scillæ maritimæ, syrup of squill.

Take of the vinegar of squill two pounds; pounded refined sugar three pounds and a half. Let the sugar be dissolved in the vinegar by a gentle heat.

An active expectorant. Dose one or two drachms.

Syrupus toluiferæ balsami, syrup of tolu balsam, Ed. Syr. tolutani, Lond.

Take of common syrup two pounds; tincture of tolu one ounce. To the syrup recently prepared and taken from the fire, add by degrees the tincture, and gently agitate them together.

This syrup is only to be valued from its flavour.

Syrupus violæ odoratæ, syrup of violet, Ed. Syr. violæ, Lond.

Take of the fresh flowers of the sweet-scented violet one pound; boiling water four pounds; purified sugar seven pounds and a half. Macerate the flowers in the water for twenty-four hours, in a covered glass or earthen vessel; then strain without expression, and add pounded sugar, so as to form syrup.

A mild laxative. Dose to infants one or two tea-spoonfuls. The London Pharmacopœia has the syrupus succi fructus mori, syrup of mulberry-juice. Syrupus succi fructus rubi idæi, syrup of raspberry-juice. Syrupus succi fructus ribis nigri, syrup of black currant juice. Syrupus croci, syrup of saffron. Syrupus papaveris, syrup of red poppy. The two last are principally employed on account of their colour. The mel acetatum, oxymel colchici, mel rosæ, mel scillæ, oxymel scillæ, vary but little from their corresponding syrups.

Vina, wines.

Vinum aloes socotorinæ, wine of socotorine aloes, Ed. Vin. aloes, Lond.

Take of socotorine aloes powdered an ounce; lesser cardamom seeds, ginger root, of each contused, one drachm; Spanish white wine two pounds. Digest for seven days, frequently agitating, and strain.

A stimulating cathartic. Dose from one or two drachms to an ounce.

Vinum gentianæ compositum, compound gentian wine.

Take of gentian root half an ounce; Peruvian bark one ounce; orange-peel dried two drachms; canella bark one drachm; diluted alcohol four ounces; Spanish white wine two pounds and a half. The root and barks being bruised, pour first on them the diluted alcohol, and after four-and-twenty hours add the wine. Macerate for seven days, and strain.

Dose, as a stomachic, half an ounce, or six drachms.

Vinum ipecacuanhæ, ipecacuan wine, Ed. Vin. ipecac. Lond.

Take of ipecacuan root bruised one ounce; Spanish white wine fifteen ounces. Macerate, and after seven days strain through paper. Dose as an emetic one ounce.

Vinum nicotianæ tabaci, tobacco wine.

Take of tobacco leaves one ounce; Spanish white wine one pound. Macerate, and after seven days strain through paper.

Dose, as a diuretic, thirty drops increased.

Vinum rhei palmati, rhubarb wine.

Take of the rhubarb root cut two ounces; canella bark one drachm; diluted alcohol two ounces; Spanish white wine fifteen ounces. Macerate for seven days, and strain through paper.

Dose from half an ounce to one ounce.

Aceta, vinegars.

Acetum aromaticum, aromatic vinegar.

Take of the rosemary tops dried, the dried leaves of sage, of each four ounces; lavender flowers dried two ounces; cloves two drachms; distilled acetous acid eight pounds. Macerate for seven days, and strain the expressed liquor through paper.

Principally employed as a perfume.

Acidum acetosum camphoratum, camphorated acetous acid.

Take of the stronger acetous acid six ounces; camphor half an ounce; alcohol as much as is sufficient. Rub the camphor into powder with the alcohol, which put into the acid, so as to dissolve it.

A grateful stimulant, snuffed up the nostrils.

Acetum scillæ maritimæ, vinegar of squill, Ed. Acet. scillæ, Lond.

Take of dried squill two ounces; distilled acetous acid two pounds and a half; alcohol three ounces. Macerate the squill with the vinegar for three days, then express it; add the alcohol; and when the impurities have subsided pour off the liquor.

Dose from one to two drachms.

Tincturæ, tinctures.

Tinctura aloes socotorinæ, tincture of aloes, Ed. Tinct. aloes, Lond.

Take of powdered socotorine aloes half an ounce; extract of liquorice an ounce and a half; alcohol four ounces; water one pound. Digest with a gentle heat for seven days in a closed vessel, frequently shaking it (which is to be observed in the preparation of all tinctures).

Dose one ounce, as a cathartic.

Tinctura aloes ætherea, etherial tincture of aloes.

Take of myrrh, socotorine aloes, of each an ounce and a half; English saffron one ounce; spirit of sulphuric æther one pound. Digest the myrrh with the spirit for four days in a closed vessel; then add the aloes and saffron. Again digest for four days; and when the fæces have subsided pour off the tincture.

Dose one or two drachms.

Tinctura aloes cum myrrhâ, tincture of aloes with myrrh, Ed. Tinct. aloes comp. Lond.

Take of powdered myrrh two ounces; alcohol one pound and a half; water half a pound. Mix the alcohol with the water, then add the myrrh. Digest for four days, and now add an ounce and a half of socotorine aloes, and one ounce of English saffron; again digest for three days, and pour off the pure tincture.

Tinctura amomi repentis, tincture of cardamom, Ed. Tinct. cardamom, Lond.

Take of cardamom seeds four ounces; diluted alcohol two pounds and a half. Digest for seven days, and strain through paper.

This is a grateful aromatic. In the London Ph. a compound tincture of cardamom is ordered, in which are introduced caraway, cinnamon, and raisins.

Tinctura aristolochiæ serpentariæ, tincture of snake root, Ed. Tinct. serpent. Lond.

Take of snake root two ounces; cochineal one drachm; diluted alcohol two pounds and a half. Digest for seven days, and filtre through paper.

Dose two drachms.

Tinctura assafœtidæ, tincture of assafœtida, Ed. Tinct. assafœtid. Lond.

Take of assafœtida four ounces: alcohol two pounds and a half. Digest for seven days, and strain through paper.

Dose one drachm.

Tinctura benzoes composita, compound tincture of benzoin, Ed. Tinct. benz. c. Lond.

Take of benzoin three ounces; Peruvian balsam two ounces; hepatic aloes half an ounce; alcohol two pounds. Digest for seven days, and strain.

This tincture is in vulgar use to recent wounds.

Tinctura camphoræ, tincture of camphor, Ed. Spiritus camphoratus, Lond.

Take of camphor one ounce; alcohol one pound. Mix so as the camphor may be dissolved.

A stimulant embrocation.

Linimentum camphoræ, camphor liniment, Lond.

Take of camphor two ounces; water of ammonia six ounces: spirit of lavender sixteen ounces. Mix the spirit, and water of ammonia; and distil from a glass retort, with a gentle heat, sixteen ounces.

This liniment is more powerful than the preceding.

Tinctura cassiæ sennæ composita, tincture of sennæ, Ed. Tinct. sennæ, Lond.

Take of senna leaves two ounces; jalap root one ounce; coriander seeds half an ounce; diluted alcohol three pounds and a half. Digest for seven days, and to the tincture filtred through paper add four ounces of refined sugar.

Dose an ounce.

Tinctura castorei, tincture of castor, Ed. and Lond.

Take of Russian castor an ounce and a half; alcohol one pound. Digest for seven days, and strain through paper.

In the London Ph. diluted alcohol is employed. Dose one drachm.

Tinctura castorei composita, compound tincture of castor.

Take of Russian castor an ounce; assafœtida half an ounce; ammoniated alcohol one pound. Digest for seven days, and filtre through paper.

Dose one drachm.

Tinctura cinchonæ officinalis, tincture of Peruvian bark, Ed. Tinct. cinchonæ, Lond.

Take of Peruvian bark powdered four ounces; diluted alcohol two pounds and a half. Digest for seven days, and filtre through paper.

Dose two drachms.

Tinctura cinchonæ composita, compound tincture of Peruvian bark, Lond.

Take of Peruvian bark powdered two ounces and a half; dried orange-peel one ounce and a half; Virginian snake root three drachms; saffron one drachm; cochineal in powder two scruples; proof spirit twenty ounces. Digest for four days, and strain.

This is the Huxham's tincture. Dose two or three drachms.

Tinctura cinchonæ ammoniata, ammoniated tincture of bark, Lond.

Take of powdered Peruvian bark four ounces; compound spirit of ammonia two pounds. Digest in a close vessel for ten days, and strain.

This is an improper preparation.

Tinctura colombæ, tincture of colombo, Ed. Tinct. colombæ, Lond.

Take of colombo root, beaten into powder, two ounces; diluted alcohol two pounds. Digest for seven days, and strain.

Dose two or three drachms.

Tinctura convolvuli jalapæ, tincture of jalap, Ed. Tinct. jalapæ, Lond.

Take of jalap in powder three ounces; diluted alcohol fifteen ounces. Digest for seven days, and filtre through paper.

Tinctura croci, tincture of saffron.

Take of English saffron an ounce; diluted alcohol fifteen ounces. Digest for seven days, and filtre through paper.

This tincture has perhaps no other virtue but that of colour.

Tinctura digitalis purpureæ, tincture of foxglove.

Take of the leaves of foxglove dried an ounce; diluted alcohol eight ounces. Digest for seven days, and strain through paper.

A most active and useful medicine. Dose ten grains, gradually increased.

Tinctura gentianæ composita, compound tincture of gentian, Edin. and Lond.

Take of the gentian root two ounces; orange-peel an ounce; canella bark half an ounce; cochineal half a drachm; diluted alcohol two pounds and a half. Digest for seven days, and filtre through paper.

Dose two or three drachms.

Tinctura guaiaci, tincture of guaiac.

Take of guaiac resin one pound; alcohol two pounds and a half. Digest for seven days, and filtre through paper.

Dose two or three drachms.

Tinctura guaiaci ammoniata, ammoniated tincture of guaiac, Ed. and Lond.

Take of guaiac resin four ounces; ammoniated alcohol a pound and a half. Digest for seven days, and filtre through paper.

This is a useful tincture in chronic rheumatism. Dose from one to three drachms.

Tincturi hellebori nigri, tincture of black hellebore, Ed. and Lond.

Take of black hellebore root four ounces; cochineal half a drachm; diluted alcohol two pounds and a half. Digest for seven days, and filtre through paper.

Dose one drachm.

Tinctura hyoscyami nigri, tincture of black henbane.

Take of black henbane leaves dried an ounce; diluted alcohol eight ounces. Digest for seven days, and strain through paper.

Tinctura kino, tincture of kino.

Take of kino two ounces, diluted alcohol one pound a half.

Dose a drachm.

Tinctura lauri cinnamomi, tincture of cinnamon, Ed. Tinct. cinnam. Lond.

Take of cinnamon bark three ounces; diluted alcohol two pounds and a half. Digest for seven days, and strain through paper.

Tinctura lauri cinnamomi composita, compound tincture of cinnamon, Ed. Tinct. cin. comp. Lond.

Take of the cinnamon bark and cardamom seeds, of each an ounce; long pepper two drachms; diluted alcohol two pounds and a half. Digest for seven days, and strain through paper.

Tinctura meloes vesicatorii, tincture of cantharides, Ed. Tinct. cantharidis, Lond.

Take of cantharides one drachm; diluted alcohol one pound. Digest for seven days, and strain through paper.

Dose internally from fifteen to thirty drops.

Tinctura mimosæ catechu, tincture of catechu, Ed. Tinct. catechu, Lond.

Take of catechu three ounces; cinnamon two ounces; diluted alcohol two pounds and a half. Digest for seven days, and strain through paper.

Dose one drachm.

Tinctura myrrhæ, tincture of myrrh, Ed. and Lond.

Take of bruised myrrh three ounces; alcohol twenty ounces; water ten ounces. Digest for seven days, and filtre through paper.

Tinctura opii, tincture of opium, Ed. and Lond.

Take of opium two ounces; diluted alcohol two pounds. Digest for seven days, and filtre through paper.

Dose from fifteen to twenty-five drops.

Tinctura opii ammoniata, ammoniated tincture of opium.

Take of the acid of benzoin, and English saffron, of each three drachms; opium two drachms; volatile oil of anise half a drachm; ammoniated alcohol sixteen ounces. Digest for seven days in a closed phial, and filtre through paper.

Dose from half a drachm to a drachm.

Tinctura opii camphorata, camphorated tincture of opium, Lond.

Take of hard purified opium powdered, benzoin flowers, of each one drachm; camphor two scruples; oil of anise one drachm; proof spirit two pounds by measure. Digest for ten days, and strain.

This is the elixir paregoric. Dose one or two drachms.

Tinctura rhæi palmati, tincture of rhubarb, Ed. Tinct. rhabarbari, Lond.

Take of the rhubarb root three ounces; lesser cardamoms half an ounce; diluted alcohol two pounds and a half. Digest for seven days, and strain through paper.

Dose half an ounce.

Tinctura rhæi cum aloe, tincture of rhubarb and aloes.

Take of rhubarb root ten drachms; socotorine aloes six drachms; lesser cardamoms half an ounce; diluted alcohol two pounds and a half. Digest for seven days, and strain through paper.

Dose six drachms.

Tinctura rhæi cum gentiana, tincture of rhubarb with gentian.

Take of rhubarb root two ounces; gentian root half an ounce; diluted alcohol two pounds and a half. Digest for seven days, and strain through paper.

Dose from two to four drachms.

Tinctura rhabarbari composita, compound tincture of rhubarb, Lond.

Take of cut rhubarb two ounces; bruised liquorice half an ounce; ginger in powder, and saffron, of each two drachms; distilled water one pound; proof spirit twelve ounces. Digest for fourteen days, and strain.

Dose half an ounce.

Tinctura saponis, tincture of soap, Ed. Linimentum saponis compositum, Lond.

Take of soap four ounces; camphor two ounces; essential oil of rosemary half an ounce; alcohol two pounds. Digest the soap in the alcohol for three days; then, the liquor being strained, add the camphor and oil, agitating the liquor.

Tinctura saponis cum opio, tincture of soap with opium.

To be made in the same manner with the last, only adding from the beginning an ounce of opium.

Tinctura toluiferæ balsami, tincture of tolu balsam, Ed. Tinct. bals. tolut. Lond.

Take of tolu balsam one ounce and a half; alcohol one pound. Digest until the balsam is dissolved, and strain through paper.

Tinctura veratri albi, tincture of white hellebore.

Take of white hellebore root eight ounces; diluted alcohol two pounds and a half. Digest for seven days, and filtre through paper.

This is too violent for internal administration.

The following are tinctures peculiar to the Ph. Lond.

Tinctura corticis aurantii, tincture of orange-peel.

Take of fresh orange-peel three ounces; proof spirit two pounds. Digest for three days, and strain.

Tinctura balsami Peruviani, tincture of Peruvian balsam

Take of Peruvian balsam four ounces; rectified spirit one pound. Digest until the balsam is dissolved.

Tinctura cascarillæ, tincture of cascarilla.

Take of cascarilla in powder four ounces; proof spirit two pounds. Digest with a gentle heat for eight days, and strain.

Tinctura galbani, tincture of galbanum.

Take of galbanum cut into small pieces two ounces; proof spirit two pounds. Digest with a gentle heat for eight days, and strain.

Dose one to two drachms.

Tinctura sabinæ composita, compound tincture of savin.

Take of savin extract one ounce; tincture of castor one pound; tincture of myrrh half a pound. Digest until the savin is dissolved, and strain.

Dose half a drachm to one drachm.

Tinctura scillæ, tincture of squill.

Take of recently dried squill four ounces; proof spirit two pounds. Digest for eight days, and pour off the liquor.

Dose from twenty drops to a drachm.

Tinctura valerianæ, tincture of valerian.

Take of wild valerian, powdered coarsely, four ounces; proof spirit two pounds. Digest with a gentle heat for eight days, and strain.

Tinctura valerianæ ammoniata, ammoniated tincture of valerian.

Take of the coarse powder of wild valerian four ounces; compound spirit of ammonia two pounds. Digest for eight days, and strain.

Dose from one to two drachms.

Tinctura zinziberis, tincture of ginger.

Take of powdered ginger two ounces; proof spirit two pounds. Digest with a gentle heat for eight days, and strain.

Extracta, extracts.

1. Extraca per aquam, extracts by water.

Extractum gentianæ luteæ, extract of gentian, Ed. Ext. gent. Lond.

Take of gentian root any quantity; add to it, when cut and bruised, eight parts of distilled water. Boil it to half, and with strong pressure strain. Then evaporate the liquor to the consistence of thick honey by means of a bath of boiling water, saturated with muriat of soda.

In the same manner are prepared the following:

Extractum radicis glycyrrhizæ glabræ, extract of liquorice, Ed. Extr. glycyr. Lond.—Hellebori nigri, of hellebore, Ed. and Lond.—Foliorum rutæ graveolentis, of rue, Ed. Extr. rutæ, Lond.—Foliorum cassiæ sennæ, of senna, Ed. Extr. sennæ, Lond.——Florum anthemidis nobilis, of chamomile, Ed. Extr. cham. Lond.—Capitum papaveris somniferi, of poppy, Ed. Extr. pap. alb. Lond.—Ligni hæmatoxyli campechensis, of logwood, Ed. Extr. hæmatoxyli, Lond.

Besides these, in the London Ph. we have the following:

Extractum cacuminis genistæ, extract of broom tops. Sabinæ, of savin. Cinchonæ, of Peruvian bark; which last is ordered to be prepared as follows:

Take of Peruvian bark coarsely powdered one pound; distilled water twelve pounds. Boil for an hour or two, and pour off the liquor; which, while hot, will be red and pellucid, but as it cools becomes yellow and turbid. Pour on again the same quantity of water, boil as formerly, and repeat the boiling until the liquor, when cold, remains limpid. Then mix all the liquors (strained) together, and evaporate to a proper consistence. The extract should be prepared under two forms; one soft, fit to form pills; the other hard, so that it may be reduced to powder.

Dose fifteen grains.

2. Extracta per aquam et alcohol, extracts by water and alcohol.

Extractum cinchonæ officinalis, extract of Peruvian bark, Ed. Extract. cinchonæ, Lond.

Take of Peruvian bark in powder one pound; alcohol four pounds. Digest for four days, and pour off the tincture. Boil the residuum in five pounds of water for a quarter of an hour, and while hot strain through linen. Repeat this decoction and straining with the same quantity of water, and evaporate the liquor to the consistence of thick honey. Then mix the liquors thus inspissated, and reduce them to a proper consistence in a bath of boiling water, saturated with muriat of soda.

Dose ten or fifteen grains.

Extractum radicis convolvuli jalapæ, extract of jalap, Ed. Extract. jalapii, Lond.

To be prepared in the same manner as the last.

Dose ten or twelve grains.

Besides these the following extracts are peculiar to the London Ph.

Extractum cascarillæ, extract of cascarilla.

Dose twenty or thirty grains.

Extractum colocynthidis compositum, compound extract of colocynth.

Take of the pith of colocynth, cut small, six drachms; socotorine aloes powdered one ounce and a half; powdered scammony half an ounce; lesser cardamoms, freed from the husks, and powdered, one drachm; proof spirit one pound. Digest the colocynth with the spirit, with a gentle heat, for four days. To the expressed tincture add the scammony and aloes. These being dissolved, draw off the spirit by distilling; then evaporate the water, and add the seeds towards the end of the evaporation. Make an extract proper for forming pills.

A cathartic of considerable power. Dose from five grains to a scruple.

Opium purificatum, purified opium.

Take of opium, cut small, one pound; proof spirit twelve pounds. Digest with a gentle heat, and frequent agitation, until the opium is dissolved; strain the tincture through paper, and distil it to a proper consistence. Purified opium should be kept in two forms: soft, so as to be fit to make pills; and hard, so as to be capable of reduction to powder.

This is an unnecessary preparation.

Aquæ stillatitiæ, distilled waters.

Aqua distillata, distilled water, Ed. and Lond.

Let water be distilled in close vessels until about two-thirds have come over.

Aqua corticis citri aurantii, water of orange-peel.

Take of fresh orange-peel two pounds; pour on these as much water, that when ten pounds shall have been drawn off a sufficient quantity shall remain to prevent empyreuma. After due maceration, let ten pounds be distilled.

In the same manner prepare the following, ten pounds of water being drawn off from each of the annexed quantities:

Aqua corticis fructus citri medicæ recentis, fresh lemon-peel water (with two pounds).

—— corticis lauri cassiæ, cassia water (with one pound).

Aqua corticis lauri cinnamomi, cinnamon water. Aq. cinnamomi, Lond. (with one pound).

—— menthæ piperitæ florentis, peppermint water (with three pounds). Aq. menthæ piperitidis, Lond.

—— menthæ pulegii florentis, pennyroyal water (with three pounds). Aq. pulegii, Lond.

—— fructus myrti pimentæ, pimento water (with half a pound). Aq. pimento, Lond.

—— petalorum rosæ centifoliæ recentium, rose water (with six pounds). Aq. rosæ, Lond.

Besides these we have in the Ph. Lond. Aqua anethi, dill seed water.—Aqua fœniculi, fennel seed water.—Aqua menthæ sativæ, spearmint water. To each pound of distilled water let half an ounce be added of diluted alcohol.

Spiritus stillatitii, distilled spirits.

Spiritus carui, spirit of caraway, Ed. Sp. carui, Lond.

Take of caraway seeds half a pound; pour on them nine pounds of diluted alcohol. Macerate in a closed vessel for two days; then add as much water as is required to prevent empyreuma; and distil over nine pounds.

In the same manner are to be prepared the following spirits, nine pounds being drawn from the quantities affixed to each.

Spiritus corticis lauri cinnamomi, cinnamon spirit (with one pound). Sp. cin. Lond.

—— menthæ piperitæ florentis, spirit of peppermint (with one pound and a half). Sp. menth. p. Lond.

—— nucis myristicæ moschatæ, nutmeg spirit (with two ounces). Spirit. nuc. mosch. Lond.

—— fructus myrti pimentæ, pimento spirit (with half a pound). Sp. pimento, Lond.

In the Lond. Ph. the following are added: Spiritus menthæ sativæ, —— of spearmint. Sp. pulegii, —— of pennyroyal.

The following are the compound spirits of the Pharmacopœias:

Spiritus juniperi communis compositus, compound spirit of juniper, Ed. Sp. junip. comp. Lond.

Take of bruised juniper berries one pound; caraway seeds, fennel seeds, of each one ounce and a half; diluted alcohol nine pounds. Macerate for two days, and adding water sufficient to prevent empyreuma, draw over nine pounds.

Spiritus anisi compositus, compound spirit of anise, Ph. Lond.

Take of anise and of angelica seeds, of each bruised half a pound; proof spirit one gallon; water sufficient to prevent empyreuma. Distil one gallon.

Spiritus raphani compositus, spirit of horse-radish, Lond.

Take of fresh horse-radish root, dried orange-peel, of each two pounds; fresh garden scurvy-grass four pounds; bruised nutmegs one ounce; proof spirit two gallons; water sufficient to prevent empyreuma. Distil over two gallons.

The following are distilled with pure alcohol:

Spiritus lavendulæ spicæ compositus, compound spirit of lavender, Ed. Sp. lavend. comp. Lond.

Take of spirit of lavender (which is prepared with two pounds of lavender flowers, and eight pounds of alcohol, seven pounds being distilled over in a water-bath) three pounds; spirit of rosemary one pound; cinnamon one ounce; cloves two drachms; nutmeg half an ounce; red saunders wood three drachms. Macerate for seven days, and strain.

Spiritus rorismarini officinalis, spirit of rosemary, Ed. Sp. rorism. Lond.

Take of fresh rosemary tops two pounds; alcohol eight pounds. Draw off seven pounds by distilling in a water-bath.

Alcohol. In the London Ph. the following process is ordered for its preparation:

Take of rectified spirit of wine one gallon; prepared kali hot one ounce. Mix the spirit with the pure kali, and then add one pound of the prepared kali while hot; agitate and digest for twenty-four hours. Pour off the spirit; now add the remainder of the prepared kali, and distil from a water-bath. The alcohol is to be kept in a closely stopped vessel. The prepared kali should be heated to 300°. The specific gravity of alcohol to distilled water is as 815 to 1000.

Olea volatilia, volatile, or essential, oils.

Olea herbæ menthæ piperitæ florentis, oil of peppermint, Ed. Ol. menth. p. Lond.

—— herbæ juniperi sabinæ, — of savin, Ed.

—— summitarum florentum rorismarini officinalis, — of rosemary, Ed. Ol. rorism. Lond.

—— spicarum lavendulæ florentium spicæ, — of lavender, Ed. Ol. lav. Lond.

—— seminum pimpinellæ anisi, — of anise, Ed. Ol. ess. anisi, Lond.

—— baccarum juniperi communis, — of juniper, Ed. Ol. junip. Lond.

—— radicis lauri sassafras, — of sassafras, Ed. Ol. rad. sassaf. Lond.

—— fructus myrtæ pimentæ, — of pimento, Ed.

—— essentiale carui, — of caraway, Lond.

—— menthæ sativæ, — of spearmint, Lond.

—— origani, of wild thyme, Lond.

—— pulegii, of pennyroyal, Lond.

These oils are to be prepared in the same manner as distilled waters, except that a smaller quantity is to be added of water. Seeds or roots are to be bruised or rasped. The oil comes over with the water; and according as it is lighter or heavier, it swims on the surface, or falls to the bottom. It is afterwards to be separated.

Oleum succini et acidum succinicum, oil and acid of amber, Ed. Sal et ol. suc. Lond.

Take of amber in powder, and pure sand, of each equal parts; place them mixed in a glass retort, of which they shall fill one-half. Having adapted a large receiver, distil from a sand-bath, with a gradually raised fire. First will come over a watery liquor with a little yellow oil; then yellow oil with an acid salt; afterwards a reddish and black oil. Let the liquor be poured out of the receiver, and the oil separated from the water. Let the acid salt, collected from the sides of the receiver and from the neck of the retort, be pressed between folds of bibulous paper, and freed from the adhering oil. Then let it be purified by solution in hot water and crystallization.

Oleum succini purissimum, purified oil of amber, Ed. Ol. succ. rectific. Lond.

Distil oil of amber, mixed with water, six times its quantity, from a glass retort, until two-thirds have passed over into the receiver. Then separate the oil from the water, and preserve it in vessels effectually stopped.

Oleum terebinthinæ volatile purissimum, rectified oil of turpentine, Ed. Ol. tereb. rect. Lond.

Take of volatile oil of turpentine one pound; water four pounds. Distil as long as any oil passes over.

Oleum animale, animal oil, Lond.

Take of oil of hartshorn one pound. Distil three times

Oleum petrolei, oil of mineral tar, Lond.

Distil petroleum in a sand-bath.

Oleosa, oily preparations.

Oleum ammoniatum, ammoniated oil.

Take of olive oil two ounces; water of ammonia two drachms. Mix them.

The linimentum ammoniæ fortius of the London Ph. is prepared with water of pure ammonia one ounce: olive oil two ounces.

The linim. ammoniæ, Ph. Lond. is made with water of carbonated ammonia half an ounce; olive oil an ounce and a half.

These are all used as rubefacients.

Oleum lini cum calce, linseed oil with lime.

Take of linseed oil and lime water, of each equal parts. Mix them.

An application to burns.

Oleum camphoratum, camphorated oil.

Take of olive oil two ounces; camphor half an ounce. Mix so as to dissolve the camphor.

An anodyne and stimulant embrocation.

Oleum sulphuratum, sulphurated oil, Ed. Ol. sulph. Lond.

Take of olive oil eight ounces; sublimed sulphur one ounce. Boil with a slow fire in a large iron pot, stirring constantly, till they unite.

This preparation is discarded from practice.

In the London Pharmacopœia a solution of oil in petroleum, petroleum sulphuratum, is ordered to be made.

Sales et salina, salts and saline preparations.

Acidum acetosum distillatum, distilled acetous acid, Ed. Acetum distill. Lond.

Distil eight pounds of acetous acid in glass vessels with a slow fire. The first two pounds that come over are to be thrown away as too watery; the four pounds which follow are the distilled vinegar; the residuum gives a still stronger, but a too much burnt acid.

Acidum acetosum forte, strong acetous acid.

Take of dried sulphate of iron one pound; acetite of lead ten ounces. Rub them together. Place them in a retort, and distil from sand, with a moderate fire, as long as acid is produced.

Acidum acetosum, acetous acid, Lond.
Take of verdigris, in coarse powder, two pounds; dry it perfectly in a bath of water saturated with sea salt. Then distil in a sand-bath, and distil the liquor a second time. Its specific gravity is as 1050 to 1000.

Acidum benzoicum, benzoic acid, Ed. Flores benzoes, Lond.
Take of benzoin, in powder, any quantity. Place it in an earthen pot, to the mouth of which has been adapted a paper cone; apply a gentle fire, that the acid may be sublimed: if it is contaminated with oil, it is to be purified by solution in hot water and crystallization, or, as the Ph. Lond. directs, by mixing it with white clay, and again subliming.

Acidum muriaticum, muriatic acid, Ed. Acid. muriat. Lond.
Take of muriat of soda two pounds; sulphuric acid sixteen ounces; water one pound. First expose the muriat of soda in a pot to a red heat for a short time; when cold put it into a retort. Then pour the acid mixed with the water and cold on the muriat of soda. Distil from a sand-bath, with a gentle heat, as long as acid comes over. Its specific gravity is as 1170 to 1000.

Acidum nitrosum, nitrous acid, Ed. and Lond.
Take of pure nitrat of potass powdered two pounds; sulphuric acid sixteen ounces; the nitrat of potass being put into a glass retort, pour upon it the sulphuric acid, and distil from a sand-bath, with a fire gradually raised, until the iron pot is of an obscure red heat. Its specific gravity is 1550 to 1000.

Acidum nitrosum dilutum, diluted nitrous acid, Ed. and Lond.
Take of nitrous acid, water, equal weights. Mix them, avoiding the noxious vapours.

Acidum nitricum, nitric acid.
Take of nitrous acid any quantity; put it into a retort; and having adapted a receiver, apply a very gentle heat, until the reddest part shall have passed over, and the acid remaining in the retort shall have become nitric.

Spiritus ætheris nitrosi, spirit of nitrous ether, Ed. and Lond.
Take of alcohol three pounds; nitrous acid one pound; pour the alcohol into a large phial, placed in a vessel filled with cold water, and add the acid gradually with constant agitation. Close lightly the phial, and set it aside for seven days in a cool place; then distil the liquor with the heat of boiling water into a receiver cooled with water or snow, as long as any spirit shall pass over.

Dose from thirty to fifty drops.

Acidum sulphuricum dilutum, diluted sulphuric acid, Ed. Acid vitriolicum dilut. Lond.
Take of sulphuric acid one part; water seven parts (in the Ph. Lond. eight). Mix them.

Dose from fifteen to thirty drops.

Acidum sulphuricum aromaticum, aromatic sulphuric acid.
Take of alcohol two pounds; sulphuric acid six ounces. Drop gradually the alcohol upon the acid. Digest the mixture with a very gentle heat for three days in a close vessel; then add cinnamon an ounce and a half; ginger one ounce. Digest again in a closed vessel for six days, and filtre through paper with a glass funnel.

Dose about thirty drops.

Æther sulphuricus, sulphuric ether, Ed. Æth. vitriolicus, Lond.
Take of sulphuric acid, alcohol, of each thirty-two ounces; pour the alcohol into a glass retort, capable of bearing a sudden heat; then pour on the acid in a continued stream. Mix gradually with frequent and gentle agitation; then immediately distil from a sand-bath, heated previously, into a receiver kept cool by water or snow. The fire is to be so regulated, that the liquor may be made to boil as soon as possible, and continue to boil until sixteen ounces have distilled over; then remove the retort from the sand. To the distilled liquor add two drachms of potass; then again distil from a high-necked retort, with a very gentle heat, into a receiver preserved cool, until ten ounces have come over. If after the first distillation sixteen ounces of alcohol are added to the acid remaining in the retort, and the distillation is repeated, ether will again be produced; and this process may be repeated more than once.

Dose from thirty to sixty drops.

Æther sulphuricus cum alcohole, sulphuric ether with alcohol.
Take of sulphuric ether one part; alcohol two parts. Mix them.

The London college order a compound spirit (sp. ætheris vitriolici comp.) to be prepared by mixing two pounds of unrectified ether with three drachms of oil of wine.

Æther sulphuricus cum alcohole aromaticus, aromatic sulphuric ether with alcohol.
This is made from the same materials and in the same manner with the compound tincture of cinnamon, unless that sulphuric ether with alcohol is employed instead of diluted alcohol.

These are useless preparations.

Carbonas ammoniæ, carbonat of ammonia, Ed. Ammonia preparata, Lond.
Take of muriat of ammonia one pound; carbonat of lime, vulgarly called chalk, dried, two pounds. Being each separately powdered, mix them, and sublime from a retort into a receiver kept cold.

Dose from five grains to a scruple.

Aqua carbonatis ammoniæ, water of carbonat of ammonia, Ed. Aq. ammoniæ, Lond.
Take of muriat of ammonia, carbonat of potass, of each sixteen ounces; water two pounds. To the salts mixed and put into a glass retort pour on the water; then distil to dryness from a sand-bath, with a fire gently raised.

Liquor volatilis, sal, et oleum cornu cervi, volatile liquor, salt, and oil of hartshorn, Lond.
Take of hartshorn ten pounds; distil, gradually increasing the fire. A volatile liquor, salt, and oil, come over. The oil and the salt being separated, distil the liquor three times. To the salt add an equal weight of prepared chalk, and sublime three times, or until it becomes white. The same volatile liquor, salt, and oil, may be procured from any of the parts of animals, except fat.

Aqua ammoniæ, water of ammonia, Ed. Aqua ammoniæ puræ, Lond.
Take of muriat of ammonia sixteen ounces; lime fresh-prepared two pounds; water six pounds. To one pound of water, in an iron or an earthen vessel, add the lime broken down, and close the vessel for twenty-four hours, until the lime falls into powder, which is to be put into a retort. To this add the muriat of ammonia dissolved in five pounds of water, and, shutting the mouth of the retort, mix them with agitation. Lastly, distil with such a moderate heat, that the operator can easily apply his hand to the retort into a receiver kept cold, until twenty ounces have distilled over. In this process the vessels are to be so luted, as that the penetrating vapours may be effectually confined.

Dose about twenty drops internally; outwardly it is used as a rubefacient.

Alcohol ammoniatum, ammoniated alcohol, Ed. Sp. ammoniæ, Lond.
Take of diluted alcohol four pounds; muriat of ammonia four ounces; carbonat of potass six ounces. Mix, and draw off two pounds by distilling with a gentle fire.

Alcohol ammoniatum aromaticum, aromatic ammoniated alcohol, Ed. Sp. amm. comp. Lond.
Take of spirit of ammonia eight ounces; volatile oil of rosemary a drachm and a half; volatile oil of lemon one drachm. Mix so as to dissolve the oils. In the Ph. Lond. oil of cloves is ordered instead of the rosemary oil.

Dose from twenty to forty drops.

Alcohol ammoniatum fœtidum, fœtid ammoniated alcohol, Ed. Sp. ammoniæ fœtidæ, Lond.
Take of spirit of ammonia eight ounces; assafœtida half an ounce. Let them be digested in a close vessel for twelve hours; then bring over eight ounces by the heat of a water-bath.

Dose thirty or forty drops.

Spiritus ammoniæ succinatus, Ph. Lond. Succinated spirit of ammonia.
Take of alcohol one ounce; water of pure ammonia four ounces; rectified oil of amber one scruple; soap ten grains. Digest the soap and the oil of amber in the alcohol until they are dissolved; then add the water of pure ammonia, and mix by agitation.

This has been named eau de luce.

Carbonas potassæ, carbonat of potass, Ed. Kali præparatum, Lond.
Let impure carbonat of potass (pearl-ashes) be put into a crucible, and brought to a red heat, that the oily impurities, if there are any present, may be burnt out; then rubbing the carbonat with an equal weight of water, let them be well mixed by agitation. The liquor, after the impurities have subsided, being poured off into a clean iron pot, is to be boiled to dryness; towards the end of the boiling the salt is to be kept constantly stirred, lest any adhere to the vessel.

In the London college this preparation is better ordered by dissolving the pearl-ashes, and evaporating the solution till a pellicle appears on the surface; then immediately setting it aside, previous to further evaporation, that the sulphat and muriat of potass, which the pearl-ashes contain, may be separated by crystallization.

Carbonas potassæ purissimus, pure carbonat of potass (salt of tartar).

Take of impure supertartite of potass any quantity. Having wrapped it in moist bibulous paper, or put it into a crucible, place it among live coals, that it may be burnt into a black mass. Being reduced to powder, subject it to a moderate heat in an open crucible, until it becomes white, or cinder-like, taking care that it does not melt. Then let it be dissolved in warm water, the liquor strained through linen, and evaporated in a clean iron vessel, stirring the matter assiduously towards the end of the evaporation with an iron spoon, that it may not adhere to the bottom of the vessel. A very white salt will remain, which is to be left for some time on the fire, until the bottom of the vessel is nearly of a red heat. When cold, the salt is to be preserved in a glass vessel well stopped.

Aqua potassæ, water of potass, Ed. Aqua kali puri, Lond.

Take of newly prepared lime eight ounces; carbonat of potass six ounces. Put the lime into an iron or earthen vessel, with twenty-eight ounces of warm water. The ebullition being over, immediately add the salt; and the whole being completely mixed, close the vessel until they become cold. Now let them be well agitated, and poured into a glass funnel, the throat of which is obstructed with clean linen. Cover the upper orifice of the funnel while its neck is inserted in another glass vessel, that the water of potass may gradually drop through the linen into the lower vessel. When it first ceases to drop, pour into the funnel some ounces of water, cautiously, that it may swim above the matter. The water of potass will now again begin to drop. In this manner is to be repeated the affusion of water until three pounds have been filtred, which will be in the space of two or three days. The upper are to be mixed by agitation with the lower parts of the liquor, which is to be kept in a well stopped vessel.

Aqua supercarbonatis potassæ, water of supercarbonat of potass.

Take of water ten pounds; pure carbonat of potass one ounce. Dissolve, and expose the solution to a stream of carbonic acid gas, which is produced from carbonat of lime, sulphuric acid, of each three ounces, with three pounds of water cautiously and gradually mixed. The apparatus invented by Dr. Nooth is well adapted to this preparation. If a greater quantity is required, Woulfe's apparatus is to be preferred. In proportion to the coldness of the air, and the extent of pressure, the liquor will be better. It should be kept in well stopped vessels.

Carbonas sodæ, carbonat of soda, Ed. Natron præparatum, Lond.

Take of impure carbonat of soda any quantity; bruise it, and boil it in water until all the salt is dissolved. Strain the solution through paper, and evaporate it in an iron vessel, that, after cooling, crystals may form.

The barilla of commerce.

Aqua supercarbonatis sodæ, water of supercarbonat of soda.

This is prepared from ten pounds of water, and two ounces of carbonat of soda, in the same mode as the supercarbonat of potass.

Aqua acetitis ammoniæ, water of acetite of ammonia, Ed. Aq. ammoniæ acetatæ, Lond.

Take of carbonat of ammonia any quantity. Pour on it as much distilled acetous acid as may be necessary exactly to saturate the ammonia.

Acetis potassæ, acetite of potass, Ed. Kali acetatum, Lond.

Take of pure carbonat of potass any quantity. Boil it with a gentle heat in four or five times its weight of distilled acetous acid, and at different times add more acid, until on the watery part of the former portion being nearly evaporated, the acid newly added occasions no effervescence. This will be the case when about twenty parts of acid have been consumed. Then let it be slowly dried. Let the remaining impure salt be liquefied with a gentle heat for a short time; then dissolved in water, and strained through paper. If the liquefaction has been properly done, the strained liquor will be limpid; if not, it will be of a brown colour. Afterwards evaporate this liquor with a gentle heat in a shallow glass vessel, well closed, that it may not liquefy by the air.

Potassa, potass, Ed. Kali purum, Lond.

Take of water of potass any quantity; evaporate it in a covered clean vessel of iron, until, the ebullition being finished, the saline matter flows smoothly like oil, which will be the case before the vessel is at a red heat. Then pour it on a clean iron plate; cut it into small masses before it becomes hard, and immediately put them into a phial well stopped.

Potassa cum calce, potass with lime, Ed. Calx cum kali puro, Lond.

Take of water of potass any quantity. Evaporate to one-third in a covered iron vessel; then mix with it as much newly slaked lime as may suffice to give it the consistence of a solid paste, which is to be kept in a stopt vessel.

Sulphas potassæ, sulphat of potass, Ed. Kali vitriolatum, Lond.

Take of sulphuric acid, diluted with six times its weight of water, any quantity; put it into a large glass vessel; and gradually drop into it of carbonat of potass, dissolved in six times its weight of water, as much as may suffice perfectly to saturate the acid. The effervescence being finished, filtre the liquor through paper; and, after due exhalation, put it aside that crystals may form. This salt may otherwise be made by dissolving the residuum of the distillation of nitrous acid in warm water, and saturating it with carbonat of potass.

Sulphas potassæ cum sulphure, sulphat of potass with sulphur.

Take of nitrat of potass in powder, sublimed sulphur, equal weights. Throw them well mixed into a red-hot crucible, by small quantities at a time. The deflagration being over, let the salt cool. Keep it in a glass phial well stopped.

Tartris potassæ, tartrite of potass, Ed. Kali tartarisatum, Lond.

Take of carbonat of potass one pound: supertartrite of potass three pounds, or as much as necessary; boiling water fifteen pounds. To the carbonat of potass dissolved in the water add gradually the supertartrite of potass rubbed to fine powder, as long as effervescence is excited, which generally ceases before three times its weight of carbonat of potass have been thrown in. When the liquor is cold filtre it through paper, and set it aside, that crystals may be formed.

Dose as a purgative one ounce.

Tartris potassæ et sodæ, tartrite of potass and soda, Ed. Natron tartarisatum, Lond.

This is to be prepared from carbonat of soda and supertartrite of potass, in the same mode as tartrite of potass.

A pleasant purgative. Dose an ounce.

Phosphas sodæ, phosphat of sodæ.

Take of bones burnt to whiteness and powdered ten pounds; sulphuric acid six pounds; water nine pounds. Mix the powder with the acid in an earthen vessel; then add the water, and again mix. Keep the vessel in a water-bath for three days; then dilute the matter, by adding nine pounds more of boiling water, and strain through a strong linen cloth, pouring gradually over it boiling water, until all the acid is washed out. Put aside the strained liquor that the impurities may subside, from which pour it off, and evaporate to nine pounds. To this liquor, again poured off from its impurities, and heated in an earthen vessel, add carbonat of soda dissolved in warm water, till it no longer excites effervescence. Now strain, and put it aside, that crystals may form. These being removed, add, if necessary, to the liquor, a little carbonat of soda, that the phosphoric acid may be completely saturated, and again prepare it by evaporation to form crystals as long as these can be produced. Lastly, let the crystals be preserved in a vessel well stopt.

A mild and useful cathartic. Dose one ounce.

Sulphas sodæ, sulphat of soda, Ed. Natron vitriolatum, Lond. (Glauber's salt.)

Dissolve the acidulous salt, which remains after the distillation of muriatic acid, in water, and add to it chalk, in order to remove the superfluous acid. Put it aside until its impurities have subsided; then having poured off the liquor, and strained it through paper, reduce it by evaporation, so as to form crystals.

Dose one ounce, or more.

Sulphuretum potassæ, sulphuret of potass, Ed. Kali sulphuratum, Lond.

Take of carbonat of potass, sublimed sulphur, of each eight ounces; having rubbed them together, let them be put into a large coated crucible, to which a cover being adapted, apply the fire cautiously, until the materials melt The crucible, when it has cooled, is to be broken, and the sulphuret taken out, and preserved in a close-stopt phial.

Hydro-sulphuretum ammoniæ, hydro-sulphuret of ammonia.

Take of water of ammonia four ounces. Expose it in a chemical apparatus to the stream of gas which arises from sulphuret of iron four ounces, muriatic acid eight ounces, previously diluted with two pounds and a half of water. The sulphuret of iron for this purpose is conveniently prepared from three parts of purified iron filings, and one of sublimed sulphur, mixed, and exposed in a covered crucible to a moderate fire until they unite.

This is principally given in diabetes, in the dose of four or five drops.

Murias barytæ, muriat of barytes.

Take of sulphat of barytes two pounds; powdered charcoal four ounces. Roast the sulphat that it may be more easily powdered fine; then mix the charcoal; put the matter into a crucible, to which adapt a cover, and apply a vigorous fire for some hours. Put the matter well rubbed into six pounds of boiling water, in a closed glass or earthen vessel, and mix them by agitation, guarding as much as possible against the access of air. Let the vessel stand in a water-bath until the undissolved matter has subsided; then pour off the liquor. Pour four pounds of boiling water on the residuum, which add to the former liquor after agitation and subsidence. While it is still hot (or, if it has cooled, after it has been heated), drop into it muriatic acid as long as effervescence is occasioned. Then strain and evaporate it so as to form chrystals.

Solutio muriatis barytæ, solution of muriat of barytes.

Take of muriat of barytes one part; distilled water three parts. Dissolve.

Dr. Crawford introduced this in scrophulous affections. Dose from five to twenty drops.

Solutio muriatis calcis, solution of muriat of lime.

Take of pure carbonat of lime (white marble) bruised into small pieces nine ounces; muriatic acid sixteen ounces; water eight ounces. Mix the acid with the water, and gradually add the pieces of carbonat of lime: the effervescence being over, digest for an hour. Pour off the liquor, and evaporate to dryness. Dissolve the residuum in its weight and a half of water, and strain.

This has been recently introduced as a tonic. Dose thirty drops.

Carbonas magnesiæ, carbonat of magnesia, Ed. Magnesia alba, Lond.

Take of sulphat of magnesia, carbonat of potass, of each equal weights. Let them be separately dissolved in twice their weight of warm wrter, and either strained or otherwise freed from impurities; then mix them, and add eight times their weight of boiling water. Boil the liquor a little, and stir it during the boiling; then allow it to rest until the heat is in some measure diminished; then strain through linen, upon which the salt will remain. Let it be washed with pure water until it is perfectly tasteless.

Magnesia, magnesia, Ed. Magnesia usta, Lond.

Let carbonat of magnesia be exposed in a crucible to a red heat for two hours; then let it be preserved in glass vessels well stopped.

Metallica, metallic preparations.

Nitras argenti, nitrat of silver, Ed. Argentum nitratum, Lond.

Take of the purest silver, extended in plates and cut, four ounces; diluted nitrous acid eight ounces; distilled water four ounces. Dissolve the silver with a gentle heat in a phial, and evaporate the solution to dryness. Then put the mass into a large crucible, which is to be placed on the fire, at first gentle, and gradually increased, until the mass flows like oil. Then pour it into iron pipes, warmed and rubbed with grease. Keep it in a glass vessel well stopt.

A strong, and frequently employed, caustic.

Sulphuretum antimonii, prepared or sulphureted antimony, Ed. Antim. præparatum, Lond.

This is to be prepared in the same manner as carbonat of lime.

Oxidum antimonii cum sulphure vitrificatum, vitrified sulphureted oxide of antimony, Ed. Antim. vitrificatum, Lond.

Strew sulphuret of antimony coarsely powdered like sand on a shallow earthen vessel not glazed, and apply to it a moderate fire that the sulphuret of antimony may be slowly heated; at the same time stir the powder constantly, that it may not run into lumps. White vapours arise, smelling like sulphur. When these, while the same degree of heat is kept up, cease, augment the heat in some measure, that vapours may again exhale. Proceed in this manner until the powder, now raised to a red heat, gives out no more vapours. This powder being put into a crucible, is to be melted with a strong fire, until it assumes the appearance of fused glass. It is now to be poured upon a heated brass plate.

Oxidum antimonii vitrificatum cum cera, vitrified oxide of antimony with wax.

Take of yellow wax one pound; vitrified sulphureted oxide of antimony eight parts. To the wax melted in an iron vessel, add the oxide reduced to powder, and roast with a gentle fire for a quarter of an hour, constantly stirring with a spatula; then pour off the matter, which when cold is to be powdered.

This is an obsolete remedy.

Oxidum antimonii cum phosphate calcis, oxide of antimony with phosphat of lime, Ed. Pulvis antimonialis, Lond.

Take of sulphuret of antimony coarsely powdered, hartshorn shavings, of each equal parts. Mix and throw them into a wide iron pot red-hot, and keep them constantly stirred until they are burnt into a cineritious-coloured matter, which is to be removed from the fire, rubbed into a powder, and put into a coated crucible. To this crucible, lute another inverted, in the bottom of which is drilled a small hole; apply the fire, which is to be gradually raised to a white heat, and kept so for two hours. Lastly, rub the matter when cold into a very fine powder.

This preparation is nearly the same as James's powder. Dose five or six grains.

Sulphuretum antimonii præcipitatum, precipitated sulphuret of antimony, Ed. Sulphur antimonii præcipitatum, Lond.

Take of water of potass four pounds; water three pounds; prepared sulphuret of antimony two pounds. Boil them in a covered iron pot on a gentle fire for three hours, stirring frequently with an iron spatula, and adding water occasionally. Strain the liquor while hot through a doubled linen cloth, and to the strained liquor add as much as may be necessary to precipitate the sulphuret, which carefully wash with warm water.

A precipitate nearly similar to this has been much employed on the continent, especially under the name of kermes mineral. Both the one and the other have been principally used as alterative or diaphoretic. Their operation is uncertain. Dose five or six grains.

Oxidum antimonii cum sulphure per nitratum potassæ, oxide of antimony with sulphur and nitrat of potass, Ed. Crocus antimonii, Lond.

Take of sulphuret of antimony, nitrat of potass, of each equal weights. Triturate them separately; and having mixed them well together, throw them into a red-hot crucible. The deflagration being finished, separate the reddish matter from the white crust, and rub it into powder, which is to be frequently washed with warm water until it becomes tasteless.

This is used in some of the other preparations; but as a medicine it is so uncertain in its operation, that it is scarcely employed.

Antimonium muriatum, muriat of antimony, Ed. and Lond.

Take of oxide of antimony with sulphur, nitrat of potass, sulphuric acid, of each one pound; dried muriat of soda, two pounds. Pour the acid into a retort, adding by degrees the muriat of soda, and the oxide of antimony previously mixed. Then distil from warm sand. Expose the distilled matter for some days to the air, that it may liquefy; then pour the liquid from the impurities.

This preparation is not proper for internal administration.

Tartris antimonii, tartrite of antimony (tartar emetic), Ed. Antimonium tartarisatum, Lond.

Take of oxide of antimony with sulphur by nitrat of potass three parts; supertartrite of potass four parts; distilled water thirty-two parts. Boil them in a glass vessel for a quarter of an hour; strain the liquor through paper, and set it aside that it may form crystals.

The most certain and useful of all antimonial preparations. Dose, as an emetic, from one to two or more grains; as a diaphoretic, a quarter of a grain.

Vinum tartritis antimonii, wine of tartrite of antimony.

Take of tartrite of antimony twenty-four grains; white wine one pound. Mix so as to dissolve the tartrite.

Vinum antimonii tartarisati, Ph. L. Wine of tartarised antimony.

Take of tartarised antimony two scruples; boiling distilled water by measure two ounces; Spanish white wine eight ounces. Dissolve the tartarised antimony in the boiling distilled water, and add the wine.

The two last preparations materially

differ in strength. Dose, as a diaphoretic, of the former about 40, of the latter 20, drops.

Vinum antimonii, antimonial wine, Ph. L.
Take of vitrified antimony powdered one ounce; Spanish white wine one pound and a half. Digest for twelve days with frequent agitation, and filtre through paper.

This is a preparation of very uncertain strength.

Antimonium calcinatum, calcined antimony, Ph. L. White oxide of antimony.
Take of antimony in powder eight ounces; powdered nitre two pounds. Mix them, and throw the mixture gradually into a red-hot crucible. Burn the matter which remains after the deflagration for half an hour, and when cold rub it to powder; then wash it with distilled water.

This has been employed as a substitute for James's powder. Its dose is however uncertain.

Ammoniaretum cupri, ammoniaret of copper (cuprum ammoniacum).
Take of pure sulphat of copper two parts; carbonat of ammonia three parts. Rub them assiduously in a glass mortar until all effervescence is over, and they form into a violet-coloured mass, which being wrapped in bibulous paper, is to be dried first on a chalkstone and afterwards by means of a gentle heat. The ammoniaret is to be preserved in a glass phial well stopped.

Dose half a grain at first, gradually increased to three or more grains.

Solutio sulphatis cupri composita, compound solution of sulphat of copper.
Take of sulphat of copper and sulphat of alumen, of each three ounces; water two pounds; sulphuric acid one ounce and a half. Boil the sulphats in water, that they may dissolve; then to the liquor filtred through water add the acid.

Aqua cupri ammoniati, water of ammoniated copper, Lond.
Take of sal ammoniac (muriat of ammonia) one drachm; lime-water one pound. Allow them to remain in a copper vessel until the ammonia is saturated with copper.

This is employed as a gentle escharotic.

Carbonas ferri præcipitatus, precipitated carbonat of iron.
Take of sulphat of iron four ounces; carbonat of soda five ounces; water ten pounds. Dissolve the sulphat in the water; then add the carbonat, previously dissolved in a quantity of water, as much as necessary, and mix them well together. Let the carbonat of iron which is precipitated be washed with warm water and afterwards dried.

Dr. Griffiths's preparation of steel is an extemporaneous formula similar to the above.

Sulphas ferri, sulphat of iron, Ed. Ferrum vitriolatum, Lond.
Take of purified filings of iron six ounces; sulphuric acid eight ounces; water two pounds and a half. Mix them; and the effervescence being finished, digest for a short time in a sand-bath. Then strain the liquor through paper, and after proper evaporation put it on one side in order to form crystals.

This is perhaps the most active and useful of the chalybeates. Dose from one to four or five grains.

Sulphas ferri exsiccatus, dried sulphat of iron.
Take of sulphat of iron any quantity: heat it in an earthen vessel unglazed on a gentle fire until it becomes white and perfectly dry.

Oxidum ferri rubrum, red oxide of iron.
Let dried sulphat of iron be exposed to a violent heat until it is converted into a red matter.

Tinctura muriatis ferri, tincture of muriat of iron, Ed. Tinctura ferri muriati, Lond.
Take of the purified black oxide of iron powdered three ounces; muriatic acid about ten ounces, or sufficient to dissolve the powder. Digest with a gentle heat, and the powder being dissolved, add sufficient quantity of alcohol to make the whole liquor two pounds and a half.

An active and useful preparation. Dose from ten to twenty drops.

Murias ammoniæ et ferri, muriat of ammonia and iron, Ed. Ferrum ammoniacale, Lond.
Take of red oxide of iron washed and again dried; muriat of ammonia, of each equal parts. Let them be well mixed, and sublime.

This preparation is not much in use.

Tinctura ferri ammoniacalis, Ph. Lond.
Take of ammoniacal iron four ounces; proof spirit by measure one pound. Digest and strain.

This is a superfluous preparation.

Ferrum tartarisatum, tartarised iron, Ph. Lond.
Take of filings of iron one pound; crystals of tartar powdered two pounds; distilled water one pound. Mix them, and expose the mixture to the air in an open glass vessel for eight days; then rub the matter dried by a sand-bath into a very fine powder.

Dose from five to ten or fifteen grains.

Vinum ferri, wine of iron, Ph. Lond.
Take of iron filings four ounces; Spanish white wine four pounds. Digest for a month with frequent agitation, and strain.

Dose one or two drachms.

Hydrargyrus purificatus, purified quicksilver, Ed. and Lond.
Take of quicksilver four parts; filings of iron one part. Rub them together, and distil from an iron vessel.

Acetis hydrargyri, acetite of quicksilver, Ed. Hydrargyrus acetatus, Lond.
Take of purified quicksilver three ounces; diluted nitrous acid four ounces and a half, or a little more than may suffice to dissolve the quicksilver; acetite of potass three ounces; boiling water eight pounds. Mix the quicksilver with the diluted nitrous acid, and towards the end of the effervescence digest, if it may be necessary, with a gentle heat, until the quicksilver is totally dissolved; then dissolve the acetite of potass in boiling water, and immediately on this solution while hot pour the other, mixing them by agitation. Then place the mixture on one side that crystals may form. These being put into a funnel, wash them with cold distilled water; and lastly dry them with a very gentle heat. In preparing the acetite of quicksilver, it is necessary that all the vessels and the funnel which are used, are of glass.

This has been employed as an antisyphilitic, in the dose of a grain night and morning. Its operation, however, is perhaps not to be depended on.

Murias hydrargyri, muriat of mercury, Ed. Hydrargyrus muriatus, Lond.
Take of purified quicksilver two pounds; sulphuric acid two pounds and a half; muriat of soda dried four pounds. Boil the quicksilver with the sulphuric acid in a glass vessel placed on a sand-bath till the matter becomes dry. When cold, mix it with the muriat of soda; then sublime it in a glass cucurbit, with a heat gradually raised. Separate the sublimed matter from the scoriæ.

This (the corrosive sublimate) is the most active of all the mercurial preparations. Dose about a fourth of a grain. It is not now so much as formerly used in the cure of syphilis.

Submurias hydrargyri, submuriat of quicksilver, Ed. Calomelas, Lond.
Take of muriat of quicksilver rubbed to powder in a glass mortar four ounces; purified quicksilver three ounces. Let them in a glass mortar be rubbed together, with a very little water, in order to guard against the acrid powder which would without this precaution arise, until the quicksilver is extinguished. Put the dried powder into an oblong phial, of which it shall occupy one-third, and let it be sublimed in a sand-bath. The sublimation being completed, and the phial broken, the red powder about the bottom and white about the neck of it, are to be both rejected, the remaining mass is again to be sublimed and rubbed into a fine powder, which is lastly to be washed with boiling distilled water.

This of all mercurial preparations is the most important in medicine. Its dose, according to the different diseases and circumstances under which it is employed, varies from an eighth of a grain to ten or more grains. It ought never to be given in solution.

Submurias hydrargyri præcipitatus, precipitated submuriat of mercury, Ed. Hydrargyrus muriatus mitis, Lond.
Take of diluted nitrous acid, purified quicksilver, of each eight ounces; muriat of soda four ounces and a half; boiling water eight pounds. Mix the quicksilver with the diluted acid, and towards the end of the effervescence digest with a gentle heat, frequently shaking the vessel. It is necessary that more quicksilver should be mixed with the acid than this can dissolve, that the solution may be obtained completely saturated. Dissolve at the same time the muriat of soda in the boiling water while it is warm; pour on it the other solution, and quickly mix them together. After the precipitation, pour off the saline liquor, and wash the submuriat of mercury by frequently adding warm water, pouring it off after each time of the subsiding of the precipitate until it comes off tasteless.

This preparation does not materially differ from the preceding.

Oxidum hydrargyri cinereum, ash-coloured oxide of quicksilver.

Take of purified quicksilver four parts; diluted nitrous acid five parts; distilled water fifteen parts; water of carbonat of ammonia as much as sufficient. Dissolve the quicksilver in the acid; add gradually the distilled water; then pour on as much of the water of carbonat of ammonia as will suffice to throw down the oxide of quicksilver, which is then to be washed with pure water and dried.

This has lately been recommended by Dr. Home and others as one of the most efficacious and permanent of antisyphilitic remedies. Dose one grain.

Oxidum hydrargyri rubrum per acidum nitricum, red oxide of quicksilver by nitrous acid, Ed. Hydrargyrus nitratus ruber, Lon.

Take of purified quicksilver one pound; of diluted nitrous acid sixteen ounces. Let the quicksilver be dissolved, and with a gentle fire evaporate the solution into a dry white mass, which rubbed into powder is to be put into a glass cucurbit, a thick glass plate being put over its surface; then having adapted a capital, and placed the vessel in sand, let it be roasted with a fire gradually raised until it assumes the form of small red scales.

This is used as an escharotic.

Subsulphas hydrargyri flavus, yellow subsulphat of quicksilver, Ed. Hydrargyrus vitriolatus, Lond.

Take of purified quicksilver four ounces; sulphuric acid six ounces. Put them into a glass cucurbit, and let them boil in a sand-bath to dryness; the white matter remaining at the bottom of the vessel being powdered, is to be thrown into boiling water; it will thus be changed into a yellow, which ought to be frequently washed with warm water.

This preparation, formerly denominated turpeth mineral, is scarcely at present employed in medicine.

Sulphuretum hydrargyri nigrum, black sulphuret of quicksilver, Ed. Hydrargyrus cum sulphure, Lond.

Take of purified quicksilver and sublimed sulphur, of each equal weights. Let them be rubbed together in a glass mortar with a glass pestle, until the globules of quicksilver entirely disappear.

This is vulgarly denominated ethiops mineral. It is the least active of all the mercurial preparations, and is not much in use.

The following additional preparations of mercury are found exclusively in the Ph. Lond.

Hydrargyrus sulphuratus ruber, red sulphureted quicksilver.

Take of purified quicksilver forty ounces; sulphur eight ounces. Mix the quicksilver with the melted sulphur. If the mixture inflames, extinguish it by covering the vessel. Powder and sublime the material.

This (cinnabar) is principally used to fumigate venereal ulcers.

Hydrargyrus cum creta, quicksilver with chalk.

Take of purified quicksilver three ounces; prepared chalk five ounces. Rub them together till the globules disappear.

This is scarcely employed.

Hydrargyrus calcinatus, calcined quicksilver.

Take of purified quicksilver one pound. Expose it in a glass cucurbit with a flat bottom, in a sand-bath, to a heat of 600°, until it concretes into a red powder.

This has been recommended in doses of half a grain or a grain in confirmed syphilis, which has appeared to oppose other mercurial preparations.

Calx hydrargyri albi, white calx of quicksilver.

Take of muriated quicksilver, sal ammoniac, water of prepared kali, of each half a pound. First dissolve the sal ammoniac, and then the muriated quicksilver, in distilled water, to which add the water of prepared kali. Wash the powder until it is tasteless.

White precipitate, as the above preparation is commonly called, is used externally in the form of ointment in psora, and other affections of the skin.

Acetis plumbi, acetate of lead, Ed. Cerussa acetata, Lond.

Take of white oxide of lead any quantity, put it into a cucurbit, and upon it pour twice its quantity in weight of distilled acetous acid; the mixture is to stand on warm sand, until the acid becomes sweet: then pour it off, and add a fresh quantity of acid as often as may be necessary, until it ceases to become sweet; then the whole liquor, freed from impurities, is to be evaporated to the consistence of thin honey, and put aside in a cool place that crystals may form, which are to be dried in the shade. Evaporate the remaining liquor so as to form new crystals, and repeat this process, till the liquor ceases to crystallize.

This preparation (the sugar of lead) is employed chiefly for injections and collyria.

Aqua lithargyri acetati, water of acetated litharge, Ph. Lond.

Take of litharge two pounds and four ounces; distilled vinegar one gallon. Mix them and boil to six pounds, stirring constantly; then put the liquor aside, and after the impurities have subsided, strain it.

This preparation has long been employed under the denomination of Goulard's extract. It is applied to the same purposes with the preceding.

Oxidum zinci, oxide of zinc.

Let a large crucible be placed in a furnace filled with burning coals, in such a manner that it shall be somewhat inclined to its mouth; and when the bottom of the crucible is at a moderate red heat, throw in pieces of zinc, each of them about the weight of a drachm. The zinc shortly inflames, and is converted into white flocculi, which from time to time are to be removed from the surface of the metal, with an iron spatula, that the combustion may be more effectual; when the inflammation ceases, remove the oxide of zinc from the crucible. Another piece being thrown in, renew the operation, which repeat as often as may be necessary. Lastly, let the oxide of zinc be prepared in the same manner as carbonat of lime.

Dose as a tonic, from 2 to 5 or more grains.

Sulphas zinci, sulphat of zinc. White vitriol.

Take of zinc, cut into small pieces, three ounces; sulphuric acid, five ounces; water, twenty ounces. Mix them, and the consequent effervescence being over, digest for some time on warm sand. Then strain through paper, and after due exhalation put the liquor aside, that chrystals may form.

This is often used as an injection and collyrium.

Solutio sulphatis zinci, solution of sulphat of zinc.

Take of sulphat of zinc sixteen grains, distilled water eight ounces, diluted sulphuric acid sixteen drops. Dissolve the sulphat of zinc in the water; then the acid being added, filtre through paper.

Aqua zinci vitriolati cum camphora, water of vitriolated zinc with camphor. Ph. Lond.

Take of vitriolated zinc half an ounce, camphorated spirit half an ounce by measure, boiling water by measure two pounds. Mix them, and filtre through paper.

This is used as a collyrium; it requires no further dilution.

Solutio acetitis zinci, solution of acetite of zinc.

Take of sulphat of zinc, one drachm; distilled water ten ounces. Dissolve it. Take then of acetite of lead, four scruples; distilled water, ten ounces; dissolve this. Mix the solutions; and when the liquor has remained some time at rest, strain it.

The solution is regarded as more astringent than the acetite of lead, and of a less irritating nature than the sulphat of zinc.

Pulveres, powders.

Pulvis aromaticus, aromatic powder. Ed. and Lond.

Take of cinnamon, smaller cardamom seeds, and ginger, of each equal parts. Rub them into a very fine powder, which is to be preserved in a glass phial well stopped. In the Ph. Lond. the proportion of cinnamon is greater, and one part is added of long pepper.

Pulvis asari Europæi compositus, compound powder of asarabacca, Ed. Pulv. asari compos. Lond.

Take of asarabacca leaves three parts; the leaves of marjoram and lavender flowers, of each one part. Rub them together to a powder.

A mild errhine.

Pulvis carbonatis calcis compositus, chalk powder.

Take of prepared carbonat of lime, four ounces; of cinnamon, a drachm and a half; nutmeg, half a drachm. Rub them together to powder.

Pulvis cretæ compositus, compound powder of chalk. Ph. Lond.

Take of prepared chalk, half a pound; cinnamon, four ounces; tormentil and gum arabic, of each three ounces; long pepper, half an ounce. Reduce them to powder separately, and then mix them.

Dose of either of the above aromatic astringents, from 15 grains to half a drachm.

Pulvis e creta compositus cum opio.

Take of compound powder of chalk, eight ounces; hard purified opium, rubbed to powder, one drachm and a half. Mix them.

Dose, one scruple, or half a drachm.

Pulvis chelarum cancri compositus, compound powder of crab's claws. Ph. Lond.
Take of prepared crab's claws one pound; prepared chalk, prepared coral, of each three ounces. Mix them.

This, though apparently a compound, is in reality a simple preparation, as the ingredients are all mere carbonats of lime.

Pulvis jalapæ compositus, compound powder of jalap.
Take of the powder of jalap one part; supertartrite of potass two parts; rub them together into a very fine powder.

This, in the dose of a drachm and a half, is an excellent cathartic.

Pulvis ipecacuanhæ et opii, powder of ipecacuan and opium, Ed. Pulvis ipecacuanhæ compositus, Lond. (Dover's powder.)
Take of ipecacuan powder and opium, of each equal parts; sulphat of potass eight parts. Rub them together into a fine powder.

Dose from 15 grains to half a drachm.

Pulvis opiatus, opiate powder.
Take of opium one part; prepared carbonat of lime nine parts. Rub them together to a fine powder.

Pulvis opiatus, opiate powder, Ph. Lond.
Take of hard purified opium, rubbed to powder, one drachm; prepared burnt hartshorn nine drachms. Mix them.

Pulvis scammonii compositus, compound powder of scammony.
Take of scammony, supertartrite of potass of each equal parts. Rub them together into a very fine powder.

Dose from 10 grains to a scruple.

Pulvis scammonii compositus, compound powder of scammony, Ph. Lond.
Take of scammony, extract of jalap, of each two ounces; ginger half an ounce. Rub them to powder separately, and mix them.

Dose about ten grains.

Pulvis scammonii compositus cum aloe, compound powder of scammony with aloes, Ph. Lond.
Take of scammony six drachms; extract of jalap, socotorine aloes, of each one ounce and a half; ginger half an ounce. Rub them to powder separately, and mix them.

Dose 10 or 15 grains.

Pulvis scammonii cum calomelane, powder of scammony with calomel, Ph. Lond.
Take of scammony half an ounce; calomel and refined sugar, of each two drachms. Rub them separately to powder, and mix them.

Dose from 10 grains to 15.

Pulvis sulphatis aluminæ compositus, compound powder of sulphat of argil.
Take of sulphat of argil four parts; kino one part. Rub them into a fine powder.

A styptic powder principally used externally.

Pulvis aloes cum canella, powder of aloes with canella, Ph. Lond.
Take of socotorine aloes one pound; white canella three ounces. Rub them separately to powder, and mix them.

This is generally given in spirits as a tincture.

Pulvis aloes cum guaiaco, powder of aloes with guaiac, Ph. Lond.
Take of socotorine aloes one ounce and a half; guaiac gum-resin one ounce; aromatic powder half an ounce. Rub the aloes and guaiac into powder separately, then mix them with the aromatic powder.

This is seldom used: dose 15 or 20 grains.

Pulvis aloes cum ferro, powder of aloes with iron, Ph. Lond.
Take of socotorine aloes an ounce and a half; myrrh two ounces; dried extract of gentian and sulphat of iron, of each an ounce. Rub them separately to powder, and mix them.

Dose from 10 to 15 grains.

Pulvis cerussæ compositus, compound powder of ceruss, Ph. Lond.
Take of cerusse five ounces; sarcocolla one ounce and a half; tragacanth half an ounce. Rub them together into powders.

This is used diffused in water as an injection and collyrium.

Pulvis contrayervæ compositus, compound powder of contrayerva, Ph. Lond.
Take of contrayerva rubbed to powder, five ounces; compound powder of crab's claws one pound a half.

This is a useless combination.

Pulvis myrrhæ compositus, compound powder of myrrh, Ph. Lond.
Take of myrrh, dried savin, dried rue, Russian castor, of each an ounce. Rub them together to a powder.

Dose a scruple, or half a drachm.

Pulvis sennæ compositus, compound powder of senna, Ph. Lond.
Take of senna, crystals of tartar, of each two ounces; scammony half an ounce; ginger two drachms. Rub the scammony separately, the others together, into a powder, and mix them.

Dose from half a drachm to a drachm.

Pulvis tragacanthæ compositus, compound powder of tragacanth, Ph. Lond.
Take of tragacanth powdered, gum arabic, starch, of each one ounce and a half; refined sugar, three ounces. Rub them into a powder together.

Dose one or two drachms.

Electuaria, electuaries.

Electuarium aromaticum, aromatic electuary, Ed. Confectio aromatica, Lond.
Take of aromatic powder one part; syrup of orange-peel two parts. Mix beating them well together so as to form an electuary.

Electuarium cassiæ fistulæ, electuary of purging cassia, Ed. El. cassiæ, Lond.
Take of cassia pulp in pods four parts; tamarind pulp, and manna, of each one part; syrup of pale rose four parts. Dissolve the manna beat in a mortar, in the syrup, with a gentle heat; then add the pulps, and by continuing the heat, reduce the mixture to a proper consistence.

This is scarcely used.

Electuarium cassiæ sennæ, electuary of senna, Ed. Elect. sennæ, Lond.
Take of senna leaves eight ounces; seeds of coriander four ounces; liquorice root three ounces; figs one pound; pulp of tamarind, of cassia, and of prunes, of each half a pound; sugar two pounds and a half. Rub the senna with the coriander seeds; and separate by passing through a sieve, ten ounces of mixed powders. Let the residuum with the figs and liquorice be boiled in four pounds of water down to one-half, then express and strain. Evaporate the strained liquor to about one pound and a half: afterwards add the sugar so as to form a syrup; add the syrup gradually to the pulps, and lastly mix in the powder.

This is the well known lenitive electuary. Dose from half an ounce to an ounce.

Electuarium catechu, electuary of catechu.
Take of catechu extract four ounces; kino three ounces; cinnamon and nutmeg of each one ounce; opium, diffused through a sufficient quantity of Spanish white wine, one drachm and a half; syrup of red rose boiled to the consistence of honey, two pounds and a quarter. Reduce to powder the solid ingredients, and mixing them with the opium and syrup, form an electuary.

In this electuary, formerly called japonic confection, one grain of opium is contained in rather more than three drachms of the mass.

Electuarium opiatum, opiate electuary, Ed. Confectio opiata, Lond.
Take of aromatic powder six ounces; Virginian snake root finely powdered, three ounces; opium, diffused in a sufficient quantity of white wine, half an ounce; syrup of ginger, one pound. Mix so as to make an electuary.

This preparation has been inserted in the Pharmacopœia, in the place of the complicated mithridate of the antients, and theriaca Andromachi.

Electuarium scammonii, electuary of scammony, Ph. Lond.
Take of scammony powdered one ounce and a half; cloves and ginger, of each six drachms; oil of caraway half a drachm; syrup of roses as much as may be sufficient. Mix the aromatics rubbed together into a powder, with the syrup; then add the scammony, and lastly the oil of caraway.

A stimulant purgative; dose 1 drachm or more.

Pilulæ, pills.

Pilulæ aloeticæ, aloetic pills.
Take of socotorine aloes in powder, soap, of each equal parts. Beat them with common syrup, so as to form a mass fit to be made into pills.

Pilulæ aloes composita, compound aloes pills, Ph. Lond.
Take of socotorine aloes in powder one ounce; extract of gentian half an ounce; oil of caraway two scruples; syrup of ginger as much as necessary. Beat them together.

Dose 2 pills, or 10 grains.

Pilulæ aloes cum assafœtida, pills of aloes with assafœtida.
Take of socotorine aloes, assafœtida, soap, of each equal parts. Beat them with mucilage of gum arabic into a mass.

Dose 2 or 3 pills.

Pilulæ aloes cum colocynthide, pills of aloes with colocynth.
Take of socotorine aloes, scammony, of each eight parts; colocynth four parts; sulphat of potass with sulphur, oil of cloves, of each one part. Let the aloes and scammony with the salt be reduced to powder; then let the colocynth be rubbed into a fine powder, and the oil be added. Lastly,

beat them into a mass with the mucilage of gum arabic.

Dose 2 pills. It is a powerful cathartic.

Pilulæ aloes cum myrrha, pills of aloes with myrrh, Ed. and Lond.

Take of socotorine aloes four parts; myrrh two parts; saffron one part. Beat them with simple syrup into a mass.

This is in frequent use as a purgative. Dose 2 or 3 pills.

Pilulæ assafœtidæ compositæ, compound assafœtida pills.

Take of assafœtida, galbanum, myrrh, of each eight parts; rectified oil of amber one part. Beat them with simple syrup into a mass.

Dose 2 or 3 pills.

Pilulæ galbani compositæ, compound pills of galbanum, Lond.

Take of galbanum, opoponax, myrrh, sagapenum, of each one ounce; assafœtida half an ounce; syrup of saffron as much as may be sufficient. Beat them together.

These pills are nearly similar to the preceding.

Pilulæ ammoniareti cupri, pills of ammoniaret of copper.

Take of ammoniaret of copper sixteen grains; crumb of bread four scruples; water of carbonat of ammonia, as much as is sufficient. Beat them into a mass which is to be divided into thirty pills.

Dose 1 pill.

Pilulæ hydrargyri, mercurial pills, Ed. and Lond.

Take of purified quicksilver, conserve of the red rose, of each one ounce; starch two ounces. Rub the quicksilver with the conserve in a glass mortar, until the globules disappear, adding, as occasion shall require, a little gum arabic mucilage; then add the starch, and beat with a little water into a mass, which immediately divide into 480 pills.

Dose 2 pills, gradually increased.

Pilulæ opiatæ, opiate pills, Ed. Pilulæ opii, Lond.

Take of opium one part; extract of liquorice seven parts; Jamaica pepper two parts. Mix separately the opium and the extract, softened with diluted alcohol, and beat them into a pulp; then add the pepper previously reduced to powder, and beat them into a mass.

In the Ph. L. the pepper is omitted.

Pilulæ rhæi compositæ, compound rhubarb pills.

Take of rhubarb root one ounce; socotorine aloes six drachms; myrrh half an ounce; oil of peppermint half a drachm. Beat them with syrup of orange-peel into a mass.

Dose 2 pills.

Pilulæ scilliticæ, squill pills, Ed. Pilulæ scillæ, Lond.

Take of dried squills powdered one scruple; gum ammoniac, smaller cardamom seeds in powder, and extract of liquorice, of each one drachm. Beat them into a mass with simple syrup.

Dose 2 pills.

Trochisci, troches, or lozenges.

Trochisci carbonatis calcis, troches of carbonat of lime, Ed. Trochisci cretæ, Lond.

Take of prepared carbonat of lime four ounces; gum arabic one ounce; nutmeg one drachm; refined sugar six ounces. Rub these into powder, and with water form it into a mass fit for making troches.

Trochisci glycyrrhizæ, liquorice troches, Ed. and Lond.

Take of extract of liquorice and gum arabic, of each one part; refined sugar two parts. Let these be dissolved in warm water and strained; then with a gentle heat evaporate the solution into a mass, which is to be divided into troches.

Trochisci glycyrrhizæ cum opio, liquorice troches with opium.

Take of opium two drachms; tincture of tolu balsam half an ounce; simple syrup eight ounces; extract of liquorice softened with warm water, and gum arabic in powder, of each five ounces. First rub the opium with the tincture; then gradually add the syrup and the extract; afterwards sprinkle in by degrees the gum arabic powder, and lastly dry the mass, that it may be made into troches, each weighing ten grains.

These are useful in relieving catarrhal cough.

Trochisci gummosi, gum troches.

Take of gum arabic four parts; starch one part; refined sugar twelve parts. These, powdered, are to be formed with rose water into a mass, fit for making troches.

Trochisci nitratis potassæ, troches of nitrat of potass, Ed. Trochisci nitri, Lond.

Take of nitrat of potass one part; refined sugar three parts. Beat them to powder, and make them, with gum tragacanth mucilage, into a mass, proper for forming troches.

Trochisci amyli, starch troches, Lond.

Take of starch one ounce and a half; liquorice six drachms; Florentine orris half an ounce; refined sugar one pound and a half. Rub these to powder, and with tragacanth mucilage form troches. They may be made, if preferred, without the orris.

Trochisci magnesiæ, magnesia troches, Lond.

Take of burnt magnesia four ounces; refined sugar two ounces; powdered ginger one scruple. Rub them together, and adding mucilage of gum arabic, form them into troches.

Trochisci sulphuris, sulphur troches, Ph. Lond.

Take of washed flowers of sulphur two ounces; refined sugar four ounces: mucilage of quince seeds as much as sufficient. Rub them together and form troches.

Linimenta, unguenta, et cerata, liniments, ointments, and cerates.

In making these compositions, fatty and resinous substances are to be melted with a gentle heat, constantly stirring, and sprinkling in the dry ingredients, if there are any, in fine powder, until by cooling the mixture acquires a stiffness of consistence.

Linimentum simplex, simple liniment.

Take of olive oil four parts; white wax one part.

Unguentum simplex, simple ointment.

Take of olive oil five parts; white wax two parts.

Ceratum simplex, simple cerate, Ed. Ceratum spermatis ceti, Lond.

Take of olive oil six parts; white wax three parts; spermaceti one part.

The above three compositions only differ in consistence.

Unguentum adipis suillæ, ointment of hog's lard, Ph. Lond.

Take of prepared hog's lard two pounds; rose water three ounces. Beat the lard with the rose water until they are mixed, then liquefy with a gentle heat, and put it aside that the water may subside. After pour off the ointment, stirring it constantly until it has cooled.

Unguentum resinosum, resinous ointment, Ed. Ung. resinæ flavæ, Lond.

Take of hog's lard eight parts; white resin five parts; yellow wax two parts.

This ointment is used principally when suppuration is wished to be promoted.

Unguentum pulveris meloes vesicatorii, ointment of the powder of cantharides, Ed. Ceratum cantharidis, Lond.

Take of resinous ointment seven parts; powder of cantharides, one part.

The cantharides ointment is used principally when the discharge, excited by a blister, is wished to be preserved and converted into a purulent matter.

Unguentum infusi meloes vesicatorii, ointment of infusion of cantharides, Ed. Ung. cantharidis, Lond.

Take of cantharides, white resin, yellow wax, of each one part; Venice turpentine and hog's lard, of each two parts; boiling water four parts. Macerate the cantharides in the water for a night, and strain the liquor, pressing it strongly: having added the lard boil the liquor until the water is evaporated, then add the wax and resin. These being melted and removed from the fire, add the turpentine.

This is milder than the preceding.

Unguentum subacetitis cupri, ointment of subacetite of copper (verdigris).

Take of resinous ointment fifteen parts; subacetite of copper one part.

An escharotic applied principally to foul and obstinate ulcers.

Unguentum hydrargyri, ointment of quicksilver (blue ointment).

Take of quicksilver, mutton suet, of each one part; hog's lard three parts. Carefully rub them in a mortar until the quicksilver globules disappear. It may be made with double or triple the quantity of quicksilver.

Unguentum hydrargyri fortius, stronger ointment of quicksilver, Ph. Lond.

Take of purified quicksilver two pounds; prepared hog's lard twenty-three ounces; prepared tallow one ounce. Rub first the quicksilver with the tallow, and a little lard, until the globules disappear. Then add the remaining lard so as to form an ointment.

Unguentum hydrargyri mitius, milder ointment of quicksilver, Ph. Lond.

Take of the stronger ointment of quicksilver one part; prepared hog's lard two parts. Mix them. One drachm of the stronger ointment to be introduced by friction; the weaker ointments are superfluous.

Unguentum oxidi hydrargyri cinerei, ointment of grey oxide of quicksilver.

Take of grey oxide of quicksilver one part; hog's lard three parts.

This it has been supposed will prove more active than the common blue ointment, on account of the quicksilver being more oxidised.

Unguentum oxidi hydrargyri rubri, ointment of red oxide of quicksilver.

Take of red oxide of quicksilver by nitric acid one part; hog's lard eight parts.

This is chiefly used to remove fungi from ulcers.

Unguentum calcis hydrargyri albi, ointment of white calx of quicksilver, Ph. Lond.

Take of white calx of quicksilver one drachm; ointment of hog's lard one ounce and a half. Mix them so as to form an ointment.

Used principally in psora.

Unguentum nitratis hydrargyri fortius, stronger ointment of nitrat of quicksilver, Ed. Ung. hydrargyri nitrati, Lond.

Take of purified quicksilver one part; nitrous acid two parts; hog's lard twelve parts. Digest the quicksilver with the nitrous acid in a sand-bath, until a solution is obtained, which while hot is to be mixed with the hog's lard melted, and beginning to cool. Beat the mixture thoroughly in a glass mortar, so as to make an ointment.

Unguentum nitratis hydrargyri mitius, milder ointment of nitrat of quicksilver.

This is made in the same manner as the last with a triple proportion of lard.

Unguentum acidi nitrosi, ointment of nitrous acid.

Take of hog's lard one pound; nitrous acid six drachms. Mix gradually the acid with the melted lard, and during the cooling of the mixture, beat it thoroughly.

Unguentum oxidi plumbi albi, ointment of white oxide of lead.

Take of simple ointment five parts; white oxide of lead one part.

Unguentum acetitis plumbi, ointment of acetite of lead, Ed. Ung. cerussæ acetatæ, Lond.

Take of simple ointment twenty parts; acetite of lead one part.

Ceratum lithargyri acetati compositum, compound cerate of acetated litharge, Ph. Lond.

Take of water of acetated litharge two ounces and a half; yellow wax four ounces; olive oil nine ounces; camphor half a drachm. Rub the camphor with a little of the oil. Melt the wax with the remaining oil, and as soon as the mixture begins to thicken, pour on gradually the water of acetated litharge, and stir constantly until the mixture has cooled; then mix with it the camphor rubbed with oil.

This is the common Goulard's cerate.

Ceratum carbonatis zinci impuri, cerate of impure carbonat of zinc, Ed. Cerat. lapidis calaminaris, Lond.

Take of simple cerate five parts; prepared impure carbonat of zinc one part.

This is the common healing cerate.

Unguentum oxidi zinci impuri, ointment of impure oxide of zinc, Ed. Ung. tutiæ, Lond.

Take of simple liniment five parts; prepared impure oxide of zinc one part.

Principally employed in chronic inflammation of the eyes.

Unguentum oxidi zinci, ointment of oxide of zinc.

Take of simple liniment six parts; oxide of zinc one part.

This is employed likewise in ophthalmia.

Unguentum picis, ointment of tar, Ed. and Lond.

Take of tar five parts; yellow wax two parts.

The chief use of tar ointment is in tinea capitis.

Unguentum sulphuris, ointment of sulphur, Ed. and Lond.

Take of hog's lard four parts; sublimed sulphur one part. To each pound of this ointment add essential oil of lemon, or oil of lavender, half a drachm.

This is deemed one of the most efficacious ointments in psora.

Unguentum elemi compositum, compound ointment of elemi, Ph. Lond.

Take of elemi one pound; common turpentine ten ounces; prepared suet two pounds; olive oil two ounces. Melt the elemi with the suet, and having removed it from the fire, mix it immediately with the turpentine and oil, then strain the mixture.

Unguentum hellebori albi, ointment of white hellebore, Ph. Lond.

Take of white hellebore rubbed to powder one ounce; ointment of hog's lard four ounces; essence of lemon half a scruple. Mix them so as to form an ointment.

This ointment is often employed in psora.

Unguentum sambuci, ointment of elder, Ph. Lond.

Take of elder flowers four pounds; prepared mutton suet three pounds; olive oil one pound. Beat the elder flowers with the suet and oil, until they become friable; then pour out the fluid and strain it.

Ceratum saponis, cerate of soap, Ph. Lond.

Take of soap eight ounces; yellow wax ten ounces; litharge in powder one pound; olive oil one pound; vinegar one gallon. Boil the vinegar with the litharge on a gentle fire, constantly stirring, until the mixture becomes uniform and thick; then mix with it the other ingredients, so as to form a cerate.

Emplastra, plasters.

Emplastrum simplex, simple plaster, Ed. Emp. ceræ comp. Lond.

Take of yellow wax three parts; mutton suet and resin of each two parts.

This is principally employed as an application after a blister.

Emplastrum oxidi plumbi semivitrei, plaster of semivitreous oxide of lead, Ed. Emp. lithargyri, Lond.

Take of the semivitreous oxide of lead one part; olive oil two parts. Having added water, boil them, stirring constantly, until the oil and oxide unite and form plaster.

This is chiefly applied to excoriations or trivial wounds.

Emplastrum resinosum, resinous plaster, Ed. Emp. lithargyri cum resina, Lond.

Take of plaster of semivitreous oxide of lead five parts; resin one part.

This is the common adhesive plaster.

Emplastrum oxidi ferri rubri.

Take of plaster of semivitreous oxide of lead twenty-four parts; resin six parts; yellow wax, olive oil, of each three parts; red oxide of iron eight parts. Rub the red oxide of iron with the oil, and add to it the other ingredients melted.

The strengthening plaster, applied principally in lumbago.

Emplastrum assafœtidæ, assafœtida plaster.

Take of plaster of semivitreous oxide of lead, assafœtida, galbanum, yellow wax, of each equal parts.

This is sometimes used in hysteric complaints, applied to the breast.

Emplastrum gummosum, gum plaster.

Take of plaster of semivitreous oxide of lead eight parts; ammoniac, galbanum, yellow wax, of each one part.

A stimulant plaster employed to encourage suppuration.

Emplastrum hydrargyri, quicksilver plaster, Ed. Emp. lithargyri cum hydrargyro, Lond.

Take of olive oil, resin, of each one part; quicksilver three parts; plaster of semivitreous oxide of lead six parts. Rub the quicksilver with the oil and resin melted together, and then cooled, until the globules disappear; then add gradually the plaster of semivitreous oxide of lead, melted, and mix them all together.

A discutient plaster.

Emplastrum saponaceum, soap plaster, Ed. Emp. saponis, Lond.

Take of plaster of semivitreous oxide of lead four parts; gum plaster two parts; sliced soap one part. Mix the soap with the plasters melted together.

This as a discutient is inferior to the preceding.

Emplastrum meloes vesicatorii, plaster of cantharides, Ed. Emp. cantharidis, Lond.

Take of mutton suet, yellow wax, resin and cantharides, of each equal weights. The Spanish flies rubbed with fine powder, are to be used with other ingredients, melted together, and removed from the fire.

Common blistering plaster.

Emplastrum meloes vesicatorii compositum, compound plaster of cantharides.

Take of Burgundy pitch eighteen parts; turpentine and cantharides of each twelve parts; subacetite of copper two parts; mustard seed and black pepper of each one part. To the melted Burgundy pitch and wax, add the turpentine. When the liquefaction is complete, and while the fluid is still warm, sprinkle in the other ingredients, powdered and mixed, stirring constantly so as to form plaster.

Emplastrum ammoniaci cum hydrargyro, plaster of ammoniac with quicksilver, Ph. Lond.

Take of strained ammoniac one pound; purified quicksilver three ounces; sulphureted oil one drachm, or as much as sufficient. Rub the quicksilver with the sulphureted oil, until the globules disappear; then gradually add the melted ammoniac and mix them.

Emplastrum cumini, cumin plaster, Ph. Lond.

Take of cumin, caraway, bay berries, of each three ounces; Burgundy pitch three pounds; yellow wax three ounces. With the pitch and wax melted, mix the other ingredients rubbed to powder.

Emplastrum ladani compositum, compound plaster of ladanum, Ph. Lond.

Take of ladanum three ounces; frankincense

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one ounce; cinnamon in powder, expressed oil of nutmeg, of each half an ounce; oil of spearmint one drachm. To the melted frankincense add first the ladanum, softened by heat, then the expressed oil of nutmeg; afterwards mix these and the cinnamon with the oil of mint, and beat them in a warm mortar. Keep the plaster in a close vessel.

This as a stimulant application is superior to the preceding.

Emplastrum lithargyri compositum, compound litharge plaster, Ph. Lond.

Take of litharge plaster three pounds; strained galbanum, eight ounces; common turpentine, ten drachms; frankincense, three ounces. Mix the frankincense, rubbed to powder, with the galbanum and turpentine melted, and add the litharge plaster melted with a slow fire.

Emplastrum picis Burgundicæ compositum, compound Burgundy pitch plaster, Ph. Lond.

Take of Burgundy pitch two pounds; ladanum, one pound; yellow resin, yellow wax, of each four ounces; expressed oil of nutmeg, one ounce. To the pitch resin and wax melted together, add first the ladanum, then the oil of nutmeg.

Emplastrum thuris compositum, compound frankincense plaster, Ph. Lond.

Take of frankincense half a pound; dragon's blood, three ounces; litharge plaster, two pounds. To the litharge plaster melted, add the others rubbed to powder.

This is employed as a strengthening plaster.

Cataplasmata, cataplasms.

Cataplasma aluminis, alum cataplasm, Ph. Lond.

Take the whites of two eggs, agitate them with a piece of alum until a coagulum is formed.

Applied in some kinds of ophthalmia.

Cataplasma cumini, cumin cataplasm, Ph. Lond.

Take of cumin one pound; bay berries, dried scordium, Virginian snake root, of each three ounces; cloves one ounce. Rub them all together into powder, and having added three times their weight of honey, form a cataplasm.

Cataplasma sinapeos, mustard cataplasm, Ph. Lond.

Take of mustard in powder, crumbs of bread, of each half a pound; warm vinegar as much as is sufficient. Mix so as to form a cataplasm.

This is the sinapism which is usually applied to the soles of the feet, as a stimulant in the last stages of typhoid fever, and in other affections of debility.

A table shewing the quantity of opium, antimony, and quicksilver, in the different compound medicines of the Edinburgh and London Pharmacopœias.

Vinum tartritis antimonii, Ed. has two grains of tartrite of antimony in each ounce. Vinum antimonii tartarisati, Lond. has four grains of the tartrite of antimony (antim. tart.) in each ounce.

Tinctura opii, Ed. has three grains and a half of opium to one drachm of the tincture. Tinct. opii, Lond. has one grain of opium in each thirteen drops of the tincture.

Tinct. opii ammoniata, Ed. has rather more than a grain of opium in each drachm of the tincture. Tinct. opii camphorata, Lond. has a grain of opium to half an ounce of the tincture.

Tinctura saponis cum opio, Ed. has a scruple of opium in each ounce of the liquid.

Pulvis ipecacuanhæ et opii, Ed. has a grain of opium in ten grains of the powder. Pulv. ipecacuanhæ compositus, Lond. the same.

Pulvis opiatus, Ed. and Lond. ten grains contain a grain of opium.

Electuarium catechu, Ed. has in each ounce about two grains and a half of opium.

Electuarium opiatum, Ed. has in each drachm a grain and a half of opium. Confectio opiata, Lond. has one grain of opium to thirty-six of the mass.

Pilulæ hydrargyri, Ed. has fifteen grains of mercury to each drachm, Lond. a grain to each two grains and a half.

Pilulæ opiatæ, Ed. Ten grains of the mass contain a grain of opium, Lond. five grains contain a grain.

Trochisci glycirrhizæ cum opio, Ed. One drachm of the mass has a grain of opium.

Unguentum nitratis hydrargyri fortius et mitius, Ed. The first has in each drachm four grains of quicksilver and eight of nitrous acid; the second has half a grain of quicksilver and one of nitrous acid, in each scruple.

Unguentum hydrargyri, Ed. in each drachm has twelve grains of quicksilver. Ung. hyd. fortius, Lond. has a drachm of quicksilver in two of the mass; the mitius has a drachm in five drachms.

Emplastrum hydrargyri, Ed. has in each drachm about sixteen grains of quicksilver.

Table of the gradations in doses of medicine, from Mr. Murray's Materia Medica.

Suppose that the proper dose of the medicine to be given is one drachm:

For a person from 14 to 21 years, it will be two-thirds or two scruples.

For a person from 7 to 14 years, it will be one-half or half a drachm.

For a person from 4 to 7 years, it will be one-third or a scruple.

For a person of 4 years, it will be one-fourth or fifteen grains.

For a person of 3 years, it will be one-sixth or half a scruple.

For a person of 2 years, it will be one-eighth, or eight grains.

For a person of 1 year, it will be one-twelfth or five grains.

PHARNACEUM, a genus of the pentandria trigynia class of plants, without any corolla; but the calyx resembles one, being coloured on the inside, and its edges thin; the fruit is an oval capsule, obscurely trigonal, and in part covered by the cup; it consists of three cells, in which are contained numerous nitid, orbiculated, and depressed seeds, surrounded with a margin.

PHARO is the name of a game of chance, the principal rules of which are: the banker holds a pack consisting of 52 cards; he draws all the cards one after the other, and lays them down alternately at his right and left hand; then the ponte may at his pleasure set one or more stakes upon one or more cards, either before the banker has begun to draw the cards, or after he has drawn any number of couples. The banker wins the stake of the ponte when the card of the ponte comes out in an odd place on his right hand, but loses as much to the ponte when it comes out in an even place on his left hand. The banker wins half the ponte's stake when it happens to be twice in one couple. When the card of the ponte, being but once in the stock, happens to be the last, the ponte neither wins nor loses; and the card of the ponte being but twice in the stock, and the last couple containing his card twice, he then loses his whole stake. De Moivre has shewn how to find the gain of the banker in any circumstance of cards remaining in the stock, and of the number of times that the ponte's card is contained in it. Of this problem he enumerates four cases, viz. when the ponte's card is once, twice, three, or four times in the stock. In the first case, the gain of the banker is $\frac{1}{n}$, n being the number of cards in the stock. In the second case, his gain is $\frac{\overline{n-2}\times y}{n\times\overline{n-1}}+\frac{2}{n\times\overline{n-1}}$, or $\frac{\frac{1}{2}n-1}{n\times\overline{n-1}}$, supposing $y=\frac{1}{2}$. In the third case, his gain is $\frac{3y}{2\times\overline{n-1}}$, or $\frac{3}{n\times\overline{n-1}}$, supposing $y=\frac{1}{2}$. In the fourth case, the gain of the banker, or the loss of the ponte, is $\frac{2n-5}{\overline{n-1}\times\overline{n-3}}y$, or $\frac{2n-5}{2\times\overline{n-1}\times\overline{n-3}}$, supposing $y=\frac{1}{2}$. De Moivre has calculated a table, exhibiting this gain or loss for any particular circumstance of the play; and he observes, that at this play the least disadvantage of the ponte, under the same circumstance of cards remaining in the stock, is when the card of the ponte is but twice in it; the next greater when three times, the next when once, and the greatest when four times. He has also demonstrated, that the whole gain per cent. of the banker upon all the money that is adventured at this game, is 2*l.* 19*s.* 10*d.* See De Moivre's Doctrine of Chances, p. 77.

PHARUS, a genus of the hexandria order, in the monœcia class of plants, and in the natural method ranking under the fourth order, gramina. The male calyx is a bivalved uniflorous glume; the corolla, a bivalved glume; the female calyx the same with the male; the corolla an uniflorous, long, and wrapping glume. There is but one seed. There are three species, grasses of the East and West Indies.

PHARYNX. See ANATOMY.

PHASCUM, in botany, a genus of the order of musci, belonging to the cryptogamia class of plants. The anthera is operculated, with a ciliated mouth; the calyptræ are minute.

PHASEOLUS, *kidney-bean*, a genus of the diadelphia decandria class of plants, the corolla whereof is papilionaceous; the vexillum is cordated, obtuse, emarginated, and reclined with reflex sides; the alæ are roundish, of the same length with the vexillum, and stand upon long ungues; the carina is narrow, and revolves spirally in a contrary direction to the sun; the fruit is a long, straight, coriaceous, and obtuse pod; the seeds are oblong, compressed, and kidney-shaped. There are 21 species.

PHASES. See ASTRONOMY.

PHASIANUS, in ornithology, a genus belonging to the order of gallinæ. The cheeks are covered with a smooth naked skin. Phasianus is derived from the river Phasis, the banks of which are the native habitation of the pheasant. The species are:

1. The gallus, or common cock and hen, with a compressed caruncle, or fleshy comb on the top of the head, and two caruncles or wattles under the chin. The ears are naked, and the tail is compressed and erected. Of all birds, perhaps this species affords the greatest number of varieties, there being scarcely two to be found that exactly resemble each other in plumage and form. The tail, which makes such a beautiful figure in the generality of these birds, is yet found entirely wanting in others; and not only the tail, but the rump also. The toes, which are usually four in all animals of the poultry kind, yet in a variety of the cock are found to amount to five. The feathers, which lie so sleek and in such beautiful order in most of those we are acquainted with, are in a peculiar breed all inverted, and stand staring the wrong way. Nay, there is a species that comes from Japan, which, instead of feathers, seems to be covered over with hair.

It is not well ascertained when the cock was first made domestic in Europe; but it is generally agreed that we first had him in our western world from the kingdom of Persia.

In his wild condition, his plumage is black and yellow, and his comb and wattles yellow and purple. There is another peculiarity also in those of the Indian woods; their bones, which, when boiled, with us are white, as every body knows, in those are as black as ebony.

No animal in the world has greater courage than the game cock, when opposed to one of his own species; and in every part of the world where refinement and polished manners have not entirely taken place, cock-fighting is a principal diversion. In China, India, the Philippine islands, and all over the East, cock-fighting is the sport and amusement even of kings and princes. With us it is declining every day; and it is hoped it will in time be utterly banished.

The cock claps his wings before he sings or crows. His sight is very piercing; and he never fails to cry in a peculiar manner when he discovers any bird of prey in the air. His extraordinary courage is thought to proceed from his being the most salacious of all other birds whatsoever. A single cock suffices for ten or a dozen hens.

The hen seldom clutches a brood of chickens above once a season, though instances have been known in which they have produced two. The number of eggs a domestic hen will lay in the year are above two hundred, provided she is well fed and supplied with water and liberty. Ten or twelve chickens are the greatest number that a good hen can rear and clutch at a time; but as this bears no proportion to the number of her eggs, schemes have been imagined to clutch all the eggs of a hen, and thus turn her produce to the greatest advantage. See Hatching.

Of this species Mr. Latham enumerates no less than 13 permanent varieties, beginning with the wild cock, which is a third less in the body than the domestic cock. This variety he imagines to be the original stock whence all our domestic varieties have sprung. They appear to be natives of the forests of India. There are but few places, however, as Mr. Latham goes on to observe, where the different voyagers have not met with cocks and hens, either wild or tame; and mention has been particularly made of finding them at St. Jago, Pulo Condore, isle of Timor, Philippine and Molucca Isles, Sumatra and Java, New Guinea, Tinian, and most of the isles of the South Seas.

2. The motmot, or Guinea pheasant, is brownish, somewhat red below, with a wedge-like tail, and wants spurs. 3. The colchicus is red, with a blue head, a wedge-shaped tail, papilous cheeks. It is a native of Africa and Asia. 4. The argus is yellowish, with black spots, a red face, and a blue crest on the back part of the head. It is found in Chinese Tartary. 5. The pictus has a yellowish crest, a red breast, and a wedge-shaped tail. It is a native of China. See Plate Nat. Hist. fig. 331.

Mr. Latham enumerates nine different species of pheasants, and of the common pheasant he reckons six varieties. The first which he describes is the superb pheasant. This bird Linnæus described from the various representations of it painted on paper-hangings and China-ware; and farther confirmed by a figure and description in a Chinese book which came under his inspection.

"We have lately seen," says Latham, "a drawing of the tail feather of a bird of the pheasant kind, which measured above six feet in length, and which, it is probable, must have belonged to some bird not hitherto come to our knowledge. The drawing is in the possession of major Davies, who took it from the original feather; two of which were in the possession of a gentleman of his acquaintance, and were brought from China. They are exactly in shape of the two middle feathers of the painted pheasant; the general colour is that of a fine blue grey, margined on the sides with a rufous cream-colour, and marked on each side the shaft with numerous bars of black; between 70 and 80 bars in all, those on the opposite sides of the shaft seldom corresponding with each other.

"The argus, though a native of China, is very commonly found in the woods of Sumatra, where it is called coo-ow. It is found extremely difficult to be kept alive for any considerable time after catching it in the woods; never for more than a month. It seems to have an antipathy to the light, being quite inanimate in the open day; but when kept in a dark place it appears perfectly at ease, and sometimes makes its note or call, from which it takes its name, and which is rather plaintive, and not harsh like that of a peacock. The flesh resembles that of the common pheasant."

For the parraka, which Mr. Latham reckons a variety of the common pheasant, and which is found in the woods of America, and remarkable for its loud cry, see Plate Nat. Hist. fig. 330.

PHASMA, a genus of insects of the order hemiptera; the generic character is, head large; antennæ filiform; eyes small, rounded; stemmata three, between the eyes; wings four, membranaceous, the upper pair abbreviated, the lower pleated; feet formed for walking.

This, which is not, strictly speaking, a Linnæan genus, being formed from some of the Linnæan mantes, differs from the genus mantis in having all the legs equally formed for walking, or without the falciform joint, which distinguishes the fore-legs in the genus mantis. The antennæ are setaceous, and the head large and broad: to these characters may be added the shortness of the upper wings or hemelytra, which scarcely cover more than about a third part of the body, while the lower wings are often very large and long. In their mode of life the phasmata differ from the mantes; feeding entirely on vegetable food. In the extraordinary appearance of many of its species this genus is at least equal to that to which we allude.

The most remarkable is the phasma gigas, or giant phasma. (Mantis gigas, Lin.) This insect measures six or eight inches in length, and is of a very lengthened shape both in thorax and abdomen, which are of a subcylindric form, the thorax being roughened on the edges and upper surface by numerous small spines or tubercles; the upper wings are small, green, and veined like the leaves of a plant, while the lower are very ample, reaching half the length of the body or farther, of a very pale transparent brown, elegantly varied and tesselated by darker spots and patches: the legs are of moderate length, with the joints roughened by spines. The larva and pupa of this species bear a more singular appearance than even the complete insect, greatly resembling, on a general view, a piece of dry stick with several small broken twigs adhering to it; for this reason it has been generally known in collections by the name of the walking-stick, and under this title is figured in Edwards's Gleanings of Natural History, and many other publications. It is, however, probable, that though of a pale brown in its dry state, it is in reality green when living; the natural colour fading after death, as in many others of this tribe. It is a native of the island of Amboina. It may be added, that this insect either runs into several varieties as to size and some other particulars, or that there exist in reality many distinct species, which have been confounded under one common name.

The phasma dilatatum is another extraordinary species, and seems to have been first described in the fourth volume of the Transactions of the Linnæan Society, by Mr. John Parkinson.

It is supposed to be a native of Asia, and belongs to that tribe of insects which Stoll has called spectres, and which constitute a distinct genus from that of mantis. It measures six inches and a quarter from the upper part or top of the head to the extremity of the abdomen. The whole animal is of a flattened form, more especially on the abdomen, which measures about an inch and a half across in its broadest part: the thorax is of an obtusely rhomboidal form, the slides sloping each way from the flattish upper part. The whole thorax is not only edged with spines, but has also several very sharp ones distantly scattered over its surface. The head rises up backwards into an obtusely conic shape, and has several very strong and large spines or processes. The abdomen is edged, almost throughout its whole length, with a continued series of small spines, to the number of five on the side of each individual segment: the extreme segments are without spines. The thighs or first joints of the lower pair of legs are in this insect remarkably strong, of a somewhat triangular shape, and beset with some strong spines; but the tibiæ or second joints are armed with far larger and stronger ones. The general colour of the thorax, abdomen, and head, is brown in the dead, but might probably have been green in the living, animal. The wings are scarcely larger than the elytra or wing-sheaths, and seem originally to have been reddish; the tips are green. These wings are very strongly veined with brown fibres; the wing-cases are of a strong opake green, and were doubtless more vivid in the living insect: they have a great resemblance to a pair of leaves. The mouth has four palpi, which are rather long, and under the mouth are situated two leaf-shaped organs, perhaps belonging to the action of that part. The abdomen is terminated by a kind of boat-shaped organ, the keel of which possesses a considerable space beneath the abdomen, so that fewer segments appear on that part than above. The concavity of this organ is covered by a terminal scale and bifid process, constituting the tip of the abdomen on the upper part. On raising this valve, an ovum, nearly of the size of a pea, but of a more lengthened form, is discovered lying in the cavity beneath; and on inspecting farther into the cavity of the abdomen, a great many more ova, exactly similar, were found, to the number of five or six and twenty: these eggs are of a slightly oblong shape, but flattened at one end; they are of a brown colour, and marked all over with numerous impressed points, and have on one side a mark or double waved line, so disposed as to represent a kind of cross, as if carved on the surface; the flattened end is surrounded by a small rim or ledge, and seems to be the part which opens at the exclusion of the larva, since it readily separates from the rest. On immersing some of these ova in warm water, and opening them, the included yolk, of a deep yellow colour, and of the appearance of a transparent gum, was discovered; and this, when burned, afforded the usual smell of animal substances, but in some it was accompanied by a slight degree of fragrance.

Some insects of this genus, like the preceding, are remarkable for the extreme, and even deceptive resemblance which their upper wings bear to leaves of trees. This is a wise provision of nature for the security of the animal against the attacks of birds, as well as for the more ready attainment of its prey; since when sitting among the branches, it eludes the notice of both.

PHEASANT. See PHASIANUS.

PHELLANDRIUM, *water-hemlock*, a genus of the digynia order, in the pentandria class of plants. The florets of the disk are smaller; fruit ovate, even crowned, with the perianthium and pistillum. There are two species, one of which, viz. the aquaticum, is a native of Britain. This grows in ditches and ponds, but is not very common. The stalk is remarkably thick and dichotomous, and grows in the water. It is a poison to horses, bringing upon them, as Linnæus informs us, a kind of palsy, which, however, he supposes to be owing not so much to the noxious qualities of the plant itself, as to those of an insect which feeds upon it, breeding within the stalks, and which he calls curculio paraplecticus.

PHILADELPHUS, the *pipe-tree*, or *mock orange*, a genus of the monogynia order, in the icosandria class of plants. The species are:

1. The coronarius, white syringa, or mock orange, has been long cultivated in the gardens of this country as a flowering shrub; it is not well known in what country it is to be found native. 2. The scoparius. 3. The aromaticus. 4. The laniger. The propagation of all the sorts is very easy: they are increased by layers, cuttings, or suckers.

PHILLYREA, *mock privet*, a genus of the monogynia order, in the diandria class of plants. Each flower contains two males and one female. There are three species, all of them shrubby plants, and natives of France or Italy.

1. Phillyrea media, the oval-leaved phillyrea, or mock privet, or the medical-leaved phillyrea, a tall evergreen shrub, native of the south of Europe. 2. Phillyrea latifolia, the broad-leaved phillyrea, or mock privet, a tall evergreen shrub, native of the south of Europe. 3. Phillyrea angustifolia, the narrow-leaved phillyrea, or mock privet, a deciduous shrub, native of Spain and Italy.

PHILOLOGY, a science, or rather assemblage of several sciences, consisting of grammar, rhetoric, poetry, antiquities, history, and criticism.

PHILOSOPHY. See EXPERIMENTAL and NATURAL PHILOSOPHY, ETHICS, &c.

PHILYDRUM, a genus of the class and order monandria monogynia. The spathe is one-flowered; perianthium none; corolla four-petalled, irregular; capsule three-celled, many-seeded. There is one species, a herb of China.

PHLEBOTOMY. See SURGERY.

PHLEUM, *cat's-tail grass*, a genus of the triandria digynia class of plants, the corolla of which consists of two valves; and the seed, which is single, is included within the calyx and corolla. There are four species. See HUSBANDRY.

PHLOAS, a genus of vermes testacea; the animal an ascidia; shell bivalve, divaricate, with several lesser differently shaped accessory ones at the hinge; hinges recurved, united by a cartilage: in the inside, beneath the hinge, is an incurved tooth. The inhabitants of this genus perforate clay, spongy stones and wood, while in the younger state; and as they increase in size, enlarge their habitation within, and thus become imprisoned. They contain a phosphorous liquor of great brilliancy in the dark, and which illuminates whatever it touches or happens to fall upon. There are 12 species.

All that we can know with certainty is, that they must have penetrated these substances when very small, because the entrance of the hole in which the phloas lodges is always much less than the inner part of it, and indeed than the shell of the phloas itself. Hence some have supposed that they were hatched in holes accidentally formed in stones, and that they naturally grew of such a shape as was necessary to fill the cavity.

The holes in which these insects lodge, are usually twice as deep, at least, as the shells themselves are long; the figure of the holes is that of a truncated cone, excepting that they are terminated at the bottom by a rounded cavity, and their position is usually somewhat oblique to the horizon. The openings of these holes are what betray the phloas being in the stone; but they are always very small in proportion to the size of the fish. There seems to be no progressive motion of any animal in nature so slow as that of the phloas; it is immersed in the hole, and has no movement except a small one towards the centre of the earth; and this is only proportioned to the growth of the animal. Its work is very difficult in its motion; but it has great time to perform it in, as it only moves downwards, sinking itself deeper in the stone as it increases itself in bulk. That part by means of which it performs this is a fleshy substance placed near the lower extremity of the shell; it is of the shape of a lozenge, and is considerably large in proportion to the size of the animal; and though it is of a soft substance, it is not to be wondered at that in so long a time it is able, by constant work, to burrow into a hard stone. The manner of their performing this may be seen by taking one of them out of the stone, and placing it upon some soft clay; for they will immediately get to work in bending and extending that part allotted to dig for them, and in a few hours they will bury themselves in the mud in as large a hole as they had taken many years to make in the stone. They find little resistance in so soft a substance; and the necessity of their hiding themselves evidently makes them hasten their work. The animal is lodged in the lower half of the hole in the stone, and the upper half is filled up by a pipe of a fleshy substance and conical figure, truncated at the end. This they usually extend to the orifice of the hole, and place on a level with the surface of the stone; but they seldom extend it any farther than this. The pipe, though it appears single, is in reality composed of two pipes, or at least it is composed of two parts separated by a membrane. The use of this pipe or proboscis is the same with that of the proboscis of other shell-fish, to take in sea-water into their bodies, and afterwards to throw it out again. In the middle of their bodies they have a small green vessel, the use of which has not yet been discovered. This, when plunged in spirit of wine, becomes of a purple colour; but its colour on linen will not become purple in the sun like that of the murex; and even if it would, its quantity is too small to make it worth preserving.

The phloas is remarkable for its luminous quality. That this fish is luminous was noticed by Pliny, who observes that it shines in the mouth of the person who eats it; and if it touches his hands or clothes, it makes them luminous. He also says that the light depends upon its moisture. The light of this fish has furnished matter for various observations and experiments to M. Reaumur and the Bolognian academicians, especially Beccarius, who took so much pains with the subject of phosphoreal light.

M. Reaumur observes, that whereas other fishes give light when they tend to putrescence, this is more luminous in proportion to its being fresh; that when they are dried, their light will revive if they are moistened either with fresh or salt water, but that brandy immediately extinguishes it. He endeavoured to make this light permanent, but none of his schemes succeeded.

The attention of the Bolognian academicians was engaged to this subject by M. F. Marsilius, in 1724, who brought a number of these fishes, and the stones in which they were enclosed, to Bologna, on purpose for their examination.

Beccarius observed, that though this fish ceased to shine when it became putrid, yet that in its most putrid state it would shine, and make the water in which it was immersed luminous when it was agitated. Galeatius and Montius found that wine and vinegar extinguished this light; that in common oil it continued some days, but in rectified spirit of wine or urine, hardly a minute.

In order to observe in what manner this light was affected by different degrees of heat, they made use of a Reaumur's thermometer, and found that water rendered luminous by these fishes increased in light till the heat arrived to 45°, but that it then became suddenly extinct, and could not be revived again.

In the experiments of Beccarius, a solution of sea-salt increased the light of the luminous water; a solution of nitre did not increase it quite so much. Sal ammoniac diminished it a little, oil of tartar per deliquium nearly extinguished it, and the acids entirely. This water poured upon fresh calcined gypsum, rock crystal, ceruse, or sugar, became more luminous. He also tried the effects of it when poured upon various other substances, but there was nothing very remarkable in them. Afterwards, using luminous milk, he found that oil of vitriol extinguished the light, but that of tartar increased it.

This gentleman had the curiosity to try how differently-coloured substances were affected by this kind of light; and having, for this purpose, dipped several ribbons in it, the white came out the brightest, next to this was the yellow, and then the green; the other colours could hardly be perceived. It was not, however, any particular colour, but only light, that was perceived in this case. He then dipped boards painted with the different colours, and also glass tubes filled with substances of different colours, in water rendered luminous by the fishes. In both these cases, the red was hardly visible, the yellow was the brightest, and the violet the dullest. But on the boards, the blue was nearly equal to the yellow, and the green more languid; whereas in the glasses, the blue was inferior to the green.

Of all the liquors to which he put the phloades, milk was rendered the most luminous. A single phloas made seven ounces of milk so luminous, that the faces of persons might be distinguished by it, and it looked as if it was transparent.

Air appeared to be necessary to this light; for when Beccarius put the luminous milk into glass tubes, no agitation would make it shine unless bubbles of air were mixed with it. Also Montius and Galeatius found, that, in an exhausted receiver, the phloas lost its light, but the water was sometimes made more luminous; which they ascribed to the rising of bubbles of air through it.

Beccarius, as well as Reaumur, had many schemes to render the light of these phloades permanent. For this purpose he kneaded the juice into a kind of paste with flour, and found that it would give light when it was immersed in warm water; but it answered best to preserve the fish in honey. In any other method of preservation, the property of becoming luminous would not continue longer than six months, but in honey it had lasted above a year; and then it would, when plunged in warm water, give as much light as ever it had done.

PHLOMIS, the *sage-tree*, or *Jerusalem sage*, a genus of the gymnospermia order, in the didynamia class of plants. The calyx is angular; corolla, upper lip incumbent, compressed, villose. There are 22 species, all of which have perennial roots, and of many the stalks also are perennial. The latter rise from two to five or six feet high, and are adorned with yellow, blue, or purple flowers in whorls. They are all ornamental plants, and deserve a place in gardens or greenhouses. Some are sufficiently hardy to endure the ordinary winters in this climate, but they require a pretty warm situation.

PHLOX, *lychnidea*, or *bastard lychnis*, a genus of the monogynia order, in the pentandria class of plants. The corolla is salver-shaped; filam. unequal; stigma trifid; calyx prismatical; capsules three-celled, one-seeded. There are 12 species, all but one natives of North America. They have perennial roots, from which arise herbaceous stalks from nine inches to two feet in height, adorned with tubulated flowers of a white or purple colour. They are propagated by offsets, and will bear the winter in this country. They require a moist rich soil, in which they thrive better and grow taller than in any other.

PHOCA, *seal*, a genus of quadrupeds of the order feræ. The generic character is, fore-teeth in the upper jaw six, pointed, parallel, the exterior larger; in the lower jaw four, bluntish, parallel, distinct, equal; canine teeth one on each side in both jaws, large, pointed; the upper ones distinct from the cutting-teeth, the lower from the grinders; grinders five on each side above, six below, obtusely tricuspidated. This genus is marine. It is, however, so constituted as to require occasionally some intervals of repose, and even a considerable degree of continuance, on dry land; forsaking, at particular periods, the water, and congregating in vast multitudes on the shores, on floating ice, or on insulated rocks, especially during the season in which the young are produced. See AMPHIBIOUS. There are about 19 species, the most noted of which are:

1. Phoca vitulina, the common seal, is a native of the European seas, and is found about all the coasts of the northern hemisphere, and even extends as far as the opposite one, being seen in vast numbers about the southern polar regions. It also inhabits some fresh-water lakes, as that of Baikal, Oron, &c. and in these lakes it is considerably smaller, but much fatter, than when found in the sea.

The size of the seal varies, but its general length seems to be from five to six feet. The head is large and round, the neck small and short; on each side the mouth are situated several strong vibrissæ or whiskers, each hair being marked throughout its whole length with numerous alternate contractions and dilations. The parts about the shoulders and breast are very thick, and thence the body tapers towards the tail. The eyes are large; there are no external ears; the tongue is bifid or cleft at the tip. The legs are so very short as to be scarcely perceptible; and the hinder ones are so placed as to be only of use to the animal in swimming, or but very little to assist it in walking, being situated at the extremity of the body, and close to each other. All the feet are strongly webbed, but the hind ones much more widely and conspicuously than the fore. The toes on all the feet are five in number, and the claws are strong and sharp. The tail is very short. The whole animal is covered with short thick-set hair. In colour the seal varies considerably, being sometimes grey, sometimes brown or blackish, and sometimes variously patched or spotted with white or yellowish. When these animals collect together in great numbers on the shore, they diffuse a very strong and disagreeable smell.

Seals may often be observed sleeping on the tops of rocks, near the coast; but when approached they suddenly precipitate themselves into the water. Sometimes, however, their sleep is very profound, and it is even affirmed by some that the seal sleeps more profoundly than most other quadrupeds. The seal is possessed of a considerable degree of intelligence, and may be tamed, so as to become perfectly familiar with those to whose care it is committed, and even to exhibit several tricks and gesticulations. Of this we have numerous examples. The female seals produce their young in the winter season, and seldom bring more than two at a birth. It is said that they suckle the young for about the space of a fortnight on the spot where they were born, after which they take them out to sea, and instruct them in swimming and seeking for their food, which consists not only of fish, but of sea-weeds, &c. &c. When the young are fatigued, the parent is said to carry them on its back. The seal is supposed to be a long-lived animal, and Buffon is even inclined to suppose that it may attain to the age of a hundred years. The voice of a full-grown seal is a hoarse kind of sound, not unlike the barking of a dog: that of the young resembles the mewing of a kitten. They have, however, like most other quadrupeds, various inflections of voice, according to the passions with which they are inspired. They are said to delight in thunder-storms, and at such periods to sit on the rocks and contemplate with seeming delight the convulsions of the elements; in this respect differing widely from the terrestrial quadrupeds, which are extremely terrified at such times. Seals are generally very fat, and are hunted in the northern regions for the sake of their oil, which forms a great article of commerce: their skins also are much used for various œconomical purposes. See Plate Nat. Hist. fig. 333.

2. Phoca ursina, ursine seal. This is one of the larger seals, growing to the length of eight feet, and weighing eight hundred pounds. The female falls far short of the size and weight of the male. The length of the fore legs is about twenty-four inches, and they are less immersed in the body than those of other seals; the feet are formed with toes, but are covered with a naked skin, and have merely the rudiments of nails, giving them the appearance of a turtle's fin; the hind legs are twenty-two inches long, and are fixed to the body behind, but are capable of being brought quite forwards occasionally, so that the animal can rub its head with them; these feet are divided into five toes, separated by a large web, and are a foot broad: the tail is only two inches long. The hair is long and rough, and beneath it is a soft down of a bay colour; on the neck of the male the hair is upright, and a little longer than the rest. The general colour of the animal is black, but the hair of the old ones is tipped with grey, and

the females are cinereous. The flesh of the females and the young is said to resemble lamb, and the young are said to be as good as sucking pigs.

They live in families; each male has from eight to fifty females, whom he guards with the jealousy of an Eastern monarch. Though they lie by thousands on the shore, each family keeps itself separate from the rest, and is sometimes so numerous as to amount to above a hundred. The old animals which have been deserted by the females, are said to live apart, and are most excessively splenetic and quarrelsome. They are extremely fierce, and enormously fat. It sometimes happens that they approach or intrude upon each other's station, in which case a battle ensues between the two individuals; and they, in the conflict, disturb the repose of some of their neighbours, till in the end the discord becomes universal, and is in a manner spread through the whole shore. Exclusive of the contests between these solitary males, similar disagreements take place between those who live in a more social state, either from invading each others' seats, endeavouring to allure the females, or interfering in the disputes of their neighbours. These conflicts are very violent, and the wounds they receive are very deep, and resemble the cuts of a sabre. At the end of the fray they fling themselves into the sea to wash away the blood. They shew a great attachment to their young, and shew all the signs of the deepest concern on losing them.

The ursine seal is an inhabitant of the islands in the neighbourhood of Kamtschatka. In these islands they are seen from June to September, during which time they breed and educate their young. In September they are said to quit their stations, and to return, some to the Asiatic, and some to the American shore; but are generally confined to a space in those seas between lat. 50 and 56. They swim very swiftly, at the rate of seven miles an hour, and are very fierce and strong. They are said to be very tenacious of life, and to live a fortnight after receiving such wounds as would immediately destroy almost any other animal.

3. Phoca leonina, bottle-nosed seal. This species (in the male) is distinguished by its projecting snout, which hangs several inches over the lower jaw; the upper part consisting of a loose wrinkled skin, which the animal, when angry, has a power of inflating, so as to give the nose an arched or hooked appearance. It is a very large species, the male measuring twenty, and the female about eighteen feet in length. The feet are short: the hinder ones webbed in such a manner as to resemble a kind of fins.

In the British Museum is a tolerably well preserved skin of a female, which formerly belonged to the museum of the Royal Society. This species inhabits the seas about New Zealand, the island of Juan Fernandez, and the Falkland islands. In Juan Fernandez, during the breeding-season, viz. in June and July, they are seen in great numbers suckling their young on the shore. They bring two young at a birth; the females are observed to be excessively fierce during the time of rearing the young; towards evening both the male and female swim out a little way to sea, the female bearing the young on her back, which it is said the male frequently pushes off, in order to oblige them to exercise their swimming powers. On the arrival of these animals on the breeding-islands, they are said to be so excessively fat as to resemble skins of oil; the tremulous motion of the blubber being plainly perceivable beneath the skin. A single animal has been known to yield a butt of oil, and to be so full of blood that what has run out has filled two hogsheads. The flesh is eatable. Lord Anson's sailors ate it under the denomination of beef, to distinguish it from that of the seal, which they termed lamb.

4. Phoca jubata, sea lion, or leonine seal. This is so termed from the large and loose mane or floating hair with which the head and neck of the male are furnished. The nose is short and turns up a little, the eyes are large, the whiskers very large and strong, the hair on the whole body is smooth, short, and glossy, its colour is a deep brown; but those of this species which are found in Kamtschatka are said to be reddish, and the females tawny. The males are far larger than females, and grow from the length of from ten to fourteen feet; the females are from six to eight feet, and of a more slender form than the males. The weight of a full-grown male is from twelve to fifteen hundred pounds. A still greater size has been ascribed to those of Falkland isles, viz. that of twenty-five feet in length, and nineteen or twenty feet round the shoulders.

These animals inhabit, in vast numbers, the islands called Penguin and Seal islands, near Cape Desire, on the coast of Patagonia; and are found within the Magellanic straits, and on Falkland islands, but have not been discovered in any other part of the southern hemisphere, nor in any other place nearer than the sea between Kamtschatka and America. They live in families distinct from the ursine and other seals; their manners, however, are nearly the same; they are polygamous, each male being accompanied by from two to thirty females. The males utter a snorting sound, and occasionally roar like bulls; the voice of the females resembles that of calves, and the young bleat like lambs. The food of the leonine seal consists of the smaller kinds of penguins, fish, seals, &c. but during the breeding-season they are said to fast for three or four months, during which time they swallow a number of large stones, in order to keep their stomachs in a distended state.

5. Phoca lupina, urigne seal. This is a smaller species than the former, being found from about three to eight feet in length. The body is thick at the shoulders, and gradually lessens to the hind legs. The head resembles that of a dog with close-cut ears; the nose is short and blunt; in the mouth are six cutting teeth above, and four below; the fore feet have four toes inclosed in a membranaceous sheath, so as to resemble fins; and the hind feet are hid in a continuation of the skin of the back, and have five toes of unequal length like the fingers of the human hand; the tail is three inches long; the skin is covered with two sorts of hair, one like that of an ox, the other harder; the colours are various. These animals are the sea-wolves mentioned by navigators off the island of Lobos near the river Plata. They are said to appear there in vast multitudes, and to meet the ships, and even to hang at the ship's side by their paws, seeming to stare at and admire the crew, then drop off and return to their former haunts. The natives of Chili kill them for the sake of their oil.

PHŒNICOPTERUS, or Flamingo, in ornithology, a genus of birds belonging to the order of grallæ. The beak is naked, teethed, and bent, as if it was broken; the nostrils are linear; the feet are palmated, and four-toed. There is but one species, viz. the bahamensis of Catesby, a native of Africa and America.

This bird resembles the heron in shape, excepting the bill, which is of a very singular form. It is two years old before it arrives at its perfect colour, and then it is entirely red, excepting the quill-feathers, which are black. A full-grown one is of equal weight with a wild duck; and when it stands erect, it is five feet high. The feet are webbed. The flesh is delicate, and most resembles that of a partridge in taste. The tongue, above any other part, was in the highest esteem with the luxurious Romans. These birds make their nests on hillocks in shallow water, on which they sit with their legs extended down, like a man sitting on a stool. They breed on the coasts of Cuba and the Bahama islands in the West Indies, and frequent salt water only. From the particular shape of its bill, this bird, in eating, twists its neck from side to side, and makes the upper mandible touch the ground. They are very stupid, and will not rise at the report of a gun; nor is it any warning to those who survive that they see others killed by their side; so that, by keeping himself out of sight, a fowler may kill as many as he pleases.

These birds prefer a warm climate. In the old continent they are not often met with beyond 40 degrees north or south. They are met with every where on the African coast and adjacent isles, to the Cape of Good Hope: and sometimes on the coasts of Spain, Italy, and those of France lying in the Mediterranean sea; being at times found at Marseilles, and for some way up the Rhone. In some seasons they frequent Aleppo and the parts adjacent. They are seen also on the Persian side of the Caspian Sea, and thence along the western coast as far as the Wolga; though this is at uncertain times, and chiefly in considerable flocks coming from the north-east, mostly in October and November; but as soon as the wind changes they totally disappear. They breed in the Cape Verd isles, particularly that of Sal. They go for the most part together in flocks, except in breeding time. They are very numerous at the Cape; keeping in the day on the borders of the lakes and rivers, and lodging themselves at night in the long grass on the hills. They are also common to various places in the warmer parts of America, frequenting the same latitudes as in other quarters of the world; being found at Peru, Chili, Cayenne, and the coast of Brasil, as well as the various islands of the West Indies. Sloane found them in Jamaica. When seen at a distance, they appear as a regiment of soldiers, being ranged alongside one another, on the borders of the rivers, searching for food, which chiefly consists of small fish, or the eggs of them; and of water-insects, which they search after by plunging in the bill and part of the head, from time to time trampling with their feet to muddy the water, that their prey may be raised from the bottom. Whilst they are feeding, one of them is said to stand sentinel, and the moment he sounds the alarm, the whole flock takes wing. This bird, when at rest, stands on one leg, the other being drawn up close to the body, with the head placed under the wing on that side of the body it stands on. See Plate Nat. Hist. fig. 332.

They are sometimes caught young, and are brought up tame; but are always impatient of cold; and in this state will seldom live a great while, gradually losing their colour, flesh, and appetite, and dying for want of that food which in a state of nature at large they were abundantly supplied with.

PHŒNIX, in astronomy, one of the constellations of the southern hemisphere, unknown to the antients, and invisible in our northern parts. See ASTRONOMY.

PHŒNIX, the *great palm* or *date-tree*, a genus of plants belonging to the order palmæ. The calyx is 3-parted; corolla 3-petalled; male stamina three; female pist. one, drupe ovate. There is only species, viz. the dactylifera, or common date-tree, a native of Africa and the Eastern countries, where it grows to 50, 60, and 100 feet high. The trunk is round, upright, and studded with protuberances, which are the vestiges of the decayed leaves. From the top issues forth a cluster of leaves or branches eight or nine feet long, extending all round like an umbrella, and bending a little towards the earth. The bottom part produces a number of stalks like those of the middle, but seldom shooting so high as four or five feet. These stalks, says Adanson, diffuse the tree very considerably; so that wherever it naturally grows in forests, it is extremely difficult to open a passage through its prickly leaves. The date-tree was introduced into Jamaica soon after the conquest of the island by the Spaniards. There are, however, but few of them in Jamaica at this time. The fruit is somewhat in the shape of an acorn. It is composed of a thin, light, and glossy membrane, somewhat pellucid and yellowish, which contains a fine, soft, and pulpy fruit, which is firm, sweet, and somewhat vinous to the taste, esculent, and wholesome; and within this is enclosed a solid, tough, and hard kernel, of a pale grey colour on the outside, and finely marbled within like the nutmeg. The best are brought from Tunis: they are also very fine and good in Egypt, and in many parts of the East. Those of Spain and France look well; but are never perfectly ripe, and very subject to decay. Dates have always been esteemed moderately strengthening and astringent.

Though the date-tree grows every where indiscriminately on the northern coasts of Africe, it is not cultivated with care, except beyond mount Atlas; because the heat is not sufficiently powerful along the coasts to bring the fruits to proper maturity. We shall here extract some observations from M. Des Fontaines respecting the manner of cultivating it in Barbary, and on the different uses to which it is applied. All that part of the Zaara, which is near mount Atlas, and the only part of this vast desert which is inhabited, produces very little corn; the soil being sandy, and burnt up by the sun, is almost entirely unfit for the cultivation of grain, its only productions of that kind being a little barley, maize, and sorgo. The date-tree, however, supplies the deficiency of corn to the inhabitants of these countries, and furnishes them with almost the whole of their subsistence. They have flocks of sheep; but as they are not numerous, they preserve them for the sake of their wool; besides, the flesh of these animals is very unwholesome food in countries that are excessively warm; and these people, though ignorant, have probably been enabled by experience to know that it was salutary for them to abstain from it. The date-trees are planted without any order, at the distance of 12 feet one from the other, in the neighbourhood of rivulets and streams, which issue from the sand. Forests of them may be seen here and there, some of which are several leagues in circumference. The extent of these plantations depends upon the quantity of water which can be procured to water them, for they require much moisture. All these forests are intermixed with orange, almond, and pomegranate trees, and with vines which twist round the trunks of the date-trees; and the heat is strong enough to ripen the fruit, though they are never exposed to the sun.

It is generally in winter that new plantations of this tree are formed. For this purpose those who cultivate them take shoots of those which produce the best dates, and plant them at a small distance one from the other. At the end of three or four years, these shoots, if they have been properly taken care of, begin to bear fruit: but this fruit is as yet dry, without sweetness, and even without kernels; they never reach the highest degree of perfection of which they are susceptible till they are about 15 or 20 years old.

These plants are, however, produced from the seeds taken out of the fruit, provided they are fresh. They should be sown in pots filled with light rich earth, and plunged into a moderate hot-bed of tanner's bark, which should be kept in a moderate temperature of heat, and the earth frequently refreshed with water. When the plants are come up to a proper size, they should be each planted in a separate small pot, filled with the same light earth, and plunged into a hot-bed again; observing to refresh them with water, as also to let them have air in proportion to the warmth of the season, and the bed in which they are placed. During the summer time they should remain in the same hot-bed; but in the beginning of August they should have a great share of air to harden them against the approach of winter; for if they are too much forced, they will be so tender as not to be preserved through the winter without much difficulty, especially if you have not the conveniency of a bark-stove to keep them in.

The trees, however, which spring from seed, never produce so good dates as those that are raised from shoots, they being always poor and ill-tasted. It is undoubtedly by force of cultivation, and after several generations, that they acquire a good quality. The date-trees which have been originally sown grow rapidly, and we have been assured that they bear fruit in the fourth or fifth year. Care is taken to cut the inferior branches of the date-tree in proportion as they rise; and a piece of the root is always left of some inches in length, which affords the easy means of climbing to the summit. These trees live a long time, according to the account of the Arabs; and in order to prove it, they say that when they have attained to their full growth, no change is observed in them for the space of three generations.

The number of females which are cultivated is much superior to that of the males, because they are much more profitable. The sexual organs of the date-tree grow, as is well known, upon different stalks, and these trees flower in the months of April and May, at which time the Arabs cut the male branches to impregnate the female. For this purpose they make an incision in the trunk of each branch which they wish to produce fruit, and place in it a stalk of male flowers; without this precaution the date-tree would produce only abortive fruit. In some cantons the male branches are only shaken over the female. The practice of impregnating the date-tree in this manner is very antient. Pliny describes it very accurately in that part of his work where he treats of the palm-tree.

There is scarcely any part of the date-tree which is not useful. The wood, though of a spungy texture, lasts such a number of years, that the inhabitants of the country say it is incorruptible. They employ it for making beams and instruments of husbandry; it burns slowly, but the coals which result from its combustion are very strong, and produce a great heat.

The Arabs strip the bark and fibrous parts from the young date-trees, and eat the substance, which is in the centre; it is very nourishing, and has a sweet taste: it is known by the name of the marrow of the date-tree. They eat also the leaves, when they are young and tender, with lemon-juice; the old ones are laid out to dry, and are employed for making mats and other works of the same kind, which are much used, and with which they carry on a considerable trade in the interior parts of the country. From the sides of the stumps of the branches which have been left, arise a great number of delicate filaments, of which they make ropes, and which might serve to fabricate cloth.

A white liquor, known by the name of milk, is drawn also from the date-tree. To obtain it, all the branches are cut from the summit of one of these trees, and after several incisions have been made in it, they are covered with leaves, in order that the heat of the sun may not dry it. The sap drops down into a vessel placed to receive it, at the bottom of a circular groove made below the incisions. The milk of the date-tree has a sweet and agreeable taste when it is new; it is very refreshing, and is even given to sick people to drink, but it generally turns sour at the end of 24 hours. Old trees are chosen for this operation, because the cutting of the branches, and the large quantity of sap which flows from them, greatly exhaust them, and often cause them to decay.

The male flowers of the date-tree are also useful. They are eaten when still tender, mixed up with a little lemon-juice. They are reckoned to be very provocative; the odour which they exhale is probably the cause of this property being ascribed to them. These date-trees are very lucrative to the inhabitants of the desert. Some of them produce 20 bunches of dates; but care is always taken to lop off a part of them, that those which remain may become larger; 10 or 12 bunches only are left on the most vigorous trees. It is reckoned that a good tree produces, one year with another, about the value of 10 or 12 shillings to the proprietor. A pretty considerable trade is carried on with dates in the interior part of the country, and large quantities of them are exported to France and Italy. The crop is gathered towards the end of November. When the bunches are taken from the tree, they are hung up in some very dry place where they may be sheltered and secure from insects.

Even the stones, though very hard, are not thrown away. They give them to their camels and sheep as food, after they have bruised them or laid them to soften in water.

The date, as well as other trees which are cultivated, exhibits great variety in its fruit, with respect to shape, size, quality, and even colour. There are reckoned to be at least 20 different varieties. Dates are very liable to be pierced by worms, and they soon corrupt in moist or rainy weather.

From what has been said, it may easily be perceived that there is, perhaps, no tree whatever used for so many and so valuable purposes as the date-tree.

PHORMIUM, *flax-plant*, a genus of the class and order hexandria monogynia. There is no calyx; the corolla is six-petalled, three inner larger; capsule oblong, three-sided; seeds oblong, compressed. Of this plant there is one species: the leaves resemble those of flags; the flowers are in one variety yellow, and in the other a deep red. Of the leaves of these plants, with very little preparation, the New Zealanders make all their common apparel, and also their strings, lines, and cordage, for every purpose; which are so much stronger than any thing we can make with hemp, that they will not bear a comparison. From the same plant, by another preparation, they draw long slender fibres, which shine like silk, and are as white as snow. Of these, which are very strong, they make their finest cloths; and of the leaves, without any other preparation than splitting them into proper breadths, and tying the strips together, they make their fishing-nets, some of which are of an enormous size. The seeds of this valuable plant have been brought over into England; but upon trial appeared to have lost their vegetating power.

PHOSPHATS, salts formed by the phosphoric acid, with the alkalies, earths, and metallic oxides. They may be distinguished by the following properties: (1.) When heated with combustibles, they are not decomposed, nor is phosphorus obtained. (2.) Before the blowpipe they are converted into a globule of glass, which in some cases is transparent, in others opaque. (3.) Soluble in nitric acid without effervescence, and precipitated from that solution by lime-water. (4.) Decomposed, at least partially, by sulphuric acid; and their acid, which is separated, when mixed with charcoal and heated to redness, yields phosphorus. (5.) After being strongly heated, they often phosphoresce.

The phosphats readily combine with an excess of acid, and form superphosphats.

The phosphats at present known amount to 12; two of which are triple salts. Some of these salts occur in different states, constituting varieties.

Phosphat of barytes. It may be prepared either by saturating phosphoric acid with barytes or carbonat of of barytes, or by mixing together an alkaline phosphat and nitrat or muriat of barytes. In either case the phosphat of barytes precipitates immediately in the form of a white powder.

This salt is tasteless, incrystallizable by art, insoluble in water, and not altered by exposure to the air. Its specific gravity is 1.2867. When strongly heated, it melts into a grey-coloured enamel. The proportion of its component parts is unknown.

This salt has not been applied to any use.

When phosphoric acid is dropt into a solution of barytes-water, a precipitate of phosphat of barytes immediately falls. But this precipitate is redissolved by adding an excess of acid. Hence it follows, that this salt is capable of combining with an additional dose of acid, and forming a superphosphat of barytes.

Phosphat of strontian. Like the former, it may be formed by dissolving carbonat of strontian in phosphoric acid, or by mixing together nitrat of strontian and phosphat of soda. A white precipitate immediately falls, which is the phosphat of strontian.

This salt is tasteless, insoluble in water, and not alterable by exposure to the air. It is soluble in an excess of phosphoric acid; a property which distinguishes it from phosphat of barytes. Before the blowpipe it fuses into a white enamel, and at the same time emits a phosphoric light. It is completely decomposed by sulphuric acid, but by no other. According to Vauquelin, it is composed of

41.24	acid
58.76	strontian.
100.00	

Phosphat of lime. Of this salt there are two varieties, the first neutral, the other a supersalt.

1. Phosphat of lime. As this salt constitutes the basis of bones, it is not necessary to prepare it artificially. It may be obtained in a state of purity by the following process: Calcine the bones to whiteness, reduce them to powder, and wash them repeatedly with water, to separate several soluble salts which are present. Dissolve the whole in muriatic acid, and precipitate by means of ammonia. The precipitate, when well washed and dried, is pure phosphat of lime.

Phosphat of lime, thus prepared, is always in the state of a white powder; but it is found native in regular crystals. In that state it is known by the name of apatite. The primitive form of its crystals is, according to Hauy, the regular six-sided prism; and the primitive form of its integrant particles is a three-sided prism, whose bases are equilateral triangles: but it very often assumes other forms. It is destitute of taste, insoluble in water, and not liable to be altered by exposure to the air. It may be exposed to a strong heat without undergoing any change; but in a very violent heat it becomes soft, and is converted into a white semitransparent enamel, or rather porcelain. According to the experiments of Saussure, a heat of 378° Wedgewood is necessary to produce this effect.

Sulphuric, nitric, muriatic, fluoric, and several vegetable acids, are capable of decomposing phosphat of lime; but the decomposition is only partial. Fourcroy and Vauquelin have ascertained, that these acids are only capable of abstracting 0.40 parts of the lime, while the remainder continues combined with the phosphoric acid, constituting a superphosphat of lime. Hence the reason that phosphoric acid is capable also of decomposing partially the combinations of these acids with lime; it abstracts as much of the lime as is sufficient to convert it into superphosphat. Phosphat of lime, according to Fourcroy and Vauquelin, is composed of

41	acid
59	lime
100.	

2. Superphosphat of lime. It is this salt which always remains in the aqueous solution when calcined bones are decomposed by means of sulphuric acid; and it may be formed artificially by dissolving phosphat of lime in phosphoric acid, till the acid refuses to take up any more, and afterwards evaporating the solution till the salt crystallizes. Its crystals are usually thin brilliant plates, resembling mother-of-pearl, which easily adhere together, and acquire a kind of gluey consistency. Its taste is strongly acid. Water dissolves it, and in a greater proportion when boiling-hot than when cold Hence a saturated solution of it in boiling water crystallizes on cooling. It attracts a little moisture when exposed to the air. When heated, it readily undergoes the watery fusion, then swells up and dries. In a high temperature it melts into a semitransparent glass, which is tasteless and insoluble, and is not altered by exposure to the air. When this salt is heated to redness along with charcoal, its excess of acid is decomposed, and converted into phosphorus, and phosphat of lime remains behind. It is from this salt that phosphorus is usually obtained; but the process of Fourcroy, which consists in decomposing the superphosphat of lime by means of acetat of lead, and afterwards decomposing the phosphat of lead by means of charcoal, must yield a much greater proportion of phosphorus.

No acid hitherto tried is capable of decomposing this salt, except the oxalic, which abstracts its base completely, and precipitates with it in the form of oxalat of lime; but it is decomposed and reduced to the state of phosphat of lime by all the alkaline and earthy bases. It is composed, according to the analysis of Fourcroy and Vauquelin, of

54	acid
46	lime
100.	

Phosphat of potass. Of this salt there are two varieties: the first, which contains an excess of acid, and is in reality a superphosphat, has been long known, and appears to have been first mentioned by Lavoisier in 1774; but it is to Vauquelin that we are indebted for an examination of its properties. The second, which is a neutral salt, was lately discovered by Darracq. It had been formed indeed previously by Guyton Morveau and Desormes; but these gentlemen had mistaken it for phosphat of lime.

1. Superphosphat of potass is prepared by dropping carbonat of potass into phosphoric acid till all effervescence ceases, and then evaporating to the proper consistency. It does not crystallize. When evaporated sufficiently, it assumes the form of a jelly; and if the evaporation is carried farther, it becomes dry altogether. Its specific gravity, when dry, is 2.85. It is exceedingly soluble in water, and when dry readily attracts moisture

from the atmosphere, and is converted into a viscid liquid. When heated, it first undergoes the watery fusion; then allows its water of crystallization to evaporate, and is reduced to dryness. In a high temperature it melts into a transparent glass, which deliquesces again when exposed to the air.

It is completely decomposed by the sulphuric, nitric, and muriatic acids; and by barytes, strontian, and lime.

2. Phosphat of potass. This salt may be formed by mixing together superphosphat of potass and pure potass, and exposing them to a strong heat in a platinum crucible. A white-coloured substance is obtained, which is the phosphat in question. This salt is tasteless and insoluble in cold water, but soluble in hot water, and it precipitates as the solution cools in a gritty brilliant powder. It is extremely fusible; melting before the blowpipe into a transparent bead, which becomes opaque on cooling. It is soluble in nitric, muriatic, and phosphoric acids: the solutions are thick, glutinous, and adhesive. When sufficiently diluted, the alkalies occasion no precipitate in these solutions; but when they are concentrated, a precipitate appears.

Phosphat of soda. This salt exists ready-formed in urine, and was the first known of all the phosphats. It occupied a good deal of the attention of chemists; and the difficulty of analysing it gave occasion to various hypotheses concerning its nature. Hellot remarked it in urine; and described it in 1737, as a salt different from those that had usually been observed. Haupt described it in 1740 under the name of sal mirabile perlatum, or "wonderful perlated salt." It was called perlated from the grey, opaque, pearl-like colour, which it assumed when melted by the blowpipe. Margraff examined it in 1745, and found it would not yield phosphorus when treated with charcoal, as the other salts of urine did.

Dr. Pearson afterwards introduced it with great advantage into medicine as a purgative. He gives the following process for preparing it: Dissolve, in a long-necked matrass, 1400 grains of crystallized carbonat of soda, in 2100 grains of water at the temperature of 150°. Add gradually 500 grains of phosphoric acid of the specific gravity 1.85. Boil the liquor for some minutes; and while it is boiling-hot, filtrate it, and pour it into a shallow vessel. Let it remain in a cool place, and crystals will continue to form for several days. From the above quantities of materials he has obtained from 1450 to 1550 grains of crystals.

Its crystals are rhomboidal prisms, of which the acute angles are 60°, and the obtuse angles 120°, terminated by a three-sided pyramid. Its specific gravity is 1.333. Its taste is almost the same with that of common salt. It is soluble at the temperature of 60° in about four parts of water, and in two parts of boiling water. This solution crystallizes on cooling; but in order to obtain the salt properly crystallized, the solution should contain a slight excess of alkali. When exposed to the air, this salt very soon effloresces on the surface. When heated, it undergoes the watery fusion. At a red heat it melts into a white enamel. Before the blowpipe it melts into a transparent globule, which becomes opaque on cooling, and its surface acquires a polyhedral figure. It is not altered by combustibles nor metals. With metallic oxides it enters into fusion, and forms a coloured globule of glass. Sulphuric, nitric, and muriatic acids, decompose it partially, and convert it into superphosphat of soda. In this state it is more soluble in water, and not so easily crystallized; but may be obtained, by proper evaporation, in the state of thin scales, not unlike boracic acid.

The greater number of earths may be fused along with this salt, and converted into glass.

This salt has been applied to various uses. It has been introduced into medicine as a purgative, and on account of its pleasant taste has of late been much used. It is usually taken in broth, which it is employed to season instead of common salt. It may be substituted for borax to promote the soldering of metals. Mineralogists employ it very much as a flux when they examine the action of heat on minerals by means of the blowpipe.

Phosphat of ammonia. It exists also in urine, and seems to have been first accurately distinguished by Rouelle. It is usually prepared by saturating with ammonia the superphosphat of lime obtained from bones, and evaporating the solution to such a consistency, that when allowed to cool, the phosphat of ammonia is obtained in crystals.

It crystallizes in four-sided prisms, terminated by equal-sided pyramids. Its taste is cooling, salt, and ammoniacal. Its specific gravity is 1.80. It is soluble in four parts of water at the temperature of 60°, and in rather a smaller proportion of boiling water. It is by spontaneous evaporation that it is obtained in the state of regular crystals. It is not altered by exposure to the air. When heated, it undergoes the watery fusion; it then dries; but if the heat is continued, it swells up, loses its alkaline base, and the acid melts into a transparent glass. It is the only one of the earthy and alkaline phosphats which can be decomposed by heat. Hence the reason that it yields phosphorus when distilled along with charcoal.

It is decomposed by the sulphuric, nitric, and muriatic acids, and by the fixed alkalies and alkaline earths. It is capable of combining with an additional dose of acid, and of passing into the state of a superphosphat.

This salt is much employed as a flux in experiments with the blowpipe. It enters also as an ingredient in those coloured glasses called pastes, which are made in imitation of precious stones.

Phosphat of magnesia. It is usually prepared by dissolving carbonat of magnesia in phosphoric acid, and evaporating the solution gradually till the salt crystallizes; but it may be obtained in large regular crystals by a much easier process. Mix together equal parts of the aqueous solutions of phosphat of soda and sulphat of magnesia. No apparent change takes place at first; but in a few hours large transparent crystals of phosphat of magnesia make their appearance in the solution.

Its crystals are six-sided prisms, the sides of which are unequal. It has very little taste; however, it leaves a cooling and sweetish impression upon the tongue. Its specific gravity is 1.55. It requires about 15 parts of cold water to dissolve it. It is more soluble in boiling water, but it crystallizes in part as the solution cools. When exposed to the air it loses its water of crystallization, and falls down in powder. When heated moderately, it is also reduced to a dry powder. In a high temperature it melts into a transparent glass.

Phosphat of glucina. It is obtained by pouring phosphat of soda into the solution of glucina in sulphuric, nitric, or muriatic acids. The phosphat of glucina is precipitated in the state of a white powder. It does not crystallize. It is tasteless, insoluble in water unless it contains an excess of acid, and not liable to be altered by exposure to the air. When heated strongly, it melts into a transparent glass.

Phosphat of yttria. When the solution of phosphat of soda is mixed with the sulphat, nitrat, or muriat of yttria, phosphat of yttria precipitates in gelatinous flakes.

Phosphat of alumina. It may be formed by saturating phosphoric acid with alumina. It is a tasteless powder, insoluble in water. Dissolved in phosphoric acid it yields a gritty powder, and a gummy solution, which by heat is converted into a transparent glass.

Phosphat of soda and ammonia, known to chemists by the names of microcosmic salt, and fusible salt of urine, was extracted from urine, and examined, much sooner than any of the other phosphats: it was long before philosophers were able to form precise notions concerning its nature, or even to obtain it in a state of purity. This indeed could not be expected till the phosphats of soda and of ammonia had been accurately examined, and their composition ascertained. Fourcroy was the first who gave a precise account of the proportion of its component parts. According to him, it is composed of

32	acid
24	soda
19	ammonia
25	water
100.	

The properties of this salt are nearly those of the phosphat of soda and phosphat of ammonia joined together. It answers better than the first of them as a flux; because the heat soon drives off the ammonia, and leaves an excess of acid. Its specific gravity is 1.5. When exposed to the air, this salt effloresces, and gradually loses its ammonia.

Phosphat of ammonia and magnesia was first discovered by Fourcroy, who found it in a calculous concretion formed in the colon of a horse. Since this discovery Fourcroy and Vauquelin have observed it also in human urine.

It might be prepared by mixing together solutions of the phosphats of ammonia and of magnesia in water; the triple salt immediately precipitates in the state of a white powder. When urine is allowed to remain a considerable time in close vessels, it often deposits this salt in regular crystals on the sides and bottom of the vessel. These crystals are small four-sided prisms, terminated by irregular four-sided pyramids. This salt is tasteless, scarcely soluble in water, and not liable to be altered by exposure to the air. When heated it falls to powder, gives out its ammonia, and in a high temperature melts into a transparent globule. It is composed of

33 phosphat of ammonia
33 phosphat of magnesia
33 water

99.

Phosphoric acid and silica, when mixed together and exposed to a strong heat, melt into a beautiful transparent glass, which is not decomposed either by the action of acids or of alkalies. Fourcroy has given this compound the name of phosphat of silica; but it is essentially different from salts, and ought therefore rather to be ranked among some other class of bodies.

PHOSPHITES, salts formed with the phosphorous acid united to the earths, alkalies, and metallic oxides. These salts may be distinguished by the following properties: 1. When heated they emit a phosphorescent flame. 2. When distilled in a strong heat, they give out a little phosphorus, and are converted into phosphats. 3. They detonate when heated with nitrat or oxymuriat of potass, and are converted into phosphats. 4. They may be converted into phosphats by nitric and oxymuriatic acid. 5. They are fusible in a violent heat into glass.

The phosphites at present known amount to eight:

1. Phosphite of lime. This salt may be formed by dissolving lime in phosphorous acid. When the saturation is complete, the salt precipitates in the state of a white powder. It is tasteless and insoluble in water; but it dissolves in an excess of acid, and forms a superphosphite. This last salt may be obtained in prismatic crystals by evaporating the solution. It is not altered by exposure to the air. When heated, it phosphoresces and emits a little phosphorus. In a violent heat, it melts into a transparent globule.

It is composed of 34 acid
51 lime
15 water

100.

2. Phosphite of barytes may be formed by pouring phosphorous acid into barytes water, or this last water into a solution of phosphite of soda. In either case phosphite of barytes precipitates in the form of a white powder. It is tasteless, and but very sparingly soluble in water, unless there is an excess of acid. It is not altered by exposure to the air. Before the blowpipe it melts, and is surrounded with a light so brilliant that the eye can scarcely bear it. The globule which it forms becomes opaque as it cools.

It is composed of 41.7 acid
51.3 barytes
7.0 water.

100.0

3. Phosphite of magnesia is best formed by mixing together aqueous solutions of phosphite of potass or soda and sulphat of magnesia; the phosphite of magnesia gradually precipitates in beautiful white flakes. It has no sensible taste. It is soluble in 400 parts of water at the temperature of 60°, and scarcely more soluble in boiling water. When its solution is evaporated slowly, a transparent pellicle forms on its surface, flakes are deposited, and towards the end of the process small tetrahedral crystals are precipitated. When exposed to the air it effloresces. When heated it phosphoresces and melts into a glass, which becomes opaque on cooling.

It is composed of 44 acid
20 magnesia
36 water

100.

4. Phosphite of potass. This salt is formed by dissolving carbonat of potass in phosphorous acid, and evaporating the solution slowly till it deposits crystals of phosphite of potass. It crystallizes in four-sided rectangular prisms, terminated by dihedral summits. Its taste is sharp and saline. It is soluble in three parts of cold water, and still more soluble in boiling water. It is not altered by exposure to the air. When heated, it decrepitates, and then melts into a transparent globule, which becomes opaque on cooling. It does not phosphoresce so evidently as the other phosphites, perhaps because it contains an excess of potass, which saturates the phosphoric acid as it forms.

It is composed of 39.5 acid
49.5 potass
11.0 water.

100.0

5. Phosphat of soda may be prepared exactly in the same way as phosphite of potass. Its crystals are irregular four-sided prisms or elongated rhomboids. Sometimes it assumes the form of square plates, or of plumose crystals. Its taste is cooling and agreeable. It is soluble in two parts of cold water, and scarcely more soluble in boiling water. When exposed to the air it effloresces. Before the blowpipe it emits a beautiful yellow flame, and melts into a globule, which becomes opaque on cooling.

It is composed of 16.3 acid
23.7 soda
60.0 water.

100.0

6. Phosphite of ammonia may be prepared by the same processes as the two last-described phosphites. It crystallizes sometimes in long transparent needles, and sometimes in four-sided prisms terminated by four-sided pyramids. It has a very sharp saline taste. It is soluble in two parts of water at the temperature of 60°, and still more soluble in boiling water. When exposed to the air, it attracts moisture, and becomes slightly deliquescent. When distilled in a retort, the ammonia is disengaged partly liquid and partly in the state of gas, holding phosphorus in solution, which becomes luminous when mixed with oxygen gas. Before the blowpipe on charcoal, it boils, and loses its water of crystallization; it becomes surrounded with a phosphorescent light; and bubbles of phosphureted hydrogen gas are emitted, which burn in the air with a lively flame, and form a fine coronet of phosphoric acid vapour. This gas is emitted also when the salt is heated in a small glass bulb, the tube belonging to which is plunged under mercury.

This salt is composed of 26 acid
51 ammonia
23 water

100.

7. Phosphite of ammonia and magnesia. This salt may be formed by mixing together the aqueous solutions of its two component parts. It is sparingly soluble in water, and may be obtained in crystals; but its properties have not been examined with precision.

8. Phosphite of alumina may be prepared by saturating phosphorous acid with alumina, and then evaporating the solution to a proper consistence. It does not crystallize, but forms a glutinous mass, which dries gradually, and does not afterwards attract moisture from the air. Its taste is astringent. It is very soluble in water. When heated, it froths and gives out phosphorus, but it does not readily melt into a globule of glass.

PHOSPHORIC ACID. Phosphorus forms an acid with two different proportions of oxygen: combined with the largest portion of oxygen, it constitutes phosphoric acid, and with the smaller it constitutes phosphorous acid.

1. It may be formed by setting fire to a quantity of phosphorus contained in a vessel filled with oxygen gas. The phosphorus burns with great rapidity, and a great number of white flakes are deposited, which are phosphoric acid in a state of purity. It may be obtained too by heating phosphorus under water till it melts, and then causing a stream of oxygen gas to pass through it by means of a tube. In this case the acid as it forms combines with the water; but the liquid may be evaporated off by the application of heat, and then the acid remains behind in a state of purity. But the usual method of procuring it is, to throw phosphorus in small pieces at a time into hot nitric acid. A violent effervescence takes place, the phosphorus combines with oxygen, and nitrous gas is emitted. After the whole of the phosphorus is acidified, the liquid is to be evaporated to dryness, in order to drive off the remains of nitric acid which may not have been decomposed. This process was first put in practice by Lavoisier. Care must be taken not to apply too much heat, nor to add too much phosphorus at once, and not to have the nitric acid too strong; otherwise the phosphorus takes fire, and usually breaks the vessels in pieces.

2. The acid, thus prepared, may be put into a platinum crucible, and heated to redness to drive off all the water. It is then in a state of purity. It is solid, colourless, and transparent, and not unlike glass in appearance. It reddens vegetable blues; it has no smell: its taste is very acid, but it does not destroy the texture of organic bodies.

When exposed to the open air, it soon attracts moisture, and deliquesces into a thick oily-like liquid, in which state it is usually kept by chemists. When exposed to the fire in a platinum crucible, its water gradually evaporates, and leaves it in the state of a transparent jelly. If the heat is increased it boils and bubbles up, owing to the separation of the remainder of its water accompanied with a small portion of acid. At a red heat it remains in the form of a transparent liquid, and when cooled assumes the form of the purest crystal. In this state it is known by the name of phosphoric glass. This glass is merely phosphoric acid totally deprived of water: It has an acid taste, is soluble in water, and deliquesces when exposed to the air.

The specific gravity of this acid, in a state of dryness, is 2.687; in the state of glass 2.85; in the state of deliquescence 14.

3. This acid is very soluble in water. When in the state of white flakes, it dissolves with a hissing noise similar to that made by red-hot iron plunged into water. When in the state of glass it dissolves much more slowly. The heat evolved during the combination of this acid and water, is much inferior to that evolved when sulphuric acid enters into a similar combination. Phosphoric acid obtained by deliquescence, when mixed with an equal quantity of distilled water, acquired so little heat as to raise the thermometer only one degree, as Mr. Sage observed. Mr. Lavoisier raised the thermometer from 50° to 63°, by mixing phosphoric acid boiled to the consistence of a syrup with an equal quantity of water; and from 50° to 104° when the acid was as thick as turpentine.

4. Oxygen gas has no action on phosphoric acid, whatever is the temperature. Neither is it decomposed or altered by any of the simple combustibles, if we except charcoal; which, though it has no action on it while cold, at a red heat decomposes it completely; carbonic acid is formed, and phosphorus sublimed. This is the common process for obtaining phosphorus.

5. Neither of the simple incombustibles has any particular action on it.

6. This acid, when in a liquid state, is capable of oxidizing some of the metals, especially when assisted by heat; at the same time hydrogen gas is emitted. Hence we see that the oxidizement is owing to the decomposition of water. In this manner it oxidizes iron, tin, lead, zinc, antimony, bismuth, manganese; but on some of these it acts very slowly. When fused with several of these metals, as tin, iron, and zinc, it is converted into phosphorus; a proof that they have a stronger affinity for oxygen.

It does not act upon gold, platinum, silver, copper, mercury, arsenic, cobalt, nickel. It appears, however, to have some action on gold in the dry way, as it is called; for when fused with gold-leaf it assumes a purple colour, a proof that the gold has been oxidized.

7. Phosphoric acid combines with alkalies, earths, and metallic oxides, and forms with them salts known by the name of phosphats.

8. Its affinities are as follow:

Barytes,
Strontian,
Lime,
Potass,
Soda,
Ammonia,
Magnesia,
Glucina,
Alumina,
Zirconia,
Metallic oxides,
Silica.

9. The component parts of this acid have been ascertained in a more satisfactory manner than almost any other chemical compound. Mr. Lavoisier proved, that 45 parts of phosphorus, when burnt in oxygen, absorbed about 69.375 parts of that gas, and produced about 114 parts of phosphoric acid Hence it follows that this acid is composed of about

60	oxygen
40	phosphorus
100,	

or 3 parts oxygen to 2 parts of phosphorus.

This acid is too expensive to be brought into common use. If it could be procured at a cheap rate, it might be employed with advantage, not only in several important chemical manufactures, but also in medicine, and perhaps even in domestic economy.

PHOSPHOROUS ACID: the acid obtained by the burning of phosphorus differs according to the rapidity of the combustion; or, which is the same thing, according to the temperature in which the process is conducted. When heated to 141° it burns rapidly, and the product is phosphoric acid: when allowed to burn gradually, at the common temperature of the air, the product is phosphorous acid, which contains a smaller proportion of oxygen. The difference between these two acids had been remarked by Sage, by Proust, and by Morveau; but it was Lavoisier who first, in 1777, demonstrated that they form different compounds with other bodies, and that the difference between them is owing to the different proportions of oxygen which they contain.

1. Phosphorous acid is prepared by exposing phosphorus during some weeks to the ordinary temperature of the atmosphere. Even in winter the phosphorus undergoes a slow combustion, and is gradually changed into a liquid acid. For this purpose, it is usual to put small pieces of phosphorus on the inclined side of a glass funnel, through which the liquor which is formed drops into the bottle placed to receive it. From one ounce of phosphorus about three ounces of acid liquid may be thus prepared.

2. Phosphorous acid, thus prepared, is a viscid liquid, of different degrees of consistence, adhering like oil to the sides of the glass vessel in which it is contained. It emits the smell of garlic, especially when heated. Its taste is acid, like that of phosphoric acid, and it produces the same effect upon vegetable colours. Its specific gravity has not been determined.

3. It combines with water in every proportion; but it cannot, like phosphoric acid, be obtained in a concrete state.

When heated, part of the water which it contains is at first evaporated. When large bubbles of air rise to the surface, there they break, and emit a dense white smoke, or even take fire if the experiment is performed in an open vessel. The emission of these bubbles of phosphureted hydrogen gas continues for a long time. When the process is finished, the acid which remains is no longer phosphorous, but phosphoric acid. These phenomena would lead one to suspect that phosphorous acid is not, as has been hitherto supposed, a compound of phosphorus and oxygen; but that it is phosphoric acid saturated with phosphureted hydrogen gas.

4. This acid is converted into phosphoric acid by exposure to air or oxygen gas. The process is exceedingly slow, and the conversion is never complete. It succeeds better when the acid is diluted with a great proportion of water.

5. Phosphorous acid is not acted upon by any of the simple combustibles except charcoal, and perhaps also hydrogen. Charcoal decomposes it at a red heat as well as phosphoric acid. The products are carbonic acid and phosphorus. It does not act on the simple incombustibles.

6. Its action on metals is exactly similar to that of phosphoric acid, excepting only that the hydrogen gas evolved during the oxydisement of the metals has a fetid smell, and holds phosphorus in solution.

7. It combines with alkalies, earths, and metallic oxides, and forms compounds distinguished by the name of phosphites.

8. Sulphuric acid produces no change upon it while cold; but at a boiling heat it parts with some of its oxygen, and the phosphorous acid is converted into phosphoric. Nitric acid also, when assisted by heat, converts it readily into phosphoric acid. This furnishes us with by far the best process for obtaining phosphoric acid at present known.

9. The affinities of phosphorous acid, as ascertained by Bergman, Fourcroy, and Vauquelin, observe the following order:

Lime,
Barytes,
Strontian,
Potass,
Soda,
Ammonia,
Glucina,
Alumina,
Zirconia.

This acid has not hitherto been put to any use. The history of its preparation is sufficient to convince us, that it is composed of the same constituents as phosphoric acid: but the exact proportion of these constituents has not hitherto been ascertained.

PHOSPHORUS, in chemistry, a combustible substance remarkable for its strong attraction for oxygen, and which consequently spontaneously inflames in the open air at a moderate temperature.

History of its discovery. It was accidentally discovered by Brandt, a chemist of Hamburgh, in the year 1669, as he was attempting to extract from human urine a liquid capable of converting silver into gold. He showed a specimen of it to Kunkel, a German chemist of considerable eminence, who mentioned the fact as a piece of news to one Kraft, a friend of his at Dresden. Kraft immediately repaired to Hamburgh, and purchased the secret from Brandt for 200 dollars, exacting from him at the same time a promise not to reveal it to any other person. Soon after he exhibited his phosphorus publicly in Britain and France, expecting doubtless that it would make his fortune. Kunkel, who had mentioned to Kraft his intention of getting possession of the process, being vexed at the treacherous conduct of his friend, attempted to discover it himself; and about the year 1674 he succeeded, though he only knew from Brandt that urine was the substance from which phosphorus had been procured. Accordingly he is always reckoned, and deservedly too, as one of the discoverers of phosphorus.

Boyle likewise discovered phosphorus, and revealed the process to Godfrey Hankwitz, a London apothecary, who continued for many years to supply all Europe with phosphorus. Hence it was known to chemists by the name of English phosphorus.

Phosphorus may be procured by the following process: Let a quantity of bones be burnt, or, as it is termed in chemistry, calcined, till they cease to smoke, or to give out any odour, and let them afterwards be reduced to a fine powder. Put 100 parts of this powder into a bason of porcelain or stone ware, dilute it with four times its weight of water, and then add gradually (stirring the mixture after every addition) 40 parts of sulphuric acid. The mixture becomes hot, and a vast number of air-bubbles are extricated. Leave the mixture in this state for 24 hours; taking care to stir it well every now and then with a glass or porcelain rod, to enable the acid to act upon the powder.

The whole is now to be poured on a filtre of cloth; the liquid which runs through the filtre is to be received in a porcelain bason; and the white powder which remains on the filtre, after pure water has been poured on it repeatedly, and allowed to strain into the porcelain bason below, being of no use, may be thrown away.

Into the liquid contained in the porcelain bason, which has a very acid taste, sugar of lead, dissolved in water, is to be poured slowly; a white powder immediately falls to the bottom: the sugar of lead must be added as long as any of this powder continues to be formed. Throw the whole upon a filtre. The white powder which remains upon the filtre is to be well washed, allowed to dry, and then mixed with about one-sixth of its weight of charcoal-powder. This mixture is to be put into an earthenware retort. The retort is to be put into a sand-bath, and the beak of it plunged into a vessel of water, so as to be just under the surface. Heat is now to be applied gradually till the retort is made red-hot. A vast number of air-bubbles issue from the beak of the retort, some of which take fire when they come to the surface of the water. At last there drops out a substance which has the appearance of melted wax, and which congeals under the water. This substance is phosphorus.

Properties. 1. Phosphorus, when pure, is semitransparent, and of a yellowish colour; but when kept some time in water, it becomes opaque externally, and then has a great resemblance to white wax. Its consistence is nearly that of wax; it may be cut with a knife, or twisted to pieces with the fingers (a dangerous process). It is insoluble in water. Its mean specific gravity is 1.77.

2. It melts at the temperature of 99°. Care must be taken to keep phosphorus under water when melted; for it is so combustible, that it cannot easily be melted in the open air without taking fire. When phosphorus is newly prepared, it is always dirty, being mixed with a quantity of charcoal-dust and other impurities. These impurities may be separated by melting it under water, and then squeezing it through a piece of clean shamoy-leather. It may be formed into sticks, by putting it into a glass funnel with a long tube, stopped at the bottom with a cork, and plunging the whole under warm water. The phosphorus melts, and assumes the shape of the tube. When cold, it may be easily pushed out with a bit of wood. If air is excluded, phosphorus evaporates at 219°, and boils at 554°.

3. When phosphorus is exposed to the atmosphere, provided the temperature is not lower than 43°, it emits a white smoke, which has the smell of garlic, and is luminous in the dark. This smoke is more abundant the higher the temperature is, and is occasioned by the gradual combustion of the phosphorus, which at last disappears altogether.

4. When a bit of phosphorus is put into a glass jar filled with oxygen gas, part of the phosphorus is dissolved by the gas at the temperature of 60°; but the phosphorus does not become luminous unless its temperature is raised to 80°. Hence we learn, that phosphorus burns at a lower temperature in common air than in oxygen gas. This slow combustion of phosphorus, at the common temperature of the atmosphere, renders it necessary to keep phosphorus in phials filled with water. The water should be previously boiled to expel a little air, which that liquid usually contains. The phials should be kept in a dark place; for when phosphorus is exposed to the light, it soon becomes of a white colour, which gradually changes to a dark brown. When thus altered, the French chemists give it the name of oxide of phosphorus; supposing it now to be no longer pure phosphorus, but phosphorus combined with a little oxygen. Phosphorus, when newly prepared, always contains some of this oxide of phosphorus mixed with it; but it may be easily separated by plunging the mass into water heated to about 100°. The phosphorus melts, while the oxide remains unchanged, and swims upon the surface of the melted phosphorus.

5. When heated to 148°, phosphorus takes fire and burns with a very bright flame, and gives out a great quantity of white smoke, which is luminous in the dark; at the same time it emits an odour which has some resemblance to that of garlic. It leaves no residuum; but the white smoke, when collected, is found to be an acid.

On examining the acid produced during the combustion of phosphorus, it is found that it is a peculiar acid, now known by the name of phosphoric acid, which see.

The combustion of phosphorus, like that of sulphur, is nothing else than its combination with oxygen: for during the process no new substance appears, except the acid, accompanied indeed with much heat and light.

6. Phosphorus combines readily with sulphur, and the two substances are capable of being mixed in different proportions. Seventy-two grains of phosphorus and nine of sulphur, when heated in about four ounces of water, melt with a gentle heat. The compound remains fluid till it is cooled down to 77°, and then becomes solid. These substances were combined in the same manner in the following proportions:

4 Phosphorus, 1 Sulphur	congeals at 59°
4 Phosphorus, 2 Sulphur	- - at 50°
4 Phosphorus, 4 Sulphur	- - at 41°
4 Phosphorus, 12 Sulphur	- - at 99°.

When the phosphorus predominates, this compound is called phosphuret of sulphur; when the sulphur exceeds, it is called sulphuret of phosphorus.

Phosphorus and sulphur may be combined also by melting them together without any water; but the combination takes place so rapidly, that they are apt to rush out of the vessel if the heat is not exceedingly moderate.

7. Phosphorus is capable likewise of combining with many other bodies; the compounds produced are called phosphurets, which see.

8. Phosphorus, when used internally, is poisonous. In very small quantities (as one-fourth of a grain), yet when very minutely divided, it is said by Leroi to be very efficacious in restoring and establishing the force of young persons exhausted by sensual indulgence.

The affinities of phosphorus have not yet been ascertained.

PHOSPHURETS, substances formed by an union of the alkalies, earths, and metallic oxides, with phosphorus. Thus we have phosphuret of lime, &c.

PHOSPHURET *of Antimony.* When equal parts of antimony and phosphoric glass are mixed together with a little charcoal-powder, and melted in a crucible, phosphuret of antimony is produced.

PHOSPHURET *of Barytes* may be formed by putting a mixture of phosphorus and barytes into a glass tube close at one end, and heating the mixture by putting the tube upon burning coals. These instances will be sufficient to explain the nature of phosphurets in general.

PHOTINIANS, a sect of Christians in the fourth century, so called from Photinus, their chief, who was bishop of Sirmich, and maintained that Jesus Christ was true man, but not true God, nor born before all ages; and that he only began to be Christ when the Holy Spirit descended upon him in the river Jordan.

PHOTOMETER, *Measurer of Light*, in a cloudy or bright day, or between different luminous bodies. A good instrument of this kind is still a desideratum in philosophy.

PHRASE, in grammar, a manner of speech peculiarly adapted to certain occasions, arts, languages, &c.

PHRENETIC VESSELS. See ANATOMY.

PHRENSY. See MEDICINE.

PHRYGANEA, a genus of insects of the order neuroptera. The generic character is, mouth without teeth, with four feelers; stemmata three; antennæ longer than thorax; wings incumbent, the lower pair pleated.

The genus phryganea consists of insects which in point of habit or general appearance bear a considerable resemblance to some of the phalænæ, and particularly to those belonging to the division entitled tineæ. They may however be readily distinguished from moths by their palpi or feelers, as well as by the stemmata situated on the top of the head. The phryganeæ proceed from aquatic larvæ of a lengthened shape, residing in tubular cases, which they form by agglutinating various fragments of vegetable substances, particles of gravel, &c. &c. These tubular cases are lined within by a tissue of silken fibres, and are open at each extremity. The included larvæ, when feeding, protrude the head and fore parts of the body, creeping along the bottom of the waters they inhabit, by means of six short and slender legs: on the upper part of the back, in most species, is situated an upright papilla or process.

serving as a kind of prop or stay, preventing the case or tube from slipping too forwards during the time the animal is feeding.

Of the European phryganeæ, one of the largest is the phryganea grandis of Linnæus, usually measuring somewhat more than an inch in length, and having very much the general aspect of a phalæna: the upper wings are grey, marked by various darker and lighter streaks and specks, and the under wings yellowish-brown and semitransparent. The larva, which measures near an inch and three quarters in length, is of a flesh-coloured grey, with brown head and legs, and inhabits a tube composed of pieces of bark, small fragments of grass-stalks, or other substances. Like other larvæ of this genus, it is known by the name of cadew-worm, or cad-bait, and is frequently used by anglers as a bait. When arrived at full growth, it fastens the case or tube by several silken filaments to the stem of some water-plant, or other convenient substance, in such a manner as to project a little above the surface of the water; and casting its skin, changes to a chrysalis of a lengthened shape, and displaying the immature limbs of the future phryganea, which in the space of about fourteen days emerges from its confinement.

Phrygania rhombica is a smaller species than the former, and is of a yellowish-brown colour, with two obliquely transverse rhomboid semitransparent white spots on each upper wing; the lower wings being whitish, with a tinge of yellow-brown towards the upper edge. The larva forms its case of small pieces of the slender stems of water-grasses or other plants, curiously disposed in an obliquely transverse direction. It is of a greenish-brown colour, and like the former, is found in rivulets and stagnant waters. The larvæ of the phryganeæ in general feed not only on the smaller water-insects, but on the spawn of fishes, and even on the young fry itself. There are twenty-four species.

PHRYMA, a genus of the didynamia gymnospermia class and order. The essential character is, seed one. There are two species, herbs of North America and the Cape.

PHRYNIUM, a genus of the monandria monogynia class and order. The calyx is three-leaved; petals three, equal; nectarine; tube filiform; border four-parted; capsule three-celled; nuts three. There is one species, a plant of Malabar.

PHTHISIS. See MEDICINE.

PHYGETHLON, in surgery, a broad, but not much elevated tumour, of the same nature with the bubo. See the article BUBO.

PHYLACTERY, in antiquity, a charm or amulet, which being worn, was supposed to preserve people from certain evils, diseases, and dangers. The Jews were remarkable for wearing phylacteries of parchment, in the form of slips or rolls, wherein were written certain passages of the law: these they wore upon their foreheads, and upon the wrists of their left arms. The modern Jews think themselves under no obligation to this practice, which they observe only at morning prayers.

PHYLACHNE, a genus of the diœcia monandria class and order. The calyx is three-leaved, superior; corolla funnel-form; fem. stigma four-cornered; capsule inferior, many-seeded. There is one species, a small mossy plant of South America.

PHYLICA, *bastard alaternus*, a genus of the monogynia order, in the pentandria class of plants; the perianthium five-parted, turbinate; petals none; capsule tricoccous. There are twenty species, of which three are commonly kept in the gardens of this country; but being natives of warm climates, they require to be kept in pots, and housed in winter. They are all shrubby plants, rising from three to five or six feet high, and adorned with beautiful clusters of white flowers. They are propagated by cuttings.

PHYLLANTHUS, *sea-side laurel*; a genus of the triandria order, in the monœcia class of plants. The male calyx is six-parted, bell-shaped; no corolla; female calyx six-parted; styles three, bifid; capsules three-celled; seeds solitary, roundish. There are eleven species, all of them natives of warm climates; and rise from twelve or fourteen feet to the height of middling trees. They are tender, and cannot be propagated in this country without artificial heat.

PHYLLIS, a genus of the pentandria digynia class and order. The stigmas are bispid, fructifications scattered; cal. two-leaved, obsolete; corolla five-petalled; seeds two. There is one species, a herb of the Canaries.

PHYSALIS, the *winter cherry*, a genus of the monogynia order, in the pentandria class of plants. The corolla is wheel-shaped; stamina converging; berry within an inflated calyx, two-celled. There are seventeen species, of which the most remarkable is the alkekengi, or common winter-cherry. This grows naturally in Spain and Italy. The flowers are produced from the wings, standing upon slender footstalks; they are of a white colour, and have but one petal. They are succeeded by round berries about the size of small cherries, inclosed in an inflated bladder, which turns red in autumn; when the top opens and discloses the red berry, which is soft, pulpy, and filled with flat kidney-shaped seeds. The plant is easily propagated, either by seeds, or parting the roots; and is very hardy.

PHYSETER, CACHALOT, a genus of fishes of the order cete. The generic character is, teeth visible in the lower jaw only; spiracle on the head or snout. 1. Physeter macrocephalus, blunt-headed cachalot. This whale, which is one of the largest species, is scarcely inferior in size to the great mysticete, often measuring sixty feet or more in length. The head is of enormous size, constituting more than a third of the whole animal; the mouth wide; the upper lip rounded, thick or high, and much broader than the lower; which is of a somewhat sharpish form, fitting, in a manner, into a longitudinal bed or groove in the upper. The teeth, at least the visible ones, as mentioned in the generic character, are situated only in the lower jaw; and when the mouth is closed, are received into so many corresponding holes or cavities in the upper: they are pretty numerous, rather blunt, and of a somewhat conic form, with a very slight bend or inclination inwards. There are also, according to Fabricius, small, curved, flattish, concave, and sharp-pointed teeth, lying almost horizontally along the upper jaw; though, from their peculiar situation and size, they are not visible like those of the lower; being imbedded in the fleshy interstices of the holes which receive the lower teeth, and presenting only their internal concave surfaces to meet the latter when the mouth is closed. The front of the head is very abrupt, descending perpendicularly downwards; and on its top, which has been improperly termed the neck by some authors, is an elevation or angular prominence containing the spiracle, which appears externally simple, but is double within. The head is distinguished or separated from the body by a transverse furrow or wrinkle. The eyes are small and black; and the ears or auditory passages extremely small. About the middle of the back is a kind of spurious fin, or dorsal tubercle, of a callous nature, not moveable, and somewhat abrupt or cut off behind. The tongue is of the shape of the lower jaw, clay-coloured externally, and of a dull red within. The throat is but small in proportion to the animal. The body is cylindrical beyond the pectoral fins, growing narrower towards the tail. The colour of the whole animal is black, but when advanced in age grows whitish beneath. It swims swiftly, and is said to be a violent enemy to the squalus carcharias, or white shark, which is sometimes driven ashore in its endeavours to escape, and according to Fabricius, will not venture to approach its enemy, even when dead, though fond of preying on other dead whales. This whale also devours the cyclopterus lumpus, or lump-fish, and many others. The Greenlanders use the flesh, skin, oil, tendons, &c. in the same manner as those of the narwhal. It is reckoned very difficult to take, being very tenacious of life, and surviving for several days the wounds it receives from its pursuers.

It is in a vast cavity within the upper part of the head of this whale, that the substance called spermaceti is found, which, while fresh and in its natural receptacle, is nearly fluid; but when exposed to the air, concretes into opake masses: this substance being so universally known, it becomes unnecessary to describe it farther.

A more curious and valuable production, the origin of which had long eluded the investigation of naturalists, is obtained from this animal, viz. the celebrated perfume called ambergris, which is found in large masses in the intestines, being in reality no other than the fæces.

2. Physeter catodon, small cachalot. This species is of far inferior size to the former, measuring about twenty-five feet in length. In its general structure, it is allied to the preceding, but has a smaller mouth in proportion, and is without any visible protuberance on the back. It is found in the northern seas.

3. Physeter microps, small-eyed cachalot. This is of equal, and sometimes even superior size to the first-described species, and is a native of the northern seas. The head is very large, and nearly half the length of the body: the eyes extremely small, and the snout slightly obtuse: on the back is a long and somewhat upright narrow and pointed fin. This species swims swiftly, and is said to be a great enemy to the porpoise, which it pursues and preys upon. Its colour is blackish above, and whitish beneath. Some of the supposed varieties of this whale are said to grow to the length of eighty or a hundred feet. The teeth are of a more curved form than the rest of the genus.

Physeter tursio, high-finned cachalot. This is particularly distinguished by the great length and narrow form of its dorsal fin, which is placed almost upright on the back, and is said by some authors to appear at a distance like the mast of a small ship; the animal growing, if we may believe report, to the length of a hundred feet. In its general appearance it is said much to resemble the former species, of which it may perhaps be a variety rather than truly distinct; but so much obscurity still prevails with respect to the cetaceous animals, that this point must be considered as very doubtful.

PHYSICIANS. No person within London, nor within seven miles of the same, shall exercise as a physician or surgeon, except he is examined and approved by the bishop of London, or by the dean of St. Paul's, calling to them four doctors of physic, and for surgery, other expert persons in that faculty, of them that have been approved; upon the pain of forfeiture for every month 5*l.* one half to the king, and the other half to any that will sue. 3 H. VIII. c. 11.

One that has taken his degree of doctor of physic in either of the universities, may not practise in London, and within seven miles of the same, without licence from the college of physicians. And it has been held, that if a person, not duly authorized to be a physician or surgeon, undertakes a cure, and the patient dies under his hands, he is guilty of felony; but he is not excluded from the benefit of clergy.

PHYSICS, called also physiology, and natural philosophy, is the doctrine of natural bodies, their phenomena, causes, and effects, with their various affections, motions, operations, &c. So that the immediate and proper objects of physics, are body, space, and motion.

PHYSIOLOGY is a word which, in its etymological signification, comprehends the science of nature in general; modern use, however, has restricted it to that department of physical knowledge which has alone relation to organic existence; and, indeed, when employed as a generic term, without any specific indication, it is made exclusively to denote the science of animal life. Naturally organized bodies are those which have "an origin by generation, a growth by nutrition, and a termination by death." In endeavouring, however, to mark the precise distinction between living or organic, and matter which is inanimate or destitute of vitality, it will be found of considerable import to ascertain the prime characteristic of either, or that to which all other laws influencing them act in subordination.

It is indivisibility, or mutual connection of parts with the whole, which appears to constitute the essential character of a living organized body. "The mode of existence in each part of inanimate matter belongs to itself, but in living bodies it resides in the whole." Separate a single branch from a tree in the full vigour of vegetation, and the part thus separated shall immediately droop, and shall shortly die; that is, it will cease to be influenced as formerly by air, heat, and other powers which support vegetation; will no longer display those phenomena which had previously resulted from the agency of such powers; will become, in the language of the Brunonian philosophy, unexcitable, and subject to the government of new laws. In the animal creation, also, the same effect will result from the same process: if a limb is separated from an animal body, the life of such limb, without any apparent injury to its organization, will be inevitably destroyed. Supposing we have thus reduced organic to inorganic, living to dead matter, in an animal body, for instance, let us pursue our experiments on the material thus changed; let the part to which we have given a new mode of existence be itself divided, and we shall now find nothing of the like result, as in the first process, to take place; its quality by this last operation will only be altered inasmuch as its quantity is diminished. Each part will be found to have a separate and independant existence. There has been no connecting integral principle interfered with; and, placed exactly under the same external circumstances, an identity in the mode of existence would be retained to the end of time by each division. Let us pursue our experiments still further. Let us subject the two parts to a difference of external circumstance; enclose one in an atmosphere of 40° of heat, the other in 100°, and the consequence will be a deprivation of that identity which till now they had retained. Each part will not continue the same mass of dead matter, but will assume a new character. Now it will be evident that in these experiments we have operated an essential change; and in each, of an essentially different nature. By seperating a part from the whole of an organic body, we effect the loss of its vitality, even though such external agents shall continue to be applied as previously operated its life and growth. By a further mechanical separation we do not effect an alteration in quality, in any other way than as this will depend on quantity, until we occasion a change in exterior agents; by which change, however, we finally ensure an actual alteration of principle or composition, as well as of aggregate power.

We have thus endeavoured to illustrate the simple and prime characteristic of organic as separated from inorganic being. But physiology we have said, according to the general acceptation of the word, confines its researches to animal life; what this last has peculiar to itself, it will be proper further to state. The usual division of organized existence is into animal and vegetable; the former possessing those faculties from which result sensation and loco-motion; the latter being destitute of such faculties: an opinion indeed has recently been hazarded that such division is unfounded and artificial; that vegetable and animal life are subject to the same laws; that plants are not merely organized, but animalized; that their motions indicate sensation and consequent volition. To enquire into the grounds of these assumptions, does not fall within the province of the present article; we are to take for granted the negative of the proposition, and proceed to consider first, the primary faculties, and secondly, the resulting functions, of those existences which are universally acknowledged to be possessed of the powers of feeling and of motion, and are truly and evidently animalized.

Of Sensibility, Irritability, and the Vital Principle.

Sensibility has been defined, the faculty which organs have of feeling; the aptitude they possess of perceiving, by the contact of an extraneous body, an impression more or less powerful, which changes the order of their motions, accelerates or retards, suppresses or completes them. "This faculty," says the author from whom we have taken the definition (M. Richerand), "generally diffused in our organs, does not exist in all to the same degree. In some it is obscure and scarcely apparent, and seems reduced to a degree absolutely indispensable for the fluids to determine the actions necessary to the functions they ought to perform. It should seem that no part of the body can do without this sensibility absolutely necessary for life. Without it, how could various organs act upon the blood, to draw from it the means of their nutrition, or materials for the different secretions? Therefore this degree of sensibility is common to every thing which has life; to animals and vegetables; to a man when asleep and awake; to the fœtus, and the infant; to the organs of assimilating functions; and to those which put us on a level with surrounding beings. This low degree of sensation could not have been sufficient for the existence of man, and of beings resembling him, exposed to numerous connections with every thing that surrounds them; therefore they possess a sensibility far superior, by which the impressions affecting certain organs are perceived, judged, compared, &c. This sort of sensibility would be more properly called perceptibility, or the faculty of judging of the motions experienced. It requires a centre to which the impressions have a mutual relation; therefore it only exists in animals which, like man, have a brain, or something equivalent in its place; whilst zoophytes and vegetables, not possessing this central organ, are both destitute of this faculty; however, polypi, and several plants, as the sensitive, have certain spontaneous motions, which seem to indicate the existence of volition, and consequently of perceptibility; but these actions, like that of a muscle from the thigh of a frog excited by the galvanic stimulus, are occasioned by an impression that does not extend beyond the part itself, and in which sensibility and contractility exist in a confused state." Elements of Physiology by A. Richerand, translated edition.

By the above definition and description of simple sensibility, as opposed to perceptibility, it will appear that our author does not consider sensation as the necessary consequence of the faculty which he terms sensibility.

The author, however, whom we have quoted, admits that this kind of latent and imperceptible sensibility "cannot be exactly compared to that of vegetables, since the parts in which it resides, generally possessing such a small share of sensibility in a state of health, have an increased or percipient degree of sensibility when in a state of disease;" and after giving examples of this, he adds, "should it not be suspected that if we have not a consciousness of impressions made upon our organs by the fluids contained in them during health, it is from our being accustomed to the sensations they excite almost uninterruptedly, of which we have only a confused perception, that terminates imperceptibly? And may we not be permitted in this point of view to compare these organs to those in which reside the senses of vision, hearing, smell, taste, and feeling, which can no longer be excited by habitual stimuli to which they have been long accustomed?" We find, however, some difficulty in admitting this principle even with the modification proposed. If sensibility becomes in this manner latent, or we cease to take cognizance of such functions as are exercised independantly of the will merely by the force of habit, does it not follow that the origin of these functions, at least in their aggregate, would have been accompanied by more sensation than is consistent with the healthy state? Thus the moment an animal became conscious of existence, it would be the subject of impression sufficiently violent to destroy, or at least to derange life. Does it not appear that involuntary living action results from a principle dissimilar to that which is preceded by sensation; and that the sensibility here spoken of is a kind of intermediate faculty between that which gives sensation and volition, and that upon which muscular irritation or contraction from stimuli depends? When the galvanic experimenter excites actions in the muscles on the insulated thigh of a frog, it cannot be supposed that such actions are attended by perception (for, as it has been properly observed by M. Cuvier, "it appears repugnant to the notions we entertain of self, and of the unity of our being, to admit the possession of sensation by these fragments"); although the actions are excited through the medium of nervous excitability, and are of a different nature from those which would follow a mere irritation of the muscular fibre. May we not then conclude that the nervous organization is endowed with a susceptibility independantly of actual, or what M. Richerand perhaps improperly denominates percipient, sensibility; and that it is through the medium of this faculty that the incessant and unperceived performance of the vital functions is accomplished? When the voluntary faculty ceases to acknowledge its accustomed and appropriate stimuli; when sensation for a time is totally suspended, as in apoplexy, or in experiments on frogs by pouring opium on the brain of these animals; the functions of vitality are still preserved by means of the susceptibility now alluded to. We have elsewhere endeavoured to prove that convulsive agitation, whether taking place in the muscles of volition, or in those organs which are independant of the will, results from deficient or transient excitement (see MEDICINE, section *Nervous Diseases*); and such defective excitement seems to result from an unhealthy condition of this nervous susceptibility, which, in instances of sudden death produced by an abrupt and entire abolition of the sentient and loco-motive faculty, for some time longer lingers in the system, deranged indeed, but not yet destroyed, and produces those spasmodic motions which are observed in an animal body under the circumstances which we are now supposing. When, for instance, a domestic fowl is deprived of life, either by its head being severed from its body, or by the more common mode of screwing the neck, a spasmodic convulsive kind of vellications will be observed, and indicate the remains of this susceptibility of action, for some time after perception or actual sensation is gone. If the principle now contended for is admitted, our compassion for the animal in this state would be misapplied; and it must likewise follow that the notion which has been maintained by some is altogether erroneous, of death from decapitation being a lingering, and therefore cruel, mode of terminating existence. In the case, however, of articulated worms, a like separation of parts does not appear to operate the same immediate destruction of the sensitive and loco-motive faculty; for as in them there is no single brain, but ganglia, as the centres of sensation and commencing points of volition. Each part of a divided worm is thus a distinct living and sentient being. From the remains of this principle of susceptibility may originate those convulsive affections which almost invariably precede death in the course of nature, and which are oftentimes exhibited in a violent degree for some time posterior to the departure of the sentient or perceiving faculty; but which last is itself destroyed prior to the total destruction of muscular irritability, or the vis insita of Haller. This last (Hallerian irritability) is denominated by modern physiologists, contractility. As actual sensation is demonstrably produced through the medium of nerve, so "the general organ of motion is the fleshy or muscular fibre. This fibre contracts itself by volition, but the will only exercises this power through the medium of the nerves. Every fleshy fibre receives a nervous filament, and the obedience of the fibre ceases when the communication of that filament with the rest of the system is interrupted. Certain external agents applied immediately to the fibre likewise cause contractions, and they preserve their action upon it even after the section of its nerve, or its total separation from the body, during a period which is longer or shorter in different species of animals. This faculty of the fibre is called its irritability. Does it in the latter case depend upon the portion of the nerve remaining in the fibre after its section, which always forms an essential part of it? or is the influence of the will only a particular circumstance, and the effect of an irritating action of the nerve on a faculty inherent in the muscular fibre? Haller and his followers have adopted the latter opinion; but every day seems to add to the probability of the opposite theory."—Cuvier's Comparative Anatomy.

If, however, we resort to analogy, which, in the present state of our knowledge with respect to the composition of muscular fibre, is all the aid with which we are furnished to solve the question of distinct or separate residences of nervous and muscular power, we should perhaps be compelled to revert to something like the Hallerian doctrine of a vis insita, or independant excitability, and conclude that the nerves are merely instruments by which the faculty of contractility is developed, and that this faculty may otherwise be produced by extraneous stimuli, without the interference of the nerves. Many plants are possessed of contractile, although not (as it appears) of actually sensitive and loco-motive power: this contractility, from the mode of its excitation, and from the phenomena which it exhibits, seems in every way similar to the irritability of the animal fibre, nevertheless neither brain nor nerves have hitherto been detected in vegetables. The attempts to prove that irritability and sensibility are one, seem to proceed from the general tendency observed in the philosophy of the present period, to strain the analogy between vegetable and animal life. M. Delametherie, a French physiologist, carries this doctrine to the extent of denying the existence in toto of any distinct muscular fibre. The substance which has been ordinarily considered to be muscle, he considers as "a congeries of blood-vessels, lymphatics, and nervous filaments, bound together by cellular membrane, in the interstices of which are deposited animal gelatine and fat." Considerations sur les Etres organisés, &c.

It appears to us, however, that sensibility and irritability, although intimately connected, and never separate in a living animal body, are yet distinct principles; at least, that more and stronger facts than have hitherto been advanced, are requisite to the full establishment of the modern doctrine, "that they are in effect the same property."

Irritability, or the power of contraction upon the application of stimuli, has been divided into two species; the one has been named by some physiologists the tonic power, the other musculosity: this difference, however, rather refers to the difference of exciting power, by which is called into action the one and the other; "the slow, gradual, and tonic-like action of the bladder in expelling the urine," seems principally to vary from that of the voluntary muscles by being more beyond the influence and caprices of the will.

The most remarkable characteristic both of sensibility and irritability (forming together vital excitability) is, that as they are subservient to different purposes, and resident in various organs, they are susceptible of developement or excitation, by peculiar and respective agents. Thus light is a stimulus to the eye, sound to the ear, a sapid substance to the taste, and an odoriferous body the smell. Thus mercury will stimulate the hepatic, foxglove the renal viscus, although in each instance the indivisible faculties of sensibility or irritability are called into play; and no difference indicating peculiar excitability can be traced by the anatomist in the arrangement, or the chemist in the composition, of the ultimate fibrillæ constituting either the nerves or the contractile organs of these respective parts.

The animal frame is thus supported in the same manner as a piece of complicated machinery, composed of several springs, each of which is kept in exercise by a principle peculiar to itself, while the combined effect of them all is one resulting whole, effected by one prime and operating principle; this, in the living machine, is named the vital principle, of which we are now to speak.

Researches into the nature and cause of living actions, appear to have been impeded by errors arising from different, and in one sense, opposite sources; the one of old, the other of modern date. The earliest philosophers could not have been long in observing, while contemplating the phenomena of life, "that it exhibits an order of truths peculiar to itself, which is no where to be found beyond the sphere of living existence." (Dumas.) Before the proper boundaries were discovered of human research, and the true nature of philosophizing ascertained, these phenomena were accounted for by the supposition of an occult agency endowed with intelligence, and acting with design; hence the origin of the vague terms archæus, or presiding power, vis naturæ medicatrix, nature, and other expressions, the inventors of which do not appear to have been conscious that they not merely amount to a confession of ignorance, but mislead the judgment by attaching it to certain preconceived systems framed from ideal knowledge. It is the province of philosophy not to imagine but to infer. When it is observed, that life in all its modifications and stages, requires for its developement and maintenance the incessant agency of peculiar powers on matter peculiarly constructed, as in the experiments before alluded to, we are not merely justified in concluding, but we are irresistibly impelled to the inference, that the combination of effects to which we have applied the term life results from such agency on such organized matter. The nature of the link which constitutes this connection may for ever be concealed, but the connection itself is demonstrated. The idea of life then is not to be confounded either with the abstract nature of the matter acted upon, or the agents through the medium of which it is produced. "There is no interior independant spring of action or support," there is no exterior abstract power. In the employment then of the term vital principle, we ought to be regarded as simply announcing a fact, not as conveying a notion of cause; and in this view it will appear, contrary even to the sentiments of some authors from whom it is almost temerity to differ, that the passive rather than the active voice of verbs, should be made use of in calculations on vital forces and effects. See the articles BRUNONIAN SYSTEM; and likewise MEDICINE, section *Fever*.

But an error from a different source than that just alluded to, appears to have insinuated itself into the physiology of the present day, viz. that of too hastily registering under one head, facts which both in their origin and result, are of a nature essentially different. We allude to the chemico-animal philosophy which has recently become so prevalent, especially in the French and German schools. Against this physiology we do not think it right to urge the objection which has been advanced, that it encourages materialism, and leads to conclusions destructive of morality; for besides that we doubt the justness of the accusation, it ought always to be recollected, that it is not until physiology terminates, that metaphysic commences.

In consequence of the radical change which has recently been effected in the whole body of chemical science, physiological researches have received a fresh impulse and a new direction. By modern chemistry many facts in the animal economy have been fully developed, which were before concealed. Such, however, is the proneness of mankind to extremes, that in this as in other instances, the auxiliary has been made to usurp the rights of the principal; chemical affinity has been supposed fully explicative of living actions, and the idea of animation being regulated by a distinct principle ridiculed as visionary. We believe, however, the ridicule to have been misapplied; and though equally ready with our modern physiologists to oppose the admission of "an occult cause" as the cause of life, we must still maintain that the attractions of matter, in the mode they contend for, are of a nature very different from those resulting from the agency of the life-producing powers on an organized body. For example: muscular contraction is generated by an abundant variety of external stimuli; among these, oxygen has been found to be one of the most active; the effect of the above agent has been therefore preposterously confounded with the agent itself, oxygen has been imagined to be the principle of irritability, and the developement of life by consequence has been supposed immediately to result from its combination with the animal fibre: with equal justice might opium or any other stimulus be in this manner as it were vitalized.

But it will be urged that the oxygenous theory of life has been abandoned; nor should we perhaps be justified in bringing it to notice, did it not appear that those hypotheses which are at this instant in repute are founded upon precisely the same principles with the conjectures which originated with Dr. Girtanner. Thus it has been inferred that the newly discovered source of nervous excitation operates upon the muscles, by virtue of an attractive power in the muscular fibre for the galvanic fluid, much in the same manner as an acid rushes into combination with an alkali, or as oxygen unites itself with an inflammable base. "I suppose, (says M. Delametherie) that muscular contraction is produced by the heat which accompanies the extrication of the galvanic fluid, upon the same principle that a piece of skin contracts which is brought near the fire, or on which is poured a concentrated acid, a caustic alkali, or any other caustic body."

From such mode of reasoning it has been inferred, that the science of medicine is resolvable into a combination and separation of principles as in the chemist's laboratory; and that life and health are to be preserved and restored in the same manner as a fluid body is made viscid by the introduction of a foreign principle. Thus we have found in the writings of medical systematics of this class the processes described, and the results confidently anticipated, of oxygenating, deoxygenating, hyperoxygenating, and galvanizing, the animal frame.

It is however obvious, that these speculations are fundamentally erroneous; for life and health are built upon a firmer basis than that either of aggregative or chemical attraction. The intimate bond of union between every the most minute portion of a living body, must be severed, the indivisibility of the frame must first be dissolved, in a word life must have deserted the body, before the above powers can be admitted. In what manner, according to the tenets we are now canvasing, could that remarkable property of animal life (caloricité) be preserved, of retaining a regular quantity of interior, amidst all the vicissitudes of exterior, heat? Almost every chemical combination is effected by a variation, and in very many cases, a trivial variation, in temperature; but the living body is capable of sustaining or of resisting heat to a degree which would immediately change animal or vegetable substance deprived of life into substance of a totally different nature.

Life, in the systems we are commenting upon, appears, as before observed, to be confounded with that which produces or elicits life. Vital phenomena are not observed and arranged in their natural and regular sequence; enquiries are instituted from a wrong point; thus, although we even accede to the position of M. Cuvier, "that the living and contracted muscular fibre is not, strictly speaking, the same body, nor composed of the same chemical materials, as the relaxed or inactive fibre," we are not therefore compelled to the alternative of referring the commencement of muscular action to a change of affinity; or with Humboldt and others, to acknowledge that the primary operation of every agent on living matter is virtually an instance of chemical combination.

Let us follow in idea, the influence of the most minute portion of some materials which effect an instantaneous change on every the most distant fibre of the body, we shall often find, for instance, an immediate excitation of all the vital functions, result from their reception into the stomach; now, allowing that the change thus operated occasions an abundance of new combinations strictly chemical, in the fluids and solids, does it therefore follow that the primary impulse on the excitability is a chemical process? if so, how could a similar result be obtained from a cause ab origine mental? or how could the mandates of the will contract the fibre?

Without further enlargement, therefore, (and was it not for the practical importance of the subject, we should conceive an apology already due to the reader,) we trust we may be permitted to conclude, that as the natural philosopher demonstrates a particular quality in bodies to be proportioned to their quantity, and designates this principle by the term gravitation; as the chemist finds the mixture of two different bodies to form a third, and refers it to the affinity of their minute particles; so the physiologist, recognizing the difference of character in the phenomena of life from either of the above modifications of being, makes a separate register or classification of such phenomena, under the comprehensive title of the vital principle; in other words, that "the primary motions of matter (or rather we should say, laws of nature) are capable of division into the three classes of gravitation, chemistry, and life."

In the above sketch we have confined our observations to what may be regarded the great characteristic of living existence, indivisibility; under the immediate influence of which the individual is preserved, and the species propagated; or the secondary faculties are exercised, of assimilation and generation; these faculties we might now proceed to notice; but as they branch out into several functions, it will be more consistent with our limits to refer their consideration to such functions which we are now to describe, together with those resulting from sensibility and irritability, which it was however first necessary to view as in a manner constituent parts of an indivisible whole.

The following table (which we have taken from M. Richerand) presents, perhaps, the most comprehensive and accurate plan which has been formed of vital functions; we shall therefore follow its arrangement, and in instances where these functions have been treated of under separate heads, refer to them under their respective titles.

Plan of a new Classification of the Functions of Life.

- **Class I.** *Functions which serve for the preservation of the individual. (Individual life.)*
  - **Order I.** Functions which assimilate the aliment by which the body is nourished. *(Assimilating, internal, or digestive functions.)*
    - Genus 1. *Digestion* extracts the nutritive part.
      - Reception of the food,
      - Mastication,
      - Solution by the saliva,
      - Deglutition,
      - Digestion in the stomach,
        - duodenum
        - intestines,
      - Excretion of the fæces and urine.
    - Genus 2. *Absorption* carries it into the mass of humours.
      - Inhalation of chyle,
        - lymph,
      - Action of vessels,
        - glands,
        - the thoracic duct,
    - Genus 3. *Circulation* propels it towards the organs.
      - Action of the heart,
        - arteries,
        - capillary vessels,
        - veins.
    - Genus 4. *Respiration* combines it with atmospheric oxygen.
      - Action of the parietes of the thorax,
        - lungs,
      - Alteration of the air,
        - in the blood,
      - Disengagement of animal heat.
    - Genus 5. *Secretion* causes it to pass through several modifications.
      - Exhalation,
      - Secretion by follicles,
        - glands.
    - Genus 6. *Nutrition* applies it to organs, to which it is to supply growth and restore their loss.
      - Different in every part according to the peculiar composition of each.
  - **Order II.** Functions which form connections with surrounding objects. *(External or relative functions.)*
    - Genus 1. *Sensations* inform the being of their presence.
      - Organs of
        - the sight,
        - hearing,
        - smell,
        - taste,
        - feeling.
      - Action of nerves,
        - the brain.
      - Human understanding,
      - Sleep and watching,
      - Dreaming and sleep-walking,
      - Sympathy,
      - Habit.
    - Genus 2. *Motions* approach towards or remove it from them.
      - Organs and muscular motion,
      - The skeleton,
      - Articulations,
      - Place.
      - Progressive motions,
        - Walking,
        - Running,
        - Jumping,
        - Swimming,
        - Flying,
        - Creeping.
    - Genus 3. The *Voice* and *Speech* cause it to communicate with similar beings without change of place.
      - The voice,
        - Articulated, or speech,
        - Modulated, or singing.
      - Stammering,
      - Lisping,
      - Dumbness,
      - Ventriloquism.
- **Class II.** *Functions which serve for the preservation of the species. (Life of the species.)*
  - **Order I.** Functions which require the concurrence of both sexes.
    - *Conception* and *Generation.*
      - General differences of the sexes,
      - Hermaphrodism,
      - Systems relative to generation.
  - **Order II.** Functions which exclusively belong to females.
    - *Gestation.*
      - Of the uterus in a state of impregnation,
      - History of the embryo,
        - fœtus and its membranes,
    - *Delivery.*
      - Of the uterus after delivery,
      - The lochiæ.
    - *Lactation.*
      - Action of the breasts,
      - Milk.
  - **Growth.**
    - Infancy—dentition, ossification,
    - Puberty—menstruation,
    - Adolescence,
    - Youth.

- *Virility.*
  - Temperaments.
    - Sanguine.
    - Muscular,
    - Biliary melancholic,
    - Lymphatic,
    - Nervous.
  - Idiosyncracy.
  - Human race.
    - European,
    - Negro,
    - Mongol,
    - Hyperbolean.
- *Decrease.*
  - Age of decrease.
  - Old age.
  - Decrepitude.
- Death.
- Putrefaction.

Of digestion.

Digestion, or that function by which the dissolution of the aliment is accomplished, and food is thus fitted for the lacteal absorbents, will be found described under the article of Digestion, Vol. I. page 150; and for those varieties in the digestive as of all other organs observed in different animals, the reader is referred to Comparative Anatomy.

Of absorption.

Absorption is that process by which the incessant waste of the system from the various secretions and excretions is constantly repaired. Thus after digestion has converted the aliment into chyle, this fluid is taken up by the lacteals or mesenteric absorbents, undergoes a farther preparation in these vessels, is thence conveyed to the thoracic duct, and at length enters the mass of circulating blood, to furnish the requisite secretions, excretions, and exhalations; in this manner a perpetual change is operated in the materials of which an animal body is composed, "for it should never be forgotten that organized living matter compounds and decompounds itself continually." But this composition and decomposition are perpetually under the influence of fibrous stimulation. "Each orifice of a lacteal and lymphatic, endued with a peculiar degree of sensibility (susceptibility?) and power of contraction, dilates or contracts, absorbs or rejects, according to the mode in which it is affected by substances that are applied to it." Thus when the chyle is applied to the orifices of the lacteal vessels (which have been termed chylous absorbents), it is not solely by means of capillary or any other species of attraction, that this fluid is made to enter its appropriate vessels, but such entrance is gained in virtue of the power possessed by chyle of stimulating these organs; a demonstration of which principle is furnished from those substances being rejected which have not the power of producing that dilatation and contraction just spoken of.

Another curious fact in support of the principle that some substances are not capable of exciting the absorbent vessels, is furnished by those marks which sailors and others are accustomed to imprint on their skin. These are generally formed by first pricking holes in the cuticle, and then rubbing the part over with charcoal or gunpowder, substances which remain undissolved in the fluids, unabsorbed in the lymphatics, and therefore continue through life. Indeed solution is a necessary prelude to every case both of lymphatic and lacteal absorption. It is then by the peculiar action of the lymphatics on exhaled fluids, that lymph is formed; and of the lacteals on the chyle, that this last becomes animalized. Those glandular bodies which are observed in these vessels are supposed to have a very important influence on their contained fluids; and "although it is not known precisely in what these alterations consist of lymph and chyle, it may be said that the object of the glands seems to be, to occasion the most intimate mixture, the most perfect combination of elements; to impress a certain degree of animalization, as proved by the greater concrescibility of lymph taken from the vasa efferentia, or those which pass from glands; to deprive them of mere heterogeneous principles, or, at least, to alter them that they may not become hurtful in passing into the mass of humours." Thus we find, that after absorption has been in the first instance effected by vital action, the contents of the absorbing vessels, still, however, under the same influencing principle, are the subjects of a species of animal chemistry.

As the course of the lymph and the chyle is less rapid than that of the blood, the dilatations, curvatures, and frequent communications of the lymphatics, must considerably obstruct the progress of their contents; but the principal cause of retardation is in the numerous glands just mentioned, which every particle of lymph and chyle has to pass through previously to its entering the blood-vessels.

There are two questions remaining at issue respecting the physiology of the absorbent system: 1st, Whether the distribution of these vessels is universal; and 2d, Whether cutaneous absorption is effected independantly of mechanical violence done to the cuticle. Anatomy has not hitherto detected absorbents in the substance of the brain; but analogy, as well as the circumstances attendant on diseases, disposes us to infer almost with certainty, their existence in every part. The second question, although it has recently been negatived by high authority (Dr. Rousseau, Dr. Currie, M Seguin and others), is generally supposed to be decided in the affirmative. The principal facts in support of the latter opinion are, "the increase of weight in the body after a walk in damp weather, the abundant secretion of the urine after remaining for some time in a bath, the evident swellings of the inguinal glands after long-continued immersion of the feet in water, the effects of mercury administered by friction, the external application of turpentine without friction altering the urine, even when, according to some, its entrance into the system by the lungs had been guarded against, &c." to which Dr. Watson's experiment may be added, of giving a Newmarket jockey, previous to a race, a glass of wine, about an ounce in weight, and finding immediately after the course, he had gained in weight 30 ounces.

Whether actual nutriment is introduced into the system in the way of cutaneous absorption, is perhaps extremely problematical. Dr. Darwin, however, inclines to this opinion, and among the nutrientia in his materia medica, classes both substances that are taken by the surface and likewise by the lungs. Others have supposed, and perhaps with justice, that all matter which is nutritive must be received through the medium of the lacteals.

Of the circulation.

As absorption to digestion, so the description of the blood's circulation naturally follows to absorption, in tracing the mysterious round of animal functions. In describing the circulation, we shall, pursuing the order of the above table, speak first of the action of the heart; secondly, of the arteries and capillary vessels; and thirdly, of the veins.

Of the action of the heart. By referring to the article Anatomy, the reader will find the heart described as consisting of four large cavities, all of which have a communication with each other; of these the two ventricles are in a manner the principal, the auricles the accessary cavities. In following the blood's course through these different divisions, it will be necessary in the first instance to suppose, that each cavity is filled and emptied in a successive order. We then commence the description of the circulation, with the blood returning from every part of the body, and collected in the two venæ cavæ inferior and superior; these joining at their entrance into the right auricle, pour their blood into this auricle, which by consequence immediately contracts, and forces the received blood principally into the contiguous ventricle: a small part, however, flows back into the cavæ. The right ventricle now distended likewise immediately contracts, and the blood is prevented from returning by the tricuspid valve, so that only a small part flows back, while the principal stream passes on into the pulmonary artery, at the entrance of which are the sigmoid valves. The blood is now impelled forwards through all the very minute divisions of the pulmonary artery, and by consequence through the lungs; in these organs it is exposed to the air by the intervention of only a very thin membrane. It now returns essentially altered, through the pulmonary veins, into the left or more properly posterior auricle; this cavity contracts in the same manner with the right or anterior; there is a very partial reflux of blood into the pulmonary veins, while the greater portion is conveyed to the left ventricle, whence it circulates through all the parts of the body; its return into the auricle being prevented by the tricuspid, into the ventricle from the aorta by the semilunar valves.

In the natural course of circulation, the above order of successive motions is not pursued; for the contraction of both auricles is simultaneous, as well as of the ventricles, while the dilatation and contraction of the auricles and ventricles are alternate to each other.

The quantity of blood propelled by each ventricular contraction cannot much exceed two ounces; the force by which the heart acts has been made a matter of mathematical calculations; but all these calculations, like the speculations of the chemical physiologist, cannot fail to be erroneous, while the peculiar nature of the vital force and action is disregarded. Keil estimated the power of the heart to be some ounces, while Borelli calculates it at 180,000 pounds!

Dr. Harvey, the discoverer of the circulation, conceived the whole of the circulatory process to be effected by the heart; in this, however, he was erroneous, for the function is likewise greatly dependant upon—

The action of the arteries. These vessels, as it respects the number, distribution, and coats, have already been described in ANATOMY. It is a remarkable fact, as stated by Mr. J. Hunter, that the elastic power is almost the only one with which the parietes of the larger arteries are furnished; while in those of smaller diameters, muscularity or irritability predominates: and that this last in the capillary vessels exists almost exclusively. "Thus the passage of the blood into the large trunks in the vicinity of the heart is principally occasioned by the propulsion communicated by this organ; and the circulation in the large vessels, as mentioned by Lazarius, is rather an hydraulic than a medical phenomenon; but in proportion as it becomes distant from the centre several causes retard it; and the blood could not arrive at every part, were not the arteries, which are more active in proportion to their smallness and distance from the heart, to act and propel it towards all the organs." (Richerand.) So erroneous was the opinion of Dr. Harvey.

The mechanical sources of the blood's retardation are, 1st, increase of space occupied by the arteries; for the collection of all the branches from a trunk would form a larger area than that of the parent branch. 2d, The resistance made by the curvatures of the arteries; this mechanism, its cause and effect, are beautifully illustrated in the tortuous course observed in the internal carotid which goes to the brain; by such mechanism an inordinate flow of blood into this organ is in a great measure obviated. 3d, Friction is said to impede the blood's motion; and lastly, its course is retarded by the angular distribution of the arterial ramifications.

The pulse of the arteries is vulgarly attributed to the alternate contractions and dilatations of the heart; but it is principally occasioned by that portion of the blood which is propelled into the aorta, coming in contact with the antecedent columns (for the arteries are always full), and thus communicating an impulse; but being obstructed by this resistance, it forces itself against the sides of the vessels, and gives them their pulsatory motion.

The pulse is more frequent in children, in females, and in persons of much irritability. In man, and individuals who are characterized by strength and regularity of excitement, it is less frequent but more vigorous. In early infancy, the pulsations are from 120 to 150 in a minute; towards the end of the second year, they are about 100; at puberty 80, manhood 70 to 75, and in elderly persons 60 or under. There are great varieties in this respect; Mr. Astley Cooper mentions in his lectures having seen an adult with a natural pulse as low as 27, and it sometimes is more than 100.

Capillary vessels. Arteries are described by some physiologists as terminating in anastomosis, in exhalants, in veins, in cellular texture, and in glands; others view the only proper terminations of these vessels to be that of their continuation into veins, which are connected with the arteries by the intervention of the capillary vessels. "The origin of the veins is only from the most minute extremities of the arteries, which are become capillary from the great number of divisions, and return upon themselves with a change of structure."

Dr. Harvey supposed that this communication was effected by an intermediate cellular substance; this, however, is the case only in some parts of the body, as in the placenta, the spleen, and corpora cavernosa penis.

In the capillary vessels the colour of the blood is lost, there not being here a sufficient mass of fluid to circulate such a collection of red globules as is necessary to constitute redness.

Action of veins. The venous is much more capacious than the arterial system of vessels. "It is estimated that out of twenty-eight or thirty pounds of blood, which is about the fifth part of the weight of the body in an adult man, nine parts are contained in the veins, and four only in the arteries."

In the arteries the circulation is effected by the action of the heart, or of their own muscular and contractile power; in the veins, however, these circulatory powers have so trivial an energy, that nature has guarded against impediments in the course of the blood through these last, in some instances, indeed, has facilitated this course, by such a distribution of the vessels as shall ensure an action of the muscles in propelling the vital fluid. The motion too of the neighbouring arteries assists the venal circulation, as also the valves, in like manner with those of the lymphatics, which divide the column of fluid into a number of small streams, equivalent to the diameters of the spaces thus formed.

Although on account of the comparative tardiness of venal circulation, and its not having such obstacles as arterial, there is no pulse in the veins; yet, in the vicinity of the heart, a species of undulatory motion is communicated to these vessels, principally occasioned by the reflux of blood before spoken of.

Demonstrations of the circulation. If an artery is opened, the blood is thrown out from the side next the heart; if a vein is pierced, the contrary is observed. If, again, a ligature is made on an artery, the course of the blood is arrested above the ligature; if on a vein, below it. Moreover in the semi-transparent vessels of frogs and some other animals, the direct passage of the blood from the heart to the arteries, and thence to the veins, may be actually seen by the aid of a microscope.

Of the blood.

The blood circulating in its vessels has the character of an homogeneous fluid; when separated, however, from the body, or withdrawn from the sphere of vital influence, it shortly divides itself into different parts. Immediately upon separation it exhales a strong vapour, to the presence of which have, with some inaccuracy of language, been attributed all its vital properties. After remaining a short time at rest, the blood separates into two distinct parts: the serum, which, according to the experiments of modern chemists, holds dissolved albumen, gelatine, soda, phosphat and muriat of soda, nitrat of potash, and muriat of lime; and the crassamentum, consisting of the colouring part, which is considered as an albumen more oxygenated and more concrescible than that of serum, holding in solution soda, phosphat of lime, and an excess of iron. Secondly, of the fibrine, formerly called coagulable lymph, which has a considerable analogy to muscular fibre, and when distilled gives out a great quantity of ammoniacal carbonat.

The above principles exist in the blood in a greater or diminished proportion, according to the constitution and health of the individual. In pale dropsical habits the serum is by far more considerable in quantity than its other parts; while the oxygenated albumen, or colouring part containing iron, is under these circumstances deficient. In diseases attended with high excitement, the fibrine is in greatest proportionate abundance.

The order we have observed would now lead us to describe the respiratory process, and the several purposes it serves in the animal economy; to notice in detail the action of the thorax, of the lungs, the alteration of air effected by respiration, the consequent alteration in the blood, and the disengagement of animal heat; for these particulars, however, we refer to the article RESPIRATION, and proceed to enquire into the function—

Of secretion.

Secretion is that process by which is separated from the blood-vessels generally, but in one or two instances, directly from the lymphatics, every species of animal fluid. These are divided by Fourcroy, and other physiologists, into, 1st, the saline, as the sweat and urine; 2d, the oleaginous, or inflammable, as the fat cerumen of the ears, &c. 3d, the saponaceous, as bile and milk; 4th, the mucous, as those which are found on the surface of the intestines; 5th, the albuminous, among which is classed the serum of the blood; 6th, the fibrous, another part of the last-mentioned fluid.

One of the most important and astonishing facts connected with secretion is, that from precisely the same fluid (the blood), are elaborated fluids of a nature widely different from each other, as well as from that whence they proceed. Thus, what can be more unlike than the urine and the blood from which it is prepared; or than the urine itself, and every other secretion? This variety of result, like others, has been referred to a mechanical filtration, and to chemical action; but a knowledge of the mechanism of the different glandular organs, still leaves us ignorant of the actual manner in which is operated this extraordinary change of combination. Secretion is, therefore, a vital action; and with this, as an ultimate fact, the physiologist must rest contented, while he is justified in instituting a research respecting the chemical composition of the fluids formed, and in tracing, as accurately as may be, the steps of their formation.

Secretory processes are divided into three kinds: 1st, serous transudation, which is effected by a mere termination of arteries on the surfaces upon which the fluid is poured out, without any intermediate structure; as on the surface of the body, furnishing the sweat; and on the membranes of joints, furnishing the lubricating fluids of these organs. 2d, Secretion by follicles, cryptæ, or lacunæ, which are supplied with a great quantity of vessels and nerves terminating on their surfaces, and an excretory duct originating from the follicles, &c. in the form of a vas efferens. This kind of gland is found in the ear, in the tonsils, and in all parts which secrete mucus. The more complicated glands which serve for the third kind of secretion, are visceral masses, constituted of an assemblage of nerves, and all kinds of vessels, disposed in packets, and united together by cellular membrane. These are called conglomerate glands; those of a more simple and smooth structure are named conglobate.

Secretion of the fat. Every fibre of the body is connected, and every organ enveloped by cellular texture. This membrane, however, does not merely serve the purpose of connection and envelopment, it is likewise the secretory organ of the adeps, which is found enclosed in separate cells in almost every part of the body. During life this substance is in a state of semifluidity, but concretes after death from the cessation of vital action, and the immediate reduction of animal temperature. The secretion of fat, both as to quantity and, in some measure, as to quality, is differently regulated at different periods of life, in different parts of the body, and under various circumstances of health. In early life the secretion is more abundant immediately under the skin; hence the plump appearance of infants. In more advanced years the surface of the body is almost destitute of adeps, while the tendency to its deposit is more internal. In an adult man in health, the adipose substance is averaged at about the twentieth part of the body's weight.

A chemical analysis of this fluid, proves it to partake more of those principles which are generally predominant in vegetable fluids, than other animal secretions; that is, it contains but a small proportion of azote, and an abundance of hydrogen and carbon. This circumstance, with the phenomena accompanying its deposit and reabsorption, seem to favour the supposition of its being "a kind of intermedium for a portion of the nutritive matter extracted from the food, through which it must necessarily pass before it is assimilated to the individual, of which it is destined to repair the loss." Thus an individual with much fat is able to abstain from food much longer than another without this supply, and, during such abstinence, the collected fat is rapidly reabsorbed.

Adeps, however, serves other purposes in the animal economy. Fat persons suffer less from cold than others; this appears to arise from animal oil being a bad conductor of caloric. It serves likewise to facilitate motion, and by surrounding the extremities of the nerves, obviates inordinate sensibility.

Of nutrition.

Digestion, by which the aliment received into the stomach is deprived of its nutritious particles; absorption, which conveys such nutritious portions into the fluids; and the circulation, by which it is further conveyed to the respective parts in order to undergo depuration by the various secretory organs; are all preliminary and subservient to the function now to be considered.

The indivisibility and individuality of the living body can only be maintained by an incessant change of the particles which enter its composition. "Thus the animal machine is continually destroyed, and at distant periods of life does not contain a single particle of the same constituent parts." The most commonly adduced evidence in favour of which, is the effect resulting from feeding animals with madder; for during the time that this substance is made part of the food, the bones become of a red colour, which is again lost if the madder is only for a short time suspended: proving that there is a constant decomposition and reformation even of those portions of the frame, which, from their compact texture, must be supposed the least susceptible of change. As then the parts of the body are constantly destroyed, new parts of the same nature are as constantly required, and to supply this demand is the office of nutrition. "A bone, for example, is a secretory organ that becomes incrusted with phosphat of lime: the lymphatic vessels, which in the work of nutrition perform the office of excretory ducts, remove this salt after it has remained a certain time in the areolæ of its texture. It is the same in muscles with respect to fibrine, and in the brain with albumen." We, therefore, find animal nutrition and organization, to consist in this: that the aliments having been converted first into chyle, and then into blood, and from this last having been furnished the various parts, solid and fluid, of which the animal is composed, such parts are at length separated by the peculiar action of their respective organs: thus the body is supported by intussusception as it has been denominated; a process very far different from that union effected by mechanical juxtaposition of particles, or operated by chemical affinity.

It has ever been the aim of the physiologist, more especially of recent times, to detect the prime, and, in a manner, common principle subservient to nutrition, in order to estimate the proportionate quantity of nutrient matter furnished by different alimentary substances. We must, however, assiduously guard against that fallacy which would connect itself with our inferences from viewing the process of nutritive elimination as a process merely of chemistry. The separation and assimilation of nutritive matter, may be pronounced to have greater reference to vital action than even to the substances themselves from which nutrition is extracted. For example: Let us suppose, with Dr. Cullen and many others, that the common principle drawn from alimentary matter is saccharine; let it even be demonstrated that such is the case; it by no means thence follows that the administration of saccharine matter in any form would be the mean of conveying into the system the largest portion of nutrition.

This doctrine it will not be improper further to illustrate, by calling the reader's attention to circumstances connected with one or two chronic maladies. Diabetes, whether originating from a disordered state of the assimilative organs, from an improper action of the kidneys, or, as appears most probable, from the conjunction of these two, is occasioned more immediately, or at least the emaciation which characterizes it, by a deprivation of saccharine matter from the frame; but the remedy for diabetes is not of a saccharine nature: on the contrary, if the disease admits of cure, such cure appears to be best ensured by an abstinence from all vegetable diet, by the exclusive use of animal food, and by the administration of certain astringent medicines. Again, in the rickets of infancy, which has an unquestionable dependance upon a loss to the bones of their due portion of phosphat of lime, the physician's object is not immediately to convey this matter into the blood, but to restore that degree and kind of excitement in the osseous vessels, from which the secretion results; and this will be effected by materials widely different, both in composition and abstract agency, from the substance, the deficiency of which is to be remedied. What quantity of phosphat of lime is discoverable by the chemist in the common chalybeate preparations, or in the nutritive aliment, which, properly administered, prove of such obvious and extensive utility in the management of the complaint in question? Hence, in another place, we were induced to remark, that the proximate cause of rickets does not so properly consist in "a deficiency of that matter which should form the solids of the system," as a deficiency of that excitation upon which the formation and deposit of such matter are momentarily dependant. See INFANCY.

M. Richerand, in his excellent work on physiology, states that "the marine plant, the ashes of which form soda, if sown in a box filled with earth that does not contain a particle of that alkali, and moistened with distilled water, furnishes it in as great quantity as if the plant had been growing on the borders of the sea, in a swampy soil, always inundated by brackish or salt water." Now what would follow a deprivation for a time of oxygen, light, or water, from such plant? Certainly a debilitated action, and consequent interruption of function. To remedy the disorder thus produced, we should not, however, apply to the plant the matter of which itself is composed; but restore those agents, through the medium of which it had preserved its due vitality. Have not these facts of the subserviency of vital support to vital action, been too much overlooked in the recommendation and imagined modus operandi of some medicines of modern physicians? When Dr. Darwin inferred that calcareous earth contributes to the nourishment of animals and vegetables, because "whatever has composed a part of an animal or vegetable, may again, after its chemical solution, become a part of another vegetable or animal," was not this vital agency and power of actually converting materials into those of an opposite nature, in some measure disregarded? But this is not the place for speculation. It is our business rather to compress than dilate: and we shall conclude by observing, that the principle now contended for, however important, is not to be received or acted upon, either in articles of food or medicine, in an unqualified or unlimited sense. A due supply of appropriate fuel as well as of stimulus, is necessary to support the flame of life. See MATERIA MEDICA.

It will be proper before quitting this subject, to observe, that as animal matter has been proved principally to differ from vegetable, in containing a larger proportion of azote than the latter, and the vital process of nutrition or animalization, however effected, has been judged to be a species of azotification, the following extract on this subject is given from the work just alluded to of M. Richerand: "Hallé believes that the hydro-carbonated oxide, or principle of nutrition, is combined with oxygen in the stomach and intestinal canal; whether the latter principle is introduced with the food into the primæ viæ, or furnished by the decomposed humours. The intestinal fluids suffer their azote to be disengaged, which is carried to the alimentary base, and replaces the carbon that had been attracted by oxygen to form the carbonic acid. This gas, when in the lungs, and again subjected to the action of atmospheric oxygen, carries off a certain portion of its carbon; and as it disengages the azote from venous blood, it effects a new combination of this principle with the chyle; and when propelled to the skin, the atmospheric oxygen again disengages its carbon, and completes its azotification. Perhaps even the cutaneous organ answers similar purposes to the lymphatic system, as the pulmonary organ may effect to the sanguiferous system."

It will be obvious to the reader, that the above theory supposes nutrition to consist in the constant loss of carbon, and constant supply of azote. It is admitted, however, not to account for the formation of phosphoric salts, adeps, and many other substances. It is, therefore, at least defective.

ON SENSATIONS.

The arrangement we have adopted now leads us to notice those functions "which connect us with surrounding objects;" and it was our original design in the present article to have treated at length on the physiology of the senses, especially of sight and hearing. As these last subjects, however, could not be made interesting or even intelligible, without connecting them with the philosophy of light and of sound, it has been judged more expedient, in order to avoid repetition, to confine their consideration exclusively to the articles OPTICS and SOUNDS. The anatomy of the organs will be found under the article ANATOMY.

Of smell. As the expansion of the optic nerve into the retina, constitutes the immediate instrument of vision, by being peculiarly invested with the faculty of perceiving light; as the portio mollis of the auditory nerve, is in like manner the direct medium for transmitting the sensation of sounds to the sensorium commune; so the organ of smell, constituted by a distribution of the olfactory nerves on that membrane which lines the nasal fossæ, is formed to receive, exclusively, the sensation of odours. It is apparently in proportion to the depth and extent of these fossæ, (affording a larger surface to the pituitary membrane,) that the perception of smell is variously regulated in different animals, and in some measure in different individuals of the same species; and the membrane itself requires to be in a perpetual state of moisture.

It is supposed by some that the olfactory nerves do not extend into the sinuses, but that these cavities merely assist the sense by longer retaining a greater mass of air, which is loaded with those odoriferous particles that constitute the exciting cause of this perception. The nasal organs are supplied with numerous small branches arising from the fifth pair of cerebral nerves; but these branches do not, according to M. Richerand, answer any further end, than that of contributing to general sensibility. The excitability to odours exists, according to our author, exclusively in those which are commonly denominated olfactory nerves.

Of taste. Every sense has been said to be strictly a modification of feeling: that of taste, however, approaches nearer than any other of the senses, even in its organization, to that of simple or proper fe eing; the surface of the tongue, which is the principal residence of this perceptibility, only varying from the common integuments in being thinner, more vascular, and having cryptæ, or follicles, which secrete the mucus of the tongue. These are situated in greatest number near its tip, and are erected "when we masticate high-flavoured food, or have a strong desire for any savoury dish." "It is observed that the sense of taste in different animals is more perfect in proportion as the nerves of the tongue are larger, the skin finer and more moist, its texture flexible, surface extensive, motions more easy and varied. The sense of taste in man would, perhaps, be more delicate than that of any other animal, if he was not to blunt its sensibility early in life by strong drinks, spicy ragouts, and all the refinements of luxury that are daily invented." "Is the lingual branch of the fifth pair of nerves alone adapted for the perception of taste? Do not the ninth pair equally serve for the same purpose?" This last question of M. Richerand has, we believe, generally been answered in the negative. It is from the fifth pair that the cryptæ, just spoken of, are supplied.

On touch. This has been with some propriety denominated the elementary sense, and all others considered as merely modifications accommodated to certain properties of bodies. "Every thing that is not light, sound, odour, or savour, is appreciated by the touch." This sense resides throughout the whole extent of the nervous system; the peculiar organ, however, of touch, or that by which we come to a knowledge of the qualities of objects, is the cutis, spread over the external surface of the body. In some part, this sense is peculiarly modified; in the skin, for example, covering the apices of the fingers; and in such parts we meet with something resembling the papillæ on the tongue; but, perhaps, not exactly similar, as they are rather constituted of nervous projections, than of glandular cryptæ: they are surrounded by an extremely fine vascular membrane. When the sense of feeling is exercised, these papillæ are supposed to swell and elevate the epidermis, which in itself is totally insensible to all such stimuli as act exclusively on living fibre. The epidermis, like the nails and hair, which last proceed from it, is a mere defence of the body, unorganized, and consequently destitute of excitability.

Action of the nerves. On this subject every thing is conjectural. We have not in this instance the assistance of anatomy for any thing farther than the fact, that the nerves are the organs through which the sensitive faculty is developed. The form, appearance, and mode of attachment of the nerves, are sufficient evidences that they do not act as vibratory chords, according to the supposition of some theorists; that they are tubes for conveying a fluid from and to the cerebral mass, is inconsistent with what has been discovered respecting the minuteness of divisibility in their fibrillæ; it likewise appears incompatible with what may be called the reacting communications between the centre or centres of sensation, and the sensitive organs: and we have already had occasion to say, that the extensive and very important discoveries of modern chemistry, have only brought us acquainted with a greater number of exciting agents; they do not appear to have cast any light upon the question respecting the actual mode of nervous or muscular excitation.

With respect to the analysis of our sensations, the production of ideas, and the comparative estimate of the human understanding with that of the instinctive and sensitive faculties of the inferior animals, we cannot be expected in this place to institute any inquiry. We must be content with expressing our opinion, that endeavours to establish an identity of faculty in the man and the brute (if the dispute is not a mere logomachy), have failed of their object; and as we believe that the fables of the Hamadryades are not realized in the "trees of our forests," "so we still flatter ourselves, notwithstanding the in dications of reason, and the great powers of imitation which have been exhibited by some individuals of the ape species, that the human intellect is of a nature essentially different from that of the monkey."

Of sleep, dreaming, somnambulism, sympathies, habit. The condition and the exciting causes of sleep, need no description; its proximate cause must necessarily lie in the same obscurity with those of other brainular and nervous affections. The artificial sleep which has been procured by pressure on the brain, proves nothing with respect to the actual condition of this organ in the sleep of nature; it is rather apoplexy than sleep that is thus occasioned. With respect to the phenomena attendant upon sleep, it has been well observed, that "the human body presents with tolerable accuracy the model of the centripetal and centrifugal powers of antient philosophy. The motion of several of the systems that enter into its structure, is directed from the centre to the circumference; it is a true exhalation that expels the produce and continual destruction of organs; such is the action of the heart, arteries, and all secretory glands. Other actions, on the contrary, are directed from the circumference towards the centre; and it is by these means that we continually receive, from the aliments introduced into the digestive organs, the air that penetrates into the internal structure of the lungs, and surrounds the surface of the body, the elements of its growth and reparation. These two motions in an opposite direction, continually balance each other, and alternately preponderate according to age, sex, sleep, or waking. During sleep, the motions are directed from the circumference towards the centre (motus in somno intrò vergunt, Hippocrates); and if the organs that connect our intercourse with external objects, repose, the internal parts act with greater advantage." Hence our author would explain, or rather trace, the connection of repose with corpulence; and of inordinate mental or bodily exercise with leanness. Sleep may, indeed, be so indulged as to reduce man to a condition of mere brutal existence, as in a case related by the author of the above extract, that of a man sleeping five-sixths of the day, with a digestion always active and easy, and with "moral affections circumscribed in the desire of aliment and repose."

Dreaming is a state intermediate between sleep and waking. It is the continued activity of some organs while others are in a state of quietude; hence incongruous associations, and all their consequences. For somnambulism (sleep-walking), see *Incubus*, in MEDICINE. *Sympathies* are, 1st, between two organs which perform the same function, as between the kidneys; 2d, those which have been attributed to the continuity of membranes, as the pain in the glans penis from calculary affections of the bladder; 3d, from the extension of local irritation, in the manner that the excretory duct of the parotid gland occasions an irritation, which is propagated in its substance, and augments its secretion; 4th, exerted between parts which do not appear to be connected either by nerves, membranes, or vessels; as when the nostrils are irritated, the diaphragm contracts and occasions sneezing; 5th, those which are considered as resulting from the agency of the vital principle, as when the rectum contracts by the stimulus of excrement.

Habit. Of the power and influence of habit, every one is sensible. Its operation in the animal economy, in relation both to the pathology of disease and the practice of medicine, requires assiduous attention. For example: a premature propulsion of the fœtus disposes to a return of the same accident, at the same period of pregnancy; thus, at this time, especial care is requisite in order to obviate this acquired propensity.

The termination of life has been referred to the power of habit, blunting gradually, and at length destroying, susceptibility of impression from the agents by which the vital principle had hitherto been supported. "Life, dependant on the continual excitement of the living solid, by the fluids that are conveyed to it, ceases, because after being accustomed to the impressions that these liquids produce on them, irritable and sensible parts become at length no longer able to perceive them; their action, gradually destroyed, would, perhaps, revive, if the stimulating powers were to acquire additional force."

For a general view of the organs subservient to animal motions, (the next subject in the order of our arrangement) consult COMPARATIVE ANATOMY, Vol. I. page 414.

OF THE VOICE, AND SPEECH.

Voice is produced by that air which is expelled from the lungs, being made to vibrate in passing through the glottis.

"Do the different modifications of which the voice is susceptible depend on the largeness or smallness of the glottis, or on the tension and relaxation of the ligaments that form the sides of the aperture from the glottis into the mouth?" which last is, indeed, the true organ of this function; for when an opening is made in the larynx below it, no sound is produced by the passage of the air. It appears, however, that both the size of this opening, and the tense or relaxed condition of the parietes of the larynx, contribute to modify voice, or, as it has been expressed, that the larynx is both a wind and a string instrument; voice being always acute in females, and in young persons previously to the age of puberty, at which time the diameter of the aperture in males undergoes a remarkable enlargement, and the state of tension in the ligaments of the glottis is always in correspondence with the narrowness of this opening.

Voice has a further dependance upon the length of the trachea. "A singer who wishes to run through the whole gamut, by passing from the upper to the lower notes, evidently shortens the neck and trachea, but, vice versa, lengthens them to produce a contrary effect.

"The strength then of the voice depends upon the volume of air that can be expelled from the lungs, and on the greater or less power of vibration of which the parietes of the canal are possessed in its passing outwards. Birds, the body of which is mostly aerial, have a voice very strong when compared to their size; their trachea provided with a double larynx, is almost entirely cartilaginous, particularly in certain chattering birds, as the jay and some others; while it is nearly membranous in the hedgehog, the noise of which is almost imperceptible."

Speech is the prerogative solely of the human species. It is constituted by modifications which the voice is made to pass through, from the motions of the tongue, lips, &c. "The ape, in which these parts are formed as in man, would speak like him, if the air in passing out of the larynx did not rush into the hyothyroid sacs, in some animals membranous, but cartilaginous in others, and even osseous in the alouette or purr, whose howl is so hoarse and frightful. Every time the animal wishes to cry, these sacs become distended, then emptied, so that it cannot furnish the different parts of the mouth with sounds to be articulated."

Articulated sounds are constituted by vowels, the consonants are merely for the purpose of connecting vowels together. The utterance of consonants is necessarily more forced and unnatural than that of vowels; hence the superior harmony of those languages which have the greatest number of such letters, as in the ancient language of the Greeks, "quibus dedit ore rotundo musa loqui." Hor. Hence, on the other hand, the harshness of the German, Dutch, and other languages. "It would be difficult," says M. Richerand, "to accumulate a greater number of consonants in one word," (and, consequently, to select a word of more difficult pronunciation), "than is found in the proper name of a German, called Schmidtgen."

Singing, stammering, lisping, dumbness, and ventriloquism. Singing is performed by an enlargement or contraction of the glottis; by an elevation or depression of the larynx; by an elongation or shortening of the neck; by an accelerated, prolonged, or retarded inspiration; and by either long or short, and abrupt expirations. "The agreeableness then, or the justness of the voice, the extent and variety of inflexions of which it is capable, depend on the correct conformation of its organs, on the flexibility of the glottis, elasticity of its cartilages, and particular disposition of different parts of the mouth, nasal passages, &c. If the two halves of the larynx or nasal fossæ are unequally disposed, it is sufficient to occasion a defect in precision and neatness of the voice."

Stammering and lisping are occasioned by a tongue too large, its frænum being too long; and by deficiency or bad arrangement in the teeth. When the apex of the tongue is prevented from striking properly the fore part of the roof of the mouth, an inability is produced of pronouncing the letter *r*.

Natural dumbness is almost invariably consequent upon deafness, and does not arise from an inability to articulate, but from an entire ignorance of sounds. See DUMBNESS, and DEAFNESS.

For the nature of those sounds produced by the ventriloquist, see likewise the article VENTRILOQUISM.

OF GENERATION.

We now proceed to notice those functions which nature has provided for the preservation not of the individual but of the species.

Differences of the sexes. During infancy we find the general characters of sex comparatively so indistinct, that some writers have been disposed to refer the successive developement of the male and female peculiarities solely to the genital organs. "Propter solum uterum mulier est id, quod est." Van Helmont. It has, however, been well observed, that we find from birth an independant variety of conformation in the male and the female; the former having less mobility of constitution, and less delicacy and roundness of form than the latter. The muscles of man are larger and firmer, the asperities of the bones are observable in a greater degree, the clavicle is more curved, the shoulders broader, the pelvis smaller, and the thigh-bones have a more outward direction. It is well known to the anatomist, that by examining attentively the skeleton, even previously to the age of puberty, the sex may generally be traced.

Even venereal desires have been imagined by some physiologists to be evolved independantly of the evolution of the genital organs. M. Richerand, from Calliot, adduces the instance of a female, who, "when advanced to the age of twenty-one, wished to satisfy the desires of nature, but in vain, she having nothing but the vulva properly formed; a small canal about two lines in diameter occupied the place of the vagina, and terminated in a cul-de-sac, an inch in depth. The most attentive examinations made by introducing a catheter into the bladder, and the index into the rectum, could not find an uterus." In this instance, however, we are disposed to think that the defect was in the position and communication of the uterus, not in its total absence; for, as opposed to this example, we remember to have heard a celebrated anatomist relate that he dissected a female, who, without venereal desires, though she lived some time beyond the age of puberty, had every external and internal part of the uterine system in perfection, excepting the ovaria. "Nulla cupido est propter vitia organorum."

Hermaphrodism, in a proper sense, has never existed in man, nor even in the inferior animals, the structure of whose genital organs are in the smallest measure analogous to man. An imperfection of organs, so as to render the sex doubtful, has, indeed, in some very few instances presented itself; but not, as in many of the lower order of animals and plants, a capability of self-impregnation.

Some physiologists have endeavoured to trace an analogy between the sexual organization of the male and female, comparing the ovaria of the latter with the testicles of the former, the Fallopian tubes with the vasa deferentia, the uterus with the vesiculæ seminales, the clitoris and vagina with the penis. These resemblances are in some measure correct: thus, the ovaria and testicles both secrete a seminal fluid, the Fallopian tubes and vasa deferentia both convey such fluid into appointed reservoirs—the uterus in the female, and the vesiculæ seminales in the male.

The generative procees in man is effected by an elimination from the blood of the semen by the testicles; the semen immediately upon its secretion passes through the seminiferous ducts into the vasa deferentia, which, after entering the abdomen, terminate in the vesiculæ seminales, and there deposit their contents. These vesicles furnish reservoirs for the semen; and we find those animals that are destitute of them, dogs for example, continue a long time in sexual contact, on account of the semen, secreted during the act of copulation, being directly transmitted from the testicles. As the semen in man passes through the prostate gland, it is mixed with the mucus which this gland secretes, and, thus mixed, enters the urethra to be ejected.

With respect to the part which the female performs in the process of generation, the following questions have been proposed. "Does the ovarium secrete a liquor, that, mixing with the male semen, produces the new being? or is there detached from it, at the moment of conception, an ovum which is vivified by the semen?" "Whatever part," says M. Richerand, "is taken in this discussion, we shall be forced to admit that the ovarium prepares something essential to generation, since its removal renders the female sterile. It is doubtless, likewise," continues our author, "that this something furnished by the ovaries, passes through the Fallopian tubes into the uterus, which receives one of their extremities, while the other, large, expanded, and fringed at its margin, floats in the cavity of the pelvis, supported by a small duplicature of the peritoneum, but contracts on itself, is closely applied to the ovarium during coition, and then constitutes a direct channel between this organ and the internal part of the uterus. The external orifice of the Fallopian tube, or its fringed parts, has been found closely investing the ovarium in certain females opened immediately after copulation. It may happen from some organic defect that the Fallopian tube cannot embrace the ovarium. In dissecting a subject at La Charité, that had been sterile, I found the fringed margins, or expanded extremities of the tubes, adhering to the lateral and superior parts of the pelvis, so that it had been impossible for them to perform their motions."

Although the semen is conveyed into the uterus, the penis does not actually enter this cavity; it is prevented by the smallness of the os tincæ, and it would be difficult to conceive even the passage of the semen, "if we did not know that the uterus, during copulation, is irritated, kept in agitation, and attracts the semen by a real aspiration."

With regard to the theory of conception, the greatest obscurity prevails. Analogy with what is observed in inferior animals, furnishes the principal assistance to the physiologist in this particular. It is well known that eggs laid by a hen which has had no intercourse with the cock, are incapable of being hatched, although they contain the rudiments of the chick; hence it has been inferred, and almost demonstrated, that it is the office of the male in general to "furnish the vivifying principle; that is, to animate the individuals, the germs of which are produced by the female."

This fecundation of the ovum is supposed to be effected in the ovarium, the seminal liquor received into the uterus having passed hither through the Fallopian tubes. This last supposition, however, has not perhaps been fully verified.

In the ovaria, after each conception, a small body is found (corpus luteum), which Haller proved to be the remains of a vesicle ruptured at the moment of conception, and permitting its contents to escape. The matter then which thus escapes, constitutes the germ of the fœtus. It will be evident that the Fallopian tubes require to be pervious, in order that conception may take place. It is observed by Morgagni, that they are often closed in courtezans, in consequence of habitual excitement

"Semen, when examined by a microscope, exhibits animalcula with a round head and slender tail, that move with rapidity;" hence the curious conjectures of Lewenhock, Boerhaave, Cowper, and others, that every part of the seminal liquor is capable of becoming a being resembling that from which it was formed. "These animalcula pass in a current through the Fallopian tubes to the ovaria, where they enter into a violent contest, in which all are killed except one, which being left champion in the field of battle, penetrates into the ovarium destined to receive it." According to the hypothesis of M. Buffon, every part of the body furnishes its appropriate molecula to compose the semen; "and these atoms coming from the eyes, ears. &c. of the man and woman, arrange themselves round the internal mould, the existence of which he admits, believes it to form the base of the edifice, and to arise from the male, if it should be a boy, and from the female, if a girl."

If it was necessary to offer any objection to this fanciful hypothesis, it would suffice to say that infants are often born perfectly organized, the parents of whom have had defects in structure.

For the history of gestation, delivery, &c. consult the article MIDWIFERY.

On ages, temperaments, varieties in the human species, &c.

The last subjects treated of by M. Richerand, very little remains to be said of in the present place.

Of infancy, its peculiarities and diseases, see the article INFANCY. The process of dentition for the most part commences towards the end of the seventh month, earlier or later, according to the constitution of the infant. The middle incisores of the upper jaw are the first to appear; shortly afterwards the incisores of the inferior maxilla; then the lateral incisors of the upper, afterwards of the under jaw; then the canine teeth in the same order; and between eighteen months and two years, but in the inverse order, the molares. This completes the first dentition. Towards the end of the fourth year, two other molares come to be added. These last remain during life, but the first teeth fall out nearly in the order of their appearance, and are succeeded by others larger and better formed. Towards the ninth year, two additional large molares appear beyond the former; and between the ages of eighteen and thirty, two teeth perforate the gums at the extremity of the alveolar processes: these are the dentes sapientiæ.

Each row of teeth exists at the same time in the maxillæ of the fœtus, each alveola containing two membranous follicles. That which is to constitute the primary tooth first swells, a calcareous matter encrusts on its surface and forms the body of the tooth, by which the follicle is obscured which secretes the osseous part, so that when the small bone is fully formed, the membranous vesicle on the sides of which the dental vessels and nerves are spread out, is in the centre of its body, and adheres to the parietes of its internal cavity.

Ossification is effected by a deposit of bony matter, (which, as we have already observed, is principally formed of phosphat of lime,) in the centres of the cartilages, which gradually proceeds to their extremities or circumferences. Although ossification is some years before it is completed, there has been sufficient bony matter deposited in the cartilages, to enable the child to stand and walk, in the course of twelve months, or less, from birth. "The vital motions of infancy tend towards the head," hence the frequency of disease in this part.

Of puberty. In England the season of puberty is scarcely before the fifteenth year, sooner or later, according to constitutional variety. The principal marks of puberty in the male are the change of voice, which arises from a sudden dilatation of the aperture in the glottis, already spoken of. In females, the menstrual discharge forms the chief index of the change alluded to. This discharge is not a mere flow of blood as from ruptured vessels, but is a proper secretion from the arteries which terminate on the internal surface of the uterus. The final cause of menstruation is unquestionably to furnish the fœtus with its requisite support during gestation. The hypotheses which have been proposed to account for menstruation, as the influence of the moon, &c. are too frivolous and antiquated to require refutation or notice.

The state of virility succeeds to that of puberty, and now the constitutional character is fully and firmly established. The antients, observing a great diversity among individuals, and supposing that such varieties must depend upon some elementary matter with which the body is impregnated, instituted a general division of constitution into four classes, which in compliance with their mode of judging respecting the origin of such differences they called temperaments; a word retained, while the theories which introduced it are abandoned. The sanguine, the melancholic, the choleric, and the phlegmatic constitutions of authors, with their endless intermixtures, do not require description in this place. M. Richerand has proposed a classification which will be seen by referring to the above table, and which is, perhaps, more accurate in relation to appearances, certainly much more so as it regards the origin of difference, than the ancient distinctions. We are persuaded, that to the physician, the arrangement of individual peculiarity would be most useful, which should be founded on those marks indicating an hereditary tendency to lymphatic, nervous, and sanguineous affections

The national varieties of man are, according to our author, the Arab-European, "with face oval, or nearly oval, in a vertical direction, the nose long, the forehead projecting, hair long, and generally lank, skin more or less white." These fundamental characters are no where so well marked as in the north of civilized Europe.

The Mongol race, with "the forehead flat, the cranium not very prominent, the eyes directed a little obliquely outwards, and the oval formed by the face, instead of being from the forehead to the chin, is from one cheek to the other." This is the most numerous race, comprehending the Chinese, Tartars, Japanese, &c.

The Hyperborean race, "with flat face, squat body, and very short stature," is formed of the Greenlanders, Samoiedes, and Laplanders. The American Indian, M. Richerand conjectures to be a race from the other continents. On the Negro, he has the following remarks: "the small progress of this race in the study of the sciences and in civilization; their decided taste and singular aptitude for all the arts that require more address than understanding and reflection, as dancing, music, fencing, &c.; the form of their head, which is a medium between the European and orang-outang; the existence of intermaxillary bones, at an age when in us the traces of their separation are completely obliterated; the high situation and smallness of the calf of the leg, &c., have been advanced as arguments which, however, are less solid than specious, by those who have endeavoured to degrade this portion of the human species, with a view of justifying the commerce made of them by civilized nations, and the slavery to which they are reduced.

"Without admitting this position," says our author, "believed by the avarice of riches, we cannot but allow that the differences in organization induce (should he not have said, are accompanied with?) an obvious inequality in the perfection of the moral and intellectual faculties. This truth will be completely elucidated if we can point out their moral differences to be equally real and strongly marked as the physical characters of the human races that have been just recapitulated: oppose European activity, versatility, and restlessness, to Asiatic indolence, phlegm, and patience; examine what effects may be produced on the character of nations by the fertility of the soil, serenity of the atmosphere, and mildness of the climate; shew by what obligation of physical and moral causes the influence of custom has so much power over Eastern people, that in India and China we find the same laws, manners, and forms of worship, as existed long before the commencement of our æra; investigate by what singularity these laws, manners, and religions, have suffered no alteration amidst the revolutions that have so frequently overturned those rich countries, which have been several times conquered by the warlike Tartars; demonstrate that ignorant and ferocious conquerors, by the irresistible ascendancy of wisdom and information, have adopted the customs of the nations they have subjugated; and prove that the stationary state of the arts and sciences, in people who have enjoyed the benefits of society and the advantages of civilization before us, *is not so much to be attributed to the imperfection of their organization*, as to the humiliating yoke of a religion, abounding in absurd practices, and which makes learning the exclusive appendage of a privileged cast."

For physiology of plants, see PLANTS, *physiology of.*

PHYSSOPHORA, a genus of vermes mollusca; the generic character is, the body gelatinous, pendant from an aerial vesicle, with gelatinous members at the sides, and numerous tentacula beneath. These are nearly allied to the medusæ, and might without much impropriety be removed to that genus. There are three species.

PHYTEUMA, *cretic rampions*, in botany, a genus of the pentandria monogynia class of plants, the flower of which is composed of a single stellated petal; the fruit is a roundish capsule, and contains three cells, with numerous seeds. There are sixteen species.

PHYTOLACCA, in botany, a genus of the decandria decagynia class of plants, the corolla whereof consists of five roundish, hollow, patent petals; the fruit is an orbiculated depressed berry, with ten longitudinal furrows, and as many cells, in each of which is a single kidney-shaped seed. There are six species. In Virginia and other parts of America the inhabitants boil the leaves, and eat them in the manner of spinach. They are said to have an anodyne quality, and the juice of the root is violently cathartic. The stems when boiled are as good as asparagus. The Portuguese had formerly a trick of mixing the juice of the berries with their red wines, in order to give thema deeper colour; but as it was found to debase the flavour, and to make the wine deleterious, the matter was represented to his Portuguese majesty, who ordered all the stems to be cut down yearly before they produced flowers, thereby to prevent any further adulteration. The same practice was common in France till it was prohibited by an edict of Louis XVI. and his predecessor under pain of death. This plant has been said to cure cancers; but the truth of this assertion has not been indisputably proved, and does not appear very probable.

PHYTOLOGY, a discourse concerning the kinds and virtues of plants.

PHYTOTAMA, a genus of birds of the order passeres; the generic character is, bill conic, straight, serrate; nostrils oval; tongue short, obtuse; feet four-toed. There is only a single species, viz. P. rara, that inhabits Chili, nearly equal in size to the quail; has a harsh interrupted cry, resembling the syllables ra, ra; feeds on fresh vegetables which it cuts down near the roots with its bill as with a saw, and is on that account a great pest to gardens; builds in high shady trees, in retired places; eggs white spotted with red.

PIA MATER. See ANATOMY.

PICA. See MUS.

PICÆ, the second order of birds, according to the Linnæan system. They are distinguished by a bill sharp-edged, convex above; legs short, strong; feet formed for walking, perching, or climbing; body toughish, impure; food various, filthy substances; nest in trees; the male feeds the female while she is sitting. They live in pairs. Of this order there are twenty-six genera, viz. alcedo, buceros, bucco, buphago, certhia, coracias, corvus, crotophaga, cuculus, galbula, glaucopis, gracula, merops, momotus, oriolus, paradisea, picus, psittacus, rhamphastos, scythrops, sitta, todus, trochilus, trogon, upupa, yunx.

PICKET, PICKQUET, or PIQUET, in fortification, a painted staff shod with iron; used in marking out the angles and principal parts of a fortification, when the engineer is tracing out a plan upon the ground.

PICQUET, a celebrated game at cards played between two persons, with only thirty-two cards; all the twos, threes, fours, fives, and sixes, being set aside.

In playing at this game, twelve cards are dealt to each, and the rest laid on the table: when if one of the gamesters finds he has not court-card in his hand, he is to declare that he has carte-blanche, and tell how many cards he will lay out, and desire the other to discard, that he may shew his game, and satisfy his antagonist, that the carte-blanche is real; for which he reckons ten. And here the eldest hand may take in three, four, or five, discarding as many of his own for them, after which the other may take in all the remainder if he pleases. After discarding, the eldest hand examines what suit he has most cards of; and, reckoning how many points he has in that suit, if the other has not so many in that, or any other suit, he reckons one for every ten in that suit, and he who thus reckons most is said to win the point. It is to be observed, that in thus reckoning the cards, every card goes for the number it bears; as a ten for ten; only all court-cards go for ten, and the ace for eleven, and the usual game is one hundred up. The point being over, each examines what sequences he has of the same suit, viz. how many tierces, or sequences of three cards; quarts, or sequences of four cards; quintes, or sequences of five cards, &c. he has. These several sequences are distinguished in dignity by the cards they begin from: thus, ace, king, and queen, are stiled tierce major; king, queen, and knave, tierce to a king; knave, ten, and nine, tierce to a knave; and the best tierce, quarte, or quinte prevails, so as to make all others in that hand good, and to destroy all those in the other hand. In like manner a quarte in one hand sets aside a tierce in the other.

The sequences over, they proceed to examine how many aces, kings, queens, knaves and tens each holds; reckoning for every three of any sort three; but here too, as in sequences, he that with the same number of threes or fours, has one that is higher than any the other has, makes his own good, and sets aside all his adversary's; but four of any sort, which is called a quatorze, because fourteen are reckoned for it, always set aside three.

The game in hand being thus reckoned, the eldest proceeds to play, reckoning one for every card he plays above nine, while the other follows him in the suit: but unless a card is won by one above nine, except it is the last trick, nothing is reckoned for it. The cards being played out, he that has most tricks reckons ten for winning the cards: but if they have tricks alike, neither reckons any thing. If one of them wins all the tricks, instead of ten, which is his right for winning the cards, he reckons forty, and this is called capot.

The deal being finished, each person sets up his game: they then proceed to deal again as before; cutting afresh each time for the deal: if both parties are within a few points of being up, the carte-blanche is the first that reckons, then the point, then the sequences, then the quatorzes, then the tierces, and then the tenth cards. He that can reckon thirty in hand by carte-blanche, points, quintes, &c. without playing, before the other has reckoned any thing, reckons ninety for them, and this is called a repike; and if he reckons above thirty, he reckons so many above ninety. If he can make up thirty, part in hand, and part in play, before the other has told any thing, he reckons for them sixty; and this is called a pique, whence the name of the game. Mr. de Moivre, in his doctrine of chances, has resolved, among others, the following problems: 1. To find, at picquet, the probability which the dealer has for taking one ace or more in three cards, he having none in his hands. He concludes from his computation, that it is 29 to 28 that the dealer takes one ace or more. 2. To find at picquet the probability which the eldest has of taking an ace or more in five cards, he having no ace in his hands. Answer; 232 to 91, or 5 to 2, nearly. 3. To find at picquet the probability which the eldest has of taking both an ace and a king in five cards, he having none in his hand. Answer; the odds against the eldest hand taking an ace and a king are 331 to 315, or 21 to 20 nearly. 4. To find at picket the probability of having twelve cards dealt to, without king, queen, or knave; which case is commonly called cartes-blanches. Answer; the odds against cartes-blanches are 323 to 578,956, or 1791 to 1 nearly. 5. To find how many different sets essentially different from one another, one may have at picquet before taking in. Answer; 28,967,278. This number falls short of the sum of all the distinct combinations, whereby twelve cards may be taken out of 32, this number 225,792,840; but it ought to be considered, that in that number several sets of the same import, but differing in suit, might be taken, which would not introduce an essential difference among the sets.

PICRAMNIA, a genus of the pentandria order, in the diœcia class of plants; and in the natural method ranking with those that are doubtful. The calyx is tripartite; the corolla has three petals; the stamina from three to five, awl-shaped, and seem to join together at the base; there are two styli, which are short and bent backwards; the berry is roundish, and contains two oblong seeds, and sometimes one seed only. There are two species: The antidesma, or murjoe bush, is frequent in copses and about the skirts of woods in Jamaica, rising about eight or nine feet from the ground. The leaves are of an oval form, pointed, and placed in an alternate form along the branches; the flower-spikes are long, pendulous, and slender; the florets small and white: the berries are numerous, at first red, then of a jet black colour; the pulp is soft, and of a purple complexion. The whole plant is bitter, and especially the berry. The negroes make a decoction of them, and use it in weaknesses of the stomach and in venereal cases.

PICRIS, *ox-tongue*, a genus of the polygamia æqualis order, in the syngenesia class of plants. The calyx is calycled; receptacle naked; seed transversely grooved; down feathered. There are six species, of which the most remarkable is the echioides, or common ox-tongue, growing spontaneously in corn-fields in Britain. It has undivided leaves embracing the stem, with yellow blossoms, which sometimes close soon after noon, at other times remain open till nine at night. It is an agreeable pot-herb while young. The juice is milky, but not too acrid.

PICRIUM, in botany, a genus of the monogynia order, in the tetrandria class of plants; and in the natural method ranking with those that are doubtful. The calyx is monophyllous and quinquefid; the corolla monopetalous, and its tube is short; the filaments are four in number, and hooded at the place of their insertion; the style long and thick; the stigma bilamellated; the capsule is round, bivalved, and contains a number of small seeds. There are two species, viz. the spicatum and ramosum; both natives of Guiana. Both species are bitter, and employed in dyspepsy, and to promote the menses: they are also recommendeded in visceral obstructions.

PICUS, the *woodpecker*, in ornithology, a genus belonging to the order of picæ. The beak is straight, and consists of many sides, and like a wedge at the point: the nostrils are covered with bristly feathers; the tongue is round like a worm, very long, and sharp at the point, which is beset with bristles bent backwards. See Plate Nat. Hist. fig. 337.

The grand characteristic of these birds is the tongue, the muscles necessary to the motions of which are singular and worthy of notice, affording the animal means of darting it forwards the whole length, or drawing it within the mouth at will. Latham enumerates no less than fifty different species of woodpeckers, besides varieties of some of them which amount to nine more. The most remarkable are as follows:

1. The picus martius, or greatest black woodpecker, is about the size of a jackdaw, being about 17 inches long; the bill is nearly two inches and a half in length, of a dark ash-colour; the whole bird is black, except the crown of the head, which is vermilion. The female differs from the male in having the hind head only red, and not the whole crown of the head; and the general colour of the plumage has a strong cast of brown in it. It has likewise been observed, that the red on the hind head has been wholly wanting; and indeed both male and female are apt much to vary in different subjects, some having a much greater proportion of red on the head than others. This species is found on the continent of Europe, but not in plenty except in Germany.

It is said to build in old ash and poplar trees, making large and deep nests; and Friesch observes, that they often so excavate a tree, that it is soon after blown down with the wind; and that under the hole of this bird, may often be found a bushel of dust and bits of wood. The female lays two or three white eggs, the colour of which, as Willughby observes, is peculiar to the whole woodpecker genus, or at least all those which have come under his inspection.

2. The picus principalis, or white-billed woodpecker, is somewhat bigger than the last, being equal in size to a crow. It is sixteen inches long, and weighs about twenty ounces. The bill is white as ivory; the head itself, and the body in general, are black.

This species inhabits Carolina, Virginia, New Spain, and Brazil: and is called by the Spaniards carpenter, and not without reason; as this as well as most of the other species make a great noise with the bill against the trees in the woods, where they may be heard at a great distance, as if carpenters were at work; making, according to Catesby, in an hour or two, a bushel of chips.

3. The picus erythrocephalus, or red-headed woodpecker, is about eight inches three quarters long, and weighs two ounces. The bill is an inch and a quarter in length, of a lead-colour; the head and the neck are of a most beautiful crimson; the back and wings are black; the rump, breast, and belly are white. The cock and hen are very nearly alike.

This species inhabits Virginia, Carolina, Canada, and most of the parts of North America; but at the approach of winter, it migrates more or less to the southward, according to the severity of the season; and upon this circumstance the people of North America foretel the rigour or clemency of the ensuing winter. During the winter they are very tame, and are frequently known to come into the houses in the same manner as the redbreast is wont to do in England. It is observed that this species is found chiefly in old trees; and the noise they make with their bills may be heard above a mile distant. It builds the earliest of all the woodpeckers, and generally pretty high from the ground. It is accounted by many people very good eating.

4. The picus pubescens, or little woodpecker, weighs only one ounce and a half. The top of the head is black, and on each side above the eye is a white line; the hind head is red; the hind part of the neck, the back, and rump, are black, which is divided into two parts by a line of white passing down the middle to the rump. The female has no red on the hind head. It abounds in New Jersey, where it is esteemed most dangerous to orchards, and is the most daring. As soon as it has pecked one hole in a tree, it makes another close to the first, in an horizontal direction, proceeding till it has made a circle of holes quite round the tree; and the apple-trees in the orchards have often several of these rings of holes round the stem, insomuch that the tree frequently dries up and decays.

5. The yellow woodpecker is about nine inches long. The hind head is crested; the head itself, the neck, and whole body, are covered with dirty-white feathers; from the lower jaw to the ears, on each side, there is a red stripe. This species is common at Cayenne, and is called there charpentier jaune. It makes its nest in old trees which are rotten within. The note of this bird is a kind of whistle six times repeated, of which the two or three last are in a graver accent than the others. The female wants the red band on the side of the head which is seen in the male.

6. The viridis, or green woodpecker, weighs six ounces and a half; its length is thirteen inches, the breadth twenty and a half; the bill is dusky, triangular, and near two inches long; the crown of the head is crimson, spotted with black; the eyes are surrounded with black, and the males have a rich crimson mark beneath the blackness; the rump is of a pale yellow; the whole of the under part of the body is of a very pale green. These birds feed entirely on insects; and their principal action is that of climbing up and down the bodies or boughs of trees. This species feeds oftener on the ground than any other of the genus: all of them make their nests in the hollows of trees; and lay five or six eggs, of a beautiful semi-transparent white. The young ones climb up and down the trees before they can fly. It is common in England.

7. The major, or great spotted woodpecker, weighs two ounces three quarters; the length is nine inches; the breadth is sixteen. The forehead is of a pale buff-colour; the crown of the head a glossy black; the hind-part marked with a rich deep crimson spot. The cheeks are white, bounded beneath by a black line that passes from the corner of the mouth and surrounds the hind part of the head. The neck is encircled with a black colour. The throat and breast are of a yellowish white; the vent-feathers of a fine light crimson. The back, rump, and coverts of the tail, and lesser coverts of the wings, are black; the scapular feathers and coverts adjoining to them are white. The quill-feathers are black, elegantly marked on each web with round white spots. The female wants the beautiful crimson spot on the head: in other respects the colours of both agree. This species is much more uncommon than the preceding, and keeps altogether in the woods. This bird is found in England, France, and Germany, and other parts of Europe, frequenting the woods like the rest of its genus, and is likewise met with in America. It is a very cunning bird; for, when a person has seen one on a tree, he is almost sure to lose sight of it, if the tree is large, and the observer not very attentive; for, the moment it spies any one, it will creep behind a branch, and there lie secure till the danger is over.

PIEPOUDRE *(Court of)*, the lowest, and at the same time the most expeditious, court of justice known to the law of England. It is called piepoudre (curia pedis pulverisati) from the dusty feet of the suitors. But the etymology given us by a learned modern writer is much more ingenious and satisfactory; it being derived, according to him, from pied puldreaux, "a pedlar," in old French, and therefore signifying the court of such petty chapmen as resort to fairs or markets. It is a court of record, incident to every fair and market; of which the steward of him who owns or holds the toll of the market is the judge. It was instituted to administer justice for all commercial injuries done in that very fair or market, and not in any preceding one; so that the injury must be done, complained of, heard, and determined, within the compass of one and the same day, unless the fair continues longer. The court has cognizance of all matters of contract that can possibly arise within the precinct of that fair or market; and the plaintiff must make oath that the cause of action arose there. From this court a writ of error lies, in the nature of an appeal, to the courts at Westminster.

PIGEONS. Every person who shall shoot at, kill, or destroy a pigeon, may be committed to the common jail for three months, by two justices of the peace, or pay 20*s.* to the poor. 1 Jac. I. c. 27.

PIKE, an offensive weapon, consisting of a shaft of wood, twelve or fourteen feet long, headed with a flat-pointed steel, called the spear. The pike was a long time in use among the infantry, to enable them to sustain the attack of the cavalry; but it is now taken from them, and the bayonet, which fixes on at the end of the carabine, is substituted in its place. Yet the pike still continues the weapon of the serjeants of foot, who perform no motions with it but in charging.

PILASTER. See ARCHITECTURE.

PILE, in artillery, denotes a collection or heap of shot or shells, piled up by horizontal courses into either a pyramidal or else a wedgelike form; the base being an equilateral triangle, a square, or a rectangle. In the triangle and square, the pile terminates in a single ball or point, and forms a pyramid.

In the triangular and square piles, the number of horizontal rows, or courses, or the number counted on one of the angles from the bottom to the top, is always equal to the number counted on one side, in the bottom row. And in rectangular piles, the number of rows, or courses, is equal to the number of balls in the breadth of the bottom row, or shorter side of the base; also in this case, the number in the top row, or edge, is one more than the difference between the length and breadth of the base.

The courses in these piles are figurative numbers.

In a triangular pile, each horizontal course is a triangular number, produced by taking the successive sums of the ordinate numbers, viz.

$$\begin{aligned} 1 &= 1 \\ 1+2 &= 3 \\ 1+2+3 &= 6 \\ 1+2+3+4 &= 10, \text{ \&c.} \end{aligned}$$

And the number of shot in the triangular pile, is the sum of all these triangular numbers, taken as far, or to as many terms, as the number in one side of the base. And therefore, to find this sum, or the number of all the shot in the pile, multiply continually together the number in one side of the base row, and that number increased by 1, and the same number increased by 2; then $\frac{1}{6}$ of the last product will be the answer, or number of all the shot in the pile.

That is, $\frac{n \cdot \overline{n+1} \cdot \overline{n+2}}{6}$ is the sum; where n is the number in the bottom row.

Again, in square piles, each horizontal course is a square number, produced by taking the square of the number in its side, or the successive sums of the odd numbers, thus,

$$\begin{aligned} 1 &= 1 \\ 1+3 &= 4 \\ 1+3+5 &= 9 \\ 1+3+5+7 &= 16, \text{ \&c.} \end{aligned}$$

And the number of shot in the square pile is the sum of all these square numbers, continued so far, or to as many terms, as the number in one side of the base. And therefore, to find this sum, multiply continually together the number in one side of the bottom course, and that number increased by 1, and double the same number increased by 1; then $\frac{1}{6}$ of the last product will be the sum or answer.

That is, $\frac{n \cdot \overline{n+1} \cdot \overline{2n+1}}{6}$ is the sum.

In a rectangular pile, each horizontal course is a rectangle, whose two sides have always the same difference as those of the base course, and the breadth of the top row, or edge, being only 1; because each course in ascending has its length and breadth always less by 1 than the course next below it. And these rectangular courses are found by multiplying successively the terms or breadths 1, 2, 3, 4, &c. by the same terms added to the constant difference of the two sides d; thus,

$$\begin{aligned} 1 \cdot \overline{1+d} &= 1 + d \\ 2 \cdot \overline{2+d} &= 4 + 2d \\ 3 \cdot \overline{3+d} &= 9 + 3d \\ 4 \cdot \overline{4+d} &= 16 + 4d, \text{ \&c.} \end{aligned}$$

And the number of shot in the rectangular pile is the sum of all these rectangles, which, it is evident, consist of the sum of the squares, together with the sum of an arithmetical progression, continued till the number of terms is the difference between the length and breadth of the base, and 1 less than the edge or top row. And therefore, to find this sum, multiply continually together the number in the breadth of the base row, the same number increased by 1, and double the same number increased by 1, and also increased by triple the difference between the length and breadth of the base; then $\frac{1}{6}$ of the last product will be the answer.

That is, $\frac{b \cdot \overline{b+1} \cdot \overline{2b+3d+1}}{6}$ is the sum;

where b is the breadth of the base, and d the difference between the length and breadth of the bottom course.

PILE, in building, is used for a large stake rammed into the ground in the bottom of rivers, or in marshy land, for a foundation to build upon.

PILE ENGINE. See ENGINE.

PILE, in coinage, denotes a kind of puncheon, which in the old way of coining with the hammer, contained the arms, or other figure and inscription, to be struck on the coin. Accordingly we still call the arms side of a piece of money the pile, and the head the cross; because in ancient coins, a cross usually took the place of the head in ours: but some will have it called pile, from the impression of a ship built on piles, struck on this side of our ancient coins.

PILLAR. See ARCHITECTURE.

PILOT, a person employed to conduct ships over bars and sands, or through intricate channels, into a road or harbour. Pilots are no constant and standing officers aboard our vessels, but are called in occasionally, on coasts or shores unknown to the master; and having piloted in the vessel, they return to the shore where they reside.

Pilots taking upon them to conduct ships up the Thames, are to be examined and approved by the master and wardens of the Trinity-house at Deptford, or shall be liable to forfeit 10*l.* for the first offence, and 20*l.* for the second, &c. and the like penalty, if they act without licence from the said master and wardens; and if by their negligence they lose a ship, they shall be for ever disabled. 3 Geo. I. and 5 Geo. II. c. 20.

PILULARIA, a genus of the cryptogamia filices. There is one species.

PIMELIA, a genus of insects of the order coleoptera. The generic character is, antennæ filiform; feelers four; thorax plano-convex, margined; head exserted; shells rather rigid; wings usually none. It is divided into sections: A, antennæ moniliform at the tip; B, entirely filiform.

PIMELITE, a mineral distinguished by a fine apple-green colour: according to Klaproth, it is composed of

35.00	silica
15.62	oxide of nickel
5.00	alumina
4.58	oxide of iron
1.25	magnesia
37.91	water.
99.36	

PIMENTA, or PIMENTO, *Jamaica pepper*, or *allspice*. See MYRTUS.

PIMPINELLA, *burnet saxifrage*, a genus of the digynia order, in the pentandria class of plants. The petals are bent in; stigma subglobular; fruit ovate, oblong. There are nine species; the most remarkable of which are: 1. The major, or greater burnet saxifrage, growing naturally in chalky woods, and on the sides of the banks near hedges, in several parts of England. 2. The ansium or common anise, an annual plant, which grows naturally in Egypt; but is cultivated in Malta and Spain, whence the seeds are annually imported into Britain.

Both these species are used in medicine. The roots of pimpinella have a grateful, warm, very pungent taste, which is entirely extracted by rectified spirit: in distillation the menstruum arises, leaving all that it had taken up from the root united into a pungent aromatic resin. This root promises, from its sensible qualities, to be a medicine of considerable utility, though little regarded in common practice: the only officinal composition in which it is an ingredient is the pulvis ari compositus. Stahl, Hoffman, and other German physicians, are extremely fond of it; and recommend it as an excellent stomachic, resolvent, detergent, diuretic, diaphoretic, and alexipharmic.

Aniseeds have an aromatic smell, and a pleasant warm taste, accompanied with a degree of sweetness. Water extracts very little of their flavour; rectified spirit, the whole. These seeds are in the number of the four greater hot seeds: their principal use is in cold flatulent disorders, where tenacious phlegm abounds, and in the gripes to which young children are subject. Frederic Hoffman strongly recommends them in weakness of the stomach, diarrhœas, and for strengthening the tone of the viscera in general; and thinks they well deserve the appellation given them by Helmont, intestinorum solamen. The smaller kind of aniseeds brought from Spain are preferred.

PIN, in commerce, a little necessary instrument made of brass wire, chiefly used by women in adjusting their dress. In the year 1543, by statute 34 and 35 of Henry VIII. cap. vi. it was enacted, "that no person shall put to sale any pinnes but only such as shall be double-headed, and have the heads soldered fast to the shank of the pins, well smoothed, the shank well shapen, the points well and round filed, canted, and sharpened." From the above extract it should appear that the art of pin-making was but of late invention, probably introduced from France; and that our manufactories since that period have wonderfully improved.

Though pins are apparently simple, their manufacture is, however, not a little curious and complex. When the brass wire, of which the pins are formed, is first received at the manufactory, it is generally too thick for the purpose of being cut into pins. The first operation therefore is that of winding it off from one wheel to another with great velocity, and causing it to pass between the two, through a circle in a piece of iron of smaller diameter: the wire being thus reduced to its proper dimensions, is straightened by drawing it between iron pins, fixed in a board in a zigzag manner, but so as to leave a straight line between them: afterwards it is cut into lengths of three or four yards, and then into smaller ones, every length being sufficient to make six pins; each end of these is ground to a point, which is commonly performed by boys, who sit each with two small grinding-stones before him, turned by a wheel. Taking up a handful, he applies the ends to the coarsest of the two stones, being careful at the same time to keep each piece moving round between his fingers, so that the points may not become flat: he then gives them a smoother and sharper point, by applying them to the other stone, and by that means a lad of twelve or fourteen years of age is enabled to point about 16,000 pins in an hour. When the wire is thus pointed, a pin is taken off from each end, and this is repeated till it is cut into six pieces. The next operation is that of forming the heads, or, as they term it, head-spinning; which is done by means of a spinning-wheel, one piece of wire being thus with astonishing rapidity, wound round another, and the interior one being drawn out leaves a hollow tube between the circumvolutions: it is then cut with shears, every two circumvolutions or turns of the wire forming one head: these are softened by throwing them into iron pans, and placing them in a furnace till they are red-hot. As soon as they are cold, they are distributed to children, who sit with anvils and hammers before them, which they work with their feet, by means of a lathe; and taking up one of the lengths, they thrust the blunt end into a quantity of the heads which lie before them; and catching one at the extremity, they apply them immediately to the anvil and hammer; and by a motion or two of the foot, the point and the head are fixed together in much less time than it can be described, and with a dexterity only to be acquired by practice; the spectator being in continual apprehension for the safety of their fingers' ends. The pin is now finished as to its form, but still it is merely brass; it is therefore thrown into a copper, containing a solution of tin and the leys of wine. Here it remains for some time; and when taken out assumes a white, though dull appearance: in order therefore to give a polish, it is put into a tub containing a quantity of bran, which is set in motion by turning a shaft that runs through its centre; and thus by means of friction it becomes perfectly bright. The pin being complete, nothing remains but to separate it from the bran; which is performed by a mode exactly similar to the winnowing of corn, the bran flying off, and leaving the pin behind fit for immediate sale.

PINCHBECK, an alloy containing three parts of zinc, and four of copper: it assumes the colour of gold, but it is not so malleable as brass. See ZINC.

PINE. See PINUS.

PINE-APPLE. See BROMELIA.

PINEAL GLAND. See ANATOMY.

PINGUICULA, *butterwort*, a genus of the monogynia order, in the diandria class of plants. The corolla is ringent, with a spur; calyx two-lipped, five-cleft; capsule one-celled. There are five species, of which the most remarkable is the vulgaris, or common butterwort, growing commonly on bogs or low moist grounds in England and Scotland. Its leaves are covered with soft upright pellucid prickles, secreting a glutinous liquor. The flowers are pale red, purple, or deep violet-colour, and hairy within. If the fresh-gathered leaves of this plant are put into the strainer through which warm milk from the cow is poured, and the milk is set by for a day or two to become acescent, it acquires a consistency and tenacity, and neither whey nor cream separates from it. In this state it is an extremely grateful food, and as such is used by the inhabitants of the north of Sweden. There is no further occasion to have recourse to the leaves; for half a spoonful of this prepared milk, mixed with fresh warm milk, will convert it to its own nature, and this again will change another quantity of fresh milk, and so on without end. The juice of the leaves kills lice; and the common people use it to cure the cracks or chops in cows' udders. The plant is generally supposed injurious to sheep, by occasioning in them that disease called the rot; but from experiments made on purpose, and conducted with accuracy, it appears that neither sheep, cows, goats, horses, nor swine, will feed upon this plant. Wherever this plant, called also *Yorkshire sanicle*, is found, it is a certain indication of a boggy soil. From the idea that the country-people have of its noxious operation on sheep, this plant has been called the white rot; since, as they imagine, it gives them the rot whenever they eat it, which they will not do but from great necessity.

The Laplanders, like the Swedes with the milk of cows, receive that of the rein-deer upon the fresh leaves of this plant, which they immediately strain off, and set it aside till it becomes somewhat acescent; and the whole acquires in a day or two the consistence of cream, without separating the serum, and thus becomes an agreeable food. When thus prepared, a small quantity of the same has the property of rennet in producing the like change on fresh milk.

PINGUIN, or PENGUIN, in ornithology, a genus of birds of the order of anseres, distinguished by the following characters: The bill is strong, straight, more or less bending towards the point, and furrowed on the sides: the nostrils are linear, and placed in the furrows; the tongue is covered with strong spines, pointing backwards; the wings are small, very like fins, and covered with no longer feathers than the rest of the body, and are useless in flight; the body is clothed with thick short feathers, having broad shafts, and placed as compactly as the scales of fishes; the legs are short, thick, and placed very near the vent; the toes are four, and are all placed forwards; the interior are loose, and the rest are webbed: the tail is very stiff, consisting of broad shafts scarcely webbed.

It is agreed that pinguins are inhabitants of southern latitudes only; being, as far as is yet known, found only on the coasts of South America, from Port Desire to the Straits of Magellan; and Frezier says they are found on the western shore as high as Conception. In Africa they seem to be unknown, except on a small isle near the Cape of Good Hope, which takes its name from them. They are found in vast numbers on land during the breeding-season, for they seldom come on shore but at that time: they form burrows under ground like rabbits; and the isles they frequent are perfectly undermined by them.

Their attitude on land is quite erect, and on that account they have been compared by some to pigmies, by others to children with white bibs. They are very tame, and may be driven like a flock of sheep. In water they are remarkably active, and swim with vast strength, assisted by their wings, which serve instead of fins; their food in general is fish; not but that they will eat grass like geese.

Mr. Latham remarks, that this genus appears to hold the same place in the southern division of the earth that the awks do in the northern; and that, however authors may differ in opinion on this head, they ought not to be confounded with one another. The pinguin is never seen but in the temperate and frigid zones south of the equator, while the awk only appears in the parallel latitudes north of the equator; for neither of these genera has yet been observed within the tropics.

The wings of the pinguin are scarcely any thing else than mere fins, while the awk has real wings and gills, though they are but small. The former has four toes on each foot, the latter only three. While swimming, the pinguin sinks wholly above the breast, the head and neck only appearing out of the water; while the awk, like most other birds, swims on the surface. There are several other peculiarities which serve to distinguish the two genera, but what we have mentioned are doubtless sufficient.

The bodies of the pinguin tribe are commonly so well and closely covered with feathers that no wet can penetrate; and as they are in general excessively fat, these circumstances united secure them from cold. They have often been found above 700 leagues from land, and frequently on the mountains of ice, on which they seem to ascend without difficulty, as the soles of their feet are very rough, and suited to the purpose. Mr. Latham enumerates nine different species of this genus, besides two varieties of the black-footed pinguin or diomedea.

1. The first, which is a very beautiful species, our author calls the crested pinguin. The birds of this species are twenty-three inches long; the bill is three inches long, and of a red colour; the head, neck, back, and sides, are black. Over each eye there is a stripe of pale yellow feathers, which lengthens into a crest behind, nearly four inches long. The female has a streak of pale yellow over the eye, but it is not prolonged into a crest behind as in the male.

This species inhabits Falkland Islands, and was likewise met with in Kerguelen's Land, or Isle of Desolation, as well as at Van Diemen's Land, and New Holland, particularly in Adventure-bay. They are called hopping pinguins, and jumping Jacks, from their action of leaping quite out of the water, on meeting with the least obstacle, for three or four feet at least; and indeed, without any seeming cause, they often do the same, appearing chiefly to advance by that means. This species seems to have a greater air of liveliness in its countenance than others, yet is in fact a very stupid bird, so much so as to suffer itself to be knocked on the head with a stick when on land. Forster says he found them difficult to kill; and when provoked, he adds, they ran at the sailors in flocks, and pecked their legs, and spoiled their clothes. When angered too, they erect their crests in a beautiful manner. These birds make their nests among those of the pelican tribe, living in tolerable harmony with them; and lay seldom more than one egg, which is white, and larger than that of a duck. They are mostly seen by themselves, seldom mixing with other pinguins, and often met with in great numbers on the outer shores, where they have been bred.

2. The second species mentioned by Latham is the Patagonian. It is distinguished by this name not only because it is found on that coast, but also because it exceeds in bulk the common pinguins as much as the natives are said to do the common race of men. It was first discovered by captain Macbride, who brought one of them from Falkland Islands, off the Straits of Magellan. The length of the stuffed skin of this particular bird measured four feet three inches, and the bulk of the body seemed to exceed that of a swan.

This species, which was, as we have seen, first met with in Falkland Islands, has since been seen in Kerguelen's Land, New Georgia, and New Guinea. M. Bougainville caught one, which soon became so tame as to follow and know the person who had the care of it; it fed on flesh, fish, and bread; but after a time grew lean, pined away, and died. Their chief food, when at large, is thought to be fish; the remains of which, as well as crabs, shell-fish, and molluscæ, were found in the stomach. This species is the fattest of the tribe; and therefore most so in January, when they moult. They are supposed to lay and sit in October. They are met with in the most deserted places. Their flesh is black, though not very unpalatable. This has been considered as a solitary species, but has now and then been met with in considerable flocks.

3. The Magellanic species is about two feet, and sometimes two feet and a half, long, and weighs eleven pounds. The bill is black, having a transverse band across near its tip; the head and neck are black, except a few markings here and there; the upper parts of the body and wings are of the same colour; the under parts of both are white from the breast. This species, which is very numerous, inhabits the Straits of Magellan, Staten Land, Terra del Fuego, and Falkland Islands. Far from being timid, these birds will often attack a man, and peck his legs. As food they are not at all unpalatable. They often mix with sea-wolves among the rushes, burrowing in holes like a fox. They swim with prodigious swiftness. They lay their eggs in collective bodies, resorting in incredible numbers to certain spots, which their long residence has freed from grass, and to which were given the names of towns. Penrose observes, that they composed their nests of mud, a foot in height, and placed as near one another as may be. It is possible that they may have different ways of nesting, according to the places they inhabit; or perhaps the manners of this may be blended with those of another. "Here, (says he, *i. e.* in the places they frequent) during the breeding-season, we were presented with a sight which conveyed a most dreary, and I may say awful, idea of the desertion of these islands by the human species: a general stillness prevailed in these towns: and whenever we took our walks among them, in order to provide ourselves with eggs, we were regarded indeed with side-long glances, but we carried no terror with us. The eggs are rather larger than those of a goose, and laid in pairs. When we took them once, and sometimes twice in a season, they were as often replaced by the birds; but prudence would not permit us to plunder too far, lest a future supply in the next year's brood might be prevented." They lay some time in November, driving away the albatrosses, which have hatched their young in turn before them. The eggs were thought palatable food, and were preserved good for three or four months."

PINION, in mechanics, an arbor, or spindle, in the body whereof are several notches, which catch the teeth of a wheel that serves to turn it round: or it is a lesser wheel which plays in the teeth of a larger.

PINITE, a mineral that has received its name from Pini in Saxony, where it has been found in granite. Its colour is reddish-brown, or black; always in crystals, either rhomboidal prisms, or six-sided prisms; sometimes entire; sometimes having their alternate lateral edges truncated; sometimes whole; surface smooth and brilliant; fracture uneven, passing to conchoidal; specific gravity 2.9. It melts at 153° of Wedgewood, into a black compact glass, the surface of which is reddish. It consists, according to Klaproth, of

63.00	alumina
29.50	silica
6.75	iron.
99.25	

PINK, a vessel used at sea, masted and rigged like other ships, only that this is built with a round stern; the bends and ribs compassing so as that her sides bulge out very much. This disposition renders the pinks difficult to be boarded, and also enables them to carry greater burdens than others, whence they are often used for store-ships, and hospital-ships, in the fleet.

PINK. See DIANTHUS.

PINNA, in zoology; a genus belonging to the order of vermes testacea. The animal is a slug. The shell is bivalve, fragile, and furnished with a beard; gapes at one end; the valves hinge without a tooth. They inhabit the coasts of Provence, Italy, and the Indian ocean. The largest and most remarkable species inhabits the Mediterranean. It is blind; as are all of the genus; but furnished with very strong calcareous valves. The cuttle-fish, an inhabitant of the same sea, is a deadly foe to this animal: as soon as the pinna opens its shell, he rushes upon her like a lion; and would always devour her, but for another animal whom she protects within her shell, and from whom in return she receives very important services. It is an animal of the crab kind (see CANCER), naked like the hermit, and very quick-sighted. This cancer or crab the pinna receives into her covering, and, when she opens her valves in quest of food, lets him out to look for prey. During this the cuttle-fish approaches; the crab returns with the utmost speed and anxiety to his hostess, who being thus warned of the danger shuts her doors, and keeps out the enemy. That very sagacious observer Dr. Hasselquist, in his voyage towards Palestine, beheld this curious phenomenon, which though well known to the antients, had escaped the moderns.

The pinnæ marinæ differ less from muscles in the size of their shells, than in the fineness and number of certain brown threads which attach them to the rocks, hold them in a fixed situation, secure them from the rolling of the waves, especially in tempests, and assist them in laying hold of slime. See MYTILUS. These threads, says Rondelet, are as fine, compared with those of muscles, as the finest flax is compared with tow. M. de Reaumur says, that these threads are nearly as fine and beautiful as silk from the silk-worm, and hence he calls them the silk-worms of the sea. Stuffs, and several kinds of beautiful manufacture, are made of these threads at Palermo; in many places they are the chief object of fishing, and become a silk proper for many purposes. It requires a considerable number of the pinnæ marinæ for one pair of stockings. Nothing can equal the delicacy of this singular thread. It is so fine, that a pair of stockings made of it can be easily contained in a snuff-box of an ordinary size. In 1754, a pair of gloves or stockings of these materials was presented to pope Benedict XIV. which, notwithstanding their extreme fineness, secured the leg both from cold and heat. A robe of the same singular materials was the gift of a Roman emperor to the satrap of Armenia. A great many manufacturers are employed in manufacturing these threads into various stuffs at Palermo and other places.

The men who are employed in fishing up the pinnæ mariæ inform us, that it is necessary to break the tuft of threads. They are fished up at Toulon, from the depth of 15, 20, and sometimes more than 30 feet, with an instrument called a cramp. This is a kind of fork of iron, of which the prongs are perpendicular with respect to the handle. Each of them is about eight feet in length, and there is a space between them of about six inches; the length of the handle is in proportion to the depth of the water; the pinnæ are seized, separated from the rock, and raised to the surface, by means of this instrument. The tuft of silk issues directly from the body of the animal; it comes from the shell at the place where it opens, about four or five inches from the summit or point in the large pinnæ.

PINNACE, a small vessel used at sea, with a square stern, having sails and oars, and carrying three masts, chiefly used as a scout for intelligence, and for landing of men, &c. One of the boats belonging to a great man of war, serving to carry the officers to and from the shore, is also called the pinnace.

PINNACLE, in architecture, the top or roof of a house, terminating in a point. This kind of roof, among the antients, was appropriated to temples; their ordinary roofs were all flat, or made in the platform way. It was from the pinnacle that the form of the pediment took its rise.

PINNATED LEAVES. See BOTANY.

PINUS, the *pine-tree*, a genus of the monadelphia order, in the monœcia class of plants. The male calyx is four-leaved; no corolla; stamina very many, with naked anthers; fem. cal. strobiles, with a two-flowered scale; corolla none; pistil one; nut with a membraneous wing. There are 21 species of this genus; of which the most remarkable are the following:

1. The pinea pineaster, or wild pine, grows naturally on the mountains in Italy and the south of France. It grows to the size of a large tree; the branches extend to a considerable distance; and while the trees are young, they are full of leaves, especially where they are not so close as to exclude the air from those within; but as they advance in age, the branches appear naked, and all those which are situated below become unsightly in a few years; for which reason they are now much less in esteem than formerly.

2. The pinus pinea, or stone pine, is a tall evergreen tree, native of Italy and Spain. It delights in a sandy loam, though like most others it will grow well in almost any land. Respecting the uses of this species, Hanbury tells us that "the kernels are eatable, and by many preferred to almonds. In Italy they are served up at table in their desserts. They are exceedingly wholesome, being good for coughs, colds, consumptions, &c. on which account only this tree deserves to be propagated."

3. The rubra, commonly called the Scots fir or pine. It is common throughout Scotland, whence its name, though it is also found in most of the other countries of Europe. M. du Hamel, of the Royal Academy of Sciences, mentions his having received some seeds of it from St. Domingo in the West Indies; and thence concludes, that it grows indifferently in the temperate, frigid, and torrid zones. The wood of this tree is the red or yellow deal, which is the most durable of any of the kinds yet known. The leaves of this tree are much shorter and broader than those of the former sort, of a greyish colour, growing two out of one sheath; the cones are small, pyramidal, and end in narrow points; they are of a light colour, and the seeds are small.

4. The pinus picea, or yew-leaved fir, is a tall evergreen, and a native of Scotland, Sweden, and Germany. This species includes the silver fir, and the balm of Gilead fir. The first of these is a noble upright tree. Mr. Marsham says, "The tallest trees I have seen were spruce and silver firs in the valleys in Switzerland. I saw several firs in the dock-yards in Venice 40 yards long; and one of 39 yards was 18 inches diameter at the small. I was told they came from Switzerland." The branches are not very numerous, and the bark is smooth and delicate. The leaves grow singly on the branches, and their ends are slightly indented. Their upper surface is of a fine strong green colour, and their under has an ornament of two white lines running lengthwise on each side the mid-rib; on account of which silvery look this sort is called the silver fir. The cones are large, and grow erect; and when the warm weather comes on, they soon shed their seeds, which should be a caution to all who wish to raise this plant, to gather the cones before that happens.

The balm of Gilead fir has of all the sorts been most coveted, on account of the great fragrance of its leaves, though this is not its only good property; for it is a very beautiful tree, naturally of an upright growth, and the branches are so ornamented with their balmy leaves as to exceed any of the other sorts in beauty.

The silver fir is very hardy, and will grow in any soil or situation, but always makes the greatest progress in rich loamy earth. The balm of Gilead fir must be planted in deep, rich, good earth; nor will it live long in any other. The soil may be a black mould, or of a sandy nature, if it is deep enough, and if the roots have room enough to strike freely.

5. The pinus abies, or European spruce fir, a native of the northern parts of Europe and Asia, includes the Norway spruce and long-coned Cornish fir. The former of these is a tree of as much beauty while growing, as its timber is valuable when propagated on that account. Its growth is naturally like the silver, upright; and the height it will aspire to may be easily conceived, when we say that the white deal, so much coveted by

the joiners, &c. is the wood of this tree; and it may perhaps satisfy the curious reader to know, that from this fir pitch is drawn. The leaves are of a dark-green colour; they stand singly on the branches. They are very narrow, their ends are pointed, and they are possessed of such beauties as to excite admiration. The cones are eight or ten inches long, and hang downwards.

6. The pinus Canadensis, American or Newfoundland spruce fir, a native of Canada, Pennsylvania, and other parts of North America, includes three varieties; the white Newfoundland spruce, the red Newfoundland spruce, and the black Newfoundland spruce. These, however, differ so little, that one description is common to them all. They are of a genteel upright growth, though they do not shoot so freely, nor grow so fast, with us, as the Norway spruce.

7. The pinus balsamea, or hemlock fir, a native of Virginia and Canada, possesses as little beauty as any of the fir tribe; though, being rather scarce in proportion, it is deemed valuable. It is called by some the yew-leaved fir, from the resemblance of the leaves to those of the yew-tree. It is a tree of low growth, with but few branches; and these are long and slender, and spread abroad without order. The cones are very small and rounded; they are about half an inch long, and the scales are loosely arranged. We receive these cones from America, by which we raise the plants; though this caution should be given to the planter, that this tree is fond of moist rich ground, and in such a kind of soil will make the greatest progress.

8. The pinus Orientalis, or Oriental fir, a native of the East, is a low but elegant tree. The leaves are very short, and nearly square. The fruit is exceedingly small, and hangs downward; and the whole tree makes an agreeable variety with the other kinds.

9. The strobus, lord Weymouth's pine, or North American white pine, grows sometimes to the height of 100 feet, and upwards, and is highly valued on account of its beauty. The bark of the tree is very smooth and delicate, especially when young; the leaves are long and slender, five growing out of one sheath, and thus make a fine appearance. The cones are long, slender, and very loose, opening with the first warmth of the spring; so that, if they are not gathered in winter, the scales open, and let out the seeds. The wood of this sort is esteemed for making masts for ships. In queen Anne's time there was a law made for the preservation of these trees, and for the encouragement of their growth in America. Within these last 50 years they have been propagated in Britain in considerable plenty.

The soil the Weymouth pine delights in most is a sandy loam; but it likes other soils of an inferior nature, although it is not generally to be planted on all lands like the Scotch fir. On stony and slaty ground, likewise, there are some very fine trees; so that whoever is desirous of having plantations of this pine, need not be too curious in the choice of his ground.

10. The pinus tæda, or swamp-pine, is a tall evergreen tree, a native of the swamps of Virginia and Canada. There are several varieties of this genus which Hanbury enumerates and describes, such as, 1st, The three-leaved American swamp-pine. 2d, The two-leaved American pine. 3d, The yellow American pine, the yellow tough pine, and the tough pine of the plains; among which there is but little variety. 4th, The bastard pine. 5th, The frankincense pine. 6th, The dwarf pine.

11. The pinus cedrus is that popularly called by us the cedar of Lebanon; by the antients cedrus magna, or the great cedar. It is a coniferous evergreen, of the bigger sort, bearing large roundish cones of smooth scales, standing erect, the leaves being small, narrow, and thick-set. They sometimes counterfeit cedar, by dying wood of a reddish hue: but the smell discovers the cheat, that of true cedar being very aromatic. In some places, the wood of the cajou tree passes under the name of cedar, on account of its reddish colour and its aromatic smell, which somewhat resemble that of santal. Cedar wood is reputed almost immortal and incorruptible; a prerogative which it owes chiefly to its bitter taste, which the worms cannot endure. For this reason it was that the ancients used cedar tablets to write upon, especially for things of importance, as appears from that expression of Persius, "Et cedrâ digna locutus." A juice was also drawn from cedar, with which they smeared their books and writings, or other matters, to preserve them from rotting.

Solomon's temple, as well as his palace, were both of this wood. "The statue (says Hanbury) of the great goddess at Ephesus was made of this material; and if this tree abounded with us in great plenty, it might have a principal share in our most superb edifices." It is remarkable that this tree is not to be found as a native in any other part of the world than mount Libanus, as far as has yet been discovered. What we find mentioned in Scripture of the lofty cedars, can be nowise applicable to the common growth of this tree; since, from the experience we have of those now growing in England, as also from the testimony of several travellers who have visited those few remaining trees on mount Libanus, they are not inclined to grow very lofty, but on the contrary extend their branches very far.

Maundrel, in his Travels, says there were but 16 large trees remaining when he visited mount Libanus, some of which were of a prodigious bulk, but that there were many more young ones of a smaller size: he measured one of the largest, and found it to be 12 yards six inches in girth, and yet sound, and 37 yards in the spread of its boughs. At about five or six yards from the ground it was divided into five limbs, each of which was equal to a great tree. What Maundrel has related was confirmed by a gentleman who was there in the year 1720, with this difference only, viz. in the dimensions of the branches of the largest tree; which he measured, and found to be 22 yards diameter. Now whether Mr. Maundrel meant 37 yards in circumference of the spreading branches, or the diameter of them, cannot be determined by his words; yet either of them well agrees with this last account.

12. The larix, or larch-tree, with deciduous leaves, and oval obtuse cones. It grows naturally upon the Alps and Apennines, and of late has been very much propagated in Britain. It is of quick growth, and the trunk rises to 50 feet or more; the branches are slender, their ends generally hanging downward. In the month of April the male flowers appear, which are disposed in form of small cones; the female flowers are collected into oval obtuse cones, which in some species have bright purple tops, and in others they are white: these differences are accidental; the cones are about an inch long, obtuse at their points; the scales are smooth, and lie over each other: under each scale there are generally lodged two seeds, which have wings. There are two other varieties of this tree, one of which is a native of America, and the other of Siberia. The cones of the American kind which have been brought to Britain, seem in general to be larger than those of the common sort.

From the larch-tree is extracted what we erroneously call Venice turpentine. This substance, or natural balsam, flows at first without incision; and when it has done dropping, the poor people who wait in the fir woods make incisions at about two or three feet from the ground into the trunks of the trees, into which they fix narrow troughs about 20 inches long. The end of these troughs is hollowed like a ladle; and in the middle is a small hole bored for the turpentine to run into the receiver which is placed below it. As the gummy substance runs from the trees, it passes along the sloping gutter or trough to the ladle, and from thence runs through the holes into the receiver. The people who gather it visit the trees morning and evening from the end of May to September, to collect the turpentine out of the receivers. When it flows out of the tree, Venice turpentine is clear like water, and of a yellowish-white; but, as it grows older, it thickens and becomes of a citron-colour. It is procured in the greatest abundance in the neighbourhood of Lyons; and in the valley of St. Martin, near St. Lucern, in Switzerland.

All the sorts of pines are propagated by seeds produced in hard woody cones. The way to get the seeds out of these cones is, to lay them before a gentle fire, which will cause the cells to open, and then the seeds may be easily taken out. If the cones are kept entire, the seeds will remain good for some years; so that the surest way of preserving them is to let them remain in the cones till the time for sowing the seeds. If the cones are kept in a warm place in summer, they will open and emit the seeds; but if they are not exposed to the heat, they will remain close for a long time. The best season for sowing the pines is about the end of March. When the seeds are sown, the place should be covered with nets to keep off the birds; otherwise, when the plants begin to appear with the husk of the seed on the top of them, the birds will peck off the tops, and thus destroy them.

From the first species is extracted the common turpentine, much used by farriers, and from which is drawn the oil of that name. The process of making pitch, tar, resin, and turpentine, from these trees, is this: In the spring time, when the sap is most free in running, they pare off the bark of the pine-tree, to make the sap run down into a hole which they cut at the bottom to receive it. In the way, as it runs down, it leaves a white matter like cream, but a little thicker. This is very different from all the kinds of resin and turpentine in use; and is generally sold to be used in the making of flambeaux, instead of white bees'-wax. The matter that is received in the hole at the bottom is taken up with ladles, and put in a large basket; a great part of this immediately runs through, and this is the common turpentine. This is received into stone or earthen pots, and is ready for sale. The thicker matter, which remains in the basket, they put into a common alembic, adding a large quantity of water. They distil this as long as any oil is seen swimming on the water. This oil they separate from the surface in large quantities, and this is the common oil or spirit of turpentine. The remaining matter at the bottom of the still is common yellow resin. When they have thus obtained all they can from the sap of the tree, they cut it down; and, hewing the wood into billets, they fill a pit dug in the earth with these billets; and setting them on fire, there runs from them, while they are burning, a black thick matter. This naturally falls to the bottom of the pit, and this is the tar. The top of the pit is covered with tiles, to keep in the heat; and there is at the bottom a little hole, out at which the tar runs like oil. If this hole is made too large, it sets the whole quantity of the tar on fire; but if small enough, it runs quietly out.

The tar, being thus made, is put up in barrels; and if it is to be made into pitch, they put it into large boiling-vessels, without adding any thing to it. It is then suffered to boil awhile, and being then let out, is found when cold to be what we call pitch.

A decoction of the nuts or seeds of the first species in milk, or of the extremities of the branches pulled in spring, is said, with a proper regimen, to cure the most inveterate scurvy. The wood of this species is not valued; but that of the Scots pine is superior to any of the rest. It is observable of the Scots pine, that when planted in bogs, or in a moist soil, though the plants make great progress, yet the wood is white, soft, and little esteemed; but when planted in a dry soil, though the growth of the trees is there very slow, yet the wood is proportionably better. Few trees have been applied to more uses than this. The tallest and straightest are formed by nature for masts to our navy. The timber is resinous, durable, and applicable to numberless domestic purposes, such as flooring and wainscoting of rooms, making of beds, chests, tables, boxes, &c. From the trunk and branches of this, as well as most others of the pine tribe, tar and pitch are obtained. By incision, barras, Burgundy pitch, and turpentine, are acquired and prepared. The resinous roots are dug out of the ground in many parts of the Highlands, and, being divided into small splinters, are used by the inhabitants to burn instead of candles. At Loch-Broom, in Ross-shire, the fishermen make ropes of the inner bark; but hard necessity has taught the inhabitants of Sweden, Lapland, and Kamtschatka, to convert the same into bread. To effect this, they, in the spring season, make choice of the tallest and fairest trees; then stripping off carefully the outer bark, they collect the soft, white, succulent, interior bark, and dry it in the shade. When they have occasion to use it, they first toast it at the fire, then grind, and after steeping the flour in warm water to take off the resinous taste, they make it into thin cakes, which are baked for use. On this strange food the poor inhabitants are sometimes constrained to live for a whole year; and we are told, through custom, become at last even fond of it. Linnæus remarks, that this same barkbread will fatten swine; and humanity obliges us to wish, that men might never be reduced to the necessity of robbing them of such a food. The interior bark, of which the abovementioned bread is made, the Swedish boys frequently peel off the trees in the spring, and eat raw with a greedy appetite. From the cones of this tree are prepared a diuretic oil, like the oil of turpentine, and a resinous extract, which has similar virtues with the balsam of Peru. An infusion or tea of the buds is highly commended as an antiscorbutic. The farina, or yellow powder, of the male flowers, is sometimes in the spring carried away by the winds, in such quantities, where the trees abound, as to alarm the ignorant with the notion of its raining brimstone. The tree lives to a great age; Linnæus affirms, to 400 years.

PIONEERS, in the art of war, are such as are commanded in from the country, to march with an army for mending the ways, for working on intrenchments and fortifications, and for making mines and approaches. The soldiers are likewise employed for all these purposes. Most of the foreign regiments of artillery have half a company of pioneers, well instructed in that important branch of duty. Our regiments of infantry and cavalry have about twenty pioneers each, provided with aprons, hatchets, saws, spades, and pick-axes. Each pioneer must have an ax, a saw, and an apron; a cap with a leather crown, and a black bear-skin front, on which is to be the king's crest in white, on a red ground; and the number of the regiment is to be on the back part of it.

PIP, or Pep, pepia, a disease among poultry, consisting of a white thin skin, or film, that grows under the tip of the tongue, and hinders their feeding. It usually arises from want of water, or from drinking puddle-water, or eating filthy meat. It is cured by pulling off the film with the fingers, and rubbing the tongue with salt. Hawks are particularly liable to this disease, especially from feeding on stinking flesh.

PIPE, in building, &c. a canal, or conduit, for the conveyance of water and other fluids. Pipes for water, water-engines, &c. are usually of lead, iron, earth, or wood: the latter are commonly made of oak or elder. Those of iron are cast in forges; their usual length is about two feet and a half: several of these are commonly fastened together by means of four screws at each end, with leather or old hat between them, to stop the water. Those of earth are made by the potters; these are fitted into one another, one end being always made wider than the other. To join them the closer, and prevent their breaking, they are covered with tow and pitch: their length is usually about that of the iron pipes. The wooden pipes are trees bored with large iron augurs, of different sizes, beginning with a less, and then proceeding with a larger successively; the first being pointed, the rest formed like spoons, increasing in diameter, from one to six inches or more: they are fitted into the extremities of each other, and are sold by the foot.

Pipe-Boring. AA, Plate Perambulator, &c. fig. 4, are two beams laid on each side of a pit, into which the chips are to fall. Upon the edges of these, the wheels of a frame DE run. This frame has four pieces, *ddaa*, across it; and two windlases, *bb*, which have chains round them, going over the piece of timber F which is to be bored. The two end-pieces *dd* have uprights *ee* in them; between which the tree is laid, and is secured with wedges in different places as the occasion requires. G is a piece lying across the two beams AA: this is connected with the frame DE by two iron bars *ff*, which are fastened to it; and go through holes in the piece *d*, and are held there by pins put through holes in both. The piece G has two uprights in it, between which is a brass pulley to support the weight of the boring-bar H. *ghi* is a wheel, with handles on its circumference to turn it by; on its axis I a rope is coiled; one end of which goes over a pulley (not seen), and is fastened to the carriage DE. At *i* the other end goes over a similar pulley, and is tied to the other end of the carriage DE. The machine is put into some place where there is a crane, by which the tree can be lifted on to the carriage; first withdrawing the carriage from the boring-bar, by turning the wheel from *g* to *i*, and separating it from the piece G by taking out the pins. It is then wedged into its place, and secured by the windlases *bb*. The wheel is next turned back, the carriage drawn up to the borer, and the piece G pinned in. The machine (either horses, water, steam, &c.) which turns the borer is then set to work; and a man constantly attends at the wheel *ghi*, to draw the pipe up to the borer. The use of the wheel in the piece G is, to support the borer just where it enters the pipe, and make it work steady. When the pipe is bored through, it is withdrawn, and another tree is placed on the carriage as before.

Pipes *of an Organ*. See Organ.

Pipes, *tobacco*, are made of various fashions; long, short, plain, worked, white, varnished, unvarnished, and of various colours, &c. The Turks use pipes three or four feet long, made of rushes, or of wood bored, at the end whereof they fix a kind of pot of baked earth, which serves as a bowl, and which they take off after smoking.

Pipe also denotes a vessel or measure for wine, containing 126 gallons.

Pipe-Office is an office wherein a person called the clerk of the pipe makes out leases of crown lands, by warrant from the lord-treasurer, or commissoners of the treasury, or chancellor of the exchequer. The clerk of the pipe makes out also accounts of sheriffs, &c. and gives the accomptants their quietus est. To this office are brought all accounts which pass the remembrancer's office, and remain there, that if any stated debt is due from any person, the same may be drawn down into the great roll of the pipe; upon which the comptroller issues out a writ, called the summons of the pipe, for recovery thereof; and if there are no goods or chattels, the clerk then draws down the debts to the lord-treasurer's remembrancer, to write estreats against their lands. All tallies which vouch the payment of any sum contained in such accounts, are examined and allowed by the chief secondary of the pipe. Besides the chief clerk in this office, there are eight attorneys, or sworn clerks, and a comptroller.

PIPER, PEPPER; a genus of the trigynia order, in the diandria class of plants. There is no calyx or corolla; the berry is one-seeded. There are 60 species, of which the most remarkable is the siriboa, with oval, heart-shaped, nerved leaves, and reflexed spikes. This is the plant which produces the pepper so much used in food. It is a shrub whose root is small, fibrous, and flexible; it rises into a stem, which requires a tree or prop to support it. Its wood has the same sort of knots as the vine; and when it is dry, it exactly resembles the vine-branch. The leaves, which have a strong smell and a pungent taste, are of an oval shape; but they diminish towards the extremity, and terminate in a point. From the flower-buds, which are white, and are sometimes placed in the middle and sometimes at the extremity of the branches, are produced small berries resembling those of the currant. Each of these contains between 20 and 30 corns of pepper; they are commonly gathered in October, and exposed to the sun seven or eight days. The fruit, which was green at first, and afterwards red, when stripped of its covering assumes the appearance it has when we see it. The largest, heaviest, and least shrivelled, is the best. The pepper-plant flourishes in the islands of Java, Sumatra, and Ceylon, and more particularly on the Malabar coast. It is not sown, but planted; and great nicety is required in the choice of the shoots. It produces no fruit till the end of three years; but bears so plentifully the three succeeding years, that some plants yield between six and seven pounds of pepper. The bark then begins to shrink; and the shrub declines so fast, that in 12 years time it ceases bearing.

Betle, or betel, is a species of this genus. It is a creeping and climbing plant like the ivy; and its leaves a good deal resemble those of the citron, though they are longer and narrower at the extremity. It grows in all parts of India, but thrives best in moist places. The natives cultivate it as we do the vine, placing props for it to run and climb upon; and it is a common practice to plant it against the tree which bears the areca nut. At all times of the day, and even in the night, the Indians chew the leaves of the betel, the bitterness of which is corrected by the areca that is wrapped up in them. There is constantly mixed with it the chinam, a kind of burnt lime made of shells. The rich frequently add perfumes, either to gratify their vanity or their sensuality.

It would be thought a breach of politeness among the Indians to take leave for any long time, without presenting each other with a purse of betel. It is a pledge of friendship that relieves the pain of absence. No one dares to speak to a superior unles his mouth is perfumed with betel; it would even be rude to neglect this precaution with an equal. The women of gallantry are the most lavish in the use of betel. Betel is taken after meals; it is chewed during a visit; it is offered when you meet, and when you separate; in short, nothing is to be done without betel. If it is prejudicial to the teeth, it assists and strengthens the stomach. At least, it is a general fashion that prevails throughout India.

The piper nigrum, or black pepper, and the piper longum, or long pepper, of Jamaica, with some other species, are indigenous, and known by the names of joint wood, or peppery elders. The first bears a small spike, on which are attached a number of small seeds of the size of mustard. The whole of the plant has the exact taste of the East India black pepper. The long-pepper bush grows taller than the nigrum. The leaves are broad, smooth, and shining; the fruit is similar to the long pepper of the shops, but smaller. The common people in Jamaica season their messes with the black pepper. To preserve both, the fruit may be slightly scalded when green, then dried, and wrapped in paper.

PIPRA, the manakin, a genus of birds of the order of passeres. Latham describes 25 different species, and five varieties. The general character of the genus is, that the bill is short, strong, hard, and slightly incurvated, and the nostrils are naked. The middle toe is connected to the outer as far as the third joint; this character, however, is not altogether universal, some of the species differing in this particular. The tail is short. This genus has a considerable resemblance to the genus parus, or titmouse. They are supposed to inhabit South America only; but this is not true, for Mr. Latham assures us that he has seen many of those species which he has described which came from other parts, but which nevertheless certainly belong to this genus.

1. The pipra rupicola, or crested manakin, is about the size of a small pigeon, being about ten or twelve inches long. The bill is about an inch and a quarter long, and of a yellowish colour. The head is furnished with a double round crest; the general colour of the plumage is orange, inclining to saffron; the wing-coverts are loose and fringed. The female is altogether brown, except the under wing-coverts, which are of a rufous orange; the crest is neither so complete nor rounded as that of the male. Both males and females are at first grey, or of a very pale yellow, inclining to brown. The male does not acquire the orange colour till the second year, neither does the female the full brown. See Plate Nat. Hist. fig. 337. This beautiful species inhabits various parts of Surinam, Cayenne, and Guiana, in rocky situations; but is no where so frequent as in the mountain Luca, near the river Oyapoc, and in the mountain Courouayé, near the river Aprouack, where they build in the cavernous hollows and the darkest recesses.

2. The next species Mr. Latham calls the tuneful manakin. Its length is four inches; the bill is dusky, the forehead yellow, and the crown and nape blue; the chin, sides of the head below the eyes, and the throat, are black; the upper part of the back, the wings, and the tail, are dusky black. It is a native of St. Domingo, where it has gained the name of organiste from its note, forming the complete octave in the most agreeable manner, one note successively after another. It is said not to be uncommon, but not easy to be shot, as like the creeper, it perpetually shifts to the opposite part of the branch from the spectator's eye, so as to elude his vigilance.

3. The albifrons inhabits South America. See Plate Nat. Hist. fig. 336. There are about 30 species.

PIRATE. By stat 28 H. VIII. c. 15, all treasons, felonies, robberies, murders, and confederacies committed upon the sea, or in any haven, creek, or place where the admiral has jurisdiction, shall be tried in such shires or places as the king shall appoint by his commission in like forms, as if such offence had been committed upon land, and according to the course of the common law, and the offenders shall suffer death without benefit of clergy. And by stat. 6 Geo. I, made perpetual, it is enacted, that if any of his majesty's natural-born subjects, or denizens of this kingdom, shall commit any piracy or robbery, or any act of hostility, against other his majesty's subjects upon the sea, under colour of any commission from any prince or state, or pretence of authority from any person whatsoever, such offender shall be deemed to be a pirate, felon, and robber; and being duly convicted thereof according to this act, or the aforesaid act of 23 H. VIII, shall have and suffer such pains of death, loss of lands, goods, and chattels, as pirates, felons, and robbers upon the seas, ought to have and suffer. By 18 Geo. II. c. 30. persons committing hostilities, or aiding enemies at sea, may be tried as pirates. Piracies at sea are excepted out of the general pardon, by 20 Geo. II. c. 52.

PIRATE'S GOODS, go to the admiral by grant; but not piratical goods, which go to the king if the owner is not known.

PISCES, in astronomy, the twelfth sign or constellation of the zodiac. The stars in Pisces, in Ptolemy's catalogue, are 38; in Tycho's, 33; and in the Britannic catalogue, 109.

PISCIDIA, a genus of the decandria order, in the diadelphia class of plants. The stigma is acute; the legume winged four ways. There are two species, viz. 1. The erythrina or dog-wood tree. This grows plentifully in Jamaica, where it rises to the height of twenty-five feet or more; the stem is almost as large as a man's body, covered with a light-coloured smooth bark, and sending out several branches at the top without order. The flowers are of a dirty-white colour; they are succeeded by oblong pods which contain the seeds. 2. The Carthaginiensis, with oblong oval leaves, is also a native of the West Indies. It differs from the former only in the shape and consistence of the leaves, which are more oblong and stiffer; but in other respects they are very similar. Both species are easily propagated by seeds; but require artificial heat to preserve them in this country. The negroes in the West Indies make use of the bark of the first species to intoxicate fish. When any number of gentlemen have an inclination to divert themselves with fishing, or, more properly speaking, with fish-hunting, they send each of them a negro-slave to the woods, in order to fetch some of the bark of the dog-wood tree. This bark is next morning pounded very small with stones, put into old sacks, carried into rocky parts of the sea, steeped till thoroughly soaked with salt water, and then well squeezed by the negroes to express the juice. This juice immediately colours the sea with a reddish hue; and, being of a poisonous nature, will in an hour's time make the fishes, such as groopers, rock-fish, old-wives, Welshmen, &c. so intoxicated, as to swim on the surface of the water, quite heedless of the danger; the gentlemen then send in their negroes, who pursue, both swimming and diving, the inebriated fishes, till they catch them with their hands; their masters in the mean time standing by, on high rocks, to see the pastime. It is remarkable, that though this poison kills millions of the small fry, it has never been known to impart any bad quality to the fish which have been caught in consequence of the intoxication. The wood of this tree, although pretty hard, is only fit for fuel.

PISCIS VOLANS, a small constellation of the southern hemisphere, unknown to the antients, and invisible to us in these northern regions.

PISOLITE, a mineral found at Carlsbad in Bohemia. It has the form of round masses composed of concentric layers, and containing a grain of sand in their centre. Colour white, often greyish, reddish, or yellowish. The round bodies are collected together like a bunch of grapes.

PISONIA, a genus of the polygamia diœcia class of plants, the corolla whereof is of an infundibuliform shape; the tube is short; the limb is semiquinquefid, acute, and patulous; the fruit is an oval quinquangular capsule, formed of five valves, and containing only one cell; the seed is single, smooth, and ovato-oblong. There are five species, trees of the West Indies.

PISTACHIA, *turpentine-tree, pistachia-nut, mastich-tree*; a genus of the pentandria order, in the diœcia class of plants. The male is an ament.; cal. five-cleft; cor. none; fem. distinct; cal. trifid; cor. none; styles two; drupe one-seeded. There are six species; of which the most remarkable are: 1. The terebinthus, or pistachia-tree. This grows naturally in Arabia, Persia, and Syria, whence the nuts are annually brought to Europe. In those countries it grows to the height of 25 or 30 feet; the bark of the stem and old branches is of a dark russet colour, but that of the young branches is of a light brown. Some of these trees produce male and others female flowers, and some have both male and female on the same tree. The male flowers come out from the sides of the branches in loose bunches or catkins. They have no petals, but five small stamina. The female flowers come out in clusters from the sides of the branches; they have no petals; but a large oval germen supporting three reflexed styles, and are succeeded by oval nuts. 2. The lentiscus, or common mastich-tree, grows naturally in Portugal, Spain, and Italy. Being an evergreen, it has been preserved in this country in order to adorn the green-houses. In the countries where it is a native, it rises to the height of eighteen or twenty feet. 3. The orientalis, or true mastich-tree of the Levant, from which the mastich is gathered, has been confounded by most botanical writers with the lentiscus, or common mastich-tree, above described, though there are considerable differences between them.

The first species is propagated by its nuts; which should be planted in pots filled with light kitchen-garden earth, and plunged into a moderate hotbed to bring up the plants. The second sort is commonly propagated by laying down the branches, though it may also be raised from the seed in the manner already directed for the pistachia-nut tree; and in this manner also may the true mastich-tree be raised. But this, being more tender than any of the other sorts, requires to be constantly sheltered in winter, and to have a warm situation in summer.

Pistachia-nuts have a pleasant, sweet, unctuous taste, resembling that of almonds; and they abound with a sweet and well-tasted oil, which they yield in great abundance on being pressed after bruising them; they are reckoned amongst the analeptics, and are wholesome and nutritive, and are by some esteemed very proper to be prescribed by way of restoratives, eaten in small quantity, to people emaciated by long illness.

PISTIA, a genus of the monadelphia octandria class and order. There is no calyx; the corolla is one-petalled, tongue-shaped, entire; anthers six or eight; style one; capsule one-celled. There is one species, an aquatic of Senegal.

PISTIL. See Botany.

PISTON. See Pump.

PISUM, pea; a genus of the decandria order, in the diadelphia class of plants. The style is triangular, above one-celled, pubescent; calyx has the two upper segments shorter. The species are, 1. The sativum, or garden-pea. 2. The maritimum, or sea-pea, with footstalks which are plain on their upper side, an angular stalk, arrow-pointed stipulæ, and footstalks bearing many flowers. 3. The ochrus, with membranaceous running footstalks, having two leaves and one flower upon a footstalk.

There is a great variety of garden-peas now cultivated in Britain, which are distinguished by the gardeners and seedsmen, and have their different titles; but as great part of these have been seminal variations, so, if they are not very carefully managed, by taking away all those plants which have a tendency to alter before the seeds are formed, they will degenerate into their original state; therefore all those persons who are curious in the choice of seeds, look carefully over those which they design for seeds at the time when they begin to flower, and draw out all the plants which they dislike from the other. This is what they call roguing their peas; meaning the taking out all the bad plants from the good, that the farina of the former may not impregnate the latter; to prevent which, they always do it before the flowers open. By thus diligently drawing out the bad, reserving those which come earliest to flower, they have greatly improved their peas of late years, and are constantly endeavouring to get forwarder varieties; so that it would be to little purpose in this place to attempt giving a particular account of all the varieties now cultivated; we shall therefore only mention the names by which they are commonly known, placing them according to their time of coming to the table, or gathering for use.

The golden hotspur.	Nonpareil.
The charlton.	Sugar dwarf.
The Reading hotspur.	Sickle pea.
Master's hotspur.	Marrowfat.
Essex hotspur.	Rose or crown pea.
The dwarf pea.	Rounceval pea.
The sugar pea.	Grey pea.
Spanish Morotto	Pig pea.

Among the new varieties we may specify an uncommonly fine species of marrowfat, raised by that truly philosophical gardener, R. P. Knight, esq. and to be had at Mr. Mason's, Fleet-street.

The English sea-pea is found wild upon the shore in Sussex and several other counties in England, and is undoubtedly a different species from the common pea.

The third sort is annual, and grows naturally among the corn in Sicily and some parts of Italy, but is here preserved in botanic gardens for the sake of variety. It has an angular stalk, rising near three feet high; the leaves stand upon winged footstalks, each sustaining two oblong lobes. The flowers are of a pale yellow colour, shaped like those of the other sort of pea, but are small, each footstalk sustaining one flower; these are succeeded by pods about two inches long, containing five or six roundish seeds, which are a little compressed on their sides. These are by some persons eaten green; but unless they are gathered very young, they are coarse, and at best not so good as the common pea. It may be sown and managed in the same way as the garden pea.

PITCAIRNIA, a genus of the hexandria monogynia class and order. The calyx is three-leaved, half-superior; corolla three-petalled, with a scale at the base of each; stigmas three, contorted; capsules three, opening inwards; seeds winged. There are three species, herbs of the West Indies.

PITCH, a tenacious oily substance, drawn chiefly from pines and firs, and used in shipping, medicine, and various other arts; or it is more properly tar, inspissated by boiling it over a slow fire. See Pinus.

Pitch, *mineral*, has a strong resemblance to common pitch. Colour black, dark-brown, or reddish. Specific gravity from 1.45 to 2. Does not stain the fingers. On a white iron it flames with a strong smell, and leaves a quantity of grey ashes. See Bitumen.

PITCHSTONE. This stone, which occurs in different parts of Germany, France, and other countries, has obtained its name from some resemblance which it has been supposed to have to pitch. It is most usually in amorphous pieces of different sizes.

Its fracture is conchoidal and uneven, and sometimes approaches the splintery. Exceedingly brittle; it yields even to the nail of the finger. Specific gravity 2.3 to 1.6. Its colours are numerous; greyish black, bluish grey, green, red, yellow of different shades. Sometimes several of these colours appear together in the same stone. A specimen of pitchstone, analysed by Mr. Klaproth, contained

73.00	silica
14.50	alumina
1.00	lime
1.00	oxide of iron
0.10	oxide of manganese
1.75	soda
8.50	water.
99.85	

PITH, in vegetation, the soft spongy substance contained in the central parts of plants and trees. See Plants, *physiology of.*

PITTOSPORUM, in botany, a genus of the monogynia order, in the pentandria class of plants. The calyx is pentaphyllous, inferior, and deciduous. The petals are five in number; the style thread-shaped; the capsule somewhat angular, trilocular, and containing three or four angulated seeds, adhering to the capsule by means of a liquid resin in the loculaments. Of this there are three species, viz. 1. Tenuifolium. 2. Umbellatum. 3. Coriaceum. The first and second are natives of the Cape of Good Hope; the third grows in Madeira, and flowers in May and June.

PITUITARY Gland. See Anatomy.

PLACENTA. See Anatomy and Midwifery.

PLAGIANTHUS, a genus of the class and order monadelphia dodecandria. The calyx is five-cleft; petals five; berry. There is one species, a native of New Zealand.

PLAGUE, Pestilence, or Pestilential fever. See Medicine.

Plague-water, one of the compound waters of the shops, distilled from mint, rosemary, angelica-roots, &c.

PLAIN, in general, an appellation given to whatever is smooth and even, or simple, obvious, and easy to be understood; and, consequently, stands opposed to rough, enriched, or laboured.

A plain figure, in geometry, is an uniform surface; from every point of whose perimeter, right lines may be drawn to every other point in the same.

A plain angle is one contained under the two lines or surfaces, in contradistinction to a solid angle. The doctrine of plain triangles, as those included under three right lines, is termed plain trigonometry. See Trigonometry.

Plain chart. See Chart.

Plain sailing. See Navigation.

Plain scale. See Scale.

Plain table, in surveying, a very simple instrument, whereby the draught of a field is taken on the spot, without any future protraction. It is generally of an oblong rectangular figure, and supported by a fulcrum, so as to turn every way by means of a ball and socket. It has a moveable frame which serves to hold fast a clean paper; and the sides of this frame, facing the paper, are divided into equal parts every way. It has also a box with a magnetical needle, and a large index with two sights; and, lastly, on the edge of the frame, are marked degrees and minutes. See Surveying.

Plain number, is a number that may be produced by the multiplication of two numbers into one another; thus 20 is a plain number produced by the multiplication of 5 into 4.

Plain place, locus planus, or locus ad planum, among the antient geometricians, denoted a geometrical locus, when it was a right line or a circle, in opposition to a solid place, which was an ellipsis, parabola, or hyperbola. These the moderns distinguished into loci ad rectum, and loci ad circulum.

Plain problem, in mathematics, is such a problem as cannot be solved geometrically, but by the intersection either of a right line and a circle, or of the circumferences of two circles; as, given the greatest side, and the sum of the other two sides of a right-angled triangle, to find the triangle, as also to describe a trapezium that shall make a given area of four given lines. Such problems can only have two solutions, in regard a right line can only cut a circle, or one circle cut another, in two points.

PLAISTER *of Paris*. See Sulphat of lime.

PLAN, in general, denotes the representation of something drawn on a plane; such are maps, charts, ichnographies, &c. See Map, Chart, &c.

The term plan, however, is particularly used for a draught of a building, such as it appears, or is intended to appear, on the ground; shewing the extent, division, and distribution of its area, or ground-plot, into apartments, rooms, passages, &c. See Architecture.

PLANARIA, a genus of vermes intestina; the generic character is, body gelatinous, flattish, with a double ventral pore, mouth terminal; this genus contains many species, and is divided into sections.

The section A is without eyes; planaria gulo, body long, pellucid, and truncate before; inhabits stagnant water, under duck-weed; body grey; the margin all round is tesselate with very fine striæ: it swallows the cyclidia which inhabit the same waters, and after a time discharges them again. Planaria operculata inhabits the sandy shores, and among fuci in the bays of Norway; something resembles a coffee berry; and moves by bending its margin, and by means of its marginal folds fixes itself to and ascends other bodies. The section B, with a single eye: C with two eyes; D with three eyes, and E with four eyes.

PLANE. See Geometry.

Plane, in joinery, an edged tool, or instrument for paring and shaving of wood smooth. It consists of a piece of wood, very smooth at bottom, as a stock or shaft; in the middle of which is an aperture, through which a steel-edge, or chisel, placed obliquely, passes, which being very sharp, takes off the inequalities of the wood it is slid along. Planes have various names, according to their various forms, sizes, and uses; as 1. The fore-plane, which is a very long one, and is usually that which is first used; the edge of its iron or chisel is not ground straight, but rises with a convex arch in the middle; its use is to take off the greater irregularities of the stuff, and to prepare it for the smoothing-plane. 2. The smoothing-plane is short and small, its chisel being finer; its use is to take off the greater irregularities left by the fore-plane, and to prepare the wood for the jointer. 3. The jointer is the longest of all; its edge is very fine, and does not stand out above a hair's breadth; it is chiefly used for shooting the edge of a board perfectly straight, for jointing tables, &c. 4. The strike-block, which is like the jointer, but shorter; its use is to shoot short joints. 5. The rabbit-plane, which is used in cutting the upper edge of a board, straight or square, down into the stuff, so that the edge of another cut after the same manner, may join in with it, on the square; it is also used in striking facias on mouldings; the iron or chisel of this plane is as broad as its stock, that the angle may cut straight, and it delivers its shavings at the sides, and not at the top, like the others. 6. The plough, which is a narrow rabbit-plane, with the addition of two staves, on which are shoulders; its use is to plow a narrow square groove on the edge of a board. 7. Moulding-planes, which are of various kinds, accommodated to the various forms and profiles of the moulding; as the round-plane, the hollow-plane, the ogee, the snipe's bill, &c. which are all of several sizes, from half an inch to an inch and a half.

PLANET. See Astronomy.

PLANETARIUM, an astronomical machine, made to represent the motions of the planets, and their satellites, as they really are in nature. We have in some degree explained the theory of the planetarium, under the article Orrery; we shall now describe a perspective view of the machine itself, and shew the nature and structure of the wheels by which the motion of the whole is produced. See Plate Planetarium.

In the planetarium exhibited in the plate, A represents the Sun, which is fixed firmly to a wire *a*, and has no motion; B is the planet Mercury, revolving round the Sun; D is the planet Venus; E represents the Earth, and *e* the Moon revolving round it; *f* is a segment of brass called the Earth's terminator, which shews that all the parts of the Earth behind it are not illuminated by the Sun; F is the planet Mars; G, Jupiter and his four satellites; H, Saturn, with his Ring and seven satellites; K the Herschel, and six satellites. L is a small winch, which when turned gives motion to Mercury and Venus, and shews the Earth's annual motion round the Sun, its diurnal motion, and the Moon's motion round the Earth. The projection in the middle of the circular board M, consists of the following parts: a steel wire *a*, whose lower end is screwed to a bridge under the board, and which carries the Sun; over this is put a tube, on whose lower end a worm-wheel, worked by a worm on the arbor of the winch L above-mentioned, is fixed; and to the upper end the frame of wheels N, with the Earth and Moon. Over these is a conical tube, which has a flaunch at its lower end, and is fastened to the board M by three screws; the arms carrying the planets Mars F, Jupiter G, Saturn H, and the Herschel K, are fitted stiffly upon this tube, so as not to turn unless they are moved. These planets do not move by turning the winch, but are to be set by hand; as also their satellites. In the frame of wheels N (figs. 1 and 2) *g* is the first wheel; which is fixed to the wire *a* (fig. 1), and is without any motion: this works into another wheel *h* of the same size, fixed to the spindle *i*. The wheel *h* works another wheel *k* of the same size, on whose spindle *y* (fig. 1) the Earth is fixed. Besides the wheel *h*, the spindle *i* has three other wheels *l m n*, fixed on it. The wheel *l* turns *o*, which works a pinion beneath the wheel *g*, carrying the planet Mercury B (fig. 1): this pinion has a hollow spindle, and goes over the wire *a*. The wheel *m* on the spindle *i* works into *p*; which gives motion to the pinion *g* (whose spindle goes over the spindle of the pinion which carries Mercury), and has the planet Venus (D fig. 1) fixed to it. The large wheel *n* on the spindle *i* turns, by intermediate wheels, the pinion S, whose arbor goes over the spindle carrying the Earth: this has an arm for the Moon fixed to it. The wire *t*, to which the Moon is fixed, slides up and down through a hole in the end of the arm; and the lower end of the wire rests on a circular ring *v*, whose plane is parallel to the plane of the Moon's orbit; so that as the arm turns round, the wire is pushed up by the inclination of the ring, and falls by its own weight. Beneath this is a ring with divisions on it, shewing the Moon's age. When the winch L is turned, it works the worm-wheel beneath the board M, and moves the frame N (fig. 1) with the Earth round the Sun; and as the wheel *g* is fixed, the wheel *h* is turned by rolling round it; and as *k* (which it works) is of the same size with the other two, it turns the Earth so that its axis always points to the pole. The wheel *l*, by means of the wheel *o*, turns the pinion which carries Mercury B (fig. 1). The wheel *m* with the wheel *p* turns *g*, and the planet Venus D (fig. 1); and the wheel *n* turns the pinion *s*, and the Moon as before described. The number of teeth in the wheels and pinions respectively, must be so proportioned, that each planet may revolve in the same periods as we have described under ASTRONOMY.

PLANIMETRY, that part of geometry which considers lines and plane figures, without any regard to heights or depths. Planimetry is particularly restricted to the mensuration of planes and other surfaces; as contradistinguished from stereometry, or the mensuration of solids, or capacities of length, breadth, and depth. Planimetry is formed by means of the squares of long measures, as square inches, square feet, square yards, &c. that is, by squares whose side is an inch, a foot, a yard, &c. So that the area or content of any surface is said to be found, when it is known how many such square inches, feet, yards, &c. it contains.

PLANISPHERE, signifies a projection of the sphere, and its various circles on a plane; in which sense maps, wherein are exhibited the meridians, and other circles of the sphere, are planispheres. See MAP, PROJECTION, &c.

PLANISPHERE, is more particularly used for an astronomical instrument used in observing the motions of the heavenly bodies. It consists of a projection of the celestial sphere upon a plane, representing the stars, constellations, &c. in their proper order; some being projected on the meridian, and others on the equator.

PLANTAGO, PLANTAIN; a genus of the monogynia order, in the tetrandria class of plants. The calyx is four-cleft; corolla four-cleft; border reflex; stamina very long; capsules two-celled, cut transversely. There are 38 species, of which the most noted are: 1. The common broad-leaved plantain, called weybread; 2. the great hoary plantain, or lamb's tongue; 3. the narrow-leaved plantain, or ribwort; and the following varieties have also been found in England, which are accidental; the besom-plantain and rose-plantain. The plantains grow naturally in pastures in most parts of England, and are frequently very troublesome weeds. The common plantain and ribwort-plantain are both used in medicine, and are so well known as to need no description. They are said to be slightly astringent; and the green leaves are commonly applied to fresh wounds by the common people.

Of the coronopus, or buck's-horn plantain,

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there are two varieties growing in England, viz. the common buck's-horn, which grows plentifully on heaths every where; and the narrow-leaved Welsh sort, which is found upon many of the Welsh mountains. The first of these was formerly cultivated as a salad herb in gardens, but has been long banished for its rank disagreeable flavour; it is sometimes used in medicine.

PLANTING, in agriculture and gardening. The first thing in planting is to prepare the ground before the trees or plants are taken out of the earth, that they may remain out of the ground as short a time as possible, and the next is to take up the trees or plants in order to their being transplanted. In taking up the trees, carefully dig away the earth round the roots, so as to come at their several parts to cut them off; for if they are torn out of the ground without care, the roots will be broken and bruised to the great injury of the trees. When you have taken them up, the next thing is to prepare them for planting by pruning the roots and heads. And first, prune off all the bruised or broken roots, all such as are irregular, and cross each other, and all downright roots, especially in fruit-trees; shorten the larger roots in proportion to the age, the strength, and nature of the tree: observing that the walnut, mulberry, and some other tender-rooted kinds, should not be pruned so close as the more hardy sorts of fruit and forest-trees; in young fruit-trees, such as pears, apples, plumbs, peaches, &c. that are one year old from the time of their budding or grafting, the roots may be left only about eight or nine inches long; but in older trees they must be left of a much greater length: but this is only to be understood of the larger roots; for the small ones must be chiefly cut quite out, or pruned very short. The next thing is the pruning of their heads, which must be differently performed in different trees; and the design of the trees must also be considered: thus, if they are designed for walls or espaliers, it is best to plant them with the greatest part of their heads, which should remain on till they begin to shoot in the spring, when they must be cut down to five or six eyes, at the same time taking care not to disturb the roots. But if the trees are designed for standards, you should prune off all the small branches close to the place where they are produced, as also the irregular ones which cross each other; and after having displaced these branches, you should also cut off all such parts of branches, as have by any accident been broken or wounded; but by no means cut off the main leading shoots which are necessary to attract from the root, and thus promote the growth of the tree. Having thus prepared the trees for planting, you must now proceed to place them in the earth; but if the first trees have been long out of the ground, so that the fibres of the roots are dried, place them eight or ten hours in water before they are planted, with their heads erect, and the roots only immersed in it; which will swell the dried vessels of the roots, and prepare them to imbibe nourishment from the earth. In planting them, great regard should be had to the nature of the soil; for if that is cold and moist, the trees should be planted very shallow; and if it is a hard rock or gravel, it will be better to raise a hill of earth where each tree is to be planted, than to dig into the rock or gravel, and fill it up with earth, as is too often practised, by which means the trees are planted as in a tub, and have but little room to extend their roots. The next thing to be observed is, to place the trees in the hole in such a manner, that the roots may be about the same depth in the ground, as before they were taken up; then break the earth fine with a spade, and scatter it into the hole, so that it may fall in between every root, that there may be no hollowness in the earth. Having filled up the whole, gently tread down the earth with your feet, but do not make it too hard; which is a great fault, especially if the ground is strong or wet. Having thus planted the trees, they should be fastened to stakes driven into the ground, to prevent their being displaced by the wind, and some mulch laid about the surface of the ground about their roots: as to such as are planted against walls, their roots should be placed about a foot from the wall, to which their heads should be nailed to prevent their being blown up by the wind. The seasons for planting are various, according to the different sorts of trees, or the soil in which they are planted; for the trees whose leaves fall off in winter, the best time is the beginning of October, provided the soil is dry; but if it is a very wet soil, it is better to defer it till the latter end of February, or the beginning of March; and for many kinds of evergreens, the beginning of April is by far the best season; though they may be safely removed at Midsummer, provided they are not to be carried very far; but you should always make choice of a cloudy wet season.

PLANTS, *physiology of*. The constituent or elementary principles of vegetables in general, are hydrogen, oxygen, and charcoal. These, as far as our observations have hitherto extended, are common to all vegetables. There are some other substances, such as lime, potass, iron, and azote, which are occasionally found in vegetables; but as they are not common to all plants, they cannot be considered as essential to the constitution of vegetable matter.

The parts of vegetables which naturalists are accustomed to consider as distinct in their nature and functions, are six: the stem or trunk, the root, the leaf, the flower, the fruit, and the seed. In many vegetables the root appears nearly similar, in all its constituent parts and principles, to the stem or trunk, and indeed the one seems a continuation of the other; which must be our apology for reversing in some degree the order of nature, and treating first of that part; which, though it seems to proceed or spring immediately from the other, is yet the most perfect in its organization, and is in general of the greatest use and importance to man.

I. The stem or trunk, which includes also the branches, we might say all the more solid and substantial parts of a tree or plant, consists of three parts, the bark, the wood, and the pith.

1st. The bark is protected on the outside by a cuticle, epidermis, or scarf-skin, which consists sometimes of numerous layers, and differs in thickness in different plants. This skin or cuticle is an organized body, composed of very minute bladders, interspersed with longitudinal fibres, as in the nettle, thistle, and the generality of herbs. It contains also longitudinal vessels, and is visibly porous in some plants, and particularly the cane.

2. On removing the cuticle, the true bark appears, and may be considered as a congeries of pulp or cellular substance, in which are placed a number of vessels, as well as longitudinal fibres. The vessels of the bark are differently situated, and destined for various uses, in different plants. In the bark of the pine, for instance, the inmost are lymph-ducts, exceedingly minute; those nearest the surface are gum or resiniferous vessels, for the secretion of the turpentine, and these are so large as to be visible to the naked eye.

3d. The wood lies between the bark and the pith. Its substance is denser than that of the bark, and its structure more difficult to be understood. It is however generally supposed to consist of two substances, the parenchymatous or cellular, and the ligneous. The ligneous parts are no more than a congeries of old dried lymph-ducts. Between the bark and the wood a new ring of these ducts is formed every year, which gradually loses its softness as the cold season approaches, and towards the middle of winter is condensed into a solid ring of wood. These annual rings, which are visible in most trees when cut transversely, serve as marks to determine their age. They seem to decrease in breadth, as the tree advances in age; and as they are found to be very unequal in size throughout, their breadth probably varies according as the season is favourable or otherwise.

Dr. Darwin distinguishes the wood into two parts, the sap-wood or alburnum, and the heart. The former is much less durable, and is most abundant in thriving trees. In an oak-tree the division between these parts is very distinguishable. The alburnum is gradually converted into heart; but we do not recollect to have met with any observations which determine the number of years in which this conversion takes place.

Dr. Darwin attributes to the sap-wood the office of nourishing the embryon buds.

"We may conclude," says this author, "that the umbilical vessels of the new bud are formed along with a reservoir of nutritious aliment about midsummer in the bark, which constitutes the long caudex of the parent bud, in the same manner as a reservoir of nutritious matter is formed in the root or broad caudex of the turnip or onion, for the nourishment of the rising stem; and that these umbilical vessels of the embryon bud, and the reservoir of nutriment laid up for it, which is secreted by the glands of the parent bud, and now intermixed with the present bark of the tree, become gradually changed into alburnum, or sap-wood, as the season advances, in part even before the end of the summer, and entirely during the winter months.

"That the alburnum of trees, which exists beneath the bark both of the trunk and roots of them, contains the nutritious matter deposited by the mature leaves, or parent buds, for the use of the embryon buds, appears not only from the saccharine liquor which oozes from the wounds made in the vernal months through the bark into the alburnum of the birch and maple, betula et acer; but also from the following experiment, which was conducted in the winter, before the vernal sap-juice rises.

"Part of a branch of an oak tree in January was cut off, and divided carefully into three parts; the bark, the alburnum, and the heart. These were shaved or rasped, and separately boiled for a time in water, and then set in a warm room to ferment; and it was seen that the decoction of the alburnum or sap-wood passed into rapid fermentation, and became at length acetous, but not either of the other, which evinces the existence both of sugar and mucilage in the alburnum during the winter months; since a modern French chemist has shewn by experiments, that sugar alone will not pass into the vinous fermentation, but that a mixture of mucilage is also required; and from this experiment it may be concluded, that in years of scarcity the sap-wood of those trees which are not acrid to the taste, might afford nutriment by the preparation of being rasped to powder, and made into bread by a mixture of flour, or by extracting their sugar and mucilage by boiling water. These observations have been since confirmed by the very accurate experiments of Mr. Knight, who has shewn that all the saccharine matter of fruit trees is elaborated in the leaves of the preceding year, and deposited in the alburnum, whence it is drawn in the following spring for the perfecting of the flower and the fruit. An essential caution (by the way) to unskilful pruners (such as the bulk of common gardeners are), who in cutting off the new wood, or alburnum, in the spring, just cut off so much of the fruit (see PRUNING); and when gardeners (falsely so called) pull off the leaves of vines, and other fruit-trees, they destroy the crop of the succeeding year.

One striking difference between the wood and the bark is, that the former is possessed of spiral vessels which run from one end of the tree to the other. From the great resemblance of these vessels to the air-vessels of insects, they are supposed to be subservient to the same function. The stem of some plants is entirely hollow; partly, it is supposed, from these plants, which are generally of a quick growth, requiring a more than ordinary supply of air.

Dr. Darwin considers the spiral vessels above alluded to as lymphatics. He admits that air is observed to issue both from green and dry wood cut transversely, which is distinctly seen by plunging the wood in water, and removing the pressure of the atmosphere by the air-pump. This circumstance, however, he attributes to the rigidity of the fibres of wood, which, when divided, suffer the sap to escape, when, as the vessels cannot collapse, the air consequently enters in its place. He illustrates and confirms his opinion with his accustomed ingenuity, and among other observations relates the following experiment; "I placed, in the summer of 1781, some twigs of a fig-tree with leaves on them, about an inch deep in a decoction of madder, and others in a decoction of log-wood, along with some sprigs cut off from a plant of picris. These plants were chosen because their blood is white. After some hours, on the next day, on taking out either of these, and cutting off from its bottom about an eighth of an inch of the stalk, an internal circle of red points appeared, which I believed to be the ends of absorbent vessels coloured red with the decoction, and which probably existed in the newly-formed alburnum, or sap-wood; while an external ring of arteries was seen to bleed out hastily a milky juice, and at once evinced both the absorbent and arterial system.

Dr. Darwin admits the existence of air-vessels which pass through the bark to the sap-wood; but these run transversely, and not in the direction of the trunk or arms. Du Hamel likewise observed large vessels, some round and some oval, which in the birch-tree stand prominent, and pierce the outer bark.

4th. The pith is situated in the centre of the stem, and in young plants it is very abundant. It is said by some authors to consist of exactly the same substance as the parenchyma or cellular substance of the bark; and to be composed of small cells or bladders, generally of a circular figure, though in some plants, as the borage and thistle, they are angular. In most plants the pith gradually dies away as they approach to maturity; and in old trees it is almost entirely obliterated. The pith appears to be essential to the life of the other parts in young shoots. In those plants which have hollow stems, this central cavity, though not filled with the pith or medulla, appears to be lined with it.

Such are the solid parts of plants; but to render their organization more clearly understood, in Plate Miscel. fig. 186, is the section of a branch of ash cut transversely, as it appears to the eye. Fig. 187, is the same section magnified: AA the bark; BB an arched ring of sap-vessels next the cuticle; CCC the cellular substance of the bark, with another arched row of sap-vessels; DD a circular line of lymph-ducts next the wood; EE the wood; F the first year's growth; G the second; H the third; HI the true wood; KK the great air-vessels; LL the lesser air-vessels; N the pith.

There is reason to believe that the proper entrance of the air to plants, is through the cuticle; which is proved to be a vascular substance, since, when under an exhausted receiver, it issues directly through the cuticle. That the air is necessary to the sustenance of plants, appears from the experiments of Dr. Bell. In the winter season he covered several young trees with varnish, leaving the tops of the branches only exposed to the air. They remained in this situation during the following summer, when some of them lived, though in a languid state; but those from which the air had been more accurately excluded, died without a single exception. To this proof the same author adds, that trees overgrown with moss have few leaves, weak shoots, and scarcely any fruit; and that it is the common practice of all judicious gardeners to strip the moss from the bark of aged trees, which by admitting the air generally restores them to vigour and fruitfulness.

II. The root, which fixes the plant to the earth, and is the chief source of its nourishment, differs much in different species of vegetables. All roots agree in being fibrous at their extremities, and it is by their fibres chiefly that they are fitted to draw nourishment from the earth. The internal structure of the root, or rather of its fibres, differs not very materially in general from that of the stem. It consists of a cuticle, bark, wood, and commonly of a small portion of pith; though there are some roots which have no pith at all; while there are others which have little or none at the extremities, but a considerable quantity near the trunk. The cuticle, in all roots, at a certain age, is double; the cortical substance, or bark, differs greatly in its quantity and disposition in different plants. The roots, as well as the trunk of plants, are furnished with a variety of vessels for the purpose of conveying and circulating air and the juices necessary to their nourishment.

In fig. 188. is a section of the root of wormwood, as it appears to the eye; and fig. 189. is the same magnified. AA, the skin with its vessels; BB, the bark; CCC, the lymph-ducts of the bark; the other holes are small cells or sap-vessels. DDD, parenchymatous insertions from the bark; EEE, the rays of the wood, with the air-vessels. This root has no pith.

III. The leaves are organs essential to the existence of plants. Trees perish when totally divested of them; and in general, when stript of any considerable proportion of their leaves, they do not shoot vigorously. The leaves exhibit a beautiful appearance when the intermediate parenchymatous matter is consumed by putrefaction. Both surfaces of the leaf are covered with a membrane, which is a thin bark, continued from the scarf-skin of the stalk.

IV. The flower consists of four parts, the calyx, the corolla, the stamina, and the pistillum. The calyx or flower-cup is almost always of a green colour, and is that which surrounds and supports all the other parts of the flower. The corolla is of various colours, is variously shaped in different vegetables, and is that which constitutes the most conspicuous part of the flower. It sometimes consists of one continued substance, but more frequently of several portions, which are called petals. The stamina are supposed to be the male part of the flower. Linnæus defines them to be an entrail of the plant, designed for the preparation of the pollen. Each stamen consists of two parts; the filamentum or fine thread which supports the anthera, and the anthera itself, which contains within it the pollen, and when come to maturity bursts and discharges it for the impregnation of the germen. From the supposed function of the stamina, they afford the chief foundation of the distribution of the vegetable system into classes. Such flowers as want this part are called female; such as have it, but want the pistillum, are male; such as have them both, hermaphrodite; and such as have neither, neuter.

The pistillum or pointal is supposed to be the female pa.t of the flower; it is defined by Linnæus to be an entrail of the plant, designed for the reception of the pollen. It consists of three parts, the germen, the style, and the stigma. The germen is the rudiment of the fruit accompanying the flower, but not yet arrived at maturity. The style is the part which serves to elevate the stigma from the germen. The stigma is the summit of the pistillum, and is covered with a moisture for the breaking of the pollen. See BOTANY.

The pericarpium or seed-vessel is the germen grown to maturity. Such are the constituent parts of the flower; they are however infinitely varied, and serve both to diversify the face of nature, and to interest and delight the curiosity of man. One curious fact it is necessary to notice, before we dismiss this branch of the subject, and that is, that in the perennial plants especially, every flower is perfectly formed many months before it makes its appearance. Thus the flowers which appear in this year are not properly the productions of this year; the mezereon flowers in January, but the flowers are completely formed in the bud in the preceding autumn: the same is obvious in the kalmir and rhododendron. If the coats of the tulip-root also are carefully separated about the beginning of September, the nascent flower, which is to appear in the following spring, will be found in a small cell, formed by the innermost coats, as represented in plate fig. 190, where the young flower A appears towards the bottom of the root.

V. The fruit consists of nearly the same parts as are found in the stem; of a skin or cuticle, which is a production or continuation of the skin of the bark; and of an outer parenchyma, which is the same substance continued from the bark, only that its vesicles are larger and more succulent or juicy. Next the core there is commonly an inner pulp or parenchyma; and the core is no more than a hard woody membrane, which incloses the seed. It is to be observed, however, that the organization of fruit is very various; in some the seeds are dispersed through the parenchymatous or pulpy substance; in some, instead of a core, we find a strong woody substance, inclosing the seed or kernel, which from its great hardness is termed the stone; in some, there are a number of seeds; and in others, only a single seed, inclosed in a large mass of parenchymatous matter.

VI. The seed is a deciduous part of a vegetable, containing the rudiment of a new one. The essence of the seed consists in the corculum or little heart, which is fastened to the cotyledones or lobes, and involved in them, and closely covered by its proper tunic. The corculum consists in the plumula, which is the vital speck of the future plant, extremely small in its dimensions, but increasing like a bud to infinity. The rostellum, however, must be included, which is the base of the plumula; it descends and strikes root, and is the part of the seed originally contiguous to the mother-plant. It is commonly supposed, and with some reason, that the perfect plant, or at least all the organization which is requisite to a perfect plant, exists in the seed surrounded by a quantity of farinaceous matter, which serves to absorb moisture, and to furnish nourishment to the corculum till its parts are sufficiently unfolded to draw support from the soil. A kidney-bean, or lupin, when it has been soaked for some time in water, and begun to swell, is easily separated into its two lobes; and between these is displayed the nascent plant. The naked eye can easily discern the stem, and its connection with the lobes. Through the lobes are diffused innumerable vessels, which immediately communicate with the embryo plant. On the external surface of the seed are absorbent vessels, which attract the moisture; by this moisture a degree of fermentation is produced; and thus a juice is prepared by a natural process, in every respect proper for the nourishment of the plant in its first efforts to extend its tender frame. The plant in its infancy is almost a gelatinous substance, and increases and indurates by degrees: and in general the hardness of wood bears a pretty exact proportion to the slowness with which a plant increases. That part of the stem which is next the root is the first which assumes the woody texture.

M. Bonnet, in order to ascertain how far the lobes of the seed were necessary to the growth and health of the corculum, detached them with great dexterity without a vital injury to the infant plant. Some French beans treated in this manner, and sowed in a light soil, grew; but the consequence was, that not only the first leaves were much smaller, but the plants were uniformly weaker in every part of their growth than others, which for the sake of comparison were sown at the same time without being mutilated. The plants from the seeds which were deprived of the lobes put forth fewer blossoms, and produced less seed. The seeds of mosses are naturally devoid of lobes. The first leaves which make their apppearance, and which are called seminal, appear not less necessary to the perfection of the plant than the farinaceous lobes. If they happen to be broken off, the plant experiences a proportional loss of vigour.

It is matter of curious observation, that seed, thrown into the ground at random, should always come up in the proper direction. M. Dodart has offered an ingenious explanation of this fact, which consists in suppoing that the rostellum contracts by humidity, and that the plumula on the contrary contracts by dryness. According to this idea, when a seed is put into the ground the wrong way, the rostellum, which then points upwards, contracts itself towards the part where there is most humidity, and therefore turns downwards. The plumula on the contrary pointing downwards, turns itself towards the part of the soil which is driest, and therefore rises towards the surface. This explanation, however, evidently rests on no better basis than conjecture; the experiments in which the truly philosophical Mr. Knight is now engaged, will probably decide the question.

Independant of the seed, there are two other methods by which plants are propagated, by slips and suckers; and many plants naturally make an effort to propagate themselves in this manner. The bulbous-rooted plants in general increase by offsets. When a tulip is first planted in the spring, the stem issues from the inner part of the bulbous root; but when the tulip is taken up in the autumn, the stem no longer proceeds from that part of the root, but seems attached to one side. The fact is, that the root which is taken up is only a part of that which was planted. Some of the outer layers of the original root have decayed, by having the substance absorbed for the nourishment of the blossom, and from the remainder what may be termed a new root has been provided for the future year.

Besides the parts above-mentioned, some writers have treated of the nerves and muscles of vegetables. These, it is confessed, have never been demonstrated, but their existence has been inferred from the motions of peculiar parts of vegetables, and more particularly those of the flower. The greater number of plants close, either partly or entirely, their petals towards night, or on the approach of cold or wet weather. The hedysarum gyrans whirls its leaves in various directions, when the air is still, by an apparently voluntary effort. The dionæa muscipula, Venus's fly-trap, closes its leaves from the stimulus of insects which crawl upon them, and pierces them with its prickles. The phenomena of the common sensitive plant, the most distant branches of which close their leaves on any violence being offered to any part of it, are commonly known and admired. Whether these appearances are the consequences of sensation in the vegetable, it is impossible to determine; but they are so similar to what we observe in animated beings, that the term sensitive plant is very appropriate. If the distant parts of the plant are affected through the medium of nerves, their action seems to be much less quick than those of animals, as the half or the whole of a minute generally elapses in this climate before the whole of the plant droops, but it is said to be otherwise in their native climate.

Fluids of plants. As the true course of the fluids in animals, and the power by which the circulation is performed, are modern discoveries, so we have still to learn a satisfactory explanation of the corresponding circumstances in vegetable life. That the juices of plants pass from one part to another, admits of no doubt; but the observations of naturalists have been so various and inconsistent, that no theory can be framed sufficiently comprehensive to embrace their several conclusions. It may indeed be concluded, that as the life of a vegetable is more obscure, so we cannot expect the same energy of action which is manifested in the circulating organs of animals.

It is manifest to common observation, that there does not exist the same intimate union between the different parts of a vegetable as we find between those of animals: different parts of the same plant will put forth leaves and ripen fruit at very different seasons of the year, according to the particular temperature in which each branch is placed. A branch of a vine introduced into a hot-house will vegetate in the midst of winter; while the rest of the plant, which remains exposed to the vicissitudes of the climate, will evince little or no sympathy. We know of nothing like this in the animal kingdom, and therefore it seems reasonable to conclude that there is not in a vegetable any thing analogous to a heart, from and to which, as a common centre, its fluids are directed.

It has been assumed by many botanists, that there is a succus communis, or universal sap, differing little from water, and the same in all plants. It seems more consonant, however, to observation, to conclude that the fluids differ in different genera of vegetables. There is an infinite variety in the obvious properties of the juices of plants, some of which, in tead of resembling water, are more of the consistency of milk. Grafts only grow on kindred stocks, which may reasonably be attributed to an unfitness of the juices of other genera of plants.

With respect to what has been called the succus proprius of plants, which alone has been said to differ in different plants, it seems to be nothing more than the product of a process analogous to that of secretion in animals; thus a plant of mint nourished by water alone, will still elaborate, by its vegetative power, an essential oil peculiar in odour to its own species.

The juices of many plants abound so much in a mucilaginous and saccharine principle as to be fermentable. The sap of the birch-tree drawn in spring by tapping has been long employed to make wine. A species of the maple affords sugar; but no plant abounds so much in this vegetable product as the sugar-cane. The mucilaginous or gummy principle prevails more particularly in the different sorts of plum. By the experiment on the sap-wood of the oak, related above, it appears that there are both sugar and mucilage in the juices of a tree remarkable for its bitterness.

Mucilage and sugar seem to exist diffused in the general mass of fluids in vegetables; on the other hand, turpentine, resin, expressed and essential oil, and what is called the extractive principle, seem to be the product of secretion; but the fluids deposited in cists are so often necessarily mixed with the other juices, by the processes of extraction, that there must remain considerable doubt as to the accuracy of this particular distribution. It may generally be remarked, that the products of secretion in plants are of an inflammable nature. The seeds of plants generally abound in a heavy oil which may be obtained by pressure, such as oil of almonds, linseed, and palma christi or castor oil. The essential oils, or those obtained by distillation, are in general extremely acrid; so much so, that they produce a wound when inadvertently applied to the tongue in an undiluted state. Oil of cloves is employed to destroy the exposed nerve in decaying teeth, in order to cure the tooth-ache; but its use requires considerable caution, as it is liable to injure the teeth adjoining to that which is diseased. The bitter, narcotic, and acid principles, are also to be considered as the products of secretion.

Few questions have excited greater attention than those respecting the course of the fluids in vegetables. When wounds have been made in trees, it is found that the sap flows more copiously from the upper side, or that part of the wound which is nearest the branches. From whatever cause this may proceed, it seems to be intimately united with another fact. If a wound is made through the bark of a growing tree, the effort which takes place to heal the wound is made from above. The lower lip of the wound remains shrivelled and inactive; and if the wound has been extensive, seems from year to year rather to suffer decay; the upper lip, on the contrary, becomes turgid, and extends itself downwards to repair the breach. This effort is particularly remarkable in wood which has suffered compression from the embraces of the honeysuckle. Dr. Darwin, in his Phytologia, attempts to explain this and many other phenomena by the ingenious idea, that a tree is a complex being composed of many individuals; for he considers every bud of a tree as having an independant vegetative power. The effort above-mentioned he considers as caused by the buds of the tree sending down their vessels, and propelling their fluids towards the root. Yet it seems generally to have been concluded, that the sap rises upwards in the spring from the root towards the branches. Early in the season Dr. Hope made incisions of different altitudes into the root and stem of a birch. As the sap rose, it first flowed from the superior margin of the lowest incision, and then irregular succession, from the upper margins of the other incisions, till at last it reached the highest. It does not appear, however, to be satisfactorily ascertained whether the sap in this experiment proceeded from the root, or whether it was successively put in motion higher and higher as the process of vegetation took place; for the upper parts of a tree are more exposed to cold, and vegetation may on that account be retarded. Dr. Hales cut off the stems of vines in the spring, and then by fixing tubes on the stumps, was able to ascertain with what force the sap was propelled. In some trials the sap rose to the height of 35 feet. Tubes have been fixed to the large arteries of animals, as near as possible to the heart, in which the blood did not rise higher than nine feet.

Such being the force with which the juices of vegetables are propelled, it can scarcely be doubted that their sap is contained in vessels. Yet differences of opinion have arisen even as to this particular; and as the vessels of vegetables have not been satisfactorily traced, it has been advanced that there exists no other circulation than a transmission of fluids through cellular substance. A circulation, however, so vigorous as that of a thriving vegetable, cannot be conceived to be conducted, except through a limited and well defined channel. It must be confessed, that considerable difficulties attend this inquiry; but the existence of vessels, at least in the leaves of plants, is proved by the following simple experiment, which may be satisfactorily tried on plants having coloured sap: Tear asunder a fig-leaf, for instance, and the white fluid will be observed to flow from certain points which are doubtless the extremities of broken vessels.

From the experiments of Dr. Hales abovementioned it appears, that the sap of the vine rose in a tube to 35 feet, or about the same height as a column of water equal in weight to the atmosphere. The pressure of the atmosphere is known to assist animals in sucking; and whether some modification of the same power may not assist vegetable absorption, may be the subject of future inquiry.

Dr. Hales, in his statical experiments, mentions several, in which he tried to change the natural flavour of fruits, and to communicate those of several spirituous liquors, and of different odoriferous infusions. With this intention he plunged in different liquors branches loaded with fruit, and left them there for some time, without being able to perceive that the taste of the fruits was in the least altered, whether the experiment was made upon them ripe or unripe. But he almost always perceived the smell of the liquors or infusions in the stalks of the leaves, and in the wood. He conjectures, with much probability, that the vessels near the fruit become so fine as not to admit the odoriferous particles.

M. Bonnet made experiments on flowers similar to those which Dr. Hales made on fruits. He chose such flowers as have naturally little perfume, as the different species of French beans. Stems with these flowers were immersed in tubes, some of which were filled with spirit of wine, others with Hungary water, &c. In about 24 hours the flowers were faded, and they had already acquired in a very sensible degree the odours of the liquors which they had imbibed. The odour became much more remarkable a few days afterwards. M. Bonnet also found that the leaves of the apricot-tree acquired a sensible odour from the liquors into which branches of that tree were plunged.

Functions of plants. The leaves of plants have been not improperly compared with the lungs of animals. "Plants, as well as animals," says an author whom we have already quoted with approbation, "perspire, and in both cases this function is essential to health. By the experiments of Dr. Hales and M. Guettard, it appears that the perspirable matter of vegetables differs in no respect from pure water, excepting that it becomes rather sooner putrid. The quantity perspired varies, according to the extent of the surface from which it is emitted, the temperature of the air, the time of the day, and the humidity of the atmosphere. As the leaves form the greatest part of the surface, it is natural to suppose, that the quantity of these will very materially affect the quantity of the perspiration. Accordingly, the experiments of Dr. Hales have ascertained, that the perspiration of vegetables is increased or diminished, chiefly in proportion to the increase or diminution of their foliage. The degree of heat in which the plant was kept, according to the same author, varied the quantity of matter perspired; this being greater, in proportion to the greater heat of the surrounding atmosphere. The degree of light has likewise considerable influence in this respect; for Mr. Philip Miller's experiments prove, that plants uniformly perspire most in the forenoon, though the temperature of the air in which they are placed should be unvaried. M. Guettard likewise informs us, that a plant exposed to the rays of the sun has its perspiration increased to a much greater degree, than if it had been exposed to the same heat under the shade. Finally, the perspiration of vegetables is increased in proportion as the atmosphere is dry, or in other words, diminished in proportion as the atmosphere is humid."

Dr. Hales found that a sun-flower, weighing three pounds, perspired 22 ounces during 24 hours. Dr. Keil perspired 31 ounces in 24 hours. The quantity therefore perspired by the sun-flower was much greater, in proportion to its weight, than that perspired from the human body. Dr. Keil ate and drank four pounds ten ounces in 24 hours. Seventeen times more nourishment was taken in by the root of the sun-flower, than was taken in by the man. If the perspiration of vegetables is checked, they speedily fade. It is checked from glutinous substances adhering to their surface: hence the advantage of washing them. The more healthy and vigorous the plant, the more copious the perspiration; though an excess, as well as a defect of it, seems prejudicial and even destructive to vegetables. It bears also a proportion to the quantity of leaves, these being the principal organs of perspiration.

The odoriferous exhalation of leaves and flowers forms an atmosphere round vegetables, which strikes our senses, and which the contact of a body on fire is sometimes capable of inflaming, as has been observed with regard to the fraxinella.

The experiments of Dr. Priestley have sufficiently shewn that vegetables have the power of correcting bad air; and Dr. Ingenhouz has proved that they have the faculty of producing oxygen gas, only when acted on by the rays of light. If a vegetable is immersed in water, and the rays of the sun directed on it, air-bubbles will be observed to collect on the leaves, and at length rise to the surface of the water. This appearance is most remarkable in the morning, as the leaves have not then been previously exhausted by the action of light. Oxygen air of a great degree of purity may be obtained in the summer time, by inverting a jar filled with water in such a manner as to receive the air-bubbles as they arise. All plants, however, do not emit this air with the same facility; there are some which emit it the moment the rays of the sun act upon them, and this is the case with lavender. Some aquatic plants afford oxygen air with great facility, some more slowly, but none later than eight or ten minutes, provided the sun's light is strong. The air is almost entirely furnished by the inferior surface of the leaves of trees; herbaceous plants afford it from almost the whole of their surface. The leaves afford more air when attached to the plant, than when gathered; and the quantity is greater, the fresher and sounder they are. Young leaves afford but a small quantity of oxygen air; those which are full grown afford more, and the more the greener they are. The epidermis, the bark, and petals, do not afford it, and in general oxygen proceeds only from those parts of plants which are of a green colour. Thus green corn and green fruits afford this air, but it is not produced by those which are ripe; and flowers in general render the air noxious. These facts may serve to explain the manner in which the light of the sun operates in maturing fruits, viz. by expelling the superfluous oxygen, and thus changing them from a harsh and sour, into a mild and sweet substance. Aquatic plants, and such as grow in moist places, are remarkable not only for affording a large quantity of oxygen gas, but also for absorbing hydrogen gas, and are therefore in all respects calculated for purifying the air of marshy situations. A very extraordinary power of absorbing hydrogen air was observed in the willow by Dr. Priestley; and this fact seems connected with the rapid growth of that plant in marshy situations, where much of this air is produced. M. Sennabier found that plants yield much more oxygen air in distilled water impregnated with carbonic acid gas, than in simple distilled water.

It appears further, from the experiments of Dr. Priestley, that plants will bear a greater proportion of hydrogen than of carbonic acid air, and that oxygen gas appeared generally injurious to plants. A sprig of mint growing in water, placed over a fermenting liquor, and of course exposed to carbonic acid air, became quite dead in one day; a red rose became of a purple colour in 24 hours. Plants die very soon both in nitrous air, and in common air when saturated with it. Air appears uniformly to have been purified by healthy plants vegetating in it; but these experiments require great nicety, as the least degree of putrefaction will injure the air. The air contained in the bladders of marine plants was found considerably purer than common air.

Atmospheric air is restored, after being injured by respiration or combustion, by a plant vegetating in it. This restoration of air depends upon the vegetating state of the plant; for a number of mint-leaves fresh-gathered being kept in air in which candles had burnt out, did not restore the air. Any plant will effect this purpose, but those of the quickest growth in the most expeditious manner.

That plants have a property of producing pure air from water, is evident from an experiment of Dr. Priestley's. The green matter which is to be observed in water is doubtless a vegetable production. Water containing this green matter always afforded oxygen air in a large quantity; but water which had it not afforded none. It has been frequently observed that vegetables do not thrive in the dark. A receiver was therefore filled with water, and kept till it was in a state of giving air copiously; after this it was removed into a dark room, and from that time the production of air entirely ceased. When placed again in the sun, it afforded no air till about ten days after, when it had more green matter; the former plants being probably all dead, and no air could be produced till new ones were formed.

From various experiments it appeared that different animal and vegetable putrescent substances afforded a very copious pabulum for this green vegetable matter, which produced so freely the oxygen air; whence the philosophic author of this discovery is led to the following conclusions: "It is impossible," says he, "not to observe from these experiments the admirable provision in nature, to prevent or lessen the fatal effects of putrefaction; especially in hot countries, where the rays of the sun are most direct, and the heat most intense. Animal and vegetable substances, by simply putrefying, would necessarily taint great masses of air, and render it unfit for respiration, did not the same substances, putrefying in water, supply a most abundant pabulum for this wonderful vegetable substance, the seeds of which seem to exist throughout the atmosphere. By these means, instead of the atmosphere being corrupted, a large quantity of the purest air is continually thrown into it. By the same means also, stagnant waters are rendered much less offensive and unwholesome than they would otherwise be. That froth which we observe on the surface of such waters, and which is apt to excite disgust, generally consists of the purest air, supplied by aquatic plants. When the sun shines, this air may be observed to issue from them. Even when animal and vegetable substances putrefy in air, as they have generally some moisture in them, various other vegetable productions, in the form of mold, &c. find a proper nutriment in them, and by converting a considerable part of the noxious effluvia into their own substance, arrest it in its progress to corrupt the atmosphere."

The same vegetables which afford oxygen

air very plentifully in the light of the sun, afford in the shade air less pure than that of the atmosphere. This striking effect of light on vegetables is a strong argument in favour of the opinion, that the motion of the juices of vegetables is performed by vessels, which, like those of animals, possess irritability, and are excited to action by stimulating substances.

The effect of vegetation in producing the oxygen air which was afforded in the preceding experiments, seemed in some measure dubious to count Rumford, who extracted vital air by immersing in water a variety of substances, as raw silk, cotton, wool, eiderdown, hare's fur, sheep's wool, ravellings of linen, and human hair. He was led, from the result of these trials, to suspect that the pure air was merely separated from the water; and that any substance which would act by a capillary attraction, so as to separate the component parts of the water, would effect the production of pure air. He therefore procured a quantity of spun glass, which consists of minute tubes, and immersed it in water, but the quantity of pure air produced was very trifling. Hence he concludes, that there is something in those substances which operates in producing pure air, and that it is not merely a mechanical separation of the component parts of water.

The light of lamps produced the same effect as the sun's light; air in great quantities was produced, and perfectly pure. Vegetables will also, with any strong light, produce oxygen air as well as with the light of the sun. The air from silk was much superior to that from vegetables.

Plants have a remarkable sensibility to light; they unfold their flowers to the sun, they follow his course by turning on their stems, and are closed as soon as he disappears. Vegetables placed in rooms where they receive light only in one direction, always extend themselves that way. If they receive light in two directions, they direct their course towards the strongest. Trees growing in thick forests, where they only receive light from above, direct their shoots almost invariably upwards, and therefore become much taller and less spreading than such as stand single. This affection for light seems to explain the upright growth of vegetables, a curious phenomenon, too common to be much attended to. It has been ascertained by repeated experiments, that the green colour of plants is entirely owing to light; for plants reared in the dark are well known to be perfectly white.

If we take a succulent plant, and express its juice, the liquor appears at first uniformly green; but allow it to stand, and the green colour separates from the watery fluid, and falls to the bottom in a sediment. If we collect this sediment it will be found to be of an oily nature, for it does not dissolve in water; but it will in spirit of wine, or oil, to which it imparts a green colour. As the sun produces the green colour in plants, and as this resides in an oily matter, it was formerly concluded that light produces the oily matter of vegetables, and that it effects this by furnishing the principle of inflammability. The new chemical doctrines, however, afford a much more satisfactory explanation of the effect of the sun's rays in producing the oily matter in vegetables. Vegetable matter consists in general of carbon, hydrogen, and oxygen; the sun's ray produce a disengagement of the latter principle in the form of vital air, and the two former are the constituent principles of oil.

M. Bonnet made a series of experiments in order to ascertain whether the superior or the inferior surfaces of leaves have a greater share in performing perspiration. From the trials which he made, he concludes that the inferior surface of the leaf is in general by far the most active in this respect, though in one or two species of vegetables this difference was much less remarkable. The mallow was the only vegetable the leaves of which perspired more by the upper than the inferior surface. The method which he employed to ascertain the comparative effect of the two surfaces was, to cover first one and then the other surface with oil. The leaves were then immersed in tubes filled with water, and the quantity of perspired matter was measured by the length of the tube emptied in a given time. The oil, by stopping up the pores, prevented perspiration from the surface to which it was applied. Some large leaves of the white mulberry-tree being kept suspended on water with their upper surfaces in contact with the fluid, faded in five days; some leaves of the same tree, being placed in a similar situation, but with the inferior surface touching the water, were preserved green for nearly six months.

The sexual system has been the prevalent system of botany for many years. It is well known that the palm is of that class of vegetables which has flowers of different sexes on different trees. The peasants in the Levant, whether acquainted with this fact, or whether directed to the practice by accident alone, have been accustomed to break branches from the male palm while in flower, and attach them to the female plant, which they find to be constantly productive of an abundant crop. This fact has also been proved by a most decisive experiment of M. Gleditsch. There was in the royal garden at Berlin a beautiful palm-tree, a female plant, which, however, though 25 years old, had been always barren. There was another palm at Leipsic of the male kind, which blossomed every year. The ingenious botanist undertook to fecundate the palm at Berlin from that at Leipsic, and had some of the blossoms conveyed by the post. The consequence was, that he produced that season excellent dates; and the experiment, prosecuted with some variation for several succeeding years, was attended with the same success.

It has been said, that the pollen was destined for the impregnation of the germen. This is performed in the following manner: The antheræ, which at the first opening of the flower are whole, burst soon after, and discharge the pollen. Being dispersed about the flower, part of the pollen lodges on the surface of the stigma, where it is detained by the moisture with which that part is covered. Each single grain or atom of the pollen has been observed by the microscrope to burst in this fluid, and is supposed to discharge something which impregnates the germen below. What the substance is which is so discharged, and whether it actually passes through the style into the germen, seem yet undetermined, from the great difficulty of observing such minute parts and operations. In some vegetables, the stamina move towards the pistillum; and a very evident motion of them is observed in the flowers of the common berberry, on touching them with the point of a pin.

As vegetables, like animals, are liable to decline, and ultimately to perish by age, the offices of the parts of fructification are of the most important nature. If trees had been capable of increase only by grafts, layers, or cuttings, it seems probable that they would long ago have been lost. An ingenious and philosophical botanist, Mr. Knight, has particularized several sorts of apples, which a century ago were extremely thriving and in high repute, some of which are at this time wholly lost, and others are in such a state of decline and imperfection as to be little esteemed. By the fertility of seeds, however, new varieties of this as well as of all other fruits and trees are continually produced. A tree produced from a cutting exactly resembles the parent plant; not so one raised from a seed, which generally derives its origin from more than one parent, and in dioecious plants must always do so. Hence the endless variety which interests the florist. When this cause is considered as having operated for ages, we cease to wonder at the diversified appearances which we observe in a bed of seedling plants. Mr. Knight strongly advises to take grafts from individuals lately raised from seeds, which he assures us possess a vigour of growth never met with in old varieties. Strawberries and potatoes also become unproductive, unless the old varieties are replaced by others raised from seed.

The nourishment of vegetables, as it is so intimately connected with the important science of agriculture, has deservedly attracted considerable attention. Mr. Boyle dried in an oven a quantity of earth proper for vegetation, and after carefully weighing it, planted in it the seed of a gourd; he watered it with pure rain-water, and it produced a plant which weighed fourteen pounds, though the earth had suffered no sensible diminution.

A willow-tree was planted by Van Helmont in a pot containing 100 pounds of earth. This was in general watered with distilled water, or sometimes with rain-water which appeared perfectly pure. The vessel containing the plant was covered in such a manner as totally to exclude the entrance of all solid matter. At the end of five years, upon taking out the plant, he found it to have increased in weight not less than 119 pounds, though the earth had lost only two ounces of its original weight.

These experiments would admit of some doubt, and must have remained in a great measure inexplicable, but for the experiments of Mr. Cavendish, and the facts related by Dr. Priestley, which place it beyond a doubt, that vegetables have a power of decomposing water, and converting it, with what they derive from the atmosphere, into almost all the different matters found to exist in their substance.

All the proper juices of vegetables depend on the organization, as it is evident from the operation of grafting. From the materials of simple water and air, are produced those wonderful diversities of peculiar juices and fruits, which the vegetable world affords; and the immense variety of tastes, smells, &c. In the same vegetable what a variety is found! The bark is different in taste from the wood, the peculiar juices have something different from them both, and the pith of some plants affords a matter which could not have been expected from their exterior qualities. The root is often different from the stem, and the fruit from both, in all their sensible qualities.

In whatever way the nourishment of vegetables is received, it may fairly be said to consist principally of water. We are inclined to believe, however, that calcareous earth, in small portions, may enter into the composition of at least many vegetables; since animals which exist entirely on vegetable food are found to have in their solid parts, the bones for instance, a considerable portion of this substance; though it must be confessed that chemical analysis, as far as it has hitherto gone, does not warrant us in supposing calcareous earth to be an essential constituent of all vegetable matter. It may be said further, that on some occasions the addition of other matters, as of different kinds of manure, adds greatly to the growth of vegetables; but in whatever degree a rich soil or dung may add to the luxuriance of growth, other facts seem to prove that it is not essential to vegetation. It is well known that many herbs flourish in pure water; and that pear, plum, and cherry-trees, planted in pure moss, have arrived at such perfection as to produce good fruit.

Different theories have been advanced to account for the operation of manures in promoting the growth of vegetables, none of which seem altogether satisfactory. The common opinion is, that the substances employed as manures contain those principles which constitute the food of plants, and which are absorbed by their roots. This hypothesis is doubtless true to a certain extent, especially when it is considered that carbon forms a great part of many manures. Another opinion is, that manures act by bringing soils to such a consistence as is favourable to the growth of the roots of vegetables, and to the affording of them water in a proper quantity. A third opinion is, that manures act as stimuli on the roots of vegetables, and thus excite them to more vigorous action. Some authors think that manures act as solvents on matters previously contained in the soil, and thus fit them for entering the roots of plants; and others, that they act chemically, by forming combinations which are favourable to vegetation. Which of these hypotheses is best founded, it is difficult to determine; but it does not seem unlikely that they may all have some foundation in fact.

When we attempt to discover the component principles of the objects around us, and the sources whence they were supported, we are lost in the greatness and diversity of the scenes presented to us. We see animals nourished by vegetables, vegetables apparently by the remains of animals, and fossils composed of the relics of both of these kingdoms. It seems certain, however, that vegetables preceded animals. A seed of moss lodging in a crevice of a bare rock is nourished by the atmosphere, and the moisture afforded by the rains and dews. It comes to perfection, and sheds its seeds in the mouldering remains of its own substance. Its offspring do the same, till a crust of vegetable mould is formed sufficiently thick for the support of grass and other vegetables of the same growth. The same process going forward, shrubs, and lastly the largest trees, may find a firm support on the once barren rock, and brave the efforts of the tempest.

From the advantages derived from a change of crops in agriculture, it has been supposed that different vegetables derive different kinds of nourishment from the same soil, selecting what is best adapted to their own support, and leaving a supply of nourishment of another kind for vegetables of another genus. Was this, however, the case, vegetables would not so much impede each other's growth when placed near together. And in the operation of grafting, we have a clear proof that the juices received by the root of one species of tree may, by the organization of the inserted twig, be subservient to the growth of leaves, flowers, and fruit, of a different kind. The advantage derived from a change of crops may be better explained on other principles: some plants extend their roots horizontally on the surface of the soil, others strike them downwards to a considerable depth. Some plants are found to bind or harden the soil, others to loosen it. Thus, for example, wheat and rye-grass render a soil stiff; while pulse, clover, and turnips, pulverize it. By varying the crops, therefore, the soil is preserved in a middle state, between too much stiffness and too much friability. Nor is this the only good effect arising from this difference of roots. From this circumstance some vegetables draw their nourishment from the surface of the earth, while others derive it partly from a greater depth; so that by a change of crops, a larger portion of the soil is made to contribute to the nourishment of plants than could have been effected by the cultivation of any single species. One other advantage to be derived from a change of crops is this: Some plants extract almost the whole of their nourishment from the soil; and this is particularly the case with those which are most valuable, and which contain the greatest quantity of solid matter. By the repetition of such crops, however, the soil is found to become too much exhausted. There are other plants which derive a large proportion of their nourishment from the air; by such therefore the soil will be much less exhausted, and under a crop of them will be in some measure at rest. The good effects of a change of crops may therefore be sufficiently explained, without supposing that each particular species of vegetables is nourished by a different kind of food. This opinion is also necessarily attended with two great difficulties; one is, that there exists in every soil as many distinct kinds of nourishment as there are species of plants capable of growing in that soil; the other, that plants are endued with the faculty of selecting, from all these kinds, their own proper nourishment. The former of these suppositions is too absurd to merit the least attention; and the latter has been disproved by actual experiment; since plants are not able to prevent their roots from absorbing such matters as prove poisonous to them. Other writers, however, have been more moderate; and though they have rejected the idea of specific nourishment in general, have nevertheless imagined that the hypothesis might be well founded with respect to particular species of vegetables. This they infer from the existence of specific manures, as soot for saintfoin, ashes for white clover, and some others. It does not seem possible, however, to draw a line of distinction; and if we reject the idea of a specific nourishment in general, we cannot admit it in particular instances.

In order to discover whether plants have an actual power of distinguishing matters presented to their roots, a gentleman of science made, among others, the following experiment:

A vigorous plant of mint was placed in a two-ounce phial, filled with filtrated well-water, to which were added four drops of a moderately strong solution of sulphate of iron. On examining the plant the following day, no other effect was observed, than that the very tips of the radicles were withered and black. Four more drops of the solution were now added. On the third day the appearances were the same; and no new change taking place on the fourth, twelve more drops of the solution were added. On the fifth day the roots appeared of a yellowish-green colour, and the top drooped very much. The larger leaves were pretty much withered and blackened. The absorption of the water appeared to be in some measure impeded, but not entirely prevented. On the sixth day the whole plant was withering very fast; the roots became of a dark olive-green colour, and the larger leaves were become very black, especially the footstalks and the projecting fibres. On the seventh day the blackness had made still further progress, and the plant was dead. A sufficient proof that some of the iron was absorbed by the plant, may be drawn from the following circumstance: Its leaves, when macerated in distilled water, produced a black colour with galls. The leaves of a plant of mint, which had been nourished by water alone, when tried by the same test, produced no colour whatever. This experiment proves two points; that plants have not the power of rejecting even injurious matters when presented to their roots, and that other matters besides water and air are capable of being absorbed by them.

The benefit produced by the common custom of letting lands lie fallow, has not yet been satisfactorily explained. Something may no doubt be attributed to the destruction of weeds, but more probably to some change produced in the soil by its being exposed to the action of the sun and air. The management of nitre-beds may tend to throw some light on this subject. These are composed of calcareous earth and dung cemented together. After being exposed for some months to the air, they are found to contain a quantity of nitric acid, which, uniting to the calcareous earth, forms a kind of salt, which is extracted by lixiviation. Now calcareous earth and dung are two of the most powerful kinds of manure, and it does not seem improbable that their fertilizing powers may be in some manner connected with their property of affording nitrous acid.

Vegetable substances. Plants contain various saline matters; such as the vegetable acids, and the three alkalies, ammonia, potass, and soda; also gum, sugar, fat oils, essential oils, balsams, camphor, resin, tar, farina, narcotic, and colouring matters; all which the reader will find treated of under their respective heads. But different kinds of plants contain matters peculiar to themselves, which an ingenious and profound modern chemist (Dr. Thomson) has classed under the general term extractive principle, and to which he ascribes the following general properties: 1st. Soluble in water, and the solution is always coloured. When the water is slowly evaporated, the extractive matter is obtained in a solid state, and transparent; but when the evaporation is rapid the matter is opaque. 2. The taste of extractive is always strong; but it is very different, according to the plant from which it is obtained. 3. Soluble in alcohol, but insoluble in ether. 4. By repeated solutions and evaporations, the extractive matter acquires a deeper colour, and becomes insoluble in water. This change is considered as the consequence of the absorption of the oxygen of the atmosphere, for which the extractive principle has a strong affinity: but if the solution is left to itself, exposed to the atmosphere, the extract is totally destroyed in consequence of a kind of putrefaction which speedily commences. 5. When oxymuriatic acid is poured into a solution containing extractive, a very copious dark-yellow precipitate is thrown down, and the liquid retains but a light lemon-colour. These flakes are the oxygenized extractive. It is now insoluble in water; but hot alcohol still dissolves it. 6. The extractive principle unites with alumina, and forms with it an insoluble compound. Accordingly, if sulphat or muriat of alumina is mixed with a solution of extractive, a flaky insoluble precipitate appears, at least when the liquid is boiled; but if an excess of acid is present, the precipitate does not always appear. 7. It is precipitated from water by concentrated sulphuric acid, muriatic acid, and probably by several other acids. When the experiment is made with sulphuric acid, the fumes of vinegar generally become sensible. 8. Alkalies readily unite with extractive, and form compounds which are soluble in water. 9. The greater number of metallic oxides form insoluble compounds with extractive. Hence many of them, when thrown into its solution, are capable of separating it from water. Hence also the metallic salts mostly precipitate extractive. Muriat of tin possesses this property in an eminent degeee. It throws down a brown powder, perfectly insoluble, composed of the oxide of tin and vegetable matter. 10. If wool, cotton, or thread, is impregnated with alum, and then plunged into a solution of extractive, they are dyed of a fawn-brown colour, and the liquid loses much of its extractive matter. This colour is permanent. The same effect is produced if muriat of tin is employed instead of alum. This effect is still more complete if the cloth is soaked in oxymuriatic acid, and then dipt into the infusion of extractive. Hence we see that the extractive matter requires no other mordant than oxygen to fix it on cloth. 11. When distilled, extractive yields an acid liquid impregnated with ammonia.

It cannot be doubted that there are many different species of extractive matter; though the difficulty of obtaining each separately has prevented chemists from ascertaining its nature with precision. Extracts in pharmacy are usually obtained by treating the vegetable substance from which they are to be procured with water, and then evaporating the watery solution slowly to dryness. All extracts obtained by this method have an acid taste, and redden the infusion of litmus. They all yield a precipitate while liquid, if they are mixed with ammonia. This precipitate is a compound of lime and insoluble extractive. Lime always causes them to exhale the odour of ammonia. It has been ascertained that the extractive principle is more abundant in plants that have grown to maturity than in young plants.

As the extracts of vegetables prepared by apothecaries for medical purposes, besides the extractive principle, always contain other bodies, frequently to the number of eight or more, and as the greater number of them are still but imperfectly examined, we shall satisfy ourselves at present with pointing out some of those vegetable substances which have been ascertained to contain extractive principle, and stating the constituents of such as have been analysed.

1. Extractive principle is not an uncommon ingredient in the sap of trees. Indeed, Deyeux and Vauquelin found it in almost all those which they examined. It is usually thrown down when the sap is mixed with oxymuriatic acid, and it precipitates in brown flakes while the sap is evaporating on a sand-bath.

2. It forms a constituent of the bark of all trees hitherto examined. This was evidently the case with all the barks which Mr. Davy subjected to experiment, namely, those of the oak, Leicester willow, Spanish chesnut, elm, common willow, and undoubtedly all barks which have an astringent taste; for tan and extractive seem scarcely ever to be found separate.

3. The infusion of catechu contains an extractive principle, united chiefly to tan. It may be obtained in a state of purity by washing the catechu in powder repeatedly with water till the fluids obtained cease to precipitate gelatine. What remains is extractive. It is of a pale reddish-brown colour, and a slightly astringent taste, leaving in the mouth a sensation of sweetness. It has no smell. Its solution in water is at first yellow-brown; but it acquires a tint of red when left exposed to the air. The solution in alcohol is of a dirty brown. It does not affect vegetable blues. Alkalies brighten its colour; but neither these bodies nor the alkaline earths precipitate it from water. Nitrat of alumina and muriat of tin render the solution slightly turbid. Nitrat of lead throws down a dense light-brown precipitate. It renders the oxysulphat of iron green, and throws down a green precipitate, becoming black by exposure to the air. Linen, when boiled in the solution, takes away almost the whole of the extractive, and acquires a light red-brown colour. When this extractive is exposed to heat, it softens, and its colour becomes darker, but it does not melt. When distilled, it yields carbonic and carbureted hydrogen gas, weak acetic acid, and a little unaltered extractive. A porous charcoal remains.

4. The infusion of senna contains a matter of a very peculiar nature, but which may be considered as a species of extractive. The senna of commerce consists of the dried leaves of the cassia senna, a shrublike annual, cultivated in Egypt. Water, at the ordinary temperature of the atmosphere, dissolves nearly one-half of the substance of these leaves. The infusion obtained has a brown colour, a bitter taste, and a peculiar aromatic odour. It contains a considerable proportion of carbonat of lime, sulphat of potass, and carbonat of magnesia, besides a little silica. But the most curious of its constituents is the extractive. When common air is made to pass for some hours through the infusion, a yellow-coloured precipitate appears: the same substance is thrown down immediately by muriatic acid and oxymuriatic acid. It appears also when a current of oxygen gas is made to traverse the infusion. This substance is the extractive altered by its combination with oxygen. It has a slight bitter taste. It is no longer soluble in water. Alcohol dissolves it, but lets it fall when diluted. The alkalies dissolve it, and form a deep-brown solution. On burning coals, it emits a thick smoke, exhales an aromatic odour, and leaves a spongy charcoal. These properties indicate a very decided approach to the resinous state.

5. The infusion of Peruvian bark likewise yields an extractive matter of a peculiar nature, which assumes a fine red colour when united to oxygen; and like the extractive of senna, acquires nearly the properties of a resin. It was obtained by Fourcroy from the cinchona of St. Domingo. Water, boiled on it till it refused to dissolve any thing more, was slowly evaporated, and the extract obtained was dissolved in alcohol. The alcohol, by evaporation, deposited the peculiar extractive. Its colour was brown, its taste bitter, insoluble in cold, but very soluble in hot, water. It was soluble in alcohol. When dry it was black, brittle, and broke with a polished fracture. Lime-water precipitated it in the state of a red powder; oxymuriatic acid threw it down in the state of a fine red powder, neither soluble in water nor alcohol, but capable of uniting with alkalies. A stronger dose of oxymuriatic acid renders it yellow.

6. Saffron yields extractive matter in great abundance. This substance consists of the summits of the pistils of the crocus sativus. Almost the whole of it is soluble in water.

The resemblance between extractive bodies and the colouring matter of plants is sufficiently striking. It is more than probable, that when this last set of bodies have been examined with more precision by chemists, they will be found to belong to the same class.

PLASHING *of quickset hedges*, an operation very necessary to promote the growth and continuance of old hedges.

It is performed in this manner: The old stubs must be cut off, &c. within two or three inches of the ground, and the best and longest of the middle-sized shoots must be left to lay down. Some of the strongest of these must also be left to answer the purpose of stakes. These are to be cut off to the height at which the hedge is intended to be left; and they are to stand at ten feet distance one from another: when there are not proper shoots for these at the due distances, their places must be supplied with common stakes of dead wood. The hedge is to be first thinned, by cutting away all those shoots which are intended to be used either as stakes or the other work of the plashing: the ditch is to be cleaned out with the spade; and it must be now dug as at first, with sloping sides each way; and when there is any cavity on the bank on which the hedge grows, or the earth has been washed away from the roots of the shrubs, it is to be made good by facing it, as they express it, with the mould dug from the upper part of the ditch: all the rest of the earth dug out of the ditch is to be laid upon the top of the bank, and the owner should look carefully into it that this is done; for the workmen, to spare themselves trouble, are apt to throw as much as they can upon the face of the bank; which being by this means overloaded, is soon washed off into the ditch again, and a very great part of the work undone; whereas, what is laid on the top of the bank always remains there, and makes a good fence of an indifferent hedge.

PLASTER. See PHARMACY.

Plasters are combinations of oils and metallic oxides destined to be spread upon leather or cloth, and in that state to be applied as a covering of ulcers, &c. They ought to be solid bodies, not so hard as to refuse to spread easily and equally, nor so soft as to run into oil when heated by the skin. They ought to admit of being easily kneaded when heated with the hand, to adhere firmly to the skin, but to be capable of being removed without leaving behind them any stain. Without these properties they do not answer the purpose for which they are destined, which is chiefly adhesion.

The only chemist who has hitherto examined plasters with attention is Deyeux, to whom we are indebted for some excellent observations on the method of preparing them.

The oxides hitherto employed for making plasters are those of lead; and litharge is usually considered as the best adapted for that purpose, of any of these oxides. But the oxides of several of the other metals, as bismuth and mercury, are also capable of forming plasters, and might perhaps in some cases be employed with advantage. Some metallic oxides, however, as those of iron, are not susceptible of that kind of combination with oils which constitutes plasters.

All the fixed oils are capable of forming plasters; but they do not all form plasters with the same properties. The drying oils, linseed-oil for instance, form plasters of a much softer consistency than the fat oils; but these last acquire the same properties as the drying oils, if they are combined with mucilage. Thus olive-oil, boiled for some time with linseed or fenugrec, forms with litharge plasters as soft as those composed of linseed-oil and litharge. According to Deyeux, olive-oil answers better for plasters than any other.

There are three different ways of forming plasters. The first consists in simply mixing together oil and litharge in proper proportions, and allowing the mixture to remain a considerable time in the common temperature of the atmosphere, agitating it occasionally. The oxide gradually loses its colour, and combines with the oil, and the mixture acquires consistence. This process is tedious, and does not furnish plasters sufficiently solid to answer the purposes for which they are intended. It is not therefore employed.

The second method consists in throwing the oxide into the oil while boiling. Plasters formed by this process have always a deep colour, and a peculiar odour, occasioned by the decomposition of a portion of the oil. When this process is followed, it is necessary that the oxide should be in the state of a fine powder; and that by agitation it should be made to combine with the oil as fast as possible, otherwise the metal will be revived altogether, in consequence of the strong tendency which oil has to combine with oxygen when raised to a high temperature.

The third method is most frequently practised, because it is not liable to the same inconveniences as the other two. This method consists in boiling the oil and the oxide together in a sufficient quantity of water. By this liquid the heat is moderated at first till the oil and oxide combine, which prevents the revival of the metal; and afterwards when the water is dissipated, the temperature is sufficiently high to give the plaster the requisite consistency.

Plasters, when long kept, become often too hard to be fit for use, especially if the requisite proportion of oil has not been employed at first. This defect is easily remedied, by melting them with a small portion of new oil. Plasters, when long kept, likewise change their colour, and most of their sensible properties; owing either to the absorption of oxygen, or to some change produced in their component parts by the action of the air.

PLASTICE, the *plastic art*, a branch of sculpture, being the art of forming figures of men, birds, beasts, fishes, &c. in plaister, clay, stucco, or the like. See SCULPTURE.

Plastice differs from carving in this, that the figures are made by the addition of what is wanting; but in carving always by subtracting what is superfluous. The plastic art is now chiefly used among us in fret-work ceilings; but the Italians apply it also to the mantlings of chimneys with great figures.

PLATALEA, the *spoonbill*, in ornithology, a genus belonging to the order of grallæ. The beak is plain, and dilates towards the point into an orbicular form; the feet have three toes, and are half-palmated. There are three species, distinguished by their colour: and of these species there are three varieties; two of which are called the white species, and one of the roseate.

1. The white species, which Linnæus calls platalea leucorodia, is about the size of a heron, but somewhat shorter in the neck and legs. The bill is more than half a foot long, and, like that of the rest of the genus, is shaped like a spoon: the colour of the bill is very various, being in some birds black, in others brown; the plumage is entirely white, though there have been specimens where the quills were tipped with black; the legs are generally either black or of a greyish-brown colour; between the toes there is a membrane connected to the outer one as far as the second joint, and to the inner as far as the first.

This bird is found in various parts of the Old Continent, and from the Ferro isles near Iceland to the Cape of Good Hope. It frequents the neighbourhood of the sea, and has been met with on the coasts of France; at Sevenhuys, near Leyden, once in great plenty, annually breeding in a wood there. The nest is placed on high trees near the sea-side. The female lays three or four white eggs, powdered with a few pale-red spots, and of the size of those of a hen. They are very noisy during breeding-time, like our rooks; are seldom found high up the rivers, chiefly frequenting the mouths of them. Their food is fish, which they are said not unfrequently to take from other birds, in the manner of the bald eagle; also mussels and other shell-fish, being found in greatest numbers where these are plenty; and they will also devour frogs and snakes, and even grass and weeds, which grow in the water, as well as the roots of reeds. They are migratory, retiring to the warmer parts as the winter approaches, and are rarely seen in England. Their flesh is said to have the flavour of a goose, and is eaten by some; and the young birds have been thought good food.

2. The roseate species, or platalea ajaja, is less than the white. The bill is marked all round with a furrow parallel to the edge, and is of a greyish-white colour, so transparent as to show the ramification of the blood-vessels belonging to it: the forehead is of a whitish colour between the bill, and eyes, and throat; the plumage is a fine rose-colour, deepest on the wings. A variety of this species is entirely of a beautiful red colour, having a collar of black at the lower part of the neck; the irides are red. It is said to be of a blackish chesnut the first year, becomes rose-coloured the second, and of a deep scarlet the third. It lives on small fish.

3. The dwarf species, or platalea pigmea, is about the size of a sparrow. The bill is black, longer than the head, flat at the end, and nearly of a rhomboidal form; the body is brown above and white beneath. It inhabits Surinam and Guiana.

PLATANUS, the *plane-tree*, a genus of the polyandria order, in the monœcia class of plants. The male calyx is an ament, globular; corolla scarcely apparent; anthers growing round the filament. Female calyx ament, globular; corolla many-petalled; stigma removed; seeds roundish, marcomate with the style, pappose at the base. The species are:

1. The orientalis, oriental or Eastern plane-tree, rises with a very straight smooth branching stem to a great height. It has palmated leaves, six or eight inches long and as much broad, divided into five large segments; having the side ones cut into two smaller, green above, and pale underneath; and long pendulous pedunculi, each sustaining several round heads of close-sitting very small flowers; succeeded by numerous downy seeds, collected into round, rough, hard balls. It is a native of Asia and many parts of the East, and grows in great plenty in the Levant.

2. The occidentalis, occidental or Western plane-tree, rises with a straight smooth stem to a great height, branching widely round; it has lobated leaves, seven or eight inches long, and from nine or ten to twelve or fourteen broad, divided into three large lobes; and very small flowers, collected into round heads, succeeded by round rough balls of seed. It is a native of Virginia and other parts of North America, where it attains an enormous size, and is remarkable for having

its stem all of an equal girt for a considerable length: we have an account of some trees being eight or nine yards in circumference, and which, when felled, afforded twenty loads of wood.

The varieties of these two species are the Spanish or middle plane-tree, having remarkably large leaves of three or five narrower segments; and the maple-leaved plane-tree, having smaller leaves, somewhat lobated into five segments, resembling the maple-tree leaf.

All these elegant trees are of hardy temperature, so as to prosper here in any common soil and exposure in our open plantations, &c. and are some of the most desirable trees of the deciduous tribe. Their propagation is by seed, layers, and cuttings. All the sorts will take tolerably by cutting off the strong young shoots; but the platanus occidentalis more freely than the oriental kind. Autumn is the best season: as soon as the leaf falls, choose strong young shoots, and plant them in a moist soil; many of them will grow, and make tolerable plants by next autumn.

PLATBAND *of a door or window*, is used for the lintel, where that is made square, or not much arched: these platbands are usually crossed with bars of iron when they have a great bearing, but it is much better to ease them by arches of discharge built over them.

PLATFORM, in the military art, an elevation of earth, on which cannon is placed to fire on the enemy: such are the mounts in the middle of curtins. On the ramparts there is always a platform, where the cannon are mounted. It is made by the heaping up of earth on the rampart; or by an arrangement of madriers, rising insensibly, for the cannon to roll on, either in a casement or on attack in the outworks. All practitioners are agreed that no shot can be depended on, unless the piece can be placed on a solid platform; for if the platform shakes with the first impulse of the powder, the piece must likewise shake, which will alter its direction, and render the shot uncertain.

Platform, or Orlop, in a ship of war, a place on the lower deck, abaft the main-mast, between it and the cockpit, and round about the main capstan, where provision is made for the wounded men in time of action.

PLATINA. See Platinum.

PLATING, is the art of covering baser metals with a thin plate of silver either for use or for ornament. It is said to have been invented by a spur-maker, not for show but for real utility. Till then the more elegant spurs in common use were made of solid silver; and from the flexibility of that metal, they were liable to be bent into inconvenient forms by the slightest accident. To remedy this defect, a workman at Birmingham contrived to make the branches of a pair of spurs hollow, and to fill that hollow with a slender rod of steel or iron. Finding this a great improvement, and being desirous to add cheapness to utility, he continued to make the hollow larger, and of course the iron thicker and thicker, till at last he discovered the means of coating an iron spur with silver in such a manner as to make it equally elegant with those which were made wholly of that metal. The invention was quickly applied to other purposes; and to numberless utensils which were formerly made of brass or iron are now given the strength of these metals, and the elegance of silver, for a small additional expence.

The silver plate was formerly made to adhere to the baser metal by means of solder; which is of two kinds, the soft and the hard, or the tin and silver solders. The former of these consists of tin alone, the latter generally of three parts of silver and one of brass. When a buckle, for instance, is to be plated by means of the soft solder, the ring, before it is bent, is first tinned, and then the silver-plate is gently hammered upon it, the hammer employed being always covered with a piece of cloth. The silver now forms, as it were, a mould to the ring, and whatever of it is not intended to be used is cut off. This mould is fastened to the ring of the buckle by two or three cramps of iron wire; after which the buckle, with the plated side undermost, is laid upon a plate of iron sufficiently hot to melt the tin, but not the silver. The buckle is then covered with powdered resin, or anointed with turpentine; and lest there should be a deficiency of tin, a small portion of rolled tin is likewise melted on it. The buckle is now taken off with tongs, and commonly laid on a bed of sand; where the plate and the ring, while the solder is yet in a state of fusion, are more closely compressed by a smart stroke with a block of wood. The buckle is afterwards bent and finished.

The mode of plating at present is, to fasten plates of silver upon thicker plates of copper, and then rolling them together into thin plates. The copper is twelve times thicker than the silver, and one ounce of silver is rolled to a surface of three feet or more. The plates being thus made, they are then stamped by a single stroke into the size and form of buckles, buttons, spoons, &c.

PLATINUM, one of the perfect metals, has hitherto been found only in Peru, and in the mine Santa Fe, near Carthagena. The workmen of these mines must no doubt have been early acquainted with it; but they seem to have paid very little attention to it. It was unknown in Europe till Mr. Wood brought some of it from Jamaica in 1741. In 1748 it was noticed by don Antonio de Ulloa, a Spanish mathematician, who had accompanied the French academicians to Peru, in their voyage to measure a degree of the meridian. Several papers on it were published by Dr. Watson in the 46th volume of the Philosophical Transactions. These immediately attracted the attention of the most eminent chemists. In 1752, Mr. Scheffer of Sweden published the first accurate examination of its properties. He proved it to be a new metal, approaching very much to the nature of gold, and therefore gave it the name of aurum album, white gold.

I. 1. Platinum, when pure, is of a white colour like silver, but not so bright. It has no taste nor smell.

2. Its hardness is 8. Its specific gravity, after being hammered, is 23.000; so that it is by far the heaviest body known

3. It is exceedingly ductile and malleable: it may be hammered out into very thin plates, and drawn into wires not exceeding $\frac{1}{1940}$ inch in diameter. In these properties it is probably inferior to gold, but it seems to surpass all the other metals.

4. Its tenacity is such, that a wire of platinum 0.078 inch in diameter, is capable of supporting a weight of 274.31 lbs. avoirdupois without breaking.

5. It is the most infusible of all metals, and cannot be melted, in any quantity at least, by the strongest artificial heat which can be produced. Macquer and Baumé melted small particles of it by means of a blow pipe, and Lavoisier by exposing them on red-hot charcoal to a stream of oxygen gas. It may indeed be melted without difficulty when combined or mixed with other bodies; but then it is not in a state of purity. Pieces of platinum, when heated to whiteness, may be welded together by hammering in the same manner as hot iron.

6. This metal is not in the smallest degree altered by the action of air or water.

II. It cannot be combined with oxygen and converted into an oxide by the strongest artificial heat of our furnaces. Platinum, indeed, in the state in which it is brought from America, may be partially oxidated by exposure to a violent heat, as numerous experiments have proved; but in that state it is not pure, but combined with a quantity of iron. It cannot be doubted, however, that if we could subject it to a sufficient heat, platinum would burn and be oxidated like other metals: for when Van Marum exposed a wire of platinum to the action of his powerful electrical machine, it burnt with a faint white flame, and was dissipated into a species of dust, which proved to be the oxide of platinum. By putting a platinum wire into the flame produced by the combustion of hydrogen gas mixed with oxygen, it was made to burn with all the brilliancy of iron wire, and to emit sparks in abundance. This metal may be oxidated in any quantity by boiling it in 16 times its weight of nitro-muriatic acid (aqua regia). The acid dissolves it, and assumes first a yellow, and afterwards a deep red or rather brown colour. On the addition of lime to the solution, a yellow powder falls to the bottom. This powder is the oxide of platinum. Its properties have not been examined with sufficient accuracy. It seems to contain but a small proportion of oxygen; probably not more than 0.07: yet it is in all probability a peroxide.

This oxide may be decomposed, and the oxygen driven off, by exposing it to violent heat.

III. Neither carbon nor hydrogen can be combined with platinum; but M. Proust has found it combined with sulphur in native platinum, and it unites without difficulty to phosphorus. By mixing together an ounce of platinum, an ounce of phosphoric glass, and a dram of powdered charcoal, and applying a heat of about 32° Wedgeworth, M. Pelletier formed a phosphuret of platinum weighing more than an ounce. It was partly in the form of a button, and partly in cubic crystals. It was covered above by a blackish glass. It was of a silver-white colour, very brittle, and hard enough to strike fire with steel. When exposed to a fire strong enough to melt it, the phosphorus was disengaged, and burnt on the surface.

He found also, that when phosphorus was projected on red-hot platinum, the metal instantly fused, and formed a phosphuret. As heat expels the phosphorus, Mr. Pelletier has proposed this as an easy method of purifying platinum.

IV. Platinum, as far as is known, does not combine with the simple incombustibles.

V. It combines with most of the metals, and forms alloys.

When gold and platinum are exposed to a strong heat, they combine, and form an alloy of gold and platinum. If the platinum exceeds $\frac{1}{17}$ of the gold, the colour of the alloy is much paler than gold; but if it is under $\frac{1}{17}$, the colour of the gold is not sensibly altered. Neither is there any alteration in the ductility of the gold. Platinum may be alloyed with a considerable proportion of gold, without sensibly altering its colour.

VI. The affinities of platinum are at present unknown. If this metal could be obtained at a cheap rate, it would furnish very useful vessels, that might be exposed to the greatest heat without alteration.

PLATONIC YEAR, or the GREAT YEAR, is a period of time determined by the revolution of the equinoxes, or the space wherein the stars and constellations return to their former places in respect of the equinoxes. The Platonic year, according to Tycho Brahe, is 25816, according to Ricciolus 25920, and according to Cassini 24800 years.

PLATOON, in the military art, a small square body of forty or fifty men, drawn out of a battalion of foot, and placed between the squadrons of horse, to sustain them; or in ambuscades, straits, and defiles, where there is not room for whole battalions or regiments. Platoons are also used when they form the hollow square, to strengthen the angles. The grenadiers are generally posted in platoons.

PLATYLOBIUM, a genus of the diadelphia decandria class and order. The calyx is bell-shaped, five-cleft; the two upper segments very large; legume pedicelled, compressed, winged at the back. There is one species, a shrub of South Wales.

PLATYPUS, a quadruped of the order of bruta. The generic character is, mouth shaped like the bill of a duck; feet webbed. Of this extraordinary genus two specimens have been sent from New Holland to sir Joseph Banks by governor Hunter.

Of all the mammalia yet known, this seems the most extraordinary in its conformation; exhibiting the perfect resemblance of the beak of a duck engrafted on the head of a quadruped. So accurate is the similitude, that, at first view, it naturally excites the idea of some deceptive preparation by artificial means; the very epidermis, proportion, serratures, manner of opening, and other particulars of the beak of a shoveler, or other broad-billed species of duck, presenting themselves to the view: nor is it without the most minute and rigid examination that we can persuade ourselves of its being the real beak or snout of a quadruped.

The body is depressed, and has some resemblance to that of an otter in miniature. It is covered with a very thick, soft, and beaver-like fur, and is of a moderately dark brown above, and of a subferruginous white beneath. The head is flattish, and rather small than large; the mouth or snout, as before observed, so exactly resembles that of some broad-billed species of duck, that it might be mistaken for such: round the base is a flat circular membrane, somewhat deeper or wider below than above, viz. below nearly the fifth of an inch, and above about an eighth. The tail is flat, furry like the body, rather short and obtuse, with an almost bifid termination; it is broader at the base, and gradually lessens to the tip, and is about three inches in length; its colour is similar to that of the body. The length of the whole animal from the tip of the beak to that of the tail is 13 inches; of the beak an inch and a half. The legs are very short, terminating in a broad web, which on the fore feet extends to a considerable distance beyond the claws; but on the hind-feet reaches no farther than the roots of the claws. On the fore-feet are five claws, straight, strong, and sharp-pointed; the two exterior ones somewhat shorter than the three middle ones. On the hind-feet are six claws, longer and more inclining to a curved form than those on the fore-feet; the exterior toe and claw are considerably shorter than the four middle ones; the interior or sixth is seated much higher up than the rest, and resembles a strong sharp spur. All the legs are hairy above; the fore-feet are naked both above and below; but the hind-feet are hairy above, and naked below. The internal edges of the under mandible (which is narrower than the upper) are serrated or channeled with numerous striæ, as in a duck's bill. The nostrils are small and round, and are situated about a quarter of an inch from the tip of the bill, and are about the eighth of an inch distant from each other. There is no appearance of teeth; the palate is removed, but seems to have resembled that of a duck; the tongue also is wanting in the specimen. The ears, or auditory foramina, are placed about an inch beyond the eyes; they appear like a pair of oval holes, of the eighth of an inch in diameter, there being no external ear. On the upper part of the head, on each side, a little beyond the beak, are situated two smallish oval white spots; in the lower part of each of which are imbedded the eyes, or at least the parts allotted to the animal for some kind of vision; for from the thickness of the fur, and the smallness of the organs, they seem to have been but obscurely calculated for distinct vision, and are probably like those of moles, and some other animals of that tribe; or perhaps even subcutaneous; the whole apparent diameter of the cavity in which they were placed not exceeding the tenth of an inch.

When we consider the general form of this animal, and particularly its bill and webbed feet, we shall readily perceive that it must be a resident in watery situations; that it has the habits of digging or burrowing in the banks of rivers or under ground; and that its food consists of aquatic plants and animals. This is all that can at present be reasonably guessed at: future observations, made in its native regions, will, it is hoped, afford us more ample information, and will make us fully acquainted with the natural history of an animal which differs so widely from all other quadrupeds, and which verifies, in a most striking manner, the observation of Buffon, viz. that whatever was possible for nature to produce, has actually been produced.

The platypus is a native of Australasia or New Holland.

PLEA, that which either party alleges for himself in court. These are divided into pleas of the crown and common pleas.

Pleas of the crown are all suits in the king's name, against offences committed against his crown and dignity, or against his crown and peace. Common pleas are those that are held between common persons.

Common pleas are either dilatory, or pleas to the action.

Pleas dilatory are such as tend merely to delay or put off the suit, by questioning the propriety of the remedy rather than by denying the injury.

Pleas to the action are such as dispute the very cause of suit. 3 Black. 301. See Tidd's K. B. Practice.

PLEADINGS, in general, signify the allegations of parties to suits when they are put into a proper and legal form; and are distinguished in respect to the parties who plead them, by the names of bars, replications, rejoinders, sur-rejoinders, rebutters, sur-rebutters, &c. and though the matter in the declaration of court does not properly come under the name of pleading, yet, being often comprehended in the extended sense of the word, it is generally considered under this head. See Tidd's K. B. Practice.

PLEBISCITUM, in Roman antiquity, a law enacted by the common people, at the request of the tribune, or other plebeian magistrate, without the intervention of the senate.

PLECTRANTHUS, a genus of the gymnospermia order, in the didynamia class of plants, and in the natural method ranking under the 42d order, verticillatæ. The calyx is monophyllous, short, and bilabiated; the upper lip of which is large, oval, and bent upwards; the inferior lip is quadrifid, and divided into two laciniæ: the corolla is monopetalous, ringent, and turned back; the labiæ look different ways, and from the base of the tube there is a nectarium like a spur: the filaments are in a declining situation, with simple antheræ: the stylus filiform; the stigma bifid. It has four seeds, covered only by the calyx. There are five species: the fruticosus is a native of the Cape of Good Hope; the punctatus is a native of Africa. The first flowers from June to September, the latter from January to May.

PLECTROMIA, a genus of the class and order pentandria monogynia. The petals are five; berry two-seeded, inferior. There is one species, a tree of the Cape.

PLEIADES, in astronomy, an assemblage of stars in the neck of the constellation Taurus. See ASTRONOMY.

PLENE ADMINISTRAVIT, a plea pleaded by an executor or administrator, where they have administered the deceased's estate faithfully and justly before the action brought against them.

PLENUM, in physics, denotes, according to the Cartesians, that state of things wherein every part of space is supposed to be full of matter; in opposition to a vacuum.

PLENUS FLOS. See BOTANY, Vol. I. p. 251.

PLETHORA. See MEDICINE.

PLEURA. See ANATOMY.

PLEURISY. See MEDICINE.

PLEURONECTES, *flounder*, a genus of fishes of the order thoracici, of which there are 17 species. The generic character is, eyes both on the same side of the head; body compressed, one side representing the back, and the other the abdomen.

The singular structure of this genus is justly considered as one of the most curious deviations from the general uniformity or regularity observed by nature in the external figure of animals, in which (except in a very few instances) both sides of the body are perfectly similar: but in the genus pleuronectes the animal is so constituted, that one side appears to represent the back, and the opposite side the abdomen. They swim laterally, and the eyes are always placed on one side. It is from this circumstance that the division of the species is conducted, viz. into those which have the eyes dextrous, or towards the right, when the fish is laid with its coloured side upwards with its abdomen towards the spectator; and sinistrous when the eyes are towards the left in the above situation of the fish. It is said, however, that instances have sometimes occurred in which this natural situation has been reversed; but such instances must be considered as extremely rare.

1. Pleuronectes hippoglossus, holibut, with eyes towards the right. This species not only exceeds in size all the rest of the present genus, but may even be considered as one of the largest of fishes; having been sometimes found of the weight of three, and even, according to some accounts, four hundred pounds. It is a native of the Mediterranean and northern seas, and appears to arrive at its greatest size in the latter. It is considered as the most voracious of its tribe; preying on a variety of other fishes, as well as on different kinds of crabs, shell-fish, &c. The holibut is, however, of a longer or more slender form than most other flat fish: its colour is deep-brown above, and white beneath; the body being quite smooth, and covered with moderately small scales. As a food it is considered as very coarse in comparison with many others of this genus. In the London markets this fish is usually cut into large pieces when exposed to sale. The Greenlanders are said to cut it into thin slips, which they dry in the sun, and thus preserve for winter use.

2. Pleuronectes platessa, plaise. This species is, in general, easily distinguished at first sight from others of the genus by its shape and colours; being very broad and flat, and of a fine palish brown above, marked both on the body and fins by pretty numerous, but rather distant, round, and moderately large, orange-coloured spots: the under side is white; behind the left eye is a row of six tubercles, reaching as far as the commencement of the lateral line; the mouth is rather small, the lower jaw longer than the upper, and both furnished with a row of small and rather blunt teeth.

The plaise is an inhabitant of the Mediterranean, Baltic, and northern seas, and is found in considerable plenty about our own coasts. Mr. Pennant observes, that it is sometimes taken of the weight of 15 pounds; but its more general weight is far short of this, one of eight or nine pounds being reckoned a large fish. The best are said to be taken off Rye on the coast of Sussex, and about the Dutch coasts. They spawn in the beginning of May. Their general food consists of small fishes, sea-insects, and the smaller kinds of shell-fish.

The plaise is in considerable esteem as a food, though far inferior to the sole and turbot. Those are most esteemed which are of moderate size, the smaller ones being less firm than those of more advanced growth.

3. Pleuronectes limanda, dab. The dab is of a very broad ovate shape, of a yellowish brown colour above, and white beneath. It is covered with moderately large rough scales. The head is small, and the eyes large; the mouth small, and the teeth are more numerous in the upper jaw than in the lower; the dorsal and anal fins are of moderate width, and the tail nearly even at the end; the lateral line curves downwards over the pectoral fins, and from thence runs straight to the tail.

This species is an inhabitant of the Mediterranean, the Baltic, and the northern seas, but is less common than either the plaise or flounder, to both of which it is superior as a food, though inferior in its general size. It is in its highest season in the months of February, March, and April, after which it is observed to grow less firm. It spawns in May, or, if the spring proves cold, in June.

4. Pleuronectes flesus. The flounder is allied to the plaise in shape, but is generally of smaller size and of more obscure colours; the upper side being of a dull brown, marbled with paler and darker variegations, and the under side of a dull white, sometimes obscurely varied with brown; the body is covered with very small scales; and along the back, at the base of the dorsal fin, runs a row of small sharp spines; a similar row runs along the base of the anal fin: the lateral line is marked by a third row, continued almost to the base of the tail, which is slightly rounded at the end: at the commencement of the anal fin is a pretty strong spine.

The flounder is an inhabitant of the Northern, Baltic, and Mediterranean seas. About our own coasts it is extremely common, and even frequents our rivers at a great distance from the salt waters. It is in considerable esteem as a food, though much inferior to some others of the genus.

The pleuronectes passer of Linnæus, considered by Mr. Pennant and some others as a variety of the flounder, having the eyes on the left side, is at present allowed to constitute a distinct species.

5. Pleuronectes solea. The sole is an inhabitant of the Northern, Baltic, and American seas, and grows to the length of more than two feet, and to the weight of eight pounds. Its general size, however, is much smaller. Its shape is that of a very long oval; its colour obscure brown above, and white beneath. It is covered with small rough scales of an oblong form, each terminated by numerous spines, and very strongly fastened to the skin. These scales, from the elegance of their structure, form a favourite microscopic object; and an erroneous idea sometimes prevails, that the spiny end of the scale is that by which it was inserted into the skin. The pectoral fins, especially that on the upper side, are commonly tipped with black.

Next to the turbot, this fish is considered as the most delicate of the genus, and is by many even preferred to the former; the flesh being remarkably firm, white, and well-flavoured: those of moderate size are in general most esteemed. The sole delights in lying at the bottom of the coasts which it frequents, preying on small shell-fish, spawn, sea-insects, &c. and is generally taken by the trawl-net. The chief fishery, according to Mr. Pennant, is at Brixham in Torbay.

6. Pleuronectes tuberculatus, with eyes towards the left. The turbot, generally considered as superior to every other species as an article of food, is an inhabitant of the Mediterranean and Northern seas, where it often arrives at a very large size. It is, however, far inferior in this respect to the holibut, and is therefore not very happily distinguished by Linnæus under the name of pleuronectes maximus. It is of a broader and squarer form than any other of the genus, except the pearl; and is of a dark brown above, marbled with blackish spots of different sizes, and white beneath; the scales are so small as to be scarcely observable, but the skin is of a wrinkled appearance, and covered with pretty numerous and moderately large pointed tubercles or abrupt spines, those on the upper or coloured side being far larger than those on the under side: the lateral line forms an arch over the pectoral fins, and thence runs straight to the tail.

Like the rest of this genus, the turbot generally lies in deep water, preying on worms, shell-fish, and marine insects, as well as on various kinds of small fishes. It is taken in great quantities about the northern coasts of England, as well as on those of France, Holland, &c. and is baited for with pieces of herring, haddock, &c. but more particularly with the smaller or river lamprey, vast quantities of which are said to be purchased of our fishermen by the Dutch, to the annual amount of not less than 700 pounds. They are chiefly taken about Mortlake, and sold to the Dutch as bait for the cod-fishery; but that people are said to have the art of preserving them till the commencement of the turbot-fishery.

The general manner in which the turbot-fishery is practised at Scarborough, is thus detailed by Mr. Pennant, in the British Zoology, from the communications of Mr. Travis of that place:

"When they go out to fish, each man is provided with three lines. Each man's lines are fairly coiled upon a flat oblong piece of wicker-work; the hooks being baited, and placed very regularly in the centre of the coil. Each line is furnished with fourteen score of hooks, at the distance of six feet two inches from each other. The hooks are fastened to the lines upon sneads of twisted horse hair 17 inches in length. When fishing there are always three men in each coble; and consequently nine of these lines are fastened together, and used as one line, extending in length nearly three miles, and furnished with 2520 hooks. An anchor and a buoy are fixed at the first end of the line, and one more at each end of each man's lines, in all four anchors, which are commonly perforated stones, and four buoys, made of leather and cork. The line is always laid across the current. The tides of flood and ebb continue an equal time upon our coast; and when undisturbed by winds, run each way about six hours: they are so rapid, that the fishermen can only shoot and haul their lines at each turn of the tide; and therefore the lines always remain on the ground about six hours. The same rapidity of the tide prevents their using hand-lines; and therefore two of the people commonly wrap themselves in the sail and sleep, while the other keeps a strict look-out, for fear of being run down by ships, and to observe the weather; for storms often rise so suddenly, that it is with extreme difficulty they can escape to shore, leaving their lines behind. The coble is twenty feet six inches long, and five feet in extreme breadth: it is about one ton burthen, rowed with three pair of oars, and admirably constructed for the purposes of encountering a mountainous sea. They hoist sail when the wind suits."

PLICA POLONICA. See MEDICINE.

PLINIA, a genus of plants of the polyandria monogynia class. The empalement is divided into five segments; the flower consists of five petals; the stamina are numerous filaments, slender, and as long as the flower; the antheræ are small, and so is the germen of the pistil; the style is subulated, and of the length of the stamina; the stigma is simple; the fruit is a large globose berry, of a striated or sulcated surface, containing only one cell, in which is a very large, smooth, and globose seed. There are two species, trees of America.

PLINTH. See ARCHITECTURE.

PLOCAMA, a genus of the monogynia order, in the pentandria class of plants. The calyx is quinquedentate; the fruit a berry and trilocular, with solitary seeds. Of this there is only one species, viz. the pendula, a native of the Canaries.

PLOTTING, among surveyors, is the art of laying down on paper, &c. the several angles and lines of a tract of ground surveyed by a theodolite, &c. and a chain. See SURVEYING.

PLOTUS, or DARTER, a genus of birds of the order anseres. The generic character is, bill straight, pointed, toothed; nostrils a slit near the base; face and chin naked; legs short, all the toes connected. Of this genus there are three species.

P. anhinga: head smooth; belly white: inhabits Brasil; two feet ten inches long; builds on trees, and is hardly ever seen on the ground: when at rest, sits with the neck drawn in between the shoulders; flesh oily and rancid.

P. melanogaster, inhabits Ceylon and Java; about three feet long: and the P. surinamensis, has its head crested, and belly white; it inhabits Surinam; is 13 inches long; is domesticated, and feeds on fish, insects, especially flies, which it catches with great dexterity, and is very active.

PLOVER. See CHARADRIUS.

PLOUGH. See HUSBANDRY.

PLOUGHING. See HUSBANDRY.

PLUKENETIA, a genus of the monœcia monadelphia class and order. The male and female flowers are produced separately on the same plant; the corolla is composed of four oval and patent petals, and the stamina form a short pyramidal body: the fruit is a depressed quadrangular capsule, containing a single roundish and compressed seed. There is one species.

PLUM-TREE. See PRUNUS.

PLUMBAGO, *lead-wort*, a genus of the monogynia order, in the pentandria class of plants. The corolla is funnel-form; stamina inserted in scales, inclosing the base of the corolla; stigma five-cleft; seed one. There are seven species, the most remarkable of which are the Europæa and Zeylonica. The first grows naturally in the southern parts of Europe, and has a perennial root striking deep in the ground. There are many slender enamelled stalks, about three feet high, terminated by tufts of small funnel-shaped flowers, of a blue or white colour. The second grows naturally in both the Indies. The upper part of the stalk and empalement are covered with a glutinous juice, which catches the small flies that light upon it. The former species is propagated by parting the roots, and by seeds; but the latter is too tender to thrive in the open air in this country.

PLUMBAGO, carburet of iron. This mineral is found in various parts of Europe and America. It occurs in kidney-form lumps of various sizes. Its colour is dark iron-grey, or brownish-black; when cut, blueish-grey. Opaque and slaty; texture fine-grained; brittle; specific gravity from 1.98 to 2.09; feels somewhat greasy; stains the fingers, and marks strongly. The use of this mineral, when manufactured into pencils, is known to every person. It consists of

90 of carbon
10 of iron
———
100.

PLUMBERY, the art of casting and working lead, and using it in buildings.

As this metal melts very easily, it is easy to cast it into figures of any kind, by running it into moulds of brass, clay, plaister, &c. But the chief article in plumbery is sheets and pipes of lead; and as these make the basis of the plumber's work, we shall here give the process of making them.

In casting sheet-lead, a table or mould is made use of, which consists of large pieces of wood well jointed, and bound with bars of iron at the ends; on the sides of which runs a frame consisting of a ledge or border of wood, two or three inches thick, and two or three inches high from the mould, called the sharps: the ordinary width of the mould, within these sharps, is from three to four feet, and its length is 16, 17, or 18 feet. This should be something longer than the sheets are intended to be, in order that the end where the metal runs off from the mould may be cut off; because it is commonly thin, or uneven, or ragged at the end. It must stand very even or level in breadth, and something falling from the end in which the metal is poured in, viz. about an inch or an inch and a half, in the length of 16 or 17 inches. At the upper end of the mould stands the pan, which is a concave triangular prism, composed of two planks nailed together at right angles, and two triangular pieces fitted in between them at the ends. The length of this pan is the whole breadth of the mould in which the sheets are cast; it stands with its bottom, which is a sharp edge, on a form at the end of the mould, leaning with one side against it; and on the opposite side is a handle to lift it up by, to pour out the melted lead; and on that side of the pan next the mould, are two iron hooks to take hold of the mould, and prevent the pan from slipping, while the melted lead is pouring out of it into the mould. This pan is lined on the inside with moistened sand, to prevent it from being fired by the hot metal. The mould is also spread over, about two-thirds of an inch thick, with sand sifted and moistened, which is rendered perfectly level by moving over it a piece of wood called a strike, by trampling upon it with the feet, and smoothing it over with a smoothing-plane; which is a thick plate of polished brass, about nine inches square, turned up on all the four edges, and with a handle fitted on to the upper or concave side. The sand being thus smoothed, it is fit for casting sheets of lead; but if they would cast a cistern, they measure out the size of the four sides, and having taken the dimensions of the front or fore-part, make mouldings by pressing long slips of wood, which contain the same mouldings into the level sand; and form the figures of birds, beasts, &c. by pressing in the same manner leaden figures upon it, and then taking them off, and at the same time smoothing the surface where any of the sand is raised up by making these impressions upon it. The rest of the operation is the same in casting either cisterns or plain sheets of lead. But before we proceed to mention the manner in which that is performed, it will be necessary to give a more particular description of the strike.

The strike then is a piece of board about five inches broad, and something longer than the breath of the mould on the inside; and at each end is cut a notch, about two inches deep, so that when it is used, it rides upon the sharps with those notches. Before they begin to cast, the strike is made ready by tacking two pieces of an old hat on the notches, or by slipping a case of leather over each end, in order to raise the under side about one-eighth of an inch, or something more, above the sand, according as they would have the sheet to be in thickness; then they tallow the under edge of the strike, and lay it across the mould. The lead being melted, it is laded into the pan, in which, when there is a sufficient quantity for the present purpose, the scum of the metal is swept off with a piece of board to the edge of the pan, letting it settle on the sand, which is by this means prevented from falling into the mould at the pouring out of the metal. When the lead is cool enough, which is known by its beginning to stand with a shell or wall on the sand round the pan, two men take the pan by the handle, or else one of them lifts it up by a bar and chain fixed to a beam in the ceiling, and pour it into the mould, while another man stands ready with the strike, and, as soon as they have done pouring in the metal, puts on the mould, sweeps the lead forward, and draws the overplus into a trough prepared to receive it. The sheets being thus cast, nothing remains but to planish the edges, in order to render them smooth and straight; but if it is a cistern, it is bent into four sides, so that the two ends may join the back, where they are soldered together, after which the bottom is soldered up.

The method of casting pipes without soldering. To make these pipes, they have a kind of little mill, with arms or levers to turn it with. The moulds are of brass, and consist of two pieces, which open and shut by means of hooks and hinges, their inward caliber or diameter being according to the size of the pipe to be made, and their length is usually two feet and a half. In the middle is placed a core, or round piece of brass or iron, somewhat longer than the mould, and of the thickness of the inward diameter of the pipe. This core is passed through two copper-rundles, one at each end of the mould, which they serve to close; and to these is joined a little copper tube about two inches long, and of the thickness the leaden pipe is intended to be of. By means of these tubes the core is retained in the middle of the cavity of the mould. The core being in the mould, with the rundles at its two ends, and the lead melted in the furnace, they take it up in a ladle and pour it into the mould by a little aperture at one end, made in the form of a funnel. When the mould is full, they pass a hook into the end of the core, and turning the mill, draw it out; and then opening the mould, take out the pipe. If they desire to have the pipe lengthened, they put one end of it in the lower end of the mould, and pass the end of the core into it; then shut the mould again, and apply its rundle and tube as before, the pipe just cast serving for rundle, &c. at the other end. Things being thus replaced, they pour in fresh metal, and repeat the operation till they have got a pipe of the length required.

For making pipes of sheet-lead, the plumbers have wooden cylinders of the length and thickness required, and on these they form their pipes by wrapping the sheet around them, and soldering up the edges all along them. See Pipe.

PLUMERIA, a genus of the pentandria monogynia class of plants, the corolla of which consists of a single funnel-like petal, with a long tube, and divided into five oblong segments at the limb: the fruit is composed of two jointed and ventricose follicles, formed of a single valve each, and containing numerous oblong seeds. There are four species.

PLUMMET, plumb-rule or plumb-line, an instrument used by carpenters, masons, &c. in order to judge whether walls. &c. are upright planes, horizontal, or the like. It is thus called from a piece of lead, plumbum, fastened to the end of a cord, which usually constitutes this instrument. Sometimes the string descends along a wooden ruler, &c. raised perpendicularly on another, in which case it becomes a level. See Level.

PLUMMING, among miners, is the method of using a mine-dial, in order to know the exact place of the work where to sink down an air shaft, or to bring an adit to the work, or to know which way the load inclines when any flexure happens in it.

It is performed in this manner: A skilful person, with an assistant, and with pen, ink, and paper, and a long line, and a sun-dial, after his guess of the place above ground, descends into the adit or work, and there fastens one end of the line to some fixed thing in it; then the incited needle is let to rest, and the exact point where it rests is marked with a pen; he then goes on farther in the line still fastened, and at the next flexure on the adit he makes a mark on the line by a knot or otherwise; and then letting down the dial again, he there likewise notes down that point at which the needle stands in this second position. In this manner he proceeds, from turning to turning, marking down the points, and marking the line, till he comes to the intended place; this done, he ascends and begins to work on the surface of the earth what he did in the adit, bringing the first knot in the line to such a place where the mark of the place of the needle will again answer its pointing, and continues this till he comes to the desired place above ground, which is certain to be perpendicularly over the part of the mine into which the air-shaft is to be sunk.

PLUNGER, in mechanics, the same with the forcer of a pump. See Pump.

PLURALITY. If any person having one benefice with cure of souls of eight pounds a year in the king's books, shall accept another of whatsoever value, and be instituted and inducted into the same, the former benefice shall be void; unless he has a dispensation from the archbishop of Canterbury, who has power to grant dispensations to chaplains of noblemen and others under proper qualifications, to hold two livings, provided they are not more than thirty miles distant from each other, and provided that he resides in each for a reasonable time every year, and that he keeps a sufficient curate in that in which he does not ordinarily reside.

PLUS, in algebra, a character marked thus +, used for the sign of addition. See Character.

PLUSH, in commerce, &c. a kind of stuff leaving a sort of velvet knap, or shag, on one side, composed regularly of a woof of a single woollen thread, and a double warp, the one wool, of two threads twisted, the other goats or camel's hair; though there are some plushes entirely of worsted, and others composed wholly of hair.

Plush is manufactured, like velvet, on a loom with three treadles; two of these separate and depress the woollen warp, and the third raises the hair warp, upon which the workman throwing the shuttle, passes the woof between the woollen and hair warp; and afterwards laying a brass broach, or needle, under that of the hair, he cuts it with a knife destined for that use; conducting the knife on the broach, which is made a little hollow all its length, and thus gives the surface of the plush an appearance of velvet. See Velvet.

There are other kinds of plush, all of silk; some of which have a pretty long knap on one side, and some on both.

PLUVIAMETER, a machine for measuring the quantity of rain that falls. Fig. 16, Plate I. Pneumatics, shews the section of a very good pluviameter. It consists of a hollow cylinder, having within it a cork ball attached to a wooden stem, which passes through a small opening at top, on which is placed a large funnel. When this instrument is placed in the open air in a free place, the rain that falls within the circumference of the funnel will run down into the tube, and cause the cork to float, and the quantity of water in the tube may be seen by the height to which the stem of the float is raised. The stem of the float is so graduated, as to shew by its divisions the number of perpendicular inches of water which fell on the surface of the earth since the last observation.

A very simple pluviameter, and which will answer all practical purposes, consists simply of a copper funnel, the area of whose opening is exactly ten inches; this funnel is fixed in a bottle, and the quantity of rain caught is ascertained by multiplying the weight in ounces by .173, which gives the depth in inches and parts of an inch.

PNEUMATICS. Though the word pneumatics means, strictly, the science which treats of the properties of air in general, yet it is commonly used to express the mechanical properties of elastic or aeriform fluids; such as their weight, density, compressibility, and elasticity. The other properties of elastic fluids are treated of under Chemistry and Air.

The air is a fluid in which we live and breathe: it entirely envelopes our globe, and extends to a considerable height around it. Together with the clouds and vapours that float in it, it is called the atmosphere. As it is possessed of gravity in common with all other fluids, it must press upon bodies in proportion to the depth at which they are immersed in it; and it also presses in every direction, in common with all other fluids.

It differs from all other fluids in the four following particulars: 1. It can be compressed into a much less space than it naturally possesses; 2. It cannot be congealed or fixed as other fluids may; 3. It is of a different density in every part upward from the earth's surface; decreasing in its weight, bulk for bulk, the higher it rises; 4. It is of an elastic or springy nature, and the force of its spring is equal to its weight.

Few people who are unacquainted with the principles of natural philosophy, suppose that the air by which we are surrounded is a material substance, like water, or any other visible matter. Being perfectly invisible, and affording no resistance to the touch, it must seem to them extraordinary, to consider it as a solid and material substance; and yet a few simple experiments will convince any one that it is really matter, and possesses weight, and the power of resisting other bodies that press against it.

Take a bladder that has not the neck tied, and you may press the sides together, and squeeze it into any shape. Fill this bladder with air, by blowing into it, and tie a string fast round the neck: you then find that you cannot, without breaking the bladder, press the sides together, and that you can scarcely alter its figure by any pressure. Whence then arise these effects? When the bladder was empty, you could press it into any form; but the air with which it is filled, prevents this: the resistance you experience when it is filled with air, proves that that is real matter as well as any other substance that we are acquainted with.

We are accustomed to say, that a vessel is empty, when we have poured out of it the water which it contained. Throw a bit of cork upon a bason of water, and having put an empty tumbler over it with the mouth downwards, force it down through the water; the cork will shew the surface of the water within the tumbler, and you will see that it will not rise so high within as without the glass; nor, if you press ever so hard, will it rise to the same level. The water is, therefore, prevented from rising within the tumbler, by some other substance which already occupies the inside; which substance is the air that filled the tumbler when it was inverted, and which could not escape, on account of the superior pressure of the water.

In like manner, having opened a pair of common bellows, stop up the nozzle securely, and you will find that you cannot shut the bellows, which seems to be filled with something that yields a little, like wool; but if you unstop the nozzle, the air will be expelled, and may be felt against the hand.

When the air is at rest, we can move in it with the utmost facility; nor does it offer to us a sensible resistance, except the motion is quick, or the surface opposed to it considerable; but when that is the case, its resistance is very sensible, as may be easily perceived by the motion of a fan.

When air is in motion, it constitutes wind; which is nothing more than a current or stream of air, varying in its force, according to the velocity with which it flows.

The invisibility of air, therefore, is only the consequence of its transparency; but it is possessed of all the common properties of matter. When a vessel is empty, in the usual way of speaking, it is in fact still filled with air.

But it is possible to empty a vessel even of the air which it contains, by which means we shall be able to discover several properties of this fluid. The instrument, or machine, by which this operation is performed, is called an air-pump. As it is by means of this useful instrument that all the mechanical properties of air are demonstrated, it will be necessary to describe its construction, and the manner of using it, before we proceed to the experiments that are made with it.

Plate I. Pneumatics, fig. 1. is the air-pump that is now most in use. AA are two brass barrels, each containing a piston, with a valve opening upwards. They are worked by means of the winch B, which has a pinion that fits into the teeth of the racks CC, which are made upon the ends of the pistons, and by this means moves them up and down alternately.

On the square wooden frame DE, there are placed a brass plate G, ground perfectly flat, and also a brass tube, let into the wood, communicating with the two barrels and the cock I, and opening into the centre of the brass plate at *a*. The glass vessel K, to be emptied or exhausted of air, has its rim ground quite flat, and rubbed with a little pomatum, or hog's-lard, to make it fit more closely upon the brass plate of the pump. These vessels are called receivers. Having shut the cock I, the pistons are worked by the winch; and the air being suffered to escape when the piston is forced down, because the valve opens upwards, but prevented from returning into the vessel for the same reason, the receiver is gradually exhausted, and will then be fixed fast upon the pump-plate. By opening the cock I, the air rushes again into the receiver.

"As light as air," is a common saying; yet air can be shewn to have more weight than is generally supposed. Take a hollow copper ball, or other vessel, which holds a wine quart, having a neck to screw on the plate of the air-pump; and after weighing it when full of air, exhaust it, and weigh it when empty; it will be found to have lost sixteen grains, which shews that this is the weight of a quart of air. But a quart of water weighs 14621 grains: this divided by 16, quotes 914 in round numbers; so that water is 914 times as heavy as air near the surface of the earth. This supposes air at a medium temperature and density; for these, as will be seen afterwards, are variable.

When the receiver is placed upon the plate of the air-pump without exhausting it, it may be removed again with the utmost facility, because there is a mass of air under it, that resists by its elasticity the pressure on the outside; but exhaust the receiver, thus removing the counter-pressure, and it will be held down to the plate by the weight of the air upon it.

What the pressure of the air amounts to, is exactly determined in the following manner:

When the surface of a fluid is exposed to the air, it is pressed by the weight of the atmosphere equally on every part, and consequently remains at rest. But if the pressure is removed from any particular part, the fluid must yield in that part, and be forced out of its situation.

Into the receiver A (fig. 2.) put a small vessel with quicksilver, or any other fluid, and through the collar of leathers at B, suspend a glass tube, closed, or hermetically sealed, as it is called, over the small vessel. Having exhausted the receiver, let down the tube into the quicksilver, which will not rise into the tube as long as the receiver continues empty. But re-admit the air, and the quicksilver will immediately ascend. The reason of this is, that upon exhausting the receiver, the tube is likewise emptied of air; and therefore, when it is immersed in the quicksilver, and the air re-admitted into the receiver, all the surface of the quicksilver is pressed upon by the air, except that portion which lies above the orifice of the tube; consequently, it must rise in the tube, and continue so to do, until the weight of the elevated quicksilver presses as forcibly on that portion which lies beneath the tube, as the weight of the air does on every other equal portion without the tube.

Take a common syringe of any kind, and having pushed the piston to the farthest end, immerse it into water; then draw up the piston, and the water will follow it. This is owing to the same cause as the last: when the piston is pulled up, the air is drawn out of the syringe with it, and the pressure of the atmosphere is removed from the part of the water immediately under it; consequently the water is obliged to yield in that part to the pressure on the surface.

It is upon this principle that all those pumps called sucking-pumps act: the piston fitting tightly the inside of the barrel, by being raised up, removes the pressure of the atmosphere from that part, and consequently the water is drawn up by the pressure upon the surface.

In the beginning of the last century, philosophers were of opinion that the ascent of water in pumps, was owing to what they called "Nature's abhorrence of a vacuum;" and that, by means of suction, fluids might be raised to any height whatever.

Galileo was the first who discovered that it was impossible to raise water higher than thirty-three feet by suction only; and thence concluded, that not the power of suction, but the pressure of the atmosphere, was the cause of the ascent of water in pumps; that a column of water thirty-three feet high was a counterpoise to one as high as the atmosphere; and that, for this reason, the water would not follow the sucker any farther.

His pupil Torricelli, considered that as mercury was fourteen times as heavy as water, a column of that fluid need only be one-fourteenth of the length of one of water, to form an equal counterpoise to the pressure of the air; and accordingly, having filled with mercury a glass tube about three feet long, hermetically sealed at one end, he inverted it into a small bason of mercury, and found, as he expected, that the mercury subsided to the height of about twenty-nine inches and a half, and there remained suspended, leaving a space at the top of the tube a perfect vacuum; which has been called, from the inventor, the Torricellian vacuum.

It was, however, some time after this experiment had been made, and even after it had been universally agreed that the suspension of the mercury was owing to the weight of the atmosphere, before it was discovered that the column of mercury varied in height, and consequently that the pressure of the air was different at different times.

This phenomenon was, however, too remarkable to be long unobserved. It was impossible to avoid observing also, that the changes in the height of the mercury were accompanied, or very quickly succeeded, by alterations in the weather. Hence the instrument obtained the name of weather-glass; and from its also measuring the weight of the atmosphere, it is called the barometer. It is merely a tube filled with mercury, and inverted into a bason of the same, having a scale fixed at the top to ascertain the rising and falling of the mercury, by the changes in the weight of the atmosphere. A more particular account of the construction and use of this instrument is given under BAROMETER.

These effects arising from the weight and pressure of the atmosphere, have been absurdly attributed to suction; a word which ought to be exploded, as it conveys a false notion of the cause of these and similar phenomena. To prove that an exhausted receiver is held down by the pressure of the atmosphere, take one open at top, and ground quite flat, as A fig. 3, and covered with a brass plate B, which has a brass rod passing through it, working in a collar of leather, so as to be air-tight; to this rod suspend a small receiver within the large one, a little way from the bottom; place the receiver A upon the pump-plate, and exhaust it: it will now be fixed fast down; but the small receiver may be pulled up or down with perfect ease, as it is itself exhausted, and all the air which surrounded it removed, consequently it cannot be exposed to any pressure; then let the small one down upon the plate, but not over the hole by which the air is extracted, and re-admit the air into the large receiver, which may then be removed; it will be found that the small one, being itself exhausted, it held down fast by the air, which is now admitted round the outside. If the large receiver is again put over it and exhausted, the small one will be at liberty; and so on, as often as the experiment is repeated.

A square column of quicksilver twenty-nine and a half inches high, and an inch thick, weighs just fifteen pounds, consequently, the air presses with a weight equal to fifteen pounds upon every square inch of the earth's surface: and 144 times as much, or 2160 pounds, upon every square foot.

The earth's surface contains in round numbers, 200,000,000 square miles; and as every square mile contains 27,876,400 square feet, there must be 5,575,080,000,000,000 square feet on the earth's surface; which number multiplied by 2160 pounds (the pressure on each square foot), gives 12,043,468,800,000,000,000 pounds for the pressure, or whole weight, of the atmosphere.

Reckoning the surface of a middle-sized man to be about 14 square feet, he sustains a pressure from the air equal to 30,240 pounds Troy, or 11 tons 2 cwt. and 18½ lbs. It may be asked, how it happens that we are not sensible of so great a pressure? The reason is, that such pressures only are perceived by us, as move our fibres, and put them out of their natural situations. Now the pressure of the air being equal on all parts of the body, it cannot possibly displace any of the fibres, but on the contrary, braces, and keeps them all in their relative situations. But if the pressure is removed from any particular part, the pressure on the neighbouring parts immediately becomes sensible. Thus, if you take a receiver open at the top, and cover it with your hand, upon exhausting the receiver, and so taking off the pressure from the palm of the hand, you will feel it pressed down by an immense weight, so as to give pain that would be insupportable, and endanger the breaking of your hand.

If the top of the receiver is covered by a piece of flat glass, upon exhausting it, the glass will be broken to pieces by the incumbent weight; and this would happen to the receiver itself, but for the arched top, that resists the weight much more than a flat surface.

This experiment may be varied, by tying a piece of wet bladder over the open mouth of the receiver, and leaving it to dry till it becomes as tight as a drum. Upon exhausting the receiver, you will perceive the bladder rendered concave, and it will yield more and more, until it breaks with a loud report, which is occasioned by the air striking forcibly against the inside of the receiver, upon being re-admitted.

Air is one of the most elastic bodies in nature; that is, it is easily compressed into less compass, and when the pressure is removed, it immediately regains its former bulk.

Let mercury be poured into a bent tube ABCD (fig. 4,) open at both ends, to a small height as BC; then stopping the end D with a cork, or otherwise, air-tight, measure the length of confined air DC, and pour mercury into the other leg AB, till the height above the surface of that in CD is equal to the height at which it stands in the barometer at the time. Then it is plain, that the air in the shorter leg will be compressed with a force twice as great as at first, when it possessed the whole space CD; for then it was compressed only with the weight of the atmosphere, but now it is compressed by that weight, and the additional equal weight of the column of mercury. The surface of the mercury will now be at E; and it will be found, upon measuring it, that the space DE, into which the air is compressed, is just half the former CD. If another column of mercury was added, equal to the former, it would be reduced into one-third of the space it formerly occupied.

Hence the density of the air is proportional to the force that compresses it.

As all the parts of the atmosphere gravitate, or press upon each other, it is easy to conceive, that the air next the surface of the earth is more compressed and denser than what it is at some height above it; in the same manner as if wool was thrown into a deep pit until it reached the top. The wool at the bottom having all the weight of what was above it, would be squeezed into a less compass; the layer, or stratum above it, would not be pressed quite so much, the one above that still less, and so on; till the upper one, having no weight over it, would be in its natural state. This is the case with the air, or atmosphere, that surrounds our earth, and accompanies it in its motion round the sun. On the tops of lofty buildings, but still more on those of mountains, the air is found to be considerably less dense than at the level of the sea.

The height of the atmosphere has never yet been exactly ascertained; indeed, on account of its great elasticity, it may extend to an immense distance, becoming, however, rarer, in proportion to its distance from the earth.

It is observed, that at a greater height than forty-five miles, it does not refract the rays of light from the sun; and this is usually considered as the limit of the atmosphere. In a rarer state, however, it may extend much farther. And this is by some thought to be the case, from the appearance of certain meteors which have been reckoned to be 70 or 80 miles distant.

Dr. Cotes has demonstrated, that if altitudes in the air are taken in arithmetical proportion, the rarity of the air will be in geometrical proportion. For instance,

At the altitude of	miles above the surface of the earth, the air is	times thinner and lighter than at earth's surface.
	7	4
	14	16
	21	64
	28	256
	35	1024
	42	4096
	49	16384
	56	65536
	63	262144
	70	1048576
	77	4194304
	84	16777216
	91	67108864
	98	268435456
	105	1073741824
	112	4294967296
	119	17179869184
	126	68719476736
	133	274877906944
	140	1099511627776

And hence it is easy to prove by calculation, that a cubic inch of such air as we breathe, would be so much rarefied at the altitude of 500 miles, that it would fill a sphere equal in diameter to the orbit of Saturn.

The elastic power of the air is always equivalent to the force which compresses it: for if it was less, it would yield to the pressure, and be more compressed; was it greater, it would not be so much reduced; for action and re-action are always equal; so that the elastic force of any small portion of the air we breathe, is equal to the weight of the incumbent part of the atmosphere; that weight being the force which confines it to the dimensions it possesses.

To prove this by an experiment, pour some quicksilver into the small bottle A (fig. 5.) and screw the brass collar *c* of the tube BC into the brass neck of the bottle, and the lower end of the tube will be immersed into the quicksilver, so that the air above the quicksilver in the bottle will be confined there. This tube is open at top, and is covered by the receiver G, and large tube EF; which tube is fixed by brass collars to the receiver, and is closed at top. This preparation being made, exhaust the air out of the receiver G, and its tube, by putting it upon the plate of the air-pump, and the air will, by the same means, be exhausted out of the inner tube BC, through its open top at C. As the receiver and tubes are exhausting, the air that is confined in the glass bottle A, will press so by its spring, as to raise the quicksilver in the inner tube to the same height as it stands at in the barometer.

Miscellaneous experiments.

There is a little machine, consisting of two mills, *a* and *b*, which are of equal weights, independant of each other, and turn equally free on their axles in the frame. Each mill has four thin arms or sails, (fig. 6.) fixed into the axis: those of the mill *a*, have their planes at right angles to its axis, and those of *b* have their planes parallel to it. As the mill *a* therefore turns round in common air, it is but little resisted by it, because its sails cut the air with their thin edges; but the mill *b* is much resisted, because the broad side of its sails moves against the air when it turns round. In each axle is a fine pin near the middle of the frame, which goes quite through the axle, and stands out a little on each side of it: under these pins a slider may be made to bear, and so hinder the mills from going, when a strong spring is set or bent against the opposite ends of the pins.

Having set this machine upon the pump-plate, fig. 1. draw up the slider to the pins on one side, and set the spring at bend on the opposite ends of the pins; then push down the slider, and the spring acting equally strong upon each mill, will set them both going with equal forces and velocities; but the mill *a* will run much longer than the mill *b*, because the air makes much less resistance against the edges of its sails than against the sides of the sails of *b*.

Draw up the slider again, and set the spring upon the pins as before; then cover the machine with the receiver upon the pump-plate: and having exhausted the receiver of air, push down the wire (through the collar of leathers in the neck) upon the slider, which will disengage it from the pins, and allow the mills to turn round by the impulse of the spring; and as there is no air in the receiver to make any sensible resistance against them, they will both move a considerable time longer than they did in the open air, and the moment that one stops the other will do so too. This shews that air resists bodies in motion; and that equal bodies meet with different degrees of resistance, according as they present greater or less surfaces to the air.

Take a tall receiver A, covered at top by a brass plate, through which works a rod in a collar of leathers, (fig. 7.) and to the bottom of which there is a particular contrivance for supporting a guinea and a feather, and for letting them drop at the same instant. If they are let fall while the receiver is full of air, the guinea will fall much quicker than the feather; but if the receiver is first exhausted, it will be found that they both arrive at the bottom at the same instant: which proves that all bodies would fall to the ground with the same velocity, if it was not for the resistance of the air, which impedes most of the motion of those bodies that have the least momentum. In this experiment the observers ought not to look at the top, but at the bottom of the receiver; otherwise, on account of the quickness of their motion, they will not be able to see whether the guinea and feather fall at the same instant.

3. Take a receiver, having a brass cap fitted to the top with a hole in it; fit one end of a dry hazel-branch about an inch long, tight into the hole, and the other end tight into a hole quite through the bottom of a small wooden cup; then pour some quicksilver into the cup, and exhaust the receiver of air; and the pressure of the outward air on the surface of the quicksilver, will force it through the pores of the hazel, whence it will descend in a beautiful shower, into a glass cup placed under the receiver to catch it.

Put a wire through the collar of leathers on the top of the receiver, and fix a bit of dry wood on the end of the wire within the receiver; then exhaust the air, and push the wire down, so as to immerse the wood into a jar of quicksilver on the pump-plate; this done, let in the air; and upon taking the wood out of the jar, and splitting it, its pores will be found full of quicksilver, which the force of the air, upon being let into the quicksilver, drove into the wood.

Join the two brass hemispherical cups A and B together (fig. 8,) with a wet leather between them, having a hole in the middle of it; then having screwed off the handle at C, put both the hemispheres together and screw them into the pump-plate, and turn the cock E, so that the pipe may be open all the way into the cavity of the hemispheres; then exhaust the air out of them, and turn the cock; unscrew the hemispheres from the pump, and having put on the handle C, let two strong men try to pull the hemispheres asunder by the rings, which they will find hard to do; for if the diameter of the hemispheres is four inches, they will be pressed together by the external air with a force equal to 190 pounds; and to shew that it is the pressure of the air that keeps them together, hang them by either of the rings upon the hook of the wire in the receiver A (fig. 3.) and, upon exhausting the air out of the receiver, they will fall asunder of themselves.

Screw the end A of the brass pipe AB (fig. 9.) into the pump-plate, and turn the cock *e* until the pipe is open; then put a wet leather on the plate *c a*, fixed on the pipe, and cover it with the tall receiver GH, which is close at top; then exhaust the air out of the receiver, and turn the cock *e* to keep it out; which done, unscrew the pipe from the pump, and set its end A into a bason of water, and turn the cock *e* to open the pipe; on which, as there is no air in the receiver, the pressure of the atmosphere on the water in the bason will drive the water forcibly through the pipe, and make it play up in a jet to the top of the receiver.

Set a square phial upon the pump-plate, and having covered it with a wire cage, put a close receiver over it, and exhaust the air out of the receiver; in doing which, the air will also make its way out of the phial, through a small valve in its neck. When the air is exhausted, turn the cock below the plate to re-admit the air into the receiver; and as it cannot get into the phial again, because of the valve, the phial will be broken into some thousands of pieces by the pressure of the air upon it. Had the phial been of a round form, it would have sustained this pressure like an arch, without breaking; but as its sides are flat it cannot.

To shew the elasticity or spring of the air: tie up a very small quantity of air in a bladder, and put it under the receiver; then exhaust the air out of the receiver, and the air which is confined in the bladder (having nothing to act against it) will expand by the force of its spring, so as to fill the bladder completely. But upon letting the air into the receiver again, it will overpower that in the bladder, and press its sides close together.

If the bladder so tied up is put into a wooden box, and has twenty or thirty pounds weight of lead placed upon it, and the box is covered with a close receiver; upon exhausting the air out of the receiver, that which is confined in the bladder will expand itself so as to raise up all the lead by the force of its spring.

Screw the pipe AB (fig. 9,) into the pump-plate; place the tall receiver GH upon the plate *c a*, as before, and exhaust the air out of the receiver; then turn the cock *e* to keep out the air, unscrew the pipe from the pump, and screw it into the mouth of the copper vessel C (fig. 10.), the vessel having been first about half filled with water. Then open the cock *e*; and the spring of the air which is confined in the copper vessel will force the water up through the pipe AB in a jet into the exhausted receiver, as strongly as it did by its pressure on the surface of the water.

If a rat, mouse, or bird, is put under a receiver, and the air is exhausted, the animal will be at first oppressed as with a great weight, then grow convulsed, and at last expire in all the agonies of a most bitter and cruel death. But as this experiment is too shocking to most spectators, it is common to substitute a machine called the lungs-glass in place of the animal.

If a butterfly is suspended in a receiver, by a fine thread tied to one of its horns, it will fly about in the receiver as long as it continues full of air; but if the air is exhausted, though the animal will not die, and will continue to flutter its wings, it cannot remove itself from the place where it hangs, in the middle of the receiver, until the air is let in again, and then the animal will fly about as before.

Put a cork into a square phial, and fix it in with wax or cement; and put the phial on the pump-plate with the wire cage, and cover it with a close receiver; then exhaust the air out of the receiver, and the air that was corked up in the phial will break it outwards by the force of its spring, because there is no air left on the outside of the phial to act against that within it.

Put a shrivelled apple under a close receiver, and exhaust the air; the spring of air within the apple will plump it out, so as to cause all the wrinkles to disappear; but upon letting the air into the receiver again, to press upon the apple, it will instantly return to its former decayed and shrivelled state.

Take a fresh egg, and cut off a little of the shell and film from its smallest end, then put the egg under a receiver, and pump out the air; upon which all the contents of the egg will be forced out into the receiver, by the expansion of a small bubble of air contained in the great end, between the shell and film.

Put some warm beer into a glass, and having set it on the pump, cover it with a close receiver, and then exhaust the air. Whilst this is doing, and the pressure more and more taken off from the beer in the glass, the air in it will expand itself, and rise up in innummerable bubbles to the surface of the beer; and thence it will be taken away with the other air in the receiver. When the receiver is nearly exhausted, the air in the beer, which could not disentangle itself quick enough to get off with the rest, will now expand itself so, as to cause the beer to have all the appearance of boiling; and the greatest part of it will go over the glass.

Put some water into a glass, and a bit of dry wainscot or other wood into the water; then cover the glass with a close receiver, and exhaust the air; upon which the air in the wood, having liberty to expand itself, will come out plentifully, and make all the water to bubble about the wood, especially about the ends, because the pores lie lengthwise. A cubic inch of dry wainscot has so much air in it that it will continue bubbling for near half an hour.

Let a large piece of cork be suspended by a thread at one end of a balance, and counterpoised by a leaden weight, suspended in the same manner, at the other. Let this balance be hung to the inside of the top of a large receiver; which being set on the pump, and the air exhausted, the cork will preponderate, and shew itself to be heavier than the lead; but upon letting in the air again the equilibrium will be restored. The reason of this is, that since the air is a fluid, and all bodies lose as much of their absolute weight in it as is equal to the weight of their bulk of the fluid, the cork being the larger body, loses more of its real weight than the lead does; and therefore must in fact be heavier, to balance it under the disadvantage of losing some of its weight; which disadvantage being taken off by removing the air, the bodies then gravitate according to their real quantities of matter, and the cork which balanced the lead in air, shews itself to be heavier when in vacuo.

Set a lighted candle upon the pump, and cover it with a tall receiver. If the receiver holds a gallon, the candle will burn a minute; and then, after having gradually decayed from the first instant, it will go out, which shews that a constant supply of fresh air is as necessary to feed flame, as animal life.

The moment when the candle goes out, the smoke will be seen to ascend to the top of the receiver, and there it will form a sort of cloud; but upon exhausting the air, the smoke will fall down to the bottom of the receiver, and leave it as clear at the top as it was before it was set upon the pump. This shews that smoke does not ascend on account of its being positively light, but because it is lighter than air; and its falling to the bottom when the air is taken away, shews that it is not destitute of weight. So most sorts of wood ascend or swim in water; and yet there are none who doubt of the wood's having gravity or weight.

Set a bell on the pump-plate, having a contrivance so as to ring it at pleasure, and cover it with a receiver; then make the clapper strike against the bell, and the sound will be very well heard; but exhaust the receiver of air, and then, if the clapper is made to strike ever so hard against the bell, it will make no sound; which shews that air is absolutely necessary for the propagation of sound.

Of condensed air. It has been shewn, that air can be rarefied, or made to expand: we now proceed to shew that it can also be condensed, or pressed into less space than it generally occupies. The instrument used for this purpose is called a condenser.

Fig. 12, represents a machine of this kind; it consists of a brass barrel containing a piston, which has a valve opening downwards; so that as the piston is raised, the air passes through the valve; but as the piston is pushed down, the air cannot return, and is therefore forced through a valve at the bottom of the barrel, that allows it to pass through into the receiver B, but prevents it from returning. Thus, at every stroke of the piston, more air is thrown into the receiver, which is of very thick and strong glass. The receiver is held down upon the plate C by the cross piece D, and the screws EF. The air is let out of the receiver by the cock G, which communicates with it.

A great variety of experiments may be performed by means of condensed air, a few of which we shall here enumerate.

The sound of a bell is much louder in condensed than in common air.

A phial that would bear the pressure of the common atmosphere, when the air is exhausted from the inside, will be broken by condensing the air round it.

A very beautiful fountain may be made by condensed air. Procure a strong copper vessel, fig. 13, having a tube that screws into the neck of it so as to be air-tight, and long enough to reach to near the bottom. Having poured a quantity of water into the vessel, but not enough to fill it, and screwed in the tube, adapt to it a condensing syringe, and condense the air in the vessel; shut the stop-cock, and unscrew the syringe; then, on opening the stop-cock, the air acting upon the water in the vessel, will force it out into a jet of very great height. A number of different kinds of jets may be screwed on the tube, such as stars, wheels, &c. forming a very pleasing appearance.

Dr. Hook invented the gage, or instrument for measuring the degree of rarefaction, or exhaustion, produced in the receiver, and which is a necessary appendage to the air-pump. If a barometer is included beneath the receiver, the mercury will stand at the same height as in the open air; but when the receiver begins to be exhausted, the mercury will descend, and rest at a height which is, in proportion to its former height, as the spring of the air remaining in the receiver, to its spring before exhaustion. Thus, if the height of the mercury, after exhaustion, is the thousandth part of what it was before, we say that the air in the receiver is rarefied 1000 times. On account of the inconvenience of including a barometer in a receiver, a tube, of six or eight inches in length, is filled with mercury, and inverted in the same manner as the barometer. This being included, answers the same purpose, with no other difference, than that the mercury does not begin to descend till about three-fourths of the air is exhausted; it is called the short barometer-gage. This is generally placed detached, but communicating with the receiver by a tube concealed in the frame, as is represented at fig. 1. Others place a tube of a greater length than the barometer, with its lower end in a vessel of mercury, exposed to the pressure of the air, while its upper end communicates with the receiver. Here the mercury rises as the exhaustion proceeds, and the pressure of its remaining air is shewn by the difference between the height and that of a barometer in the room: this is called the long barometer-gage.

These gages are not often constructed so as to answer the purpose of shewing great degrees of exhaustion; for the mercury, though at first boiled to clear it of the air and moisture that adhere to it, and render it sensibly lighter, gradually becomes again contaminated by exposure to the air in the bason of either gage. They cannot, therefore, in strictness, be compared to a good barometer, in which this does not happen. If the tubes of the gages are less than half an inch in diameter, the mercury will be sensibly repelled downwards, so as to require a correction for the long gage when compared with a barometer whose tube is of a different bore, and to render the short gage useless in great exhaustions.

Thus, for example, if the short gage has a tube of one-tenth of an inch in diameter, the mercury will fall to the level of the bason, when the exhaustion is 150 times, and will stand below the level for all greater degrees of rarefaction. These difficulties may be all removed, by making the short gage in the form of an inverted syphon, with one leg open, and the other hermetically sealed. It must be confessed, however, that it is difficult to boil the mercury in these.

In using the air-pump, every substance containing moisture should be removed from the pump-plate, as water assumes the form of an elastic vapour when the pressure of the atmosphere is taken away. The receivers used formerly to be placed upon the pump-plate, on leathers soaked in water or oil; but Mr. Nairne discovered that an elastic vapour arose from this, that considerably affected the gage, and prevented it from shewing the real degree of rarefaction of the air. Instead of the leathers to place under the receiver, the best way is, to have the pump-plate ground perfectly flat, and also the edge of the receiver, which should be rubbed with a little hog's-lard or soft pomatum, which will perfectly exclude the air, and will not afford any moisture. The pump-plate and the receiver should be wiped very clean.

When leathers are used, the barometer-gages will not shew the degree of rarefaction of the air; which, however, may be ascertained by a gage invented by Mr. Smeaton, and called, from its form, the pear-gage. It consists of a glass vessel, in the form of a pear, fig. 11, and sufficient to hold about half a pound of mercury: it is open at one end, and at the other end is a tube hermetically closed at top. The tube is graduated, so as to represent proportionate parts of the whole capacity. This gage, during the exhaustion of the receiver, is suspended in it by a slip of wire, over a cistern of mercury, placed also in the receiver. When the pump is worked as much as is thought necessary, the gage is let down into the mercury, and the air re-admitted. The mercury will immediately rise in the gage: but if any air remained in the receiver, a certain portion of it would be in the gage; and as it would occupy the top of the tube above the mercury, it would shew by its size the degree of exhaustion; for the bubble of air would be to the whole contents of the gage, as the quantity of air in the exhausted receiver would to an equal volume of the common atmospheric air. If the receiver contained any elastic vapour generated during the rarefaction, it would be condensed upon the re-admission of the atmospheric air, as it cannot subsist in the usual pressure. The pear-gage, therefore, shews the true quantity of atmospheric air left in the receiver. Hence it will sometimes indicate that all the permanent air is exhausted from the receiver, except about $\frac{1}{100000}$ part, when the other gages do not shew a degree of exhaustion of more than 200 times, and sometimes much less.

Particular care should be taken, after making any experiments where vapour has been generated, to clear the pump of it, before any other experiments are attempted; for the vapour remains not only in the receiver, but also in the tubes and barrels of the pump, and will, when the air is again rarefied, expand as before. To clear the pump of this vapour, take a large receiver, and wiping it very dry, exhaust it as far as possible. The expansible vapour which remained in the barrels and the pipes, will now be diffused through the receiver; and, consequently, will be as much rarer than it was before, as the aggregate capacity of the receiver is larger than that of the pump and pipes. If the receiver is large, one exhaustion will be sufficient to clear the pump so far, that what remains can be of no consequence. If the receiver is small, the operation should be repeated two or three times.

In all mercurial experiments with the air-pump, a short pipe must be screwed into the hole of the pump-plate, so as to rise above it about half an inch, to prevent the quicksilver from getting into the air-pipe and barrels, in case any should accidentally be spilt over the jar; for if it gets into the barrels, it spoils them, by loosening the solder, and corroding the brass.

With respect to the leathers, if your pump-plate is not ground, they are absolutely necessary; they should be previously soaked in oil from which the moisture has been expelled by boiling, or hog's-lard with a little bee's-wax, which gives a clamminess very proper for the purpose.

It is evident, that the vacuum in the receiver of the air-pump, can never be perfect, that is, the air can never be entirely exhausted; for it is the spring of the air in the receiver, that raises the valve, and forces its way into the barrel; and the barrel at each suction can only take away a certain part of the remaining air, which is in proportion to the quantity before the stroke, as the capacity of the barrel is to that of the barrel and receiver added together.

This, however, is an imperfection that is seldom of much consequence in practice, because most air-pumps, at a certain period of the exhaustion, cease to act, on account of their imperfect construction; for the valves usually consist of a piece of oiled bladder tied over a hole, so that the air is at liberty to pass by lifting up the bladder, but cannot return again; and thus there will unavoidably be a small space left between the lower valve and the piston, when down.

Now, it will happen, when the air in the receiver is very rare, that its spring will not be strong enough to overcome the adhesion of the bladder forming the lower valve, which consequently will remain shut and the exhaustion cannot proceed. Or, before this period, it may happen, that the air between the valves when the piston is up, may be so small as to lie in the space between the two valves when the piston is down, without being sufficiently condensed for its spring to overcome the adhesion of the bladder forming the upper valve, and the weight of the atmosphere that presses it: in this case, the upper valve will remain shut, and the exhaustion cannot proceed.

Various modern improvements in the air-pump, obviate these inconveniences in a great degree. Mr. Smeaton, a very ingenious mechanic, enlarged the size of the lower valve; and, to strengthen it, supported it on a brass grating, resembling a honey-comb. This allowed the valve to rise more easily. He also covered the top of the barrel, making the piston-rod work through a collar of leathers, by which he took off the pressure of the atmosphere from the piston-valve, which acted against the rarefied air in the receiver. Pumps on this construction have been made by Nairne, and other artists in London, and have answered extremely well.

The air-gun. This pneumatical instrument is an ingenious contrivance, which will drive a bullet with great violence, by means of condensed air, forced into an iron ball by a condenser. Fig. 14. represents the condenser for forcing the air into the ball. At the end *a* of this instrument is a male screw, on which the hollow ball *b* is screwed, in order to be filled with condensed air. In the inside of this ball is a valve, to hinder the air after it is injected from making its escape, until it is forced open by a pin, against which the hammer of the lock strikes; which then lets out as much air as will drive a ball with considerable force to a great distance.

When you condense the air in the ball, place your feet on the iron cross *h h*, to which the piston-rod *d* is fixed; then lift up the barrel *e a*, by the handles *i i*, until the end of the piston is brought between *e* and *c*; the barrel *a c* will then be filled with air through the hole *e*. Then thrust down the barrel *a c* by the handles *i i*, until the piston *e* joins with the neck of the iron ball at *a*: the air, being thus condensed between *e* and *a*, will force open the valve in the ball; and when the handles *i i* are lifted up again, the valve will close, and keep in the air; so by rapidly continuing the stroke up and down, the ball will presently be filled; after which, unscrew the ball off the condenser, and screw it upon another male screw, which is connected with the barrel, and goes through the stock of the gun, as represented fig. 15. Twelve dwts. of air have been injected into a ball of 3.75 inches diameter, which has discharged 15 bullets with considerable force.

There are many contrivances in constructing air-guns; some have a small barrel contained within a large one, and the space between the two barrels serves for the reception of condensed air. In this sort, a valve is fixed at *a*, (fig. 15,) with a condenser fixed to the barrel, and continued through the butt-end to *c*, where the piston-rod may be always left in. Place your feet on the pin, and the whole gun serves instead of the handles *i i* (fig. 14.) to condense the air in the barrel.

Fig. 17. is a section of the gun, by which the principle of its action may be fully understood: the inside barrel K is of a small bore from which the bullets are shot, and a larger barrel CDSR is on the outside of it. In the stock of the gun is a syringe S, which forces in the air through the valve EP into the cavity between the two barrels. The ball K is put into its place in the same way as in another gun. There is a valve at SL, which, being opened by the trigger O, permits the air to come behind the bullet, so as to drive it out with great force. If the valve is suddenly opened and closed, one charge of condensed air may make several discharges of bullets; because only part of the air will go out at a time, and a fresh bullet may be put into the place K.

The magazine air-gun differs from the common one, only by having a serpentine barrel, which contains ten or twelve balls; these are brought into the shooting barrel successively, by means of a lever; and they may be discharged so fast as to be nearly of the same use as so many different guns.

Fig. 18. shews a section of the gun, or at least, as much of it as is necessary to give a complete idea of the whole. AE is part of the stock; G the end of the injection syringe, with its valve H, opening into the cavity FF between the barrels. KK is the small or shooting barrel, which receives the bullets, one at a time, from the magazine ED, which is a serpentine cavity, where the bullets are lodged and closed at the end D; the circular part is the key of a cock, having a cylindrical hole, IK, through it, equal to the bore of the small barrel, and forming a part of it. When the lock is taken off, the several parts come in view, by means of which the discharge is made, by pushing up the pin P *p*, which rises and opens a valve, V, to let in the air against the bullet I, from the cavity FF, which valve is immediately shut down again by means of a long spring of brass, NN. This valve V, being a conical piece of brass, ground very true, will be sufficient to confine the air. To make a discharge, pull the trigger ZZ, which throws up the seer *y x*, and disengages it from the notch *x*, upon which the strong spring WW moves the tumbler T, to which the cock is fixed. The end *u* of this tumbler, bears down the end *v* of the tumbling lever R, which by its other end *m* raises the flat end, *l*, of the horizontal lever Q, by which means the pin P *p* is pushed up, and opening the valve V, discharges the bullet. To bring another bullet instantly to succeed to I, there is a part H called the hammer, represented in fig. 19. which turns the cock so as to place the cylindric bore of the key I *k* in any situation required. Thus when the bullet is in the gun, the bore of the key coincides with that of the barrel KK; but when it is discharged, the hammer H is instantly brought down to shut the pan of the gun; by which motion the bore of the key is turned into the situation *i k*, so as to coincide with the orifice of the magazine; and upon lifting the gun upright, the ball next the key tumbles into its cavity, and falling behind two small springs *s s* fig. 18. is by them detained.

American air-pump. It would not come within the limits of this work, to enumerate all the improvements, and different modes of construction, used in this instrument. The latest are the air-pumps made by Haas and Hurter, Cuthbertson, and Prince, each of which has particular advantages.

We shall however give a perspective view of the air-pump invented by Mr. Cuthbertson, which is so excellent in its structure, and so powerful in its effects, as to demand in the present improved state of science, a particular notice and description. See Plate II. Pneumatics, Cuthbertson's air-pump. The two principal gages of this pump are screwed in their places; but it is not necessary that these should be used together, except in experiments that require great nicety, and very exact exhaustion. In common cases either of them may be taken away, and a stop-screw put into its place. When the pear-gage, which has been already described, is used, a small round plate, large enough for the receiver to stand upon, must first be screwed into a hole at *a*, but when this gage is not used this hole must be closed with a stop-screw. When all these gages are used, and the receiver is exhausted, the stop-screw B, at the bottom of the pump, must be unscrewed, to admit the air into the receiver; but when the gages are not all used, the stop-screw at *a*, or either of the others in the place of gages, may be unscrewed for this purpose. The mechanism and object of the barrels D, D, the racks C, C, the plate G, and handle H, will be easily understood from the figure. CD fig. 2. represents a section of one of the barrels of the pump, F the collar of leathers which renders it air-tight, G a hollow cylindrical vessel to contain oil; R is also an oil-vessel, which receives the oil that is driven with air through the hole *a a*, when the piston is drawn upwards; and when this falls, the oil is carried over with the air along the tube T, into the oil-vessel G: *c c* is a wire which is driven upwards from the hole *a a* by the passage of the air; and as soon as this is escaped, falls down again by its own weight, shuts up the hole, and prevents any air from returning by that way into the barrel; at *d d* are fixed two pieces of brass, to keep the wire *c c* in such a direction as may preserve the hole air-tight. H is a cylindrical wire, which carries the piston I, and is made hollow to receive a long wire *q q*, that opens and closes the hole L, which forms the communication with the receiver standing on the plate: *m* is part of a pipe, one end of which is screwed into the wire *q q*, that opens and shuts the hole L; and upon the other end O, is screwed a nut, which, stopping in the smaller part of the hole, prevents the wire from being lifted too high. This wire and screw are more clearly seen in fig. 3.; they slide through a collar of leathers *r r* (see figs. 3 and 5,) in the middle of the piston. Figures 5 and 6, are the two main parts which compose the piston; and when the pieces in figs. 7 and 4 are added to it, the whole is represented in fig. 3. Figure 5 is a piece of brass, turned in a conical form, with a shoulder or ledge at the bottom; a long female screw is cut into it, about two-thirds of its length; and the remaining part of the hole, in which there is no screw, is about the same-sized diameter as the screw part; except a thin plate at the end, which is of a breadth exactly equal to the thickness of *q q* fig. 2. That part of the inside of the conical piece of brass, in which no thread is cut, is filled with oiled leathers with holes in them, through which *q q* can slide air-tight; there is also a male screw with a hole in it which is fitted to *q q*, and serves to press down the leathers *r r*. In fig. 6, *a a a a* is the outside of the piston, the inside of which is turned exactly to fit the outside of fig. 5; *b b* are round leathers, *c c* is a circular plate of brass of the size of the leathers, and *d d* is a screw which serves to press them down as tight as it is necessary. The male screw at the end of fig. 7, is made to fit the screw in fig. 5. If fig. 4. is put into fig. 5, and that again into fig. 6, and fig. 7 screwed into the end of fig. 5, these will compose the whole piston as represented by fig. 3. H in fig. 2, is that part to which the rack is fixed. If this, therefore, is drawn upwards, it will make fig. 5 shut close to fig. 6, and drive out the air above it; and when it is pushed downwards, it will open as far as the shoulders *a a* will allow, and suffer the air to pass through. AA fig. 8. is the receiver-plate; B is a long square piece of glass screwed to the undermost side of the plate, through which a hole is drilled, corresponding with that in the centre of the receiver-plate, and with the three female screws *b b c*.

To conceive how the rarefaction of the air is effected, suppose the piston to be at the bottom of the barrel, and a receiver to stand upon the plate; the inside of the barrel from the top of the piston to *a* is full of air, and the piston shut: when drawn upwards, by the cylindrical wire H, it will drive the air before it through the hole *a a* into the oil-vessel R, and out into the atmosphere by the tube T. The piston will then be at the top of the barrel at *a*, and the wire *q q* will stand nearly as it is represented in the figure, just raised from the tube L, and prevented from rising higher by means of the nut *o*. While the piston is moved upwards, the air will expand in the receiver, and be driven along the bent tube *m* into the inside of the barrel. Thus the barrel will be filled with air, which, as the piston rises, will be rarefied in proportion as the capacity of the receiver, pipes, and barrel, is to the capacity of the barrel alone. When the piston is moved downwards again by H, it will force the conical part fig. 5, out of the hollow part fig. 6, as far as the shoulders *a a.*; fig. 3. will rest upon *a a*, fig. 6, which will then be so far open as to permit the air to pass freely through it, while at the same time the end *q q* is forced against the top of the hole, and closes it in order to prevent any air from returning into the receiver. Thus the piston, while moved downwards, suffers the air to pass out between the figs. 6 and 5, and when it is at the bottom of the barrel, will have the column of the air above it; and, consequently, when drawn upwards, it will shut and drive out this air, and by opening the hole L, give a free passage to more air from the receiver. This process being continued, the air will be exhausted out of the receiver as far as the expansive power will permit: for in this instrument there are no valves, as in common air-pumps, to be forced open by the air in the receiver, which, when its elasticity is diminished, it becomes unable to effect; nor is there any thing to prevent the air from expanding to the greatest degree.

The oil-vessel G, fig. 2, must be always kept about half-full of oil; and when it has stood long without using, it will be right to draw a table-spoonful or more through it, by pouring it into the hole *a*, in the middle of the receiver-plate, fig. 1. when the piston is at the bottom of the barrel; then by moving the winch H backwards and forwards, the oil will be drawn through all the parts of the machine, and the superfluous part will be forced out through the tube T, into the oil-vessel G. Near the top of the cylindrical wire H, fig. 2, is a square hole, which is intended to let in some of the oil from the vessel G, that the oiled leathers, through which the wire *q q* slides, may always be duly supplied with it. Fig. 9. is a representation of a condensing-apparatus used with this pump.

Mr. Cuthbertson has by many experiments shewn the great powers of exhaustion of which this pump is capable. With the double syphon-gage, and also with the long gage, compared with an attached barometer in which the mercury has been well boiled, the difference between the heights of the mercurial column proved no more than $\frac{1}{40}$ of an inch: the barometer standing at 30 inches, which is an exhaustion of 1200 times; and on some occasions, when the air was very dry, he observed the difference to be as low as $\frac{1}{100}$ of an inch, which gives more than double that degree of rarefaction.

We must not omit the American air-pump, invented by Mr. Prince, who first took away the valves, which were long known to prevent the air from entering the barrel above the piston. His next attempt was to expel the air more perfectly out of the barrel than Mr. Smeaton had done, by making a better vacuum between the piston and the top plate, so that more of the air might be allowed to expand itself into the barrel from the receiver. Mr. Prince also contrived to connect the valves on the top plate with the receiver occasionally by means of a pipe and cock, by the turning of which the machine might be made to exhaust or condense at pleasure. In order to remove the pressure of the atmosphere from the valve on the top plate, so that this valve might open as easily as the piston-valve, he connected with the duct on the bottom piece, which conveys the air from the valves to the cock, a small pump of the same construction as the large one, having the barrel opening into the cistern; the piston-rod, which is solid, moving through a collar of leathers, and a valve near the top, through which the air is forced into the atmosphere. This pump with one barrel is called the valve-pump; its chief use being to rarefy the air above the valves, or to remove the weight of the atmosphere from them. When this valve-pump is used, the passage through the cock is shut up; and, therefore, instead of placing three ducts at equal distances round the cock in the manner of Mr. Smeaton's, Mr. Prince divided the whole into five equal parts, leaving the distance of one-fifth part between the ducts leading from the cistern and valves to the cock, and two-fifths between each of these and the one leading from the cock to the receiver. By this adjustment, when the communication is open between the receiver and the valves for condensation, the other hole through the cock opens the cistern to the atmosphere; but when the communication is made between the cisterns and the receiver for exhaustion, a solid part of the key comes against the duct leading to the valve and shuts it up, and the air which is forced out of the barrel, passes through the atmosphere into the valve-pump; for the valve of the small pump may be kept open while the great one is worked.

Upon this construction, the pump with two barrels may be made like the common pump, which cannot be conveniently done where the lower valve is retained. In this pump, the pistons do not move the whole length of the barrels; an horizontal section being made in them a little more than half-way from the bottom, where the top plates are inserted. The pump is thus made more convenient and simple; as the head of it is brought down upon the top of the barrels, in the same manner as in the common air-pump. The barrels also stand upon the same plane with the receiver-plate, and this plane is raised high enough to admit the common gage of 32 or 33 inches to stand under it without inconvenience in working the pump; as the winch moves through a less portion of an arch at each stroke, than it would do if the pistons moved through the whole length of the barrels.

A gage for measuring the degree of condensation, having a free communication with the valves, cock, &c. is placed between the barrels in this pump; and the gage is so constructed that it will also serve to measure the rarefaction above the valves when the air is worked off by the valve-pump. It consists of a pedestal, the die of which is made of glass, which forms a cistern for the mercury; a hollow brass pillar; and glass tube hermetically sealed at one end, which moves up and down in the pillar through a collar of leathers. When the pump is used as a condenser, the degree of condensation is shewn by a scale marked on one edge of the pillar; when it is used as an exhauster, the degree of rarefaction of the air above the valves, is shewn by a scale on the other edge of the pillar. This gage will also shew, when the valves have done playing, either with the weight of the atmosphere on them or taken off, in the manner which the author has described. The degree of condensation may be also measured by the number of strokes of the winch. For the purposes of great condensation, Mr. Prince has fitted a condenser of a smaller bore than the barrel of the great pump to the cistern of the valve-pump, to be screwed on occasionally. Or, without this condenser, the valve-pump may be adapted to the purpose by being made a little larger, and by having a plate made to screw into the bottom of the cylinder, with a valve on it opening into the cistern; a hole must be made to be opened on the same occasion near the top of the cylinder, to let air in below the piston when this is drawn up above it.

The common gage, which is generally placed under the receiver-plate, is placed in the front of this pump, that it may be seen by the person who works it, and that the plate may be left free for other uses. The plate is so fixed to the pipe leading to the cock, that it may be taken off at pleasure, and used as a transferer; and it may also serve for other purposes.

The head of this pump is made whole, except a small piece on the back, where the wheel is let in; and the wheel is freed from the piston-rods by pushing it into the back part of the head, and it is kept in its place by a button screwed into the socket of the axis behind. By this apparatus, the piston-rods are dislodged from the wheel, and let down into the cisterns, when the pump is not used; and in these cisterns they may also have the advantage of being covered with oil. The principal joints of this pump are sunk into sockets, that the leathers which close them may be covered with oil to prevent leaking. The lower part of the pump is fitted with drawers to contain the necessary apparatus.

We shall close our account of the two pumps of Prince and Cuthbertson, with the following judicious remarks of Mr. Nicholson on their respective merits and imperfections: "There is no provision to open the upper fixed valve of Prince's greater barrel, except the difference between the pressures of the elastic fluid on each side of the strip of bladder; and this may reasonably be inferred to limit the power of his small pump. In Cuthbertson's pump, the same valve is exposed to the action of the atmosphere, together with that of a column of oil in the oil-vessel. The mischief in either instrument is probably trifling, but in both the valve might have been opened mechanically. If this were done, the small pump of Prince might, perhaps, be unnecessary in most states of the atmosphere. With regard to the lower valves, Cuthbertson, by an admirable display of talents as a workman, has ensured their action. Prince, on the other hand, has, by the process of reasoning, so far improved the instrument, that no valves are wanted. In this respect, he has the advantage of simplicity and cheapness with equal effect. The mechanical combination of Cuthbertson's pump, reduces the operation to one simple act of the handle; but Prince's engine requires some manipulation with regard to the play of the small pump, though this might have been remedied by a more skilful disposition of the first mover.

"The most perfect scheme for an air-pump, taking advantage of the labours of these judicious operators, seems to be that in which two pistons of the construction of Prince should work in one barrel, one piston being fixed at the lower end of the rod, and the other at the middle. The lower piston must come clear out of the barrel when down, and work air-tight through a diaphragm at an equal distance from the effective ends of the barrel. In the diaphragm must be a metallic valve of the form of Cuthbertson's lower valve, but with a short tail beneath, that it may be mechanically opened when the piston comes up. Above the diaphragm must work the other piston, similar to the first; but as it cannot quit the barrel when down, a small portion of the barrel must be enlarged just above the diaphragm, so that the leathers may be clear in that position. Lastly, the top of the barrel must be closed and fitted with a valve and oil-vessel, according to the excellent contrivance of Cuthbertson.

"If we suppose the workmanship of such a pump to leave the space between the diaphragm and lower piston, when up, equal to one-thousandth part of the space passed through by the stroke of that piston, the rarefaction produced by this part of the engine will, in theory, bear the same proportion to that of the external air; and the same supposition applied to the upper piston, would increase the effect one thousand times more; whence the rarefaction would be one million times. How far the practical effect might fall short of this, from the imperfection of workmanship, or the nature of the air, which, in high rarefactions, may not diffuse itself equally through the containing spaces, or from other, yet unobserved circumstances, cannot be deduced from mere reasoning, without experiment.

PNEUMORA, a genus of insects of the order hemiptera. The generic character is, body ovate, inflated, diaphanous; head inflected, armed with jaws; thorax convex, carinate beneath; wing-cases deflected, membranaceous; legs formed for running. The insects of this genus appear to consist of a mere hollow inflated membrane. By rubbing together their toothed legs, they make a shrill kind of noise morning and evening, and follow a light. They are so nearly allied to the cricket tribe, that Fabricius has enumerated them under the genus gryllus. There are three species.

POA, *meadow-grass*, a genus of the digynia order, in the pentandria class of plants, and in the natural method ranking under the fourth order, gramina. The calyx is bivalved and multiflorous; the spicula or partial spike is ovate, with the valvules scarious, and a little sharp or thin on the margin. There are 71 species, most of them grasses, and very agreeable food for cattle; for one species, which grows in marshes, the cattle will frequently go so deep as to endanger their lives. This is called the aquatica, or water reed-grass. It is the largest of the British grasses, growing to the height of five or six feet. The leaves are smooth, and half an inch wide or more. The panicle is eight or ten inches long, greatly branched, and decked with numerous spicula; these are of a reddish brown colour intermixed with green, of a compressed lanceolate form, imbricated with about six flowers for the most part, but varying from five to ten. See HUSBANDRY, and Plates LXVIII. and LXIX.

POCKET, in the woollen trade, a word used to denote a larger sort of bag, in which wool is packed up to be sent from one part of the kingdom to another. The pocket contains usually twenty-five hundredweight of wool. The pocket of hops is also a small bag usually containing the best hops.

POCKET-*instruments*, in surgery. See INSTRUMENT.

PODOPHYLLUM, a genus of the monogynia order, in the polyandria class of plants, and in the natural method ranking under the 27th order rhœadeæ. The corolla has nine petals; the calyx is triphyllous; the berry unilocular, crowned with the stigma. There are two species, creeping plants of North America.

PODURA, a genus of insects of the order aptera. The generic character is, legs six, formed for running; eyes two, composed of eight; tail forked, formed for leaping, inflected; antennæ setaceous, elongated. The poduræ are small insects which, in general, are found in damp places, under stones, on the bark of trees, &c. When disturbed, they suddenly spring to a small distance by the help of a long, forked process, which is doubled under the abdomen, and which is suddenly thrown out during the act of leaping.

One of the most common of this genus is the podura aquatica of Linnæus, measuring scarcely the twelfth part of an inch in length, and entirely of a black colour. This a gregarious species, and is occasionally seen assembled in vast numbers, particularly near the brinks of ponds, covering the ground to the distance of several feet, and sometimes even the surface of the water itself. On the ground its legions, on a cursory view, have the appearance of scattered grains of gunpowder; and, if closely examined, will be found in an almost continual skipping motion.

Podura fimetaria so perfectly resembles the preceding in all respects except colour, being perfectly white, that no other specific difference can be observed. It is almost equally common in damp situations with the former.

Podura atra is of a short, subglobular shape, with lengthened antennæ: its colour is a glossy black. It is found on the bark of trees, &c.

Podura plumbea is of a blueish black or deep lead-colour, and is found in similar situations.

Podura arborea is of a lengthened form, and of a black colour, with the feet and caudal fork white. It is chiefly found on the bark of trees, among mosses, &c. There are 14 species.

POEM. See POETRY.

POETRY is that kind of literary composition which is characterised by metrical harmony. Various have been the attributes and pretensions assigned to poetry. By some it has been made to consist in fiction, by others in imitation. By one critic it has been elaborately designated as "the art of illustrating in metrical numbers every being in nature, and every object of imagination, for the delight and improvement of mankind." By a more judicious writer it is assumed to be "the language of passion, or of enlivened imagination, formed most commonly into regular numbers;" and this definition, though not perfectly correct, is, perhaps, less exceptionable than any other which has been submitted to investigation.

Poetry is commonly called an art, yet is not unfrequently classed with the sciences; a dignity perpetuated to it by traditional authority, from the early ages, when the bard was a personage sacred as the priest, and all the knowledge or the wisdom extant was enveloped in fable, or unfolded in numbers.

In the progress of society from barbarism to refinement, it was impossible that the analogies subsisting between certain operations of intellect should be overlooked; and the mythology of Greece, which embodied even the abstractions of science, gave to these metaphysical relations a personal character corresponding with the sympathies and dependances of domestic life. In these popular personifications, a remarkable predilection appears for the triple numbers. The Parcæ, the Furies, the Graces, and originally the muses, were composed of sisterly triads. In like manner, music, poetry, and painting, from the intimate connection observed between the two first of these arts, and their supposed affinity to the last, were united in the same bond of union; and the legitimacy of the relation on which this elegant allegory was founded, is yet recognized in popular language as an unequivocal and undisputed truth.

Of these kindred arts, music and poetry issued from the same woods, cherished and respected by the rudest and most uncultivated generations of men. The metre of poetry is evidently borrowed from the simple melodies of music; and it may be presumed, was produced in the first efforts to combine vocal with instrumental sounds. The ambition of the primitive poet must have been limited to that artificial modulation of language which is now considered as the least and lowest of poetical attainments, but which unquestionably forms a radical part in the constitution of poetry. The origin of painting is not equally remote. Many subordinate arts, concomitant with the progress of civilization, must have previously existed; and it is well known that poetry inspired enthusiasm and veneration, not only in the ferocious tribes of Scandinavia, but in the Hebrews and the Arabs, to whom the delineation of the human form was an art proscribed by legislative authority, or contemned by national prejudice. The first specimens of poetry could not but be rude as the society for which they were composed Alliteration appears to have been an initial character of verse; and the rudiments even of rhyme are discernible in those similar or identical terminations adopted by the Celtic and Runic bards, and exemplified in the practice of Oriental antiquity. By the agency of metre, a poetical style was gradually produced; and in the labour of balancing and adjusting his sentences, the poet insensibly acquired vigilance, discrimination, and taste. Figurative language, which is familiar to a primitive state of society, has supplied to every people some of the purest elements of poetry. But this language is not the exclusive property of the poet; it belongs to every writer of imagination; and though more essential to verse, is almost equally becoming in prose; nor would it be difficult to produce from Bacon and Jeremy Taylor in one age, from Burke and Gibbon in another, as brilliant combinations of thought as any that have been exhibited in verse.

The following passage from Shakspeare, though written in prose, is as rich in imagery as any part of his metrical compositions: "This goodly frame, the earth, seems to me a sterile promontory; this most excellent canopy, the air; this majestical roof, fretted with golden fire, why it appears no other thing to me than a foul and pestilential congregation of vapours. What a piece of work is man! How noble in reason; how infinite in faculties; in form and moving, how express and admirable; in action, how like an angel; in apprehension, how like a god!" The figures of rhetoric, therefore, (see RHETORIC,) including all the varieties of metaphor, allegory, and simile, are common to all the higher orders of literary composition; the mechanism of verse being, perhaps, the only positive line of demarcation, by which the boundaries of prose and verse are distinguished from each other.

Antient poetry.

That the higher order of poetry is not unattainable in an uncultivated age, is a truth eminently illustrated by the example of the Hebrew people. Admitting language to be, as Mr. Richardson ingeniously observes, the barometer of society, by which its comparative barbarism or civilization is indicated, it will be obvious that the bards of Sion composed their lofty songs for a primitive nation, tenacious of its customs and opinions, unenlightened by science, uncorrected by taste, and as little acquainted with the arts as the refinements of polished life.

The simplicity and energy of the Hebrew language, accorded happily with the sublime nature of sacred poetry; and to the peculiarities in its constitution it is, perhaps, owing that the primitive character of its composition is tenaciously preserved to whatever language transferred, or with whatever idioms assimilated. The musical harmony of the Hebrew language is now but imperfectly known; its prosody is, however, sufficiently understood to suggest a comparison between its rhymes, and the wild measures familiar to the Scandinavian nation. Alliteration was freely admitted in their verse, as were identical terminations and other artificial embellishments; but its distinctive feature was a symmetrical disposition of the sentences, which were cast into parallel verses of equal length, and correspondent in sense and sound: the sentiment expressed in the first distich being repeated and amplified in the second, as in the following examples: "The Lord rewardeth me according to my righteousness: according to the cleanness of my hand he hath recompensed me. The statutes of the Lord are right, rejoicing the heart: the commandment of the Lord is pure, and enlighteneth the eyes. The fear of the Lord is clean, enduring for ever: the judgments of the Lord are pure and righteous altogether." This practice, which appears to have been peculiar to the Hebrews, was derived from their rites of worship; in which the sacred hymns were chaunted by bands of singers, who alternately responded to each other.

The Hebrew bards employ few epithets: the brevity of their style renders its sublimity conspicuous; their imagery is bold and energetic; their magnificent conceptions issue from the mind in native majesty and strength; their imagination is ever rich and exuberant; and to them, metaphors spontaneously arise on every subject, in inexhaustible beauty and fertility.

Although Hebrew poetry presents nothing that in critical language can be classed with epic or dramatic composition, it affords innumerable examples of the lyric, the elegiac, and the didactic style. In the prophecies, the favourite figure is allegory: the Hebrews having, in common with other Oriental nations, a decided predilection for the parabolic species of writing. It would be injustice to the sacred bard, not to remember in what country he wrote, and with what people he lived. On examination, his images will be found to have been faithfully transcribed from nature, and beautifully to have harmonized with the scenes and manners familiar to his observation and experience; but the pure and uncorrupted theism maintained by the inspired bard, is his most exalted attribute, and is evidently the cause of his pre-eminence in sublimity over all other Oriental writers.

The Arabs were not, like the Hebrews, a stationary people, insulated from the rest of mankind. Alternately engaged in commerce and in war, their erratic chiefs visited distant regions; and in their intervals of leisure, were no less ambitious to obtain poetical distinction, than they had been to secure military fame.

Poetry, which constituted the sacred science of the Hebrews, became with the Arabs a polite accomplishment; and as the copiousness of their language supplied all the aptitudes of numbers, it is not surprizing that improvisatori bards should have been found in their deserts. The distich, and many other forms of metrical composition, adapted to familiar occasions, were of Arabian invention; and it is the plausible suggestion of sir William Jones, that rhymes were borrowed from Eastern literature by the Provençal and Castilian poets, through whose influence they were naturalized to Europe. With all the copiousness and flexibility of the Arabic, the

Persic language is found to possess an amenity and an elegance which render it eminently susceptible of poetical beauty. Its poets, like those of antient Greece, have the power of rendering language subservient to their pleasure, and of clothing original conceptions in a new-created word.

Several Arabic and Persian poems are of the epic and dramatic cast; but the compositions most inviting to the European for translation, are of an amatory, elegiac, and lyric character. In general, Oriental poetry deviates from the primitive simplicity so conspicuous in Hebrew compositions, and often degenerates into affectation and bombast. In their most admired authors indeed, a passion for the gaudy and the gorgeous is ever predominant. The magnificence of their materials is disguised by their fantastic arrangement; and the eye which has dwelt with delight on the chaste graces of classical literature, soon turns with disgust from the jewelled turban and the barbaric gold. There are, however, some passages, particularly in braminical poetry, which are perfectly simple and sublime. Of these a noble specimen is given by sir William Jones in the hymn to Narrayna.

Of classical poetry.

The germs of genius scattered through Oriental compositions with wild luxuriance, appear in classical poetry displayed in full perfection and beauty. To what causes the pre-eminence of antient Greece in this part of literature is to be attributed, it would here be futile to conjecture. From the susceptibility of his language, the poet was enabled to exhibit the same idea under a new aspect, and to give to every fluctuation of feeling a permanent expression. If the vivacity of his descriptions fascinated the imagination, his numbers dwelt with no less enchantment on the ear. The length and shortness of syllables in the Greek and Roman languages, which constituted their quantities, was determined by rules no less accurate than the notes in music; and on the proper distribution and adjustment of these quantities, the harmony of their metre depended. A stated interval of time was allowed to the pronunciation of every verse. To facilitate the labour of composition, artificial combinations of syllables by the name of feet, were invented; and by the number of these, and the quantities included in them, the character of the verse was ascertained.

To these combinations various names were given; the most important were the spondee, composed of two long syllables, and the dactyl, formed by one long and two short syllables. These were solely employed in the construction of the hexameter verse, of which an imitation has been vainly attempted in the English language. The pronunciation of the Greek and Latin languages is, indeed, almost as totally lost to us, as that of the Hebrew; but such is the exquisite mechanism of their metre, that their verses cannot be read without producing a rich and often a melodious intonation, perceptible even to the unlettered ear.

In the happy regions of Greece, it is uncertain what species of poetry was first cultivated. Fables were compositions of great antiquity; the ode formed a part of religious worship; the pastoral must have been introduced in an age sufficiently refined to relish simplicity. The immortal poems of Homer were composed at an early epoch of Grecian literature, and, as is well known, transmitted by oral tradition to a more polished age. Of this extraordinary man, so much has been said, that it would appear difficult to say any thing which should not now be trivial or impertinent. This arduous task the perseverance of modern criticism has, however, achieved; and a scholastic sect is now known to exist who would sacrilegiously remove the shrine of Homer from the temple of fame, and abandon to superstitious credulity a name sanctified by the enthusiasm and veneration of preceding ages.

It is pretended that the Iliad and Odyssey were composed at different eras, by various authors; and that these desultory tales of Troy were at length collocated and edited by some ingenious critic, who might possibly have been distinguished by the appellation of Homer. The novelty, and, perhaps, the extravagance of this hypothesis, have obtained for it partisans among those professed sceptics and segregatists who can perceive no difference between vulgar errors and popular opinions, and whose ambition it is to recede as far as possible from all participation in the sentiments or convictions of other men. It is generally admitted that the excellence in which the supposed Homer stands unrivalled, is the energy of his conceptions, which gives to his personages, his scenes, and his descriptions, a real and individual existence. With such felicity are his characters cast, that no reader of feeling can be at a loss to conceive how Achilles would look, or Nestor speak, or Ulysses act, on any imaginary occasion. The unprejudiced will decide whether such exquisite harmony of design could have been the result of chance, or whether each book had its separate Homer, or whether they were all planned and executed by one.

In lyrical composition, the most popular was the heroic ode. The name of Pindar has descended to us with honour; but the poems which inspired in his compatriots the most exalted enthusiasm, are but imperfectly understood by the student, and are almost impracticable to translation. The public recitation of the ode was accompanied both by music and dancing: a circumstance to which its structure was obviously adapted. The two first stanzas, called the strophe and the antistrophe, were of equal length. In the first part the performers approached the altars of their god; in the latter, the dance being inverted, they measured back their steps to their former place, where whilst they sung the epode they stood still. It appears that this form was peculiar to the heroic ode. There were other lyrical compositions of a different cast. Sappho's poems respire only tender, impassioned sentiment; those of Anacreon, whether amatory or convivial, are equally remote from the sublimity of Pindar, and the melting softness of Sappho. The fervid imagination of Pindar is compared by Horace to the impetuosity of a mountain torrent:

Monte decurrens velut amnis, imbres
Quem super notas aluêre ripas,
Fervet, immensusque ruit profundo
Pindarus ore:

Pindar, like some fierce torrent swoln with showers,
Or sudden cataracts of melting snow,
Which from the Alps its headlong deluge pours,
And foams and thunders o'er the vales below,
With desultory fury borne along,
Rolls his impetuous, vast, unfathomable song.

West.

The heroic ode is evidently of a dramatic character, and was the primitive source from whence the regular drama was produced. Tragedy originated in the hymns sung in honour of Bacchus; and its name was derived from the goat, which was the victim consecrated to that deity. The invention of dialogue and action belongs to Eschylus; the original ode was preserved in the chorus, which constituted the popular part of the entertainment. The chorus, like the band of a modern orchestra, was composed of several persons who recited in a different manner from the other performers. We learn from Horace that their business was to deduce from the passing scene some lesson of morality, or to inculcate on the spectator some religious precept. The intervention of the chorus, which is now rejected by the most zealous votaries of Greece, is not more repugnant to our ideas of propriety than many other usages of the antient stage: the performers appeared in masks; in their recitations they were constantly accompanied by musical instruments, by which the voice was sustained, and the melody of the verse rendered sensible to an immense audience. The rules of the antient drama were suited to its institution. The unities of time and place were necessary in a performance to which the auxiliary resources of modern machinery were wanting, and from which all the magical illusions of the modern scene were precluded. The tragedies of Euripides and Sophocles were masterpieces in their kind, but would now probably be little relished even by scholars and scholastic enthusiasts.

Comedy, like tragedy, originally consisted of a chorus, which derived its name from the god Comus. The rudiments of the comic art may, perhaps, be detected in the satyrs, a sort of interlude annexed to tragedies, in which the scene was rural, and the personages Satyrs, or sylvan deities. In the plays of Aristophanes, living characters were introduced, and Socrates beheld himself ridiculed on the stage. This abuse a better taste corrected; and the comedies of Menander, which were imitated by Terence, exhibited only interesting pictures of domestic life. The chorus at first appendant on comedy, was gradually changed into the prologue, a personage who carefully apprized the spectators of all they were to see on the stage.

The Roman writers were modelled on those of Greece, and it was long before they attempted to emulate their masters; yet Ennius, one of their elder poets, produced the satire, a species of miscellaneous poetry purely Roman, which was destined to receive perfection from Horace. With equal originality, Lucretius wrote his metaphysical poem, in which are developed the philosophical systems of his age; but it was not till the era of Augustus that the bards of Latium established their equality with those of Greece. It was then that Horace, not satisfied with having transplanted all the lyric beauties to his odes, opened a rich vein of satiric poetry; and Virgil, having equalled Theocritus, without temerity aspired to emulate Homer. In the Æneid it may be acknowledged that he sometimes fell short of his master. His characters possess not the same features of durability and grandeur; nor are his scenes equally animated and dramatic. To atone for these defects, he unites every charm that gives interest to narrative or lends enchantment to description; occasionally he rises to the sublime, but the beautiful is his natural element; he can excite terror, but he is more prone to inspire tenderness and pity. In the delicate touches of nature and pathos, he seems to have grown enamoured of his subject, and to have lingered affectionately on the endearing scenes and charities of domestic life. The four first books of the Æneid contain a tale so sweetly told, that was it transferred to a rude language totally unsusceptible of its literary graces, it would still be read and remembered by all who had capacities for sympathy and tenderness.

In the Georgics, Virgil has left a model of didactic composition, ennobled by a strain of philosophical sentiment, pure, graceful, and persuasive. Ovid, whose talents were not less versatile than those of his contemporaries, adorned the fables of mythology with description, and illustrated in his epistles almost every romantic story of antiquity. The style of his elegies is not unlike that of his epistles: he paints to the eye, but he has often too much wit and fancy to touch the heart.

Tibullus has exceeded every other elegiac writer in simplicity and tenderness. Lucan and Statius were also epic poets, but they are seldom quoted, and not often read. Lucan possessed a genius of an exalted order; but his subject was peculiarly unfortunate, and his beauties are now neglected because they are found in scenes repulsive to the imagination, and uncongenial with the feelings.

Among the last poets of Rome appeared Juvenal and Persius, of whom the former was one of the most original writers she had produced. He professes to exhibit a picture of his times; and there is in his manner an undissembled and almost a holy fervour that atones for his occasional ruggedness and asperity.

Origin of modern poetry.

The Gothic nations who over-ran Rome, though ignorant of the polite arts, were not insensible to the charms of poetry. Their bards were no less venerated than their priests; and whatever instruction they received, whatever knowledge they possessed, was communicated in metre, and probably in rhyme.

In the age of Charlemagne, the minstrels of Provence, or, as they were called, the troubadours, introduced the metrical tales or ballads, which, from the dialect in which they were written, acquired the name of romances. Their poems were all composed in rhyme; but whether this practice was borrowed from the Arabs or the Goths, is uncertain. The Italian language, which of all the corrupt dialects introduced by the barbarians, assimilated most with the Roman, soon acquired a tincture of elegance. In the middle ages Dante wrote; Ariosto followed; and Petrarch, the enthusiastical votary of classical genius, appeared among the first founders of modern literature. The passion for allegory, so long the characteristic of the Italian school, was by Chaucer rendered as prevalent in England as it had previously been on the continent. During several ages, Italy continued to be the Poets' Land of Europe; and in that interval was produced the Jerusalem Delivered, a poem not unworthy of a Roman bard, or an Augustan age.

In Spain, poetry was early cultivated, but with little attention to classical taste. In France, it emerged not from barbarism till the reign of Francis the First, and arrived at its ultimate point of perfection in the era of Louis the Fourteenth. La Fontaine and Boileau, Corneille and Racine, had then lived, and produced works destined to immortalize their names. Unfortunately for French poets, criticism was then almost coeval with poetry; and a pedantic attention to rules was soon permitted to repress the native energies of genius. The modern drama, it is well known, originated in the mysteries; a sort of religious farce, imported from the East. To the mysteries succeeded allegorical plays, called moralities: these produced the mask, which became the favourite amusement of the court in the time of Charles the First, and is redeemed from opprobrium and oblivion by Milton's Comus. Gondibert, written by lord Sackville, was the first tragedy represented on an English stage. Till the commencement of the eighteenth century, the German language was almost a stranger to poetry. Klopstock invented hexameter verse, in which the mechanism of classical numbers is rather perceived than felt by the reader. From that era, Germany has been more productive of books than all the rest of Europe; and during this period, many fine writers have arisen of real and original genius: but the literary commerce of the country is chiefly supported by translation; the Germans having arrived at no less distinction as the general translators, than did their neighbours the Dutch as the carriers, of Europe.

Of English versification.

In the English language, versification depends not on the quantities, or the length and shortness, of the syllables: but on the modulation of the accents, and the disposition of the pauses; to which is generally added the recurrence of rhyme. The heroic verse consists of ten syllables; its harmony is produced by a certain proportionate distribution of accented and unaccented syllables; and its specific character, whether lively or solemn, soft or slow, is determined by their order and arrangement. When unaccented and accented syllables are regularly alternated, it is called the iambic verse; as,

"A shepherd's boy, he seeks no higher name,
Led forth his flock beside the silver Thame."

When this order is inverted, and the unaccented is preceded by the accented syllable, it is called a trochaic verse; as,

"Ambition first *sprung* from the blest abodes."

"*Take*, holy earth, *all* that my soul holds dear."

The frequent intervention of the trochaic is apt to produce harshness. The monotony which it might be expected should result from a succession of iambic lines, is obviated by the freedom with which the pause is transferred from one syllable to another; a freedom which constitutes the charm, and produces all the variety, of English verse. The pause or cesura is that interval of suspension which must naturally arise in every verse, the position of which the English poet is allowed to change and diversify at pleasure. When the pause falls on the fourth syllable, the strain is smooth and airy; as,

"Soft is the strain | when Zephyr gently blows,
And the smooth stream | in smoother numbers flows."

When it falls on the second it is commonly accelerated; as,

"Not so | when swift Camilla scours the plain."

Occasionally the pause dwells on the first, second, or penultimate syllable:

"O friend! | may each domestic bliss be thine:
Be no unpleasing melancholy | mine.
Me,| let the tender office long engage,
To rock the cradle of declining age."

A second pause is sometimes happily introduced:

"O ever beauteous | ever lovely! | tell,
Is it in heaven a crime to love too well?"

In the following examples, the first passage has all the spirit and energy of the ode; the second, the slow and plaintive melody of the elegiac strain:

"Come then, my friend, my genius, come along,
O master of the poet and the song!
And while the muse now stoops, | and now ascends,
To man's low passions, | or their glorious ends,
Teach me, like thee, | in various nature wise,
To fall with dignity, | with temper rise;
Form'd by thy converse, | happily to steer
From grave to gay, | from lively to severe;
Correct with spirit, | eloquent with ease,
Intent to reason, | or polite to please."

"In these deep solitudes, | and awful cells,
Where heavenly pensive contemplation | dwells,
And ever-musing melancholy reigns."

The heroic verse is often diversified by the intervention of an Alexandrine line of twelve syllables, which is liberally used by Dryden: its abuse is pointedly censured by Pope:

"A needless Alexandrine ends the song,
Which, like a wounded snake, drags its slow length along."

It forms a noble termination:

"Teach me to love and to forgive;
Exact my own defects to scan,
What others are to feel, and know myself a man."

Triplets often occur in heroic verse; a practice to which Dryden was strongly addicted, but which is now generally avoided by correct writers.

The stanza of nine lines, in imitation of the Italian, was introduced by Spenser. Of this verse, which, if not impracticable, was at least repugnant, to the English language, the following extract is a favourable specimen:

"A gentle knight was pricking on the plaine,
Yclad in mightie arms, and silver shield,

Wherein old dintes of deep woundes did remain,
The cruel marks of many a bloody field;
Yet armes till that time did he never wield.
His angry steed did chide his foaming bitt,
As much disdaining to the curb to yield:
A jolly knight he seem'd, and faire did sit,
As one for knightly guests and fierce encounters fitt."

A stanza more polished in its structnre is adopted by Mr. Sotheby in his admirable translation of Wieland's Oberon. The folling passage describes Rezia's first interview with the Hermit·

" Rezia, at once entranced in holy bliss,
Aw'd by his look, that beams celestial grace,
Bows, as before the genius of the place,
And prints his wrinkled hand with pious kiss.
Touched by his gracious mien or friendly air,
His beard that swept his breast with silver hair,
Her soul this stranger as her sire reveres;
A second look has banish'd all her fears:
Each reads the other's heart, nor finds a stranger there."

The most popular stanza is that appropriate to the ballad, which is composed of four lines with interchanging rhymes. Such is the measure of Goldsmith's beautiful tale of Edwin and Angelina:

" Turn, gentle hermit of the dale,
And guide my lonely way,
To where yon taper cheers the vale
With hospitable ray."

And such, with the remission of rhyme in the first and third lines, is the measure of Chevy Chace:

" God save the king, and bless the land,
In plenty, joy, and peace;
And grant henceforth that foul debate
'Twixt noblemen may cease !"

The elegiac stanza consists of four alternately responsive lines of ten syllables each: it is well adapted to short poems; but in composition of any length, its slow monotonous cadence becomes oppressive to the ear. In the celebrated elegy of Gray, its defects, however, are all concealed by a profusion of poetical beauties; and by the graceful muse of Hammond its fetters are rendered elegant and ornamental:

" Why should the lover quit his pleasing home,
In search of danger on some foreign ground?
Or from his weeping fair ungrateful roam,
And risk in every stroke a double wound?
Ah! better far, beneath the spreading shade,
With cheerful friends to drain the sprightly bowl,
To sing the beauties of my darling maid,
And on the sweet idea feast my soul."

The common anapestic verse, of eleven and twelve syllables, in which the accent falls on every third syllable, has generally been appropriated to humorous subjects: when formed into the stanza, it assumes a different character. In the noble war-song of Burns it is however a strain truly sublime; and in the following passage flows with equal sweetness and pathos:

" 'Tis night, and the landscape is lovely no more:
I mourn, but, ye woodlands, I mourn not for you;
For morn is approaching, your charms to restore,
Perfum'd with fresh fragrance, and glittering with dew.
Nor yet for the ravage of winter I mourn;
Kind nature the embryo blossom will save:
But when shall spring visit the mouldering urn?
Oh! when shall it dawn on the night of the grave?"

This stanza is, from the intractable nature of the anapestic measure, of difficult execution. In that employed by Cowper in the following instance, constructed on similar principles, the syllables are less numerous, and the cadence is in general more harmonious:

" I am monarch of all I survey,
My right there is none to dispute;
From the centre, all round to the sea,
I am lord of the fowl and the brute.
O Solitude ! where are the charms
That sages have seen in thy face?
Better dwell in the midst of alarms
Than reign in this desolate place."

The occurrence of double rhymes is neither very frequent nor very easy in English verse; they are chiefly employed in songs, and are seldom admitted in the higher order of lyrical composition. The following passage from Dryden's ode on St. Cecilia's day, affords the most happy example of this kind of verse in our language :

" Softly sweet in Lydian measures,
Soon he sooth'd his soul to pleasures;
War, he sung, is toil and trouble,
Honour but an empty bubble;
Never ending, still beginning,
Fighting still, and still destroying:
If the world be worth thy winning,
Think, oh ! think it worth enjoying."

The simplest and most fluent of all verse is the couplet of eight syllables. In this measure Milton has written his two exquisite poems, the Allegro and Penseroso :

" And may at length my weary age
Find out the peaceful hermitage,
The hairy gown and mossy cell,
Where I may sit, and rightly spell
Of every star that heaven doth shew,
And every herb that sips the dew,
Till old experience do attain
To something like prophetic strain!"

Pope and Gray are generally considered as the most correct writers of rhyme; and Dryden, who knew the affluence of the English language, has in his own compositions exhibited all its various capacities of harmony and versification.

Blank verse

Is composed of lines of ten syllables each, which flow into each other without the intervention of rhymes; its metrical principle resides in its pauses, which should be so judiciously spread as never to suffer the accompaniment of rhyme to be missed. Of the few poets who have attempted this species of composition, Milton first, and after him, Thomson, Armstrong, Akenside, and Cowper, are pre-eminent. The amplitude of Milton's verse is unequalled: it dilates with the author's thought, it harmonizes with the reader's sentiment, and its varied cadence alternately rolls with majesty, or falls in a mellifluent strain of melody on the unwearied and unsated ear. The principle of this exquisite mechanism has been lately referred by a judicious critic (the Rev. Mr. Crowe, in his Lectures at the Royal Institution), to Milton's bold practice of distributing in separate lines, words so nearly connected (such as the preposition governing the noun, and the pronoun attached to the verb) as almost to appear indivisible. That this practice, which Mr. Crowe calls *breaking the natural joint of the sentence*, is favourable to the freedom of blank verse, cannot be disputed; but it may be questioned whether the poet was himself conscious of the mechanism which he employed, or was directed by any other principle than his own acute sensibility to harmony. The following short extracts may illustrate the difference of style perceptible in the various writers of blank verse :

" Of man's first disobedience, and the fruit
Of that forbidden tree whose mortal taste
Brought death into the world, and all our woe,
With loss of Eden, till one greater man
Restore us, and regain the blissful seat,
Sing, heavenly muse that on the secret top
Of Oreb, or of Sinai, didst inspire
The shepherd who first taught the chosen seed,
In the beginning how the heavens and earth
Rose out of chaos; or if Sion hill
Delight thee more, and Siloa's brook that flowed
Fast by the oracle of God, I thence
Invoke thy aid to my adventurous song;
That with no middle flight intends to soar
Above the Aonian mount, while it pursues
Things unattempted yet in prose or rhyme."
MILTON.

" He comes! he comes! in every breeze, the power
Of philosophic melancholy comes:
His near approach the sudden-starting tear,
The glowing cheek, the mild dejected air,
The soften'd feature, and the beating heart
Pierc'd deep with many a virtuous pang, declare.
O'er all the soul his sacred influence breathes,
Inflames imagination, through the breast
Infuses every tenderness, and far
Beyond dim earth exalts the swelling thought."
THOMSON.

" From heaven my strains begin; from heaven descends
The flame of genius to the chosen heart,
And beauty with poetic wonder join'd
And inspiration. Ere the rising sun
Shone o'er the deep, or mid the vault of night
The moon her silver lamp suspended ; ere
The vales with spring were watered, or with groves
Of oak, or pine, the antient hills were crown'd;
Then the great Spirit whom his works adore,
Within his own deep essence view'd the forms,
The forms eternal of created things :
The radiant sun, the moon's nocturnal lamp,
The mountains and the streams, the ample stores
Of earth, of heaven, of nature. From the first,
On that full scene his love divine he fix'd,
His admiration ; till in time complete,
What he admired and lov'd, his vital power
Unfolded into being."
AKENSIDE.

"O ye whose souls relentless love has tam'd
To soft distress, or friend untimely fallen!
Court not the luxury of tender thought;
Nor deem it impious to forget those pains
That hurt the living, nought avail the dead.
Go, soft enthusiast, quit the cypress groves;
Nor to the rivulet's lonely moanings tune
Your sad complaint. Go, seek the cheerful haunts
Of men, and mingle with the bustling crowd;
Lay schemes for wealth, or power, or fame—the wish
Of nobler minds, and push them night and day;
Or join the caravan, in quest of scenes
New to your eyes, and shifting every hour,
Beyond the Alps, beyond the Appenines."

ARMSTRONG.

"O winter, ruler of the inverted year,
Thy scattered hair, with sleet like ashes fill'd,
Thy breath congeal'd upon thy lips, thy cheeks
Fring'd with a beard made white with other snows
Than those of age, thy forehead wrapt in clouds,
A leafless branch thy sceptre, and thy throne
A sliding car indebted to no wheels,
But urg'd by storms along its slippery way!
I love thee, all unlovely as thou seem'st,
And dreaded as thou art. Thou hold'st the sun
A pris'ner in the yet undawning east,
Short'ning his journey between morn and noon,
And hurrying him, impatient of his stay,
Down to the rosy west; but kindly still
Compensating his loss with added hours
Of social converse, and instructive ease."

COWPER.

The defect of Young's blank verse is, that the sense commonly closes with the line, and that it has too much of the systematical uniformity, without the musical varieties, of rhyme. Whether rhyme or blank verse is entitled to pre-eminence, is a question which must ultimately be determined by individual taste. In the choice of his measure, the poet must obviously be influenced by the nature of his subject; and rhyme or blank verse will alternately obtain his preference. In all the gay and airy excursions of fancy, or the lighter touches of feeling, he will find in rhyme an auxiliary equally pleasing and important. To such compositions as require a measure of spirited and vivacious movement, rhyme is an indispensable appendage. To satire it adds poignancy, to humour it gives elegance; it imparts renovation to old ideas, and lends attraction to trivial sentiments; it renders familiar illustration graceful, and plain sense eloquent. In all but the Alpine regions of poetry, rhyme is a fence no less useful than ornamental, enriching and enlivening every object. In the Allegro and Penseroso, even Milton conceived it no dereliction of poetical freedom to have pursued the path traced out by his predecessors: but in his Paradise Lost, when "he soared beyond the visible diurnal sphere," his deviation into blank verse was as judicious as fortunate; because his subject was then too sublime, his conceptions too gigantic, for the narrow limits and demarcations of rhyme. Wherever much originality of thought exists, this metrical charm is unnecessary; and where imagination reigns in wild luxuriance, it is impertinent. In some of his juvenile poems, Milton appears to have been incumbered with the dignity of his thoughts; and Shakspeare, perplexed by the richness and variety of his combinations, is apt to become affected when he quits blank verse. Attempts have been made to enlarge the limits of blank verse, by the introduction of various measures analogous to those employed in rhyme: but to all these efforts the genius of the language discovers an invincible repugnance; vainly are varieties presented to the eye, which are imperceptible to the mind, and untasted by the ear. All rhymeless numbers either flow into good blank verse, or form lines harsh and intractable; a succession of abrupt sounds and mutilated sentences, which by no art of typography, by no imposition of nomenclature, can be made to constitute any metre at all.

Poetical classification.

The primitive sources of modern poetry may be traced to the old romance; whence was derived the simple ballad so popular in England and Scotland, and under various names and forms universally adopted in Europe. On the revival of letters, when the study and imitation of the classics became the passion of all literary men, their nomenclature was eagerly assumed; and volumes of poetry were soon composed, which the high-sounding names of odes, pastorals, satires, and epic poems, have not saved from oblivion; volumes of criticism were also compiled, to shew how pastorals, odes, and satires, ought to have been written.

PASTORAL poetry is, above all other, the most limited in its object; and when formed on the model presented to us by Virgil and Theocritus, should be a description of rural scenes and natural feelings, enriched with elegant language, and adorned by the most melodious numbers.

Few English pastorals will be recognized in this definition; the scenes they represent are artificial, and the sentiments factitious, because they are imitated from other poets, the natives of a luxuriant region, accustomed to the living tints and glowing azure of a cloudless sky. From this censure, however, the pastoral drama of Allan Ramsay must be excepted, as should Shenstone's celebrated ballad. The ballad is perhaps the happiest vehicle of pastoral poetry, and there are in our language many ballads of exquisite beauty. Some of our pastorals are elegiac; such is Milton's monody on Lycidas:

"Together both, ere the high lawns appear'd
Under the opening eyelid of the Morn,
We drove afield; and both together heard
What time the grey fly winds her sultry horn,
Batt'ning our flocks with the fresh dews of night,
Oft till the star that rose at evening bright,
Towards heaven's descent had slop'd his westering wheel."

The conclusion of this poem is in the true spirit of elegant pastoral:

"Thus sung the uncouth swain to th' oaks and rills,
When the still Morn went out in sandals grey;
He touch'd the tender stops of various quills,
With eager thought, warbling his Doric lay:
And now the sun had stretch'd out all the hills,
And now was dropt into the western bay.
At last he rose, and twitched his mantle blue,
To-morrow to fresh woods, and pastures new."

The name of ELEGY was originally given to funereal monody, but was afterwards attached to all plaintive strains. In the Latin language it was always written in hexameter and pentameter verse. By the moderns an elegiac stanza was invented, assimilating as nearly as possible with those slow melodious numbers. Many elegies, and perhaps the best, are expressive only of soothing tenderness. Such are those of Tibullus, so happily imitated by Hammond. The Jesse of Shenstone, which has perhaps never been surpassed, is all pathos. The celebrated elegy of Gray combines every charm of description and sentiment. The elegiac stanza, the monotony of which soon becomes oppressive to the ear, is sometimes happily exchanged for a lighter measure, as in Cowper's Juan Fernandez:

"Ye winds that have made me your sport,
Convey to this desolate shore
Some cordial endearing report
Of a land I shall visit no more.
My friends do they now and then send
A wish or a thought after me?
Oh! tell me I yet have a friend,
Though a friend I am never to see."

The SONNET represents in an abridged form the antient elegy; the same slow stanza is assigned to each, and the sentiments suitable to the one are appropriate to the other. The sonnet is derived from the Italian school, and was much cultivated in England during the seventeenth century. It is always limited to fourteen lines, an artificial character which should seem to indicate an Oriental extraction. The following, by Milton, is a fine specimen of the English sonnet in the Italian manner:

"O nightingale, that on yon leafy spray
Wast blest at eve, when all the woods are still!
Thou with fresh hopes the lover's heart dost fill,
When the jolly Hours lead on propitious May.
Thy liquid notes, that close the eye of Day,
First heard before the shallow cuckoo's bill,
Portend success in love. Oh! if Jove's will
Have link'd that amorous power to thy soft lay,
Now timely sing, ere the rude bird of hate
Foretell my hopeless doom in some grove nigh,
As thou from year to year hast sung too late
For my relief, yet hadst no reason why.
Whether the muse or Love call thee his mate,
Both them I serve, and of their train am I."

In the following sonnet, which is of a modern date, the stanza is happily accommodated to the English language:

Written in the church-yard of Middleton, Sussex.

"Press'd by the moon, mute arbitress of tides,
Whilst the loud equinox its power combines,
The sea no more its swelling surge confines,
But o'er the shrinking land sublimely rides.

The wild blast rising from the western cave,
Drives the huge billows from their heaving bed,
Tears from their grassy tombs the village dead,
And breaks the silent sabbath of the grave.
With shells and sea-weed mingled on the shore,
Lo! their bones whiten on the frequent wave.
But vain to them the winds and waters rave,
They hear the warring elements no more;
While I am doom'd, by life's long storm opprest,
To gaze with envy on their gloomy rest."

Pope's Elegy to an Unfortunate Lady, and his Eloisa, are in heroic verse; which, in the hands of that great master, is adequate to the expression of every feeling.

Lyric poetry is versatile and miscellaneous, admitting almost every diversity of measure and of subject. Love and heroism, friendship and devotional sentiment, the triumphs of beauty and the praises of patriotism, are all appropriate to lyrical composition. The soul of enthusiasm, the spirit of philosophy, the voice of sympathy, may all breathe in the same ode. Of our lyrical writers, Dryden is confessedly eminent; Gray is distinguished by the majesty and delicacy of his expression, and the correctness of his style; Collins is occasionally animated by a portion of Pindaric spirit. Among our heroic odes there are, perhaps, none that breathe a loftier strain than the following patriotic invocation by Burns:

"Scots, who have with Wallace bled,
Scots, whom Bruce hath often led,
Welcome to the gory bed,
Or to glorious victory.

Now's the day, and now's the hour,
See the front of battle lower;
See approach proud Edward's power,
Edward's chains and slavery.

Who will be a traitor knave?
Who can ask a coward's grave?
Who so base to be a slave?
Traitor, coward, turn and flee.

Who for Scotland, king, and law,
Freedom's sword will strongly draw,
Freeman stand, and freeman fa'?
Caledonian, on wi' me.

By oppressions, woes, and pains,
By your master's servile chains,
We will draw our dearest veins,
But they shall be, shall be free.

Lay the proud usurpers low;
Tyrants fall in every foe,
Liberty's in every blow:
Forward let us do, or die."

In the minor lyrics are included Songs, a species of composition sedulously cultivated by English writers. The themes of songs are in general amatory or convivial; there are however some, of which the strain is purely patriotic and martial; and not a few are of the humorous cast. Shakspeare, Jonson, and our other elder bards, have bequeathed to us songs of exquisite beauty. In the last century the most popular song-writer was Gay. Allan Ramsay has left some enchanting airs. Percy's collection has restored many lyrical pieces of inimitable pathos and simplicity. In latter times, many songs of classical eminence have been supplied by Stevens, Sheridan, and Burns.

Didactic poetry is minutely preceptive, and professes to convey useful instruction on some particular subject. It is obviously not easy to discover situations in which an author may become a practical teacher, without ceasing to be the poet: and this difficulty is aggravated to the English writer, who has not the resources of the Greek and Roman in the metrical capacities of his language.

Virgil's georgical poem is the performance of the first master, operating with the best materials. In imitation of Virgil, a poem was composed by John Phillips on cyder, which is now little read. Towards the middle of the last century, when the didactic muse had most votaries, polemics, physics, and metaphysics, were successively expounded in verse. But verse is not the medium by which information can be communicated with most advantage; and is less suitably employed in elucidating abstract speculation, than in enforcing popular and acknowledged truths. The philosophy of Akenside is relished only for his imagery and harmonious language. The aphorisms of Armstrong are remembered only where the author was more sensible to the influences of Apollo than of Esculapius. The Economy of Vegetation, and the Loves of the Plants, are formed on a plan not only original, but new. It is probable that the primary idea of this work was suggested to the author by the perusal of Cowley's Garden; but on that simple site he has erected a magnificent palace, in which no vestige of the antient edifice remains. With an imagination luxuriant as that of Ovid, and with powers of description scarcely less universal, he has invented a machinery appropriate to his subject, and which is also derived solely from the philosophy of modern times. From the extensive notes appended to his poems, it is however obvious, that though he might thus embody the principles of science to the eye of fancy, he despaired of rendering them intelligible without the agency of prose. Mason's English Garden is more descriptive than didactic. De Lille's Jardins is a chef-d'œuvre in its kind. In the Essay on Criticism, Pope has most happily enlivened didactic style with wit and satire.

Satirical poetry is descriptive of men and manners; its aim is to delineate the follies and chastise the vices of the age. Satire is evidently the offspring of polished times; and, unlike other poets, the satirist finds his empire enlarged, and his influence extended, by the progress of society.

Satire is either pointed or oblique: eloquence is the soul of the one, ridicule of the other. The one rushes on its object in a torrent of vehemence and declamation; the other pursues a smooth tortuous course, occasionally reflecting to the mind the most momentous truths in the playful aspect of wit and humour. In the Hudibras of Butler, the Lutrin of Boileau, and the Rape of the Lock, the effect of oblique satire is heightened by an assumption of the heroic style, the perversion of which produces an effect exquisitely ludicrous. Gay's Shepherd's Week and Gresset's Ver-vert belong to this species, as do many of Voltaire's lighter poems, and many of La Fontaine's tales. Swift's satire is commonly of a similar cast. The satire of Young is always pointed and saturnine. In Churchill the pointed and the oblique are happily united: as they are in Dryden and Pope, the two great original masters of English satire, who both possessed with wit and fancy a knowledge of men and manners, and an intuitive discernment of characters, with the aptitude of describing them, which are its first requisites. The following extracts afford a specimen of the manner of each in the delineation of character: it must, however, be remembered, that Pope moralizes whilst Dryden declaims:

"Some of their chiefs were leaders of the land:
In the first rank of these did Zimri stand;
A man so various, that he seem'd to be
Not one, but all mankind's epitome.
Stiff in opinion, always in the wrong,
Was every thing by starts, and nothing long;
But in the course of one revolving moon,
Was chemist, fidler, statesman, and buffoon;
Then all for women, painting, rhyming, drinking,
Beside ten thousand freaks that died in thinking.
Blest madman! who could every hour employ
With something new to wish, or to enjoy.
Railing and praising were his usual themes;
And both to shew his judgment in extremes.
Is ever violent, or ever civil,
That every man with him was God or devil.
In squandering wealth was his peculiar art;
Nothing went unrewarded but desert:
Beggar'd by fools, whom still he found too late,
He had his jest, and they had his estate.
He laugh'd himself from court; then sought relief
In forming parties, but would ne'er be chief."

Dryden.

"In the worst inn's worst room, with mat half-hung,
The walls of plaister, and the floor of dung;
On once a flock-bed, now repair'd with straw,
With tape-tied curtains never meant to draw;
The George and garter dangling from his head,
Where tawdry yellow strove with dirty red;
Great Villiers lies: alas! how chang'd from him
The life of pleasure, and the soul of whim,
Gallant and gay, in Cliveden's proud alcove,
The bower of wanton Shrewsbury, and love;
Or just as gay at council, in a ring
Of mimic statesmen and their merry king.
No wit to flatter left of all his store;
No fool to laugh at, which he valued more,
The victor of his health, his fortune, friends,
And fame, this lord of useless thousands ends."

It would be amusing to pursue the comparison between those two great poets in the Dunciad and Mac Flecnoe; to observe the unpruned exuberance and careless vigour of the elder bard, and the exquisite judgment of his incomparable imitator.

Epic poetry concentrates all that is sublime in action, description, or sentiment. In the structure of a regular epic poem, criticism requires that the fable should be founded in fact, and that fiction should fill the picture of which the outline is traced by truth. In the conduct of the poem, it is exacted that the machinery be subservient to the main design, and that the action should be simple and uniform. In the Iliad, the action is limited to the destruction of Troy, which is only to be effected by the conciliation of Achilles to the common cause. In the Odyssey, it is the establishment of Ulysses in Ithaca; an event which, after innumerable difficulties, he is finally enabled to accomplish. In the Æneid the hero is destined to found a Trojan colony in Latium. In the Jerusalem Delivered, the object of the poem from its commencement to its close, is the restoration of that city to the Christians. Criticism requires also that poetical justice should be dispensed to all parties, success being awarded to the virtuous, and punishment inflicted on the guilty. On these principles, three authors only, Homer, Virgil, and Tasso, have produced epic works. There are however many poems of the epic or heroic cast to which criticism has hitherto assigned no name. Such are the Lusiad of Camoens, and the Henriade of Voltaire; and in the Paradise Lost, Milton appears in solitary majesty and magnificence. He maintains a lofty independance of rules and systems, and eternizes to himself a distinction superior to all that criticism has to withhold or to bestow. The Inferno of Dante, the Orlando of Ariosto, the Fairy Queen of Spenser, are romances; a species of composition purely fictitious, in which no other restriction is imposed on the poet's fancy than that he shall continue to interest and amuse his reader. Several romances of a recent date are intitled to praise: such as the Oberon of Wieland, ably translated by Mr. Sotheby; the Thalaba of Southey, of which the beauties would be more generally appreciated if the work was less tinged with gloom; and the Lay of the Last Minstrel, in which a fable of the most superficial texture is drawn out in a succession of scenes which perpetually animate and delight the imagination. It is obvious, that the poetical nomenclature established on classical authority, is not sufficiently extensive to include all the compositions of modern times. To what classical school shall we refer the noble ethics of Pope in his Epistles, and of Cowper in his Task? By what name shall we designate the Traveller and the Deserted Village, the Pleasures of Memory, the Pleasures of Hope, (neither of which is, like the Pleasures of Imagination, included in the didactic species), with many other exquisite productions? Ossian's poems have been classed with epic compositions, but are more analogous to the old heroic lays chanted by the scalds, bards, and minstrels. The relics of Scandinavian literature afford many specimens of poetry which, though inferior in beauty, are obviously of similar origin and execution.

Originally the DRAMA was a metrical composition, and exhibited all the critical refinements of poetry. The title of poet is still given to every dramatic author, although he should have written in prose, and although the highest dramatic powers may exist without the smallest talent for poetry. The avowed object of the drama is to develope the passions, or to delineate the manners of mankind: tragedy effects the one, and comedy the other. In the English language are many popular dramas of a mixed character, which are written in verse, intermingled with prose, and which are called *plays*. The best pieces in Beaumont and Fletcher, and even Shakspeare, belong to this order. The English drama deviates essentially from that of classical antiquity; and independant of the division of acts and scenes, there is little resemblance between them. The triple unities of time, place, and action, are seldom observed on the English stage; and our best writers have allowed, that between the acts any change of scene is admissible. In reality this operation is performed in most tragedies and all comedies, at any season, without either condition or restriction; nor is, perhaps, any change censurable, the cause and object of which is immediately comprehended by the audience. To the limitation of time more attention is paid. In many tragedies the action is included in one day. Unity of design is obviously an obligation imposed by good sense; and Shakspeare, guided only by his feelings of propriety, is in general careful to exclude from his plays a divided interest, an error perpetually committed by Beaumont and Fletcher, and his other dramatic contemporaries. To construct a truly dramatic fable is no easy task. The author has to provide sources of constantly augmenting interest, to present characters, to suggest situations capable of extorting from the spectators an active participation in the scene; above all, to supply a series of natural incidents, the springs of dramatic action, by which all the life and motion of the piece are produced. The dramatic style should imbibe its character from that of the individuals presented in the scene, and transmit the impression of every feeling which is there pourtrayed. On this excellence is founded the superiority of Shakspeare to all other dramatists; from him each passion receives its appropriate language. With a few masterly touches, he lays open the heart, exhibits its most secret movements, and excites in every bosom correspondent emotions. The poet who, next to Shakspeare, has excelled in the dramatic style, is Otway. The tragedies of Rowe possess extraordinary merit. In the plays of Beaumont and Fletcher, and Massinger, are innumerable passages of high poetical beauty; and in those of Dryden are discovered the most brilliant combinations of thought and fancy: but the touches of nature are still wanting; that true dramatic idiom which is instantly understood by the heart, and the absence of which is not compensated by beautiful imagery, or the most refined graces of composition. Dramatic blank verse, when flowing with freedom and facility, is more happily adapted than prose to the expression of strong emotion; it is not only more harmonious, but more concise; and being exonerated from that metrical precision which is expected in other poetry, is simply the language of impassioned feeling. Much of the imagery which might delight in the closet, would offend on the stage: yet figurative language is often employed with great effect in describing the tempestuous passions. In a state of agitation the mind becomes peculiarly susceptible of new combinations. Grief is eloquent: and though the chain of thought is too tenacious to be broken by sensible impressions, it discovers in every external object some typical illustration of its own sufferings; some image which, by a kind of fictitious sympathy, seems respondent to its individual feelings. Thus Lear, though insensible to the storm, invokes the elements, reverting to the contumely he has experienced:

"I tax not you, ye elements, with unkindness;
I never gave you kingdom, call'd you children;
You owe me no subscription."

In impassioned language, even a mixture of metaphors is not indefensible; in a moment of distraction the mind is versatile, and indistinct in its perceptions; and consequently becomes liable to form abrupt, desultory, and even incongruous associations.

Of metrical harmony and poetical emotion.

Metrical harmony is but the medium by which the poet transmits his ideas and sentiments: it constitutes the fabric into which his conceptions are wrought, the form in which his sentiments are exhibited. Metrical harmony is common to all who assume the name of poets; from the humble versifier creeping through hedge-rows of rhyme at the foot of Parnassus, to the son of genius, who has drunk of inspiration at its source, and rides

"Upon the seraph wing of ecstacy."

It has appeared difficult to suggest a proper mode of distinction between these two orders of writers; and it has been often asked, what the real difference is between the legitimate bard and a maker of pretty verses: their respective pretensions might, it should seem, be amicably adjusted, by leaving to the former an exclusive right to the character of poet, and assigning the rank of metrical poets to the latter. There is in metrical harmony a charm that often renders a trivial thought pleasing. There are also certain agreeable epithets which, if not egregiously misplaced, must always call to the mind grateful associations; and which when aided by melodious verse, will generally impart some transient sensation of pleasure. To awaken strong and permanent feelings of delight, is the prerogative only of the original bard. Poetical emotion springs from admiration or from sympathy, and may be awakened by the novelty or the renovation of sensation. It may arise from combinations new to the fancy, or from recollections interesting to the heart. In the energy of his conceptions, and in the charm of his expression, resides all the poet's power. There are no features of sublimity and magnificence, no touches of tenderness or pathos, but may be traced to those two sources of poetical excellence. Sublimity originates in the amplitude of the poet's mind, and is discovered in the majesty of his images, or the grandeur of his sentiment: a sensation of terror, mingled with admiration, also belongs to the sublime. Such is the sensation awakened by Milton's awful description of the infernal portals:

"On a sudden open fly
With impetuous recoil, and jarring sound,
Th' infernal doors, and on their hinges grate
Harsh thunder, that the lowest bottom shook
Of Erebus."

What follows is in the true spirit of terrific sublimity:

"She opened; but to shut
Excell'd her power. The gates wide open stood;
That with extended wing a bannered host,

Under spread ensigns marching, might pass through
With horse and chariots rank'd in loose array.
So wide they stood; and like a furnace-mouth
Cast forth redounding smoke, and ruddy flame.
Before their eyes in sudden view appear
The secrets of the hoary deep; a dark
Illimitable ocean, without bound,
Without dimension, where length, breadth, and highth,
And time, and place, are lost."

Sublimity is produced by grandeur of sentiment:

"Farewell, happy fields,
Where joy for ever dwells. Hail, horrors! hail,
Infernal world! and thou, profoundest hell,
Receive thy new possessor, one who brings
A mind not to be chang'd by place or time.
The mind is its own place; and in itself
Can make a heaven of hell, a hell of heaven."

In sublime composition no image should be introduced which is not calculated to impress the mind with feelings of solemnity. The following description of Satan exemplifies the union of sublime imagery, with sublimity of sentiment. There is even something like pathos in the concluding passage:

"He, above the rest
In shape and gesture proudly eminent,
Stood like a tower. His form had not yet lost
All her original brightness; nor appear'd
Less than arch-angel ruined, and the excess
Of glory obscur'd; as when the sun, new-risen,
Looks through the horizontal misty air,
Shorn of his beams; or from behind the moon,
In dim eclipse, disastrous twilight sheds
On half the nations, and with fear of change
Perplexes monarchs. Darkened, so yet shone
Above them all the arch-angel; but his face
Deep scars of thunder had entrench'd, and care
Sat on his faded cheek; but under brows
Of dauntless courage, and considerate pride
Waiting revenge; cruel his eye, but cast
Signs of remorse and passion, to behold
The fellows of his crime (the followers rather)
Far other once beheld in bliss, condemn'd
For ever now to have their lot in pain.
Millions of spirits, for his fault, amerc'd
Of heaven, and from eternal splendour flung,
For his revolt; yet faithful how they stood;
Their glory withered, as when heaven's fire
Hath scathed the forest oak, or mountain pine,
With singed top their stately growth, though bare,
Stands on the blasted heath. He now prepared
To speak, whereat their double ranks they bend
From wing to wing, and half-inclose him round
With all his peers: attention held them mute.
Thrice he assay'd; and thrice, in spite of scorn,
Tears, such as angels weep, burst forth: at last
Words, interwove with sighs, found out their way."

An energetic simplicity is essential to the sublime, which disclaims artificial ornament. Description includes many of the elements of poetry, and alternately produces emotions of sublimity and beauty. The figurative style is often assumed, in order to give more richness and vividness to description. The elements are thus embodied, and morn and evening are perpetually represented under some popular and pleasing image. Thus Milton personifies the morning:

"Now Morn, her early steps in the eastern clime
Advancing, sowed the earth with orient pearl."

And Shakspeare:

"But see, the Morn, in russet mantle clad,
Walks o'er the dews of yon high eastern hill."

Description is sometimes rendered more lively by the introduction of a figurative allusion. Thus, in the Allegro, Milton illustrates his description of sun-rise:

"Sometimes walking not unseen,
By hedge-row elms, or hillocks green,
Right against the eastern gate,
Where the great sun begins his state,
Rob'd in flames and amber bright,
The clouds in thousand liveries dight."

In Il Penseroso he again enlivens his imagery by an interesting allusion:

"Missing thee, I walk unseen
On the dry smooth-shaven green,
To behold the wandering moon
Riding near her highest noon,
Like one that had been led astray
Through the heaven's wide pathless way;
And oft as if her head she bow'd,
Stooping through a fleecy cloud."

In Dryden's poem of the Flower and the Leaf is the following beautiful illustration of the spring:

"When first the tender blades of grass appear,
And buds, that yet the breath of Eurus fear,
Stand at the door of life, and ask to clothe the year."

Poetical description is either general or local, and admits of artificial or simple imagery. In the two following passages Pope exemplifies the difference of general and local description:

"Thy trees, fair Windsor, now shall leave their wood,
And half thy forests rush into my flood;
Bear Britain's thunder, and her cross display,
To the bright regions of the rising day;
Tempt icy seas, where scarce the waters roll,
Where clearer flames glow round the frozen pole;
Or under southern skies exalt their sails,
Led by new stars, and borne by spicy gales.
For me the balm shall bleed, the amber flow,
The coral redden, and the ruby glow,
The pearly shell its lucid globe enfold,
And Phœbus warm the rip'ning ore to gold."

Here the author dwells not sufficiently long on any object to leave a distinct picture on the mind. But in the ensuing lines the delineation is too bold to be missed:

"In genial spring, beneath the quiv'ring shade,
Where cooling vapours breathe along the mead,
The patient fisher takes his silent stand,
Intent, his angle trembling in his hand;
With looks unmov'd he hopes the scaly breed,
And eyes the dancing cork and bending reed.
Our plenteous streams a various race supply;
The bright-ey'd perch, with fins of Tyrian dye;
The silver eel, in shining volumes roll'd;
The yellow carp, in scales bedropt with gold."

The two following extracts from Milton happily illustrate the difference of artificial and simple imagery:

"Now the bright morning-star, day's harbinger,
Comes dancing from the east, and leads with her
The flowery May, who from her green lap throws
The yellow cowslip, and the pale primrose.
Hail, beauteous May, that doth inspire
Mirth, and youth, and warm desire!
Woods and groves are of thy dressing,
Hill and dale doth boast thy blessing."

"While the plowman near at hand,
Whistles o'er the furrow'd land;
And the milkmaid singeth blithe,
And the mower whets his sithe,
And every shepherd tells his tale
Under the hawthorn in the dale."

In general description, it is the poet's object to force on the mind a variety of brilliant ideas and vivid impressions. In his local or individual delineations, he presents images palpable to the imagination, and almost to the senses; he stimulates latent feelings, or renovates forgotten sensations. In the combination of artificial imagery, he employs the power of novelty; in that of simple images, he relies on the charm of truth. With the one the attention is awakened, by the other it is absorbed. The reader perceives in himself a capacity for forming associations till then unknown; but he is yet more pleased to retrace scenes and sentiments familiar to memory, and dear to the heart. In one instance he is astonished by the variety of the poet's conceptions, in the other he is enchanted by the fidelity of his imitations. The magnificence of figurative language and metaphorical description extorts admiration; the simplicity of natural images inspires delight. In local description the poet should introduce only such objects as harmonize perfectly with his design. Thus in his delicious landscape of Eden, Milton carefully avoids the intrusion of exotic imagery:

"Thus was this place
A happy rural seat, of various views:
Groves, whose rich trees wept odorous gums and balms;
Others, whose fruit burnished with golden rind
Hung amiable, Hesperian fables true
(If true), here only, and of delicious taste.
Betwixt them, lawns, or level downs, and flocks
Grazing the tender herb were interposed.
Or palmy hillock, or the flow'ry top
Of some irriguous valley, spreads her store;
Flowers of all hue, and without thorn the rose.

"Another side umbrageous grots and caves
Of cool recess, o'er which the mantling vine
Lays forth her purple grape, and gently creeps
Luxuriant: meanwhile, murmuring waters fall
Down the slope hill dispers'd; or in a lake

That to the fringed bank, with myrtle crown'd,
Her crystal mirror holds, unite their streams."

There is in local description a charm that renders objects, in themselves uncongenial, engaging to the mind. The following passage presents few images of beauty: but in contemplating it, who does not feel, that without being removed from the common walk of nature, he is visited by the influences of poetry?

"The day is come, when I again repose
Here under this dark sycamore, and view
Those plots of cottage ground, the orchard tufts,
Which at this season, with their unripe fruits,
Among the woods and copses lose themselves,
Nor with their green and simple hues disturb
The wild green landscape. Once again I see
Hedge-rows, then hardly hedge-rows, little lines
Of sportive wood run wild. These pastoral farms
Green to the very door, and wreathes of smoke
Sent up in silence from among the trees;
With some uncertain notice, as might seem,
Of vagrant dwellers in the fenceless woods;
Or of some hermit's cave, where by his fire
The hermit sits alone."

If such is the charm of local scenery, yet greater is the captivation of that individual and characteristic sentiment, which, from its appropriation to the drama, has been called dramatic. Such indeed is its enchantment, that it has been found capable of producing the most exquisite emotion, without any auxiliary embellishments from figurative language or picturesque imagery. We are never more delighted with the poet than when thus intimately admitted to his confidence, when we are suffered to commune with his heart, to explore his mostr etired thoughts, and partake his most sacred feelings. This charm of individuality was in some of his poems eminently possessed by Chaucer and some of our elder bards; it constituted the leading feature in Cowper's lays; it formed the magic of Burns; and it distinguishes the author of the Lyrical Ballads. The pathetic, like the sublime, must be concise and simple. It depends not so much on the thought as the expression. Virgil's description of Andromache on recognizing Æneas at the tomb of Hector, is strikingly beautiful:

"Verane tua facies? & verus mihi nuncius affers?
Nate deâ, vivisne? aut, si lux alma recessit,
Ubi Hector est?"

The whole passage is affecting, but the pathos dwells in the "ubi Hector est?" Figurative language is often happily employed in the description of impassioned feeling. Sometimes it appears to be the natural overflowing of tenderness:

"Thy cave should be a lover's bower,
Though raging winter rent the air;
And she a lovely little flower,
That I would tend, and shelter there."

In general, however, the simple and unadorned style is most appropriate to pathos and tenderness. Thus Constance, in her touching appeal to the Cardinals, exclaims of her son:

"And so he'll die; and rising so again,
When I shall meet him in the court of heaven
I shall not know him; therefore never, never,
Must I behold my pretty Arthur more."

The *curiosa felicitas*, that charm or felicity of expression which Horace so happily exemplified, is one of the most powerful agents in producing poetical emotion. It is the attribute which belongs only to the poet of nature; and is the effusion of some fortunate moments, when consummate judgment has been impelled and inspired by exquisite feeling. It is impossible but that the readers of Shakspeare and Milton must recollect innumerable examples of this kind of excellence. Who has not felt the enchantment conveyed by Shakspeare's "heaven-kissing hill?" What lover of nature has not in some bright autumnal morning, while contemplating a rural scene, experienced that mixed sensation of enjoyment and stillness which is all described in "the air smells wooingly?" Felicity of expression is the native idiom of genius; and as the goddess of beauty was discovered by her first movements, the genuine poet may be detected by a single epithet. The spirit of poetry is not confined to subjects of dignity and importance: it may be perceived in a simple lay, and even in a sportive song. It visited Sappho, as it had sojourned with Pindar; and was as truly the attendant of Theocritus as of Homer. Nor is poetical emotion inspired only by the song of heroes and of Gods. It may be awakened even by the strain of playful tenderness, in which the lover celebrates some darling of his mistress. The requisites of the true poetical character are thus happily summed up by the duke of Buckingham:

"'Tis not a flash of fancy, which sometimes,
Dazzling our minds, sets off the slightest rhymes,
Bright as a blaze, but in a moment done.
True wit is everlasting, like the sun,
Which, though sometimes behind a cloud retir'd,
Breaks out again, and is by all admir'd;
Number, and rhyme, and that harmonious sound
Which not the nicest ear with harshness wound,
Are necessary, yet but vulgar arts;
And all in vain these superficial parts
Contribute to the structure of the whole,
Without a genius too, for that's the soul;
A spirit which inspires the work throughout,
As that of nature moves the world about;
A flame that glows amid conceptions fit,
Even something of divine, and more than wit;
Itself unseen, yet all things by it shewn,
Describing all things, but describ'd by none."

POHLIA, a genus of the class and order cryptogamia musci, included in the bryonia of Linnæus.

POINCIANA, *Barbadoes flower-fence*, a genus of the monogynia order, in the decandria class of plants, and in the natural method ranking under the 33d order, lomentaceæ. The calyx is pentaphyllous; the petals five, the uppermost larger than the rest; the stamina long, and all fertile; the seed-vessel a legumen. There is only one species, viz. the pulcherrima, a native of both Indies. It rises with a straight stalk 10 or 12 feet high; the branches are terminated by loose spikes of flowers, which are sometimes formed into a kind of pyramid, and at others disposed more in the form of an umbel. The foot-stalk of each flower is near three inches long; the flower is composed of five petals, which are roundish at the top, but are contracted to narrow tails at the base. They spread open, and are beautifully variegated with a deep red or orange colour, yellow, and some spots of green; and emit a very agreeable odour. After the flower is past, the germen becomes a broad flat pod three inches long, divided into three or four cells by transverse partitions, each including one flattish irregular seed. The plant is propagated by seeds; but, being tender, is to be constantly kept in the bark-stove.

POINT, in geometry, as defined by Euclid, is a quantity which has no parts, or which is indivisible. Points are the ends or extremities of lines. If a point is supposed to be moved any way, it will, by its motion, describe a line.

Point *of contrary flexure*. See Flexure.

Point, in music. This word, as conjoined with others, has various significations. The different uses to which points were formerly applied, render the perusal of old compositions extremely difficult and perplexing. In those works we meet with the point of perfection, point of augmentation, point of division, and point of alteration. The point of perfection was added to those notes which were denoted by the modal signs to be perfect, or equal to three notes of the same value, but which were rendered imperfect by position. The point of augmentation is that in modern use, which the old masters used only in common, or imperfect, time. The point of division, or imperfection, was placed between two shorter notes that followed, and were succeeded by, two longer in perfect modes, to render both the long notes imperfect. The point of alteration, or of duplication, was placed before two shorter notes preceding a longer, in order to double the length of the second short note. In modern music, the point, taken as an increased power of the note, is always equal to the half of the note to which it appertains.

Point, in astronomy, a term applied to certain points or places, marked in the heavens, and distinguished by proper epithets. The four grand points or divisions of the horizon, viz. the east, west, north, and south, are called the cardinal points. See Horizon, East, West, &c. The zenith and nadir are the vertical points; the points wherein the orbits of the planets cut the plane of the ecliptic, are called the nodes: the points wherein the equator and ecliptic intersect, are called the equinoctial points; particularly, that whence the sun ascends towards the north pole, is called the vernal point; and that by which he descends to the south pole, the autumnal point. The points of the ecliptic, where the sun's ascent above the equator, and descent below it, terminate, are called the solstitial points; particularly the former of them, the estival or summer point; the latter, the brumal or winter point.

Points, in heraldry, are the several different parts of an escutcheon, denoting the local positions of any figure. See Heraldry.

Point is also an iron or steel instrument, used with some variety in several arts. Engravers, etchers, cutters in wood, &c. use points to trace their designs on the copper, wood, stone, &c. See Engraving, &c.

Point, in the manufactories, is a general term, used for all kinds of laces wrought with the needle; such are the point de Venice, point de France, point de Genoa, &c. which are distinguished by the particular economy and arrangement of their points.

Point-Blank, in gunnery, denotes the shot of a gun levelled horizontally.

POINTING *the cable*, in the sea-language, is untwisting it at the end, lessening the yarn, twisting it again, and making all fast with a piece of marline, to keep it from ravel ing out.

POISONS. Poisons are commonly divided into the animal, vegetable, and mineral kinds.

I. Poisons, *animal*. Several animals are furnished with liquid juices of a poisonous nature, which when poured into fresh wounds, occasion the disease or death of the wounded animal. Serpents, bees, scorpions, and spiders, are well-known examples of such animals. The chemical properties of these poisonous juices deserve peculiar attention; because it is only from such an investigation that we can hope to explain the fatal changes which they induce on the animal economy, or to discover an antidote sufficiently powerful to counteract their baneful influence. Unfortunately the task is difficult, and perhaps surpasses our chemical powers. For the progress already made in the investigation, we are indebted almost entirely to the labours of Fontana.

1. The poison of the viper is a yellow liquid, which lodges in two small vesicles in the animal's mouth. These communicate by a tube with the crooked fangs, which are hollow, and terminate in a small cavity. When the animal bites, the vesicles are squeezed, and the poison forced through the fangs into the wound. This structure was partly observed by Redi, an Italian philosopher; and his discoveries were completed and confirmed by the experiments and observations of Francini, Tysson, Mead, and Fontana.

This poisonous juice occasions the fatal effects of the viper's bite. If the vesicles are extracted, or the liquid is prevented from flowing into the wound, the bite is harmless. If it is infused into wounds made by sharp instruments, it proves as fatal as when introduced by the viper itself. Some of the properties of this liquid were pointed out by Mead; but it was Fontana who first subjected it to a chemical examination, sacrificing many hundred vipers to his experiments. The quantity contained in a single vesicle scarcely exceeds a drop.

It has a yellow colour, has no taste; but when applied to the tongue, occasions numbness. It has the appearance of oil before the microscope, but it unites readily with water. It produces no change on vegetable blues.

When exposed to the air, the watery part gradually evaporates, and a yellowish-brown substance remains, which has the appearance of gum arabic. In this state it feels viscid, like gum, between the teeth; it dissolves readily in water, but not in alcohol; and alcohol throws it down in a white powder from water. Neither acids nor alkalies have much effect upon it. It does not unite with volatile oils, nor sulphuret of potass. When heated, it does not melt, but swells, and does not inflame till it has become black. These properties are similar to the properties of gum, and indicate the gummy nature of this poisonous substance. Fontana made a set of experiments on the dry poison of the viper, and a similar set on gum arabic, and obtained the same results.

From the late observations of Dr. Russel, there is reason to believe that the poisonous juices of the other serpents are similar in their properties to those of the viper.

This striking resemblance between gums and the poison of the viper, two substances of so opposite a nature in their effects upon the living body, is a humiliating proof of the small progress we have made in the chemical knowledge of these intricate substances. The poison of the viper, and of serpents in genenal, is most hurtful when mixed with the blood. Taken into the stomach, it kills if the quantity is considerable. Fontana has ascertained that its fatal effects are proportional to its quantity, compared with the quantity of the blood. Hence the danger diminishes as the size of the animal increases. Small birds and quadrupeds die immediately when they are bitten by a viper; but to a full-sized man the bite seldom proves fatal.

Ammonia has been proposed as an antidote to the bite of the viper. It was introduced in consequence of the theory of Dr. Mead, that the poison was of an acid nature. The numerous trials of that medicine by Fontana robbed it of all its celebrity; but it has been lately revived and recommended by Dr. Ramsay as a certain cure for the bite of the rattlesnake.

2. The venom of the bee and the wasp is also a liquid contained in a small vesicle, forced through the hollow tube of the sting into the wound inflicted by that instrument. From the experiments of Fontana, we learn that it bears a striking resemblance to the poison of the viper. That of the bee is much longer in drying when exposed to the air than the venom of the wasp.

3. The poison of the scorpion resembles that of the viper also; but its taste is hot and acrid, which is the case also with the venom of the bee and the wasp.

4. No experiments upon which we can rely have been made upon the poison of the spider tribe. From the rapidity with which these animals destroy their prey, and even one another, we cannot doubt that their poison is sufficiently virulent.

II. Poisons, *vegetable*, seem in general to prove fatal from an excess of narcotic matter; but this is a subject which requires still farther examination. See Narcotic principle.

III. Poisons, *mineral*. In general these substances, as arsenic and corrosive mercury, seem to attack the solid parts of the stomach, and to produce death by eroding its substance; but the antimonials seem rather to attack the nerves, and to kill by throwing the whole system into convulsions.

Poison *of copper*. This metal, though when in an undissolved state it produces no sensible effects, becomes exceedingly active when dissolved; and such is the facility with which the solution is effected, that it becomes a matter of some consequence to prevent the metal from being taken into the human body even in its proper form. It does not, however, appear that the poison of copper is equally pernicious with those of arsenic or lead. The reason of this is, that it excites vomiting so speedily as to be expelled, even though taken in considerable quantity, before it has time to corrode the stomach. Blue vitriol, which is a solution of copper in the vitriolic acid, has been used as a medicine in some diseases with great success. Verdigris also, which is another very active preparation of the metal, has been by some physicians prescribed as an emetic, especially in cases where other poisons had been swallowed, in order to procure the most speedy evacuation of them by vomit. Where copper is not used with this view, it has been employed as a tonic and antispasmodic, with which view it is admitted into the Edinburgh Dispensatory under the title of cuprum ammoniacale. The effects of the metal, however, when taken in a pretty large quantity, and in a dissolved state, or when the stomach abounds with acid juices sufficient to dissolve it, are very disagreeable, and even dangerous; as it occasions violent vomitings, pains in the stomach, faintings, and sometimes convulsions and death. The only cure for these symptoms is, to expel the poison by vomiting as soon as possible, and to obtund its acrimony; for which purpose drinking warm milk will probably be found the most efficacious remedy. In order to prevent the entrance of the poison into the body, no copper vessels should be used in preparing food but such as are either well tinned, or kept exceedingly clean. The practice of giving a fine blue or green colour to pickles by preparing them in copper vessels, ought not to be tolerated; for Dr. Falconer, in a treatise on this subject, assures us, that these are sometimes so strongly impregnared by this method of preparing them, that a small quantity of them will produce nausea. Mortars of brass or bell-metal ought, for the same reason, to be avoided; as by this means a considerable quantity of the pernicious metal may be mixed with our food, or with medicines. In other cases, an equal caution ought to be used. The custom of keeping pins in the mouth, of giving copper halfpence to children to play with, &c. ought to be avoided; as thus a quantity of the metal may be insensibly taken into the body, after which its effects must be uncertain. It is proper to observe, however, that copper is much more easily dissolved when cold than when hot; and therefore the greatest care should be taken never to let any thing designed for food, even common water, remain long in copper vessels when cold; for it is observed, that though the confectioners can safely prepare the most acid syrups in clean copper vessels without their receiving any detriment whilst hot, yet if the same syrups are allowed to remain in the vessels till quite cold, they become impregnated with the pernicious qualities of the metal.

Poison *of lead*. This metal, when taken slowly into the stomach with our food, is capable of producing the disease usually called Devonshire colic, which, after a length of time, is succeeded by palsy. Dr. Houlston, in his Essay on Poisons, has given a remarkable instance of a whole family who, having successively fallen a prey to paralytic disorders, after a series of years, the cause was discovered to be their having used the water of a leaden pump, which had been gradually dissolved, and thus rendered the water poisonous. For the treatment of colic and palsy see MEDICINE. Calomel administered in small doses, till ptyalism is produced, is the most effectual way of restoring sensibility to the nerves, when lost from this cause.

We cannot sufficiently express our abhorrence of the cruel, the detestable experiments made by certain practitioners upon poor dumb creatures, to ascertain the effects of poisons; experiments made in general to gratify an idle curiosity, but which no motive can justify. We feel an honest pride in reflecting that few of these experimentalists have been Englishmen; and as our work is addressed to that generous and humane nation, we have not outraged their feelings by the shocking detail.

POLE, in spherics, a point equally distant from every part of the circumference of a great circle of the sphere, as the centre is in a plane figure; or it is a point 90° distant from the plane of a circle, and in a line, called the axis, passing perpendicularly through the centre. The zenith and nadir are the poles of the horizon; and the poles of the equator are the same with those of the sphere. See GLOBE.

POLES. See ECLIPTIC.

POLES. See MAGNETISM.

POLE or *vertex of a glass*, in optics, is the thickest part of a convex, or the thinnest of a concave glass. If the glass is truly ground, the pole will be exactly in the middle of its surface.

POLE, *Perch*, or *Rod*, in surveying, is a measure containing sixteen feet and a half.

POLE or *polar star*, is a star of the second magnitude, the last in the tail of ursa minor. Its longitude Mr. Flamsteed makes 24° 14′ 41″; its latitude 66° 4′ 11″.

POLE-CAT. See VIVERRA.

POLEMONIUM, *Greek valerian*, or *Jacob's ladder*; a genus of the monogynia order, in the pentandria class of plants; and in the natural method ranking under the 29th order, campanaceæ. The corolla is quinquepartite; the stamina inserted into scales, which close the bottom of the corolla; the stigma is trifid; the capsule bilocular superior. There are five species, of which the most remarkable is the cæruleum, with an empalement longer than the flower. It grows naturally in some places of England: its beauty, however, has obtained it a place in the gardens. There are three varieties; one with a white, another with a blue, and another with a variegated flower; also a kind with variegated leaves. They are easily propagated by seeds; but that kind with variegated leaves is preserved by parting its roots, because the plants raised from seeds would be apt to degenerate and become plain.

POLEMOSCOPE, in optics, a kind of reflecting perspective-glass invented by Hevelius, who commends it as useful in sieges, &c. for discovering what the enemy is doing, while the spectator lies hid behind an obstacle. Its description is this: The interval between the object-glass and the speculum, is enlarged by a tube, of a length sufficient to project the speculum beyond the obstacle that covers the observer. And for a further convenience of looking forward, as it were, he proposes to place another plane speculum at the other end of the tube, to reflect the rays through a hole in its side, in a direction parallel to the incident rays; and to place the concave eye-glass in this hole. By this means, the object will still appear upright, and magnified just as much as if the two speculums were removed, and the same eye-glass was placed in the axis of the tube.

POLIANTHES, the *tuberose*: a genus of the monogynia order, in the hexandria class of plants; and in the natural method ranking under the 10th order, coronariæ. The corolla is funnel-shaped, incurvated, and equal; the filaments are inserted into the throat of the corolla, in the bottom of which the germen is situated. There is but one species, consisting of some varieties; all of which, being exotics of tender quality, require aid of artificial heat, under shelter of frames and glasses, &c. to bring them to flower in perfection in this country. The varieties are the common tuberose, with single flowers; double-flowered, dwarf-stalked, variegated-leaved. They all flower here in June, July, and August: the flowers are funnel or bell-shaped; on the upper part of the stem is a long spike, consisting of from 10 to 20 or more separate in alternate arrangements, the lower flowers opening first, which are succeeded by those above, in regular order, making in the whole a most beautiful appearance, highly enriched with a most fragrant odour. The common single-flowered tuberose is the sort the most commonly cultivated, as it generally blows the most freely, and possesses the finest fragrance. The double-flowered kind also highly merits culture, as when it blows fair it makes a singularly fine appearance. The dwarf and the variegated kinds are inferior to the other two, but may be cultivated for variety. All the varieties being exotics from warm countries, although they are made to flower in great perfection in our gardens by the assistance of hotbeds, they will not prosper in the open ground, and do not increase freely in England; so that a supply of the roots is imported hither annually from Genoa, and other parts of Italy. The principal season for planting them is March and April: observing, however, that in order to continue a long succession of the bloom, it is proper to make two or three different plantings, at about a month interval; one in March, another in April, and a third the beginning of May, whereby the bloom may be continued from June until September; observing, as above mentioned, they may be flowered either by aid of a common dung or bark hotbed, or in a hot-house.

POLICY OF ASSURANCE. The deed or instrument by which a contract of assurance is effected. The premium or consideration paid for the risk or hazard assured against, must be inserted in the policy, and likewise the day, month, and year, on which the policy is executed, and it must be duly stamped. Policies for assurance against the risks of the sea are distinguished into valued and open policies; in the former the goods or property assured are valued at prime cost at the time of effecting the policy; in the latter, the value is not mentioned, but is left to be afterwards declared, or to be proved in the event of a claim. In a valued policy, the proper effect of the valuation is, the fixing the amount of the prime cost, in the same manner as if the parties had admitted it at a trial; but for every other purpose, it must be taken that the value was fixed in such a manner as that the insured meant to have an indemnity and no more. The practice of permitting the insured on a valued policy to recover the whole sum insured upon a total loss, though his interest is less than that sum, is against the statute. A valued policy on profits expected upon a voyage is not within the act, the object of an insurance being an indemnity. When a policy is once executed, it cannot be altered by either party, as this would open a door to an infinite variety of frauds, and introduce uncertainty into a species of contract, of which certainty and precision are the most essential requisites. If, however, a policy is filled up by mistake different from the original agreement, it may, even after signing, be corrected by the consent of both parties. An underwriter may, however, shift the insurance, or any part of it, from himself to other insurers, by causing a re-insurance to be made on the same risk, and the new insurers will be responsible to him, in case of loss, to the amount of the re-insurance; but the re-insurer is only responsible to the original insurer, and not to the original insured. The form of the policies in common use by the underwriters of London, for sea-assurances, is nearly the same which was adopted two hundred years ago; but Mr. Park remarks that its antiquity cannot preserve it from just censure, it being very irregular and confused, and frequently ambiguous, from making use of the same words in different senses. The policies generally used for assurances on lives, or against fire, are much more correct and intelligible.

POLIERSHIEFER, a mineral body found chiefly at Menil Montant, near Paris. Colour grey; often reddish; sometimes spotted or striped brownish-black, and lemon-yellow. Found in strata; texture earthy; fracture conchoidal; structure shistose; very soft; easily broken; adheres strongly to the tongue; feel harsh; specific gravity 2.08; absorbs water with avidity; melts to a blackish slag; constituents,

66.50	silica
7.00	alumina
1.50	magnesia
1.25	lime
2.50	oxide of iron
19.00	water.
97.75	

POLISHER, or *burnisher*, among mechanics, an instrument for polishing and burnishing things proper to take a polish. The gilders use an iron polisher to prepare their metals before gilding, and the blood-stone to give them the bright polish after gilding.

The polishers among cutlers, are a kind of wooden wheels made of walnut-tree, about an inch thick, and of a diameter at pleasure, which are turned round by the great wheel; upon these they smooth and polish their work with emery and putty.

The polishers for glass consist of two pieces of wood; the one flat, covered with old hat;

the other long and half-round, fastened on the former, whose edge it exceeds on both sides by some inches, which serve the workmen to take hold of, and to work backwards and forwards by.

The polishers used by spectacle-makers are pieces of wood a foot long, seven or eight inches broad, and an inch and a half thick, covered with old beaver-hat, on which they polish the shell and horn frames their spectacle-glasses are to be set in.

POLISHING, in general, the operation of giving a gloss or lustre to certain substances, as metals, glass, marble, &c.

The operation of polishing optic glasses, after being properly ground, is one of the most difficult points of the whole process. Before the polishing is begun, it is proper to stretch an even well-wrought piece of linen over the tool, dusting upon it some very fine tripoli. Then taking the glass in your hand, run it round forty or fifty times upon the tool, to take off the roughness of the glass about the border of it. This cloth is then to be removed, and the glass to be polished upon the naked tool, with a compound powder made of four parts tripoli mixed with one of fine blue vitriol; six or eight grains of which mixture are sufficient for a glass five inches broad. This powder must be wetted with eight or ten drops of clear vinegar, in the middle of the tool; being first mixed and softened thoroughly with a very fine small mullet. Then with a nice brush, having spread this mixture thinly and equably upon the tool, take some very fine tripoli, and strew it thinly and equably upon the tool so prepared; after which, take the glass to be polished, wiped very clean, and apply it on the tool, and move it gently twice or thrice in a straight line backwards and forwards; then take it off, and observe whether the marks of the tripoli, sticking to the glass, are equably spread over the whole surface; if not, it is a sign that either the tool or glass is too warm, in which case you must wait awhile and try again, till you find the glass takes the tripoli every where alike. Then you may begin to polish boldly, there being no danger of spoiling the figure of the glass, which in the other case would infallibly happen. This is Mr. Huygens's method; but it ought to be observed, that almost every operator has a peculiar one of his own, and of which some of them make a mighty secret.

Sir Isaac Newton no where expressly describes his method of polishing optical glasses; but his method of polishing reflecting metals he thus describes in his Optics. He had two round copper plates, each six inches in diameter, the one convex, the other concave, ground very true to one another. On the convex one he ground the object-metal, or concave which was to be polished, till it had taken the figure of the convex, and was ready for a polish. He then pitched over the convex very thinly, by dropping melted pitch upon it, and warming it, to keep the pitch soft, whilst he ground it with the concave copper wetted, to make it spread evenly all over the convex, till it was no thicker than a groat-piece; and after the convex was cold he ground it again, to give it as true a figure as possible. He then ground it with very fine putty, till it made no noise; and then upon the pitch he ground the object-metal with a brisk motion for two or three minutes; when laying fresh putty upon the pitch, he ground it again till it had done making a noise, and afterwards ground the object-metal upon the pitch as before; and this operation he repeated till the metal was perfectly polished.

POLITICAL ARITHMETIC, calculations relating to the wealth of nations. Political arithmetic does not determine in what national wealth truly consists, but estimates the value of whatever passes under this name, and distinguishes the proportions in which the component articles may be applied to purposes conducive to the safety or prosperity of the community. It must be admitted that in the application of arithmetic to the subjects of political economy, it unavoidably loses much of its precision, from the fluctuating nature of most descriptions of property, both with respect to distribution and value, the state of which it is one of its chief objects to estimate; it however retains a sufficient degree of certainty to become an interesting subject to every individual who wishes to acquire a just idea of the strength and resources either of the community to which he belongs, or of other nations.

If the particulars which it is necessary to assume as facts could be obtained correct, the conclusions drawn from them would be nearly as determinate and invariable as in any other branch of arithmetic; but if the former are not strictly true, the latter will be but approximations, however near they may come to the truth. Such approximations, however, may be sufficient for most useful purposes; though it must be confessed that a greater degree of certainty, which would render our knowledge on this subject more valuable, is highly desirable; at the same time it is difficult to attain, as it does not depend so much on the labours or investigations of individuals, as on the measures adopted by the governments of different countries, who alone possess the means of ascertaining with greater precision the principal assumptions on which political computations are founded.

The strict amount of the wealth of a country cannot be known without an exact inventory of all the particulars that compose it, a thing utterly impracticable in large, and particularly in commercial states, and which, if it were possible to be obtained perfectly true, even in the most minute particulars, would not remain so during the time necessary to make out the account, and therefore might not be of more utility than a tolerable correct estimate, which, being considered as a medium between small variations, will, for a considerable time, furnish sufficient ground for useful conclusions. So far, indeed, are we from having exact accounts of the wealth of different countries, that even such of the materials necessary to form an estimate as we do possess, though furnished pursuant to legislative authority, are scarce, in any instance, strictly correct, and being generally formed for particular purposes, as, with a view to some commercial or financial regulation, are frequently ill adapted to any other use: from such documents, however, we must be content to draw our principal information; and if the nature of the subject precludes strict demonstration, we may, at least, endeavour, by proceeding on rational grounds, to arrive at conclusions consistent with probability.

Political arithmetic has been much cultivated of late years in Germany, France, and other parts of Europe, but as its application to the wealth and strength of different states is very similar, we shall endeavour to illustrate it in an attempt to determine the increase and present state of the national wealth of Great Britain, which will be considered as consisting in the value of the land and of the stock, the latter term comprehending all useful realizations of past industry, except improvements of the soil, which make part of the present value of the land; and if the amount of the national capital can be ascertained, it will naturally lead to an investigation of the general income, both as arising from such capital, and from the profits of labour.

In all inquiries of this kind, the state of the population of the country is an object of primary importance; for it is the number of inhabitants which a country maintains, that gives the land itself the chief part of its value, of which we have many proofs in the former and present state of different parts of Europe, and in the rise of the value of land with the increase of population in our own island. That Great Britain is now more fully inhabited than in the early periods of its history, few persons will doubt, whatever may be their opinion respecting its advance or decline in this respect of late years. At the time of the Norman conquest, the people of England are supposed to have been somewhat above 2,000,000; and from their depressed condition, the frequency of foreign and domestic wars, and of pestilential distempers, their increase during many of the succeeding reigns may be reasonably doubted, though there are no means of ascertaining with any precision the real state of the population at those periods. From an account of the produce of a poll-tax, an estimate has been formed by Mr. Chalmers of the number of inhabitants in 1377, and as the additions which he has made to the number in the return certainly do not appear too small, the total, which amounts to 2,353,203, cannot be less than the whole number of the people of England and Wales at that time, if the account on which it is founded is to be depended on. Mr. Chalmers observes, that the civil wars during the greater part of the fifteenth century must have caused a great waste of inhabitants: this loss, however, was soon recovered on their termination; and the suppression of monasteries by Henry the VIIIth, with the repeal of all positive laws against the marriage of priests by Edward the VIth, continued to promote matrimony, and of course to increase the population. From documents in the British Museum, it appears, that during the reign of Elizabeth, accounts were often taken of the people. Harrison gives the result of the musters of 1575, when the number of fighting men was found to be 1,172,674, adding that it was believed a full third had been omitted. Sir Walter Raleigh asserts that there was a general review in 1583 of all the men in England capable of bearing arms, who were found to amount to 1,172,000. These accounts evidently refer to the same enumeration, though they differ in the date; and if the number is multiplied by 4, it would prove the total number of inhabitants to have been 4,688,000. This number increased during the seventeenth century, and was computed by Mr. Gregory King to amount in 1690 to 5,500,000; while Dr. Davenant estimated the population at the same period as high as 7,000,000. This disagreement between two very accurate writers, shews the great uncertainty which prevailed on this subject, and in fact there was scarce any particular relating to the state of the country on which such opposite opinions were held as on the actual number of inhabitants at particular periods, and their diminution or increase. The point has at length been determined by the results of an act passed the 31st of December, 1800, for ascertaining the population of Great Britain, and the increase or diminution thereof. From the returns thus obtained, it appeared, that the total population of Great Britain, including the army and navy, and seamen in the merchants' service, was 10,942,646; but deducting the proportion of soldiers and seamen belonging to Ireland, it may be more correctly stated at 10,820,370.

Assuming this number as a sufficiently accurate return of the total population, it may not be very difficult to distinguish nearly the proportion of those who subsist by the labour of others, to those by whom they are supported; and of the unproductive, though in most instances useful, labourers, to those on whose labour the annual produce, and consequently all additions to the national stock, depends.

From several accounts it appears, that, of the whole number of persons living, more than one-fourth are children under ten years of age, who therefore contribute little or nothing to their own maintenance; for though in some few manufactures, children under this age are employed, they are more than counterbalanced by the greater number who remain unemployed (otherwise than in education) for several years beyond the age of ten. After deducting 2,705,092, the number of these future labourers, it will be found that about one in 28 of the remainder, or 289,831 are incapacitated by old age or infirmities from useful labour, including all persons in the different hospitals and infirmaries, and most of the inhabitants of alms-houses, and other charitable establishments. But of those who are supported by the labour of others, or by the property of others, which is equivalent, there are many who follow a species of employment, by which they obtain this property, which employment is, however, of no benefit to the country, as it is not only unproductive, but useless, and in many instances injurious to the community; such are gamblers, swindlers, thieves, prostitutes, beggars, gipsies, &c. whose aggregate number, according to Mr. Colquhoun's estimate for the metropolis, probably exceeds considerably 150,000. The convicts and prisoners confined in the different prisons of Great Britains, and on board hulks, are usually about 10,000 persons, whose labour is lost to the community, for the work which is performed in some of our jails scarcely deserves mention. There is also a class of a very different description, who are supported by the labour of others: this is the nobility and gentry, whose exemption from labour is considered as a part of their honour and distinction; some, it is true, hold employments under the government, and a few are engaged in agriculture or trade; but the majority, who subsist on the income they possess, without following any useful occupation, is probably not less than 5000.

These numbers include persons of both sexes, and are all rather below the truth than beyond it; they amount together to 3,159,923 persons, and being deducted from the whole population of 10,820,370, shew the number of those who work to be 7,660,447. But it is well known that of those who gain a substance by their labour, many follow employments which, though more or less necessary and useful, do not, in the least degree, increase the quantity or value of the produce of the country; the number of these unproductive labourers is nearly as follows:

The army, officers and privates, including half-pay, commissaries, agents, &c.	200,000
The navy, ditto	127,000
Officers and clerks employed in collecting the revenue, and in other offices under government	6,500
Clergy of the churches of England and Scotland	18,000
Ditto, dissenters of every denomination	14,000
Schoolmasters (exclusive of clergymen) and schoolmistresses	20,000
Judges, counsel, attorneys, sheriff's officers, jailors, and all persons employed in the execution of the laws, except constables, headboroughs, &c.	14,000
Players, musicians, dancing masters, &c.	5,000
Women supported by their husbands' labour	500,000
Female servants of all descriptions	650,000
Male servants	150,000
Total	1,704,500

It must be confessed that the number of some of these classes of persons cannot be ascertained with much precision: this, however, is of no great importance, if the total is not far from the truth, as the object is chiefly to shew the proportion of productive to unproductive labourers; the latter may be distinguished according to the following statement:

Merchants, brokers, factors, and others depending on foreign trade	25,000
Clerks to ditto, and in the offices of commercial companies	40,000
Seamen in the merchants' service, including the coasting-trade and fisheries	144,000
Lightermen, watermen, &c.	3,500
Persons employed in the different manufactures	1,800,000
Mechanics not immediately belonging to the manufactures, such as carpenters, bricklayers, masons, wheelwrights, shipwrights, boatbuilders, &c.	50,000
Painters, engravers, carvers, and other artists	5,000
Shopkeepers, viz. butchers, bakers, publicans, fishmongers, poulterers, pastrycooks, grocers, chandlers, pawnbrokers, apothecaries, &c.	150,000
Farmers, graziers, and all other persons employed in agriculture, including millers, mealmen, farriers, horse-doctors, &c.	2,000,000
Wives and families of most of the above classes assisting in their occupations, or following other employments of profit	1,738,447
Total	5,955,947

The whole population of the country will thus appear to consist of nearly the following proportions:

Supported by others' labour	3,159,923
Unproductive labourers	1,704,500
Productive labourers	5,955,947
Total	10,820,270

It thus appears that the whole of the people depend for subsistence, and all the conveniences of life, on the labour of little more than one-half; and the increase or decrease of this number, and of the effect produced by the individuals who compose it, is the measure of the increase or decline of national strength. Of the unproductive labourers, or those who gain a subsistence by defending, instructing, or serving others, the greater part are highly useful to the community, and in the present state of society a nation could not exist without them; but as they do not contribute to the production of any of the necessaries of life, or articles of commerce, it is evident that they depend entirely on the exertions of the productive labourers, who are the source not only of the general subsistence and of the means of commerce, but of all accumulation of stock, which is in fact the surplus of former produce beyond the consumption. The power of acquiring national wealth, therefore, depends principally on the proportion of productive labourers to the whole number of inhabitants; for though the population of a country should have greatly increased, if it had been chiefly by an addition of idle hands, the produce would remain the same, and, the consumption being much greater, the country must become poorer: but it likewise depends, in a great measure, on the facility with which labour is performed; for if a country contained only half the number of labouring inhabitants, with the same number of other persons it had at a former period, but this half, by means of machinery and other improvements, could produce the same effect as the whole number before, such a country would become considerably richer, though the total population was diminished, and the proportion of unproductive to productive persons increased; for there would be the same supply and a much less consumption: and wherever the produce or supply exceeds the consumption, there will be an acquisition of stock; for, unless the surplus could be reserved for some useful or desirable purpose, it would soon cease to be produced, by the supply falling to the level of the demand for consumption. The surplus reserved or converted into stock, is a fund for supporting an increase of exertion, or for supplying the means of future enjoyment.

It has been shewn, that the whole number of the inhabitants of Great Britain is undoubtedly greater than at former distant periods; but the proportion of unproductive hands, who subsist by the labour of others, has also probably much increased; the effect of this unfavourable circumstance has however been amply compensated by the great improvements in different arts and manufactures, by which the produce of the country has been increased in quantity, and rendered much superior in quality; so that after supplying all our new factitious wants, and enabling us to defray expensive wars, it has left a considerable surplus, which, gradually accumulating, has formed the present national stock or capital.

Previously to an inquiry into its increased amount, it may not be uninteresting to view its former computed value, according to the estimate of sir William Petty, who certainly cannot be suspected of having drawn an unfavourable statement:

Computation of the wealth of England and Wales in 1664.

	£
Value of the land: 24 millions of acres, yielding 8 millions per ann. rent, worth at 18 years purchase - -	144,000,000
Houses, reckoning those within the bills of mortality equal in value to one-third of the whole - -	30,000,000
Shipping: 500,000 tons, at 6*l.* per ton, including rigging, ordnance, &c. - -	3,000,000
Stock of cattle on the 24 million acres, and the waste belonging thereto, including parks, fisheries, warrens, &c.	36,000,000
Gold and silver coin, scarce -	6,000,000
Wares, merchandize, plate, furniture, &c. - -	31,000,000
Total - -	£ 250,000,000

In comparing this estimate with similar accounts at present, it must be remembered that a great alteration has gradually taken place in the nominal value of all commodities, which, with respect to the above period, appears, from a table formed by sir G. S. Evelyn, to be in the proportion of about five to fourteen; the total of the wealth of England and Wales, in 1664, would therefore have amounted to 700,000,000*l.*, according to the present value of money.

The value of land has progressively increased, in consequence of improvements in cultivation, and the increased consumption of the produce of land. Before England became a trading nation, the general price of land was twelve years purchase. At the beginning of the last century, it sold for about sixteen years purchase: sir W. Petty valued it at eighteen years purchase: and at the commencement of the last century, it had advanced to twenty years purchase. About the year 1730, it had risen to twenty-five years purchase; and at present is from twenty-eight to thirty years purchase. The increase of the number of years purchase paid for land, is the most obvious proof of its augmented value; but it does not shew the whole augmentation of the national wealth on this account, which in part arises from the increase of the total rental beyond the advance that is caused merely by the difference in the value of money. This real increase of the rental proceeds from a greater proportion

of land being brought into cultivation, and that which was before cultivated being improved. The whole landed rental of England and Wales, and the Lowlands of Scotland, was stated by sir W. Petty at about 9,000,000*l.*; and it cannot be supposed that, if he had included the Highlands of Scotland, he would have made the rental of the whole island more than 9,500,000*l.* G. King and Dr. Davenant, in queen Anne's reign, stated the rental of England and Wales at 14,000,000*l.*; and it may be presumed this was nearly the truth at the time: but it soon began to appear too low; and between twenty and thirty years ago it was generally reckoned at 20,000,000*l.* At present, however, it considerably exceeds this sum.

The chief difficulty of forming an estimate of the land rental consists in assigning an average value to the different descriptions of land. The total number of acres in England and Wales has been computed by sir W. Petty to be 28,000,000; by Dr. Grew, 46,000,000; by Dr. Halley, 39,938,500; by Mr. Templeman, 31,648,000; by Mr. Arthur Young, 46,916,000; and by the Rev. H. Beeke, 38,498,572. Mr. Beeke's calculation appears to be by far the most accurate: it is therefore taken as the foundation of the following statement; the proportions cultivated for different purposes being nearly as given by Mr. Middleton, in his View of the Agriculture of the County of Middlesex:

	Acres.
Wheat - - -	3,160,000
Barley and rye - -	861,000
Oats and beans - -	2,872,000
Clover, rye-grass, &c. -	1,149,000
Roots and cabbages cultivated by the plough - -	1,150,000
Fallow - - -	2,297,000
Hop-grounds - -	36,000
Nursery grounds - -	9,000
Fruit and kitchen-gardens, cultivated by the spade -	41,000
Pleasure-grounds - -	16,000
Land depastured by cattle -	17,479,000
Hedge-rows, copses, and woods	1,641,000
Ways, water, &c. - -	1,316,000
Cultivated land - -	32,027,000
Commons and waste lands -	6,473,000
Total acres in England and Wales	38,500,000

If the commons and waste lands are considered as equal in annual value to only one million of cultivated acres, the whole may be taken at 33 millions. The average rent has been stated at 15*s.* per acre, which appears to be a moderate computation, and makes the rental amount to 24,750,000*l.*, the value of which, at 28 years purchase, is 693,000,000*l.* The number of cultivated acres in Scotland is upwards of 9,690,000; and of uncultivated, about 11,310,000: a great part of the latter is of very little use; but if it is wholly excluded, and the cultivated part rated at an average of 10*s.* per acre, which makes 4,845,000*l.* per annum, the total rental of the island will be 29,595,000*l.*, and the value of the land 828,660,000*l.* This must be understood as including the value of tythes, it being unnecessary in this point of view to distinguish between the rent paid to the landlord, and the part paid to the tythe proprietor.

The value of the houses of Great Britain is perhaps more difficult to ascertain than that of the land: but the following statement of their rent, founded on the number returned under the population act, will not be thought too high:

100,000 houses,	at 30*l.* per ann.	£ 3,000,000
500,000	10*l.*	5,000,000
250,000	5*l.*	1,250,000
600,000	2*l.*	1,200,000
425,000	1*l.* 10*s.*	637,500
1,875,000	Total rent	£ 11,087,500

The total rent, if valued at only 18 years purchase, makes the value of all the houses in Great Britain 199,575,000*l.*

In order to form an idea of the value of cattle and farming-stock on the land, we may consider the black cattle and calves, sheep and lambs, swine, pigs, and poultry, annually consumed in London, as worth 6,000,000*l.*, which cannot be more than a seventh part of the whole consumption, amounting therefore in value to 42,000,000*l.*; but the whole number of cattle existing must be more than double the quantity brought to market; so that, including horses, asses, cows kept for milk, and oxen employed in agriculture, the whole value of the cattle cannot be less than 90,000,000*l.*

Taking the annual consumption of grain of all sorts at 16,000,000 quarters, which is probably below the truth, we may presume, that in general there is at least three or four months supply on hand, which, at only 35*s.* per quarter, will amount to at least 7,000,000*l.* The value of hay and straw, and all kinds of fodder, and of all implements of husbandry, cannot be less than five or six millions, and with the former sum cannot be less than 12,500,000*l.* The total value of cattle and farming-stock is therefore 102,500,000*l.*

The value of the shipping belonging to Great Britain may be calculated with more accuracy. It appears from the accounts laid before parliament, that exclusive of Ireland and the plantations, the number of vessels in the merchants' service, belonging to Great Britain, on the 30th September 1804, was 17,809; and the amount of their tonnage, 2,018,999 tons: taking it at 2,000,000, at 8*l.* per ton, it makes 16,000,000*l.*, which is certainly below the real value. The shipping of the navy may at least be estimated at 4,000,000*l.*; making with the former sum, 20,000,000*l.*; to which some addition should be made for the value of ships building in all the dock-yards, and for small craft employed on the rivers and canals.

The quantity of money in the country has at different times been a subject of dispute, and has never been determined with precision. It was, however, pretty well ascertained by the re-coinage in the years 1773, 1774, and 1776. The value of the light gold delivered into the bank under the different proclamations, amounted to 15,563,593*l.*; and it was generally admitted that somewhat more than two millions of heavy guineas remained out in circulation, which, with the silver and copper coin, made the whole at that time about 20 millions; at which sum Mr. Chalmers estimated it in the year 1786. Including the cash in the coffers of the bank it appears, that at the time of the re-coinage the whole money in the country was rather above than under the sum just stated: and from the sums annually coined since that time, it might be presumed that the quantity in circulation at present was considerably greater. Mr. Rose has stated it at no less than 44,000,000*l.*; but though our commerce has considerably increased, it will hardly be thought, considering the far greater quantity of small bank notes in circulation, that, if 20 millions of coin was sufficient in 1776 or 1786, we can at present have occasion for more than 25 millions at the utmost.

Of the value of the merchandize and manufactures usually in the hands of the merchants, wholesale dealers, shopkeepers, and manufacturers, it is very difficult to form a satisfactory idea. The total amount of the imports in the year 1804 was 29,201,490*l.*, and of the exports, 34,451,367*l.*, according to the custom-house accounts; but it has long been known that these accounts are considerably below the true value, and particularly since passing the convoy act, in the execution of which it has appeared that the declared value of British manufactures exported is about 71 per cent. greater than the value in the inspector-general's register; and, with respect to the foreign merchandize imported, the difference on the whole may not be much less; for it is certain that some of the articles are at present considerably more than 71 per cent. above the value at which they are rated. Taking the whole, however, as rated only 60 per cent. under the present values, the annual amount of foreign trade will be 101,844,571*l.*, to which some addition should be made for smuggled goods. It was the opinion of a numerous meeting of merchants in the year 1797, that there is at all times at the least two months supply of export and import merchandize in the custody of the merchants and traders, which, according to the above total, will amount to 16,974,095*l.*; to which some addition should be made for property in the hands of foreign merchants, on account of the merchants of this country generally giving longer credit than they are allowed from other countries. But though the value of goods in the hands of merchants and wholesale dealers appears so considerable, it must be exceeded by the goods in the hands of the manufacturers and of retail traders: for though many of our principal manufactures depend greatly on foreign trade, their main support is the home consumption. The official value of British produce and manufactures exported in the year 1804, was 23,935,793*l.*; but the real value, as far as it can be ascertained, amounted to 40,349,642*l.* This, it may be presumed, cannot be more than half of the whole produce of our manufactures, which will thus amount to 80,699,284*l.*, of which but a small proportion is included in the value before-mentioned in the hands of the merchants; which consists chiefly of foreign merchandize and materials for the different manufactures, as they can generally obtain manufactured goods for exportation at a short notice, deducting, however, 3,000,000*l.* on this account: of the remainder it is probable that there is much more than three months supply in the hands of the manufacturer, in different stages from the raw material to finished goods, and in the possession of retail traders, who, in many branches, are obliged to keep a large assortment; but taking it only in this proportion it amounts to 19,424,821*l.*

There still remains to be valued that part of the property of individuals which consists in household furniture, wearing apparel, plate, jewels and trinkets, books, provisions, fuel, carriages, &c.; with respect to which the most that can be done is to form a conjecture that shall be generally admitted as not exceeding the truth; and certainly this general kind of property, of which every individual must possess or enjoy the use of some share, will not be thought over-rated at three times the yearly rent of the houses which contain it, or 33,262,500*l.* in all Great Britain.

Having thus valued the different descriptions of stock, or actual capital, its total amount will appear as follows:

Value of the land of Great Britain - - -	£828,660,000
Houses - - -	199,575,000
Cattle, and all kinds of farming stock - - -	102,500,000
Shipping: navy and merchant ships - - -	20,000,000
Money - - -	25,000,000
Goods in the hands of merchants and wholesale dealers	16,974,000
Goods in the hands of manufacturers and retail traders	19,424,000
Furniture, apparel, &c. -	33,262,000
Total - -	£1245,395,000

Upon this capital all other species of wealth, whether consisting in the securities of government or individuals, or of any other description, ultimately depends; for private and public loans, in which mode a great part of the property of many persons is invested, implying an obligation on the part of the borrower to repay at a future period a certain sum of money which is the measure and representative of all other species of property, or to pay an income arising from this sum till the capital is repaid, the borrower is no otherwise richer than by the greater income he can make from the money than what he agrees to pay for it: as the capital, in whatever manner he invests it, still belongs to the lender, who, though he may not by the laws of the country be permitted to take possession of the property into which his money has been converted, may, if necessary, bring it to sale, for the purpose of re-converting it into the sum equivalent to what he had lent. If therefore, the whole of the land, houses, cattle, and all other articles composing the wealth of the country, was in the hands of one half of the inhabitants, who had borrowed the above sum of 1245,395,000*l.* from the other half, it is evident that the whole real capital of the country would in fact be the property, not of those in possession of it, but of those to whom they were indebted. This is the case with respect to a considerable part of the capital of Great Britain; and the debts of the government have greatly contributed to bring it into this state: for though these debts are not contracted under an obligation to repay the principal at any fixed period, they rest on the right which the government possesses, to claim, if it should ever be necessary, a portion of the general property sufficient for this purpose, and till that time to raise sufficient contributions to pay an annuity equivalent in value to such principal.

The above estimate shews, that, notwithstanding the expensive wars in which the country has been engaged, which, by drawing much money out of the country, has greatly diminished the profits that would otherwise have remained, there has been a great accumulation; though, at the same time, the people in general appear to live in a much more expensive manner than their ancestors. We have seen that in the year 1664, the whole national capital did not exceed 700,000,000*l.*, according to the present value of money: there has therefore been an average gain since that time of nearly four millions per annum, a very considerable part of which must have arisen from foreign commerce; for commerce would not be carried on without gain; and whatever profits have been saved or converted into stock, must appear in the foregoing account: even the increased value of the land and houses is in a great measure owing to the assistance of capitals acquired in trade.

The great increase of the annual income is a further proof that there must have been such an accumulating surplus as is here stated. Sir W. Petty computed the whole income of the country to be 42,000,000*l.*; Mr. G. King estimated it at 43,500,000*l.*; Dr. Davenant, in 1701, stated it at 49,000,000*l.* These accounts are exclusive of Scotland; but after making a sufficient addition on this account, it will appear that there has been a very considerable increase. Sir John Sinclair, in 1783, observed that the income of the country arising from lands, commerce, and manufactures, was commonly calculated at 100,000,000*l.*, which he considered rather a low valuation; and there can be little doubt that of late years the profit derived from each of these sources has been greatly augmented.

A part of the national stock or capital produces no income; such as the money in circulation, furniture, apparel, &c.; and on the contrary much income arises without capital, being solely the recompence of labour. A very considerable proportion arises from capital and labour united, such as that of most farmers, merchants, and retail traders, and the difficulty of distinguishing, in many cases, that part of the income of individuals which is the wages of their labour, from the part which should be considered as the profits of their capital, must render every attempt to particularize the amount of the different branches of income liable to objections. The following statement is, however, presumed to be not very inaccurate:

From rent of lands -	£29,595,000
From rent of houses - -	11,087,000
Profits of farming, or the occupation of the land - -	6,120,000
Income of labourers in agriculture - - -	18,000,000
Profits of mines, collieries, and inland navigation -	2,000,000
Profits of shipping in the merchants' service, and small craft	1,000,000
Income of stockholders -	18,925,000
From mortgages and other money lent on private securities	2,500,000
Carried over -	£89,227,000

Brought over -	£59,227,000
Profits of foreign trade -	11,250,000
Ditto of manufactures -	13,300,000
Pay of the army and navy, and seamen in the merchants' service - - -	5,500,000
Income of the clergy of all descriptions - -	2,200,000
Income of the judges, and all subordinate officers of the law	1,800,000
Professors, schoolmasters, tutors, &c. - - -	600,000
Retail trades not immediately connected with foreign trade, or any manufacture -	6,000,000
Various other professions and employments - -	2,000,000
Male and female servants -	2,000,000
Total -	£133,877,000

Of this annual sum, the part drawn from other countries by commerce is stated at 11,250,000*l.* which is founded on a supposition that the capital employed cannot be less than 75,000,000*l.*; and that the profits thereon, including those of all persons immediately depending on foreign trade, may be taken at 15 per cent. It must not, however, be supposed that the nation receives an accession of wealth to the amount of 11,250,000*l.* annually from this source: whatever payments are made to other countries for the dividends on the share foreigners hold of the public debts, or as subsidies to their governments, or spent therein in the maintenance of troops, or by British subjects occasionally resident there, operates to the diminution of this profit in a national view. The actual wealth which the country acquires by its intercourse with other nations, may be very different from the profits of the individuals concerned in trade; as a sum equal to a great part, or even the whole, of such profits, may be sent abroad in the various ways just mentioned. The balance of trade in favour of the country has usually been estimated by the excess of the exports beyond the imports, and a comparatively small amount of the latter has been considered highly desirable. This is a concise mode of determining a very important point. But even if the customhouse accounts were much better adapted to the purpose than they are, the justness of the conclusions thus drawn from them would be very doubtful: for it may be easily shewn that in many cases, if the imports even exceeded the exports, there might notwithstanding be a considerable gain. Thus, supposing the merchants of this country to purchase British manufactures for exportation on their own account, to the value of 20,000,000*l.*, the net proceeds thereof in the countries to which they are exported cannot be considered as less than 22,000,000*l.*; and this sum being invested in foreign produce, and imported into this country, will amount, after repaying the duties and all expences, to at least 24,200,000*l.*, returning the merchants the capital originally advanced, with a profit of 21 per cent. In like manner, whenever the merchandize imported in return for any quantity exported is of greater actual value in this country, or yields a greater price, after allowing for all charges and the interest of the capital employed, the surplus must be an addition to the wealth of the country; and if the whole of the foreign trade was of this description, the excess of the imports would shew the profit or the wealth acquired by the exchange of commodities with other nations.

It has been shewn, that the total income of the country is at present upwards of 133,000,000*l.*; and that it cannot be less than this sum, may be inferred from the general expenditure. Sir W. Petty reckoned the average expence of men, women, and children, in England and Wales, at 6*l.* 13*s.* 4*d* per annum, for food, housing, clothes, and all other necessaries; Dr. Davenant took the average expence at 7*l.*, which, according to the difference in the value of money, is equal to upwards of 16*l.* for each person at present. Mr. Jonas Hanway, about 35 years ago, estimated the expence of the people of England and Wales on an average about 9*l.* each; but this must be too low at present: and the following estimate will probably approach nearer to the truth, with respect to the mere expence of subsistence, or of eating and drinking, particularly as we are not to consider what is absolutely necessary for support, but what is actually expended in this way:

Persons.			
300,000	at 16*d.* per day		£7,300,000
700,000	12*d.*	-	12,775,000
1,500,000	9*d.*	-	20,531,250
2,000,000	6*d.*	-	18,250,000
2,500,000	4*d.*	-	15,208,333
2,000,000	2*d.*	-	6,083,333
1,500,000	1*d.*	-	2,281,249
10,500,000			£82,429,165

When the price of most of the necessaries of life is considered, it will not be thought that the expence of subsistence is over-rated in the lowest classes; and if this is admitted, it cannot be too high in the other classes, when it includes strong beer, spirits, wine, and a variety of luxuries. To the expences of living must be added those of house-rent, clothing, and superfluous expences, in order to arrive at the whole actual expenditure. The first of these articles has been stated at 11,087,500*l.*; and allowing for the rent of shops, warehouses, and other buildings appropriated wholly to trade, it may be taken at 9,500,000*l.* The expence of clothing, including every article of dress, or personal decoration, will, on a very moderate computation, amount to 26 millions, viz.

150,000 persons	at 20*l.* per an.	£3,000,000
300,000	12*l.*	3,600,000
750,000	8*l.*	6,000,000
1,300,000	4*l.*	5,200,000
2,800,000	30*s.*	4,200,000
4,000,000	20*s.*	4,000,000
1,500,000	0	
10,800,000		£26,000,000

With respect to superfluous expences, when the sums spent by the nobility and people of fashion in plays, operas, concerts, routs, gambling, horses, carriages, and other amusements and luxuries, are considered, it will certainly be thought a very moderate assumption, that, including what is spent by others on objects more rational, though not absolutely requisite, there are half a million of persons who, one with another, spend 25*l.* per annum in unnecessary expences, making 12,500,000*l.* The total expence will then be:

For subsistence - -	£82,400,000
For house-rent - -	9,500,000
For clothing - -	26,000,000
For miscellaneous expences -	12,500,000
Total -	£130,400,000

The difference between this expenditure and the general income shews the annual gain of the country, or the sum applicable to the extension of commerce, the reservation of a greater quantity of foreign articles, the increase of shipping and buildings, agricultural or mechanical improvements, or other augmentations of the general stock. Without such a surplus, few improvements could be carried on, nor could there be any increase of wealth; and if this latter circumstance is thought essential to national advancement, it becomes an object of much importance, that the expences of the government should be restrained within such bounds, and provided for in such manner, as to intrench as little as possible on the annual surplus that would otherwise be converted into permanent capital.

POLIUM, *poley-mountain*, in botany, a species of teucrium, with oblong, obtuse, crenated, and sessile leaves. See TEUCRIUM.

POLL, a word used in antient writings for the head: hence to poll is either to vote or to enter down the names of those persons who give in their votes at an election.

POLL-MONEY, a capitation or tax imposed by the authority of parliament on the head or person either of all indifferently, or according to some known mark of distinction.

POLLIA, a genus of the class and order hexandria monogynia. The corolla is inferior, six-petalled; berry many-seeded. There is one species, an herbaceous plant of Japan.

POLLICHIA, a genus of the monandria monogynia class and order. The calyx is one-leafed, five-toothed; corolla, five petals; seed solitary; receptacle succulent, aggregate scales. There is one species, of the Cape.

POLLUX, in astronomy, a fixed star of the second magnitude in the constellation Gemini, or the Twins. See ASTRONOMY.

POLYADELPHIA (from πολυς, *many*, and αδελφια, *brotherhood*), many brotherhoods; the name of the 18th class of Linnæus's sexual system, consisting of plants with hermaphrodite flowers, in which several stamina or male organs are united by their filaments into three or more distinct bundles.

POLYANDRIA (from πολυς, *many*, and ανηρ, a *man* or *husband*), many husbands; the name of the 13th class in Linnæus's sexual method, consisting of plants with hermaphrodite flowers, which are furnished with several stamina that are inserted into the common receptacle of the flower.

POLYCARDIA, a genus of the class and order pentandria monogynia. The petals are five; stigma lobed; capsules five-celled; seeds arilled. There is one species, a shrub of Madagascar.

POLYCARPON, a genus of the class and order triandria trigynia. The calyx is five-leaved; petals five; capsule one-celled; seeds many. There is one species.

POLYCNEMUM, a genus of the monogynia order, in the triandria class of plants, and in the natural method ranking under the 12th order, holoraceæ. The calyx is triphyllous; and there are five calciform petals, with one seed almost naked. There are five species, of no note.

POLYGALA, *milkwort*, a genus of the octandria order, in the diadelphia class of plants, and in the natural method ranking under the 33d order, lomentaceæ. The calyx is pentaphyllous, with two of its leaflets wing-shaped and coloured; the legumen is obcordate and bilocular. There are 45 species, of which the most remarkable are:

1. The vulgaris, or common milkwort, is a native of the British heaths and pastures. The root of this plant has a bitter taste, and has been found to possess the virtues of the American rattlesnake root. It purges without danger, and is also emetic and diuretic; sometimes operating all the three ways at once. A spoonful of the decoction made by boiling an ounce of the herb in a pint of water till one-half has exhaled, has been found serviceable in pleurisies and fevers, by promoting a diaphoresis and expectoration; and three spoonfuls of the same taken once an hour, has proved beneficial in the dropsy and anasarca. It has also been found serviceable in consumptive complaints.

2. The senega, or seneka, rattlesnake-wort, grows naturally in most parts of North America. The root of this species operates more powerfully than the last; but besides the virtues of a purgative, emetic, and diuretic, it has been recommended as an antidote against the poison of a rattlesnake; but this opinion is now exploded. It still, however, maintains its character in several disorders. Its efficacy, particularly in pleurisies, is most fully established in Virginia: formerly near fity out of one hundred died of that distemper; but by the happy use of this root hardly three out of the same number have been lost.

As the seeds of the rattlesnake-wort seldom succeed even in the countries where the plant is a native, the best method of propagating it is to procure the roots from America, and plant them in a bed of light earth in a sheltered situation, where they will thrive without any other culture than keeping them free from weeds. But though the plant will stand out ordinary winters, it will be proper to cover it during that season with old tanner's bark, or other mulch, to keep out the frost.

POLYGAMIA (πολυς, *many*, and γαμος, *marriage*). This term, expressing an intercommunication of sexes, is applied, by Linnæus, both to plants and flowers. A polygamous plant is that which bears both hermaphrodite flowers and male or female, or both.

POLYGAMY, the plurality of wives or husbands, in the possession of one man or woman, at the same time. By the laws of England, polygamy is made felony, except in the case of absence beyond the seas for seven years; and where the absent person is living in England, Wales, or Scotland, and the other party has notice of it, such marrying is felony by the statute 1 Jac. I. c. 11.

POLYGLOTT, among divines and critics, chiefly denotes a bible printed in several languages. In these editions of the holy scriptures, the text in each language is ranged in opposite columns.

The first polyglott bible was that of cardinal Ximenes, printed in 1517, which contains the Hebrew text, the Chaldee paraphrase on the pentateuch, the Greek version of the LXX, and the antient Latin version. After this, there were many others: as the bible of Justiniani, bishop of Nebio, in Hebrew, Chaldee, Greek, Latin, and Arabic; the psalter, by John Potken, in Hebrew, Greek, Ethiopic, and Latin; Plantin's polyglott bible, in Hebrew, Chaldee, Greek, and Latin, with the Syriac version of the New Testament; M. Le Jay's bible in Hebrew, Samaritan, Chaldee, Greek, Syriac, Latin, and Arabic; Walton's polyglott, which is a new edition of Le Jay's polyglott, more correct, extensive, and perfect, with several new Oriental versions, and a large collection of various readings, &c.

POLYGON, in geometry, a figure with many sides, or whose perimeter consists of more than four sides at least: such are the pentagon, hexagon, heptagon, &c.

Every polygon may be divided into as many triangles as it has sides: for if you assume a point, as *a* (Plate Miscel. fig. 191), any where within the polygon, and from thence draw lines to every angle *ab*, *ac*, *ad*, &c. they shall make as many triangles as the figure has sides. Thus, if the polygon has six sides (as in the figure above), the double of that is twelve, from whence take four, and there remain eight: then all the angles *b*, *c*, *d*, *e*, *f*, *g*, of that polygon, taken together, are equal to eight right angles. For the polygon having six sides, is divided into six triangles; and the three angles of each, by 1. 32 Eucl. are equal to two right ones; so that all the angles together make twelve right ones: but each of these triangles has one angle in the point *a*. and by it they complete the space round the same point; and all the angles about a point are known to be equal to four right ones; wherefore those four taken from twelve, leave eight, the sum of the right angles of the hexagon.

So it is plain the figure has twice as many right angles as it has sides, except four. *Q. E. D.*

Every polygon circumscribed about a circle is equal to a rectangled triangle, one of whose legs shall be the radius of the circle, and the other the perimeter (or sum of all the sides) of the polygon. Hence every regular polygon is equal to a rectangled triangle, one of whose legs is the perimeter of the polygon, and the other a perpendicular drawn from the centre to one of the sides of the polygon. And every polygon circumscribed about a circle is bigger than it, and every polygon inserted is less than the circle; as is manifest, because the thing containing is always less than the thing contained.

The perimeter of every polygon circumscribed about a circle is greater than the circumference of that circle, and the perimeter of every polygon inscribed is less. Hence, a circle is equal to a right-angled triangle, whose base is the circumference of the circle, and its height the radius of it.

For this triangle will be less than any polygon circumscribed, and greater than any inscribed; because the circumference of the circle, which is the base of the triangle, is greater than the compass of any inscribed, therefore it will be equal to the circle. For, if this triangle is greater than any thing that is less than the circle, and less than any thing that is greater than the circle, it follows that it must be equal to the circle. This is called the quadrature or squaring of the circle; that is, to find a right-lined figure equal to a circle, upon a supposition that the basis given is equal to the circumference of the circle: but actually to find a right line equal to the circumference of a circle, is not yet discovered geometrically. See CIRCLE.

Problems concerning polygons. 1. On a regular polygon to circumscribe a circle, or to circumscribe a regular polygon upon a circle. Bisect two of the angles of the given polygon A and B (Plate Miscell. fig. 192), by the right lines AF, BF; and on the point F, where they meet, with the radius AF, describe a circle which will circumscribe the polygon. Next to circumscribe a polygon, divide 360 by the number of sides required, to find *c* F *d*; which set off from the centre F, and draw the line *de*, on which construct the polygon as in the following problem. 2. On a given line to describe any given regular polygon. Find the angle of the polygon in the table, and in E set off an angle equal thereto; then drawing EA = ED, through the points E, A, D, describe a circle, and in this applying the given right line as often as you can, the polygon will be described. 3. To find the sum of all the angles in any given regular polygon. Multiply the number of sides by 180°; from the product subtract 360°, and the remainder is the sum required: thus, in a pentagon, 180 × 5 = 900, and 900 — 360 = 540 = the sum of all the angles in a pentagon. 4. To find the area of a regular polygon. Multiply one side of the polygon by half the number of sides; and then multiply this product by a perpendicular let fall from the centre of the circumscribing circle, and the product will be the area required: thus, if AB (the side of a pentagon) = 54 × 2½ = 135, and 135 × 29 (the perpendicular) = 3915 = the area required. 5. To find the area of an irregular polygon, let it be resolved into triangles, and the sum of the areas of these will be the area of the polygon.

The following Table exhibits the most remarkable particulars in all the polygons, up to the dodecagon of 12 sides; viz. the angle at the centre, the angle of the polygon, and the area of the polygon, when each side is 1.

No. of sides.	Name of polygon.	Angle at cent.	Angle of polyg.	Area.
3	Trigon	120°	60°	0.4330127
4	Tetragon	90	90	1.0000000
5	Pentagon	72	108	1.7204774
6	Hexagon	60	120	2.5980762
7	Heptagon	$51\frac{3}{7}$	$128\frac{4}{7}$	3.6339124
8	Octagon	45	135	4.8284271
9	Nonagon	40	140	6.1818242
10	Decagon	36	144	7.6942088
11	Undecagon	$32\frac{8}{11}$	$147\frac{3}{11}$	9.3656399
12	Dodecagon	30	150	11.1961524

POLYGON, in fortification, denotes the figure of a town or other fortress.

The exterior or external polygon is bounded by lines drawn from the point of each bastion to the points of the adjacent bastions. And the interior polygon is formed by lines joining the centres of the bastions.

Line of POLYGONS, on the French sectors, is a line containing the homologous sides of the first nine regular polygons inscribed in the same circle; that is, from an equilateral triangle to a dodecagon.

POLYGONAL NUMBERS, are so called because the units whereof they consist may be disposed in such a manner as to represent several regular polygons.

The side of a polygonal number is the number of terms of the arithmetical progression that compose it; and the number of angles is that which shews how many angles that figure has, whence the polygonal number takes its name.

To find a polygonal number, the side and number of its angles being given, the canon is this: the polygonal number is the semi-difference of the factums of the square of the side into the number of angles diminished by two units, and of the side itself into the number of angles diminished by four units.

The several sorts of polygonal numbers, viz. the triangles, squares, pentagons, hexagons, &c. are formed from the addition of the terms of the arithmetical series, having respectively their common difference 1, 2, 3, 4, &c.; viz. if the common difference of the arithmeticals is 1, the sums of their terms will form the triangles; if 2, the squares; if 3, the pentagons; if 4, the hexagons, &c. Thus:

Arith. Prog.	1,	2,	3,	4,	5,	6,	7.
Trian. Nos.	1,	3,	6,	10,	15,	21,	28.
Arith. Prog.	1,	3,	5,	7,	9,	11,	13.
Square Nos.	1,	4,	9,	16,	25,	36,	49.
Arith. Prog.	1,	4,	7,	10,	13,	16,	19.
Pentag. Nos.	1,	5,	12,	22,	35,	51,	70.
Arith. Prog.	1,	5,	9,	13,	17,	21,	25.
Hexag. Nos.	1,	6,	15,	28,	45,	66,	91.

The sums of polygonal numbers collected in the same manner as the polygonal numbers themselves are, out of arithmetical progressions, are called pyramidal numbers.

POLYGONUM, *knot-grass*, a genus of the trigynia order, in the octandria class of plants, and in the natural method ranking under the 12th order, holoraceæ. There is no calyx; the corolla is quinquepartite and calycine, or serving instead of a calyx; there is one angulated seed. There are 36 species; but the most remarkable are:

1. The bistorta, bistort, or greater snake-weed. 2. The viviparum, or smaller bistort. Both these perennials flower in May and June, succeeded by ripe seeds in August. They grow wild in England, &c.; the first in moist, the other in mountainous situations. 3. Oriental polygonum, commonly called persicaria. 4. Fagopyrum, buck-wheat or brank, rises with an upright, smooth, branchy stem, from about a foot and a half to a yard high, heart-shaped sagittated leaves, and the branches terminated by clusters of whitish flowers, succeeded by large angular seeds, excellent for feeding pigeons and most sorts of poultry.

The root of a kind of bistort, according to Gmelin, is used in Siberia for ordinary food. This species is by Haller called bistorta foliis ad oram nervosis, and by some other botanists bistorta montana minor. The natives call it mouka; and so indolent are they, that, to save themselves the trouble of digging it out of the earth, they go in spring and pillage the holes of the mountain-rats, which they find filled with these roots. In our country, bistort is used as a medicine. All the parts of bistort have a rough austere taste, particularly the root, which is one of the strongest of the vegetable astringents. It is employed in all kinds of immoderate hæmorrhages and other fluxes, both internally and externally, where astringency is the only indication. It is certainly a very powerful styptic, and is to be looked on simply as such; the sudorific, anti-pestilential, and other like virtues ascribed to it, it has no other claim to, than in consequence of its astringency, and of the antiseptic power which it has in common with other vegetable styptics. The largest dose of the root in powder is a single drachm.

POLYGYNIA, among botanists, denotes an order or subdivision of a class of plants; comprehending such plants of that class as have a great number of pistils, or female organs of generation. See BOTANY.

POLYHEDRON, in geometry, denotes a body or solid comprehended under many sides or planes. A gnomic polyhedron is a stone with several faces, whereon are described various kinds of dials.

POLYHEDRON, *polyscope*, in optics, is a multiplying-glass or lens, consisting of several plane surfaces disposed into a convex form. See OPTICS.

POLYMNIA, a genus of the polygamia necessaria order, in the syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The receptacle is paleaceous; there is no pappus; the exterior calyx is tetraphyllous, or pentaplyllous; the interior decaphyllous, and composed of concave leaflets. There are five species.

POLYNEMUS, *polyneme*, a genus of fishes of the order abdominales. The generic character is, head compressed, covered with scales; snout very obtuse and prominent; gill-membrane five or seven-rayed; separate filaments or setaceous processes near the base of the pectoral fins.

1. Polynemus paradiseus. The genus polynemus may be considered as holding the same station among the abdominal fishes which the genus trigla does among the thoracic; being distinguished by a similar circumstance, viz. that of being furnished on each side, near the base of the pectoral fins, with several separate processes or articulated rays: these are, in general, much longer and more setaceous than in the triglæ, and, in some species, even exceed the length of the whole body. The species of polyneme are not very numerous, and are chiefly confined to the warmer latitudes.

The polynemus paradiseus, or mango-fish, as it is generally called, which seems to have been one of the first of the genus known to the Europeans, is an inhabitant of the Indian and American seas, and grows to the length of about 12 or 15 inches. It is a fish of an elegant shape, moderately broad in the middle, and gradually tapering towards the tail, which is very deeply forked; the scales are of moderate size, those towards the head and tail smaller than the rest; the thoracic filaments are of excessive length, the superior or outward ones often extending far beyond the tail; the others gradually shorten, the first or lowermost extending about half the length of the body. The colour of this fish is generally described as yellow, and its popular name of mango-fish is supposed to have been given it from that circumstance, as resembling the colour of a ripe mango. Dr. Russel, in his work on the Indian fishes, informs us, that the mango-fish is reckoned by much the most delicate of any found at Calcutta.

2. Polynemus plebeius. General appearance that of a mullet, but with the head very obtuse in front, the mouth appearing as if placed beneath; colour silvery grey, with a dusky tinge on the upper parts, and several dusky lines running from head to tail above the lateral line; scales rather large; all the fins scaly to some distance from the base; tail forked; thoracic filaments five in number on each side; the first of these is said by Gmelin to exceed the length of the body, the rest decreasing gradually.

This species is a native of the Indian and American seas, and is found about the coasts of several of the southern islands. It arrives at a very large size, measuring upwards of four feet in length. It is considered as an excellent fish for the table, and is in much esteem among the inhabitants of the Malabar coast. It is dressed in various ways, and is sometimes dried and salted for sale. Dr. Bloch informs us, on the authority of a correspondent on whom he could rely, that this fish is commonly known in India by the title of royal fish, on account of its excellence, and laments that Broussonet (who seems to have named it from its want of particular splendour) should have given it the title of P. plebeius.

3. Polynemus niloticus. This, according to Mr. Bruce, who describes and figures it in the Appendix to his Travels, is a large species, and may vie, for the elegance both of its form and taste, with any fish inhabiting the rivers running either into the Mediterranean or the ocean. The specimen from which Mr. Bruce's figure was taken weighed 32 pounds, but is said often to arrive at the weight of 70 or more. It is an inhabitant of the river Nile, where it is by no means uncommon as far up the river as Syene and the first cataract. The whole body is covered with scales of a brilliant silver-colour, so as to resemble spangles lying close together; and there is no variety of tinge on the fish, except a shade of red on the end of the nose, which is fat and fleshy.

We are informed by Mr. Bruce, that in order to take this fish, the Egyptian peasants prepare a pretty large mass or cake, consisting of oil, clay, flour, honey, and straw, kneading it with their feet till it is well incorporated. They then take two handfuls of dates and break them into pieces about the size of the point of a finger, and stick them in different parts of the mass; into the heart of which they put seven or eight hooks with dates upon them, and a string of strong whipcord to each. This mass of paste is then conveyed by the fisherman or shepherd into the stream, the man sitting for this purpose on a blown up goat-skin. When arrived at the middle, he drops the mass in the deepest part of the stream; and cautiously holding the ends of each of the strings slack, so as not to pull the dates and hooks out of the middle of the composition, he makes to shore again, a little below the spot where he has sunk the mass; and separating the ends of the strings, ties each of them, without straining, to a palm-branch fastened on the shore, to the end of which is fastened a small bell.

He then goes and feeds his cattle, or digs his trenches, or lies down to sleep. In the mean time the cake beginning to dissolve, the small pieces of date fall off, and flowing down the stream, are eagerly seized on by the fishes as they pass: they rush up the stream, picking up the floating pieces as they go, till at length they arrive at the cake itself, and voraciously falling to work at the dates which are buried in it, each fish, in swallowing a date, swallows also the hook in it, and feeling himself fast, makes off as speedily as possible: the consequence is, that in endeavouring to escape from the line by which he is held, he pulls the palm-branch to which it is fastened, and thus gives notice of his capture by ringing the bell. The fisherman runs, and having secured the fish, puts a strong iron ring through his jaw, ties a few yards of cord to it, and again commits him to the water, fastening the cord well to the shore. This is practised in order to preserve the fish ready for sale, since fish in general, when dead, will not keep long in these regions. It is rarely that on these occasions a single hook is found empty. The inhabitants of the towns of Achmim, Girge, and others, repair at intervals to the shores as to a fish-market, and are thus supplied by the country-people. There are other species.

POLYPODIUM, in botany, a genus of the order of filices, in the cryptogamia class of plants. The fructifications are in roundish points, scattered over the inferior disc of the frons or leaf. There are 137 species, of which the most remarkable is the filix mas, or common male fern. This grows in great plenty throughout Britain, in woods and stony uncultivated soils. The greatest part of the root lies horizontally, and has a great number of appendages placed close to each other in a vertical direction, while a number of small fibres strike downwards. The stalks are covered with brown filmy scales. The fructifications are kidney-shaped, and covered with a permanent scaly shield or involucrum. The capsules are of a pale brown, surrounded with a saffron-coloured elastic ring.

This fern has nearly the same qualities, and is used for most of the same intentions, as the pteris aquilina. They are both burnt together for the sake of their ashes, which are purchased by the soap and glass-makers. In the island of Jura are exported annually 150*l*.-worth of these ashes. Gunner relates, in his Flor. Noveg. that the young curled leaves, at their first appearance out of the ground, are by some boiled and eaten like asparagus; and that the poorer Norwegians cut off those succulent laminæ, like the nails of the finger at the crown of the root, which are the bases of the future stalks, and brew them into beer, adding a third portion of malt, and in times of great scarcity mix the same in their bread. The same author adds, that this fern cut green, and dried in the open air, affords not only an excellent litter for cattle, but, if infused in hot water, becomes no contemptible fodder to goats, sheep, and other cattle, which will readily eat and sometimes grow fat upon it. But the anthelmintic quality of the root of the male fern is that for which it is chiefly to be valued, and of which an account is given in the French publications of madame Nouffer, who employed this remedy with great success. Dr. Simmons also has described the mode of administering the fern-root in his treatise on the tape-worm.

POLYPREMUM, a genus of the monogynia order, in the tetrandria class of plants; and in the natural method ranking under the 22d order, caryophyllei. The calyx is tetraphyllous; the corolla quadrifid and rotaceous, with its lobes obcordate; the capsule is compressed, emarginated, and bilocular. There is one species, an annual of Cusolim.

POLYPUS, the popular name for those fresh-water insects, which class under the genus of hydra, of the order of vermes zoophytæ. The name of hydra was given them by Linnæus on account of the property they have of reproducing themselves when cut in pieces, every part soon becoming a perfect animal. Dr. Hill called them biota, on account of the strong principle of life with which every part of them is endowed. See Hydra.

Polypus, or Polypus of the heart. See Medicine.

Polypus *of the nose*. See Surgery.

POLYPASTON, in mechanics, a machine consisting of an assemblage of several pulleys; for the nature and force of which, see Mechanics.

POLYSPERMOUS. See Botany.

POLYTRICHUM, a genus of the order of musci, in the cryptogamia class of plants. The anthera is operculated, and placed upon a very small apophysis or articulation; the calyptra villous; the star of the female is on a distinct individual. There are 19 species; the most remarkable of which is the commune, or great golden maiden-hair, frequently to be met with in the bogs and wet places of this country. It grows in patches, the stalks erect, generally single and unbranched, from three inches to a foot, or even a yard, high. It is sometimes used in England and Holland to make brooms or brushes; and the Laplanders, when obliged to sleep in desert places, frequently make of it a speedy and convenient bed. Their manner of doing it is curious: Where this moss grows thick together, they mark out with a knife a piece of ground, about two yards square, or of the size of a common blanket; then beginning at one corner, they gently sever the turf from the ground; and as the roots of the moss are closely interwoven and matted together, they by degrees strip off the whole circumscribed turf in one entire piece; afterwards they mark and draw up another piece, exactly corresponding with the first; then, shaking them both with their hands, they lay one upon the ground, with the moss uppermost, instead of a mattress, and the other over it, with the moss downwards, instead of a rug; and between them both take a comfortable nap, free from fleas and bugs, and without fear of contagious distempers. It is probable they might take the hint of making such a bed from the bear, a cohabitant of their country, which prepares his winter-quarters with a large collection of this moss.

POMETIA, a genus of the monœcia hexandria class and order. The calyx is one-leaved, six-cleft; petals six; male stamina six; female, berry globular, one seed in the centre. There are two species.

POMMEREULIA, a genus of the monogynia order, in the triandria class of plants; and in the natural method ranking under the fourth order, gramina. The calyx is bivalved, and shaped like a top; the valvula quadrifid, and bearded on the back. The corolla has two unequal valves; the filaments three, with long pointed antheræ; the style simple. The whole flower forms itself into a sharp point, and the corolla serves as a covering to the seed, which is long, clear, and smooth. There is only one species, a grass of the East Indies.

PONŒA, a genus of the octandria trigynia class and order. The calyx is five-parted, spreading; petals four; germ. three-sided; capsules three-winged, three-celled. There is one species, a tree of Guiana.

PONTEDERIA, in botany, a genus of the monogynia order, in the hexandria class of plants; and in the natural method ranking under the sixth order, ensatæ. The corolla is monopetalous, sexfid, bilabiate; there are three stamina inserted into the top, and three into the tube of the corolla; the capsule is bilocular. There are seven species, aquatics of the East Indies.

PONTON, or Pontoon, in war, denotes a little floating bridge made of boats and planks. The ponton is a machine consisting of two vessels, at a little distance, joined by beams, with planks laid across for the passage of the cavalry, the cannon, infantry, &c. over a river, or an arm of the sea, &c. The late-invented ponton is of copper, furnished with an anchor, &c. to fix to it. To make a bridge, several of these are disposed two yards asunder, with beams across them; and over those are put boards or planks. They are also linked to each other, and fastened on each side the river by a rope run through a ring in each of their heads, and fixed to a tree or stake on either shore; the whole makes one firm uniform bridge, over which a train of artillery may pass.

POOP, the stern of a ship, or the highest, uppermost, and hinder part of the ship's hull.

POOR, in law. Where the last legal settlement of the father of a legitimate child is not known, the child may be sent to the place of its birth, as well as an illegitimate one. Blackerby, 246.

A legitimate child shall necessarily follow the settlement of its parents as a nurse-child or as part of the family, only till it is seven years of age; and after that age, it shall not be removed as part of the father's family; but with an adjudication of the place of its own legal settlement, as being deemed capable at that age of having gained a settlement of his own.

If a person is bound apprentice by indenture, wherever he continues forty days in the service of his master or mistress, there such apprentice gains a settlement; and where any person serves the last forty days of his apprenticeship, that is the place of his last legal settlement.

The 8 and 9 W. 3. c. 30 explains, that as some doubts had arisen touching the settlement of unmarried persons, not having child or children, lawfully hired into any parish or town for one year, it was enacted, that no such person so hired as aforesaid, should be deemed to have a good settlement in any such parish or township, unless such person should continue and abide in such service during the space of one whole year.

A general hiring, without any particular time agreed upon, is construed to be a hiring for a year, and therefore sufficient.

It is not the terms of the hiring, but the intention, that is the criterion; for though a servant may be hired for so much per week, yet if it is understood at the time, that he is to continue for the year if approved of, it is equal to a hiring for a year.

A woman marrying a husband who has a known settlement, shall follow her husband's settlement.

The act of 9 and 10 W. c. 11. does not require a person renting a tenement of 10*l.* a year, to occupy it; it is enough if he rents it and resides forty days in the parish.

POOR'S-RATE, a tax levied in England and Wales, for the relief or support of such persons as from age, infirmity, or poverty, cannot themselves procure the means of subsistence. The first law made in England respecting paupers was in 1496; it directs, "that every beggar, not able to work, shall resort to the hundred where he last dwelt, is best known, or was born; and shall there remain, upon pain of being set in the stocks three days and three nights, with only bread and water, and then shall be put out of town." The monasteries and nunneries with which the country then abounded, were the principal sources from which the poor obtained relief. In 1531 an act was passed, by which the justices of every county were empowered to grant licences to poor, aged, and impotent persons, to beg within a certain precinct; and such as should beg without licence or beyond their limits, were to be severely punished. This regulation was soon found ineffectual; and in 1536, the officers of counties, towns, and parishes, were directed to provide for the support of all aged, poor, and impotent persons, who had resided three years in one place, by means of voluntary contributions to be raised for this purpose in every parish. In 1547 and in 1555, acts were passed for the providing for the poor, by means of weekly collections from the charitably disposed inhabitants of each parish; but this provision was found to be very insufficient, particularly as the number of beggars had increased considerably upon the suppression of the monasteries, from whence many of them derived their principal support. It was therefore found necessary in 1563, to go a step further, by providing, that if any parishioner shall refuse to contribute voluntarily towards the relief of the poor; "the justices of the peace at their quarter-sessions, may tax him to a reasonable weekly sum, which if he refuses to pay, they may commit him to prison." This may be considered as the commencement of the poor's rate, which was rendered more general in 1572, by an act directing, that assessments should be made of the parishioners of every parish, for the relief of the poor. In 1601, nearly the present mode of collecting this rate was established; the churchwardens and overseers of the poor of every parish, or the greater part of them (with the consent of two justices) being empowered to raise weekly, or otherwise, by taxation of every inhabitant, parson, vicar, and other, and of every occupier of lands or houses, materials for employing the poor, and competent sums for their relief. Notice to be given in church of every such rate, the next Sunday after it is allowed. The rate to be levied by distress, on those who refuse to pay it; but appeals against it may be made by those who think themselves aggrieved.

In 1735, a committee of the house of commons was appointed, to consider the existing laws relative to the maintenance and settlement of the poor: who recommended the establishment of workhouses, hospitals, and houses of correction, to be under the management of proper persons, who should be one body politic; and that the laws relating to the poor should be reduced into one act of parliament.

Return made to parliament of the money raised for maintenance of the poor, from Easter 1775 to Easter 1776.

Money raised in England	£ 1,678,915	14	4
Ditto - Wales	40,114	1	0
	£ 1,719,029	15	4

In 1804, a more particular account was obtained, in consequence of an act passed "for procuring returns relative to the expence and maintenance of the poor in England;" from which it appeared, that the number of persons receiving relief from the poor's-rate, was as follows:

1. Persons relieved permanently:	
Out of any house of industry, workhouse, &c. -	336,199
In any house of industry, workhouse, &c. -	83,468
2. Children of persons relieved permanently out of the house, and other children maintained out of the house:	
Under 5 years of age -	120,236
From 5 to 14 years of age	194,914
3. Persons relieved occasionally:	305,899
	1,040,716

This number, great as it appears, is exclusive of 194,052 persons who were not parishioners, the greater part of whom are supposed to have been vagrants.

The total sum raised by the poor's-rate and other parish rates in England and Wales, in the year ending Easter, 1803, was, 5,348,205*l* 9*s.* 3¾*d.*; of which 4,267,965*l.* 9*s.* 2*d.* was expended on account of the poor.

The average rate in the pound of the poor's-rate for the year 1803, was in all England 4*s.* 4½*d*, in Wales, 7*s.* 1½*d.*

POPE, PAPA, FATHER, the sovereign pontiff, or supreme head of the Romish church. The appellation of pope was antiently given to all christian bishops; but about the latter end of the eleventh century, in the pontificate of Gregory VII. it was usurped by the bishop of Rome, whose peculiar title it has ever since continued. The spiritual monarchy of Rome sprung up soon after the declension of the Roman empire. This sovereign is addressed under the term holiness, and in the council of the Lateran held under Innocent III. he was declared ordinary of ordinaries. The pope was an absolute monarch in his Italian dominions, and his power was very considerable; being able, in case of necessity, to put fifty thousand men into the field, besides his naval strength in galleys. The French revolution, which has reversed all order, and overthrown every government where its power extended, and substituted a barbarous and military tyranny in its place, has greatly impaired the splendour, dignity, and power of the pope; nor shall we be at all surprised to see the papal throne entirely reversed, and the territories added to some of the subordinate kingdoms lately erected by the usurper of France.

POPLITÆUS. See ANATOMY.

POPLITEA. See ANATOMY.

POPPY. See PAPAVER.

POPULATION, the state of a country with respect to the number of inhabitants. The greater number of persons any country contains, the greater are the means it possesses of carrying agriculture, manufactures, and commerce, to a great extent, and likewise of defending itself against any hostile attempts of other states; a high degree of population has therefore been generally considered as conducive to national prosperity and security; and almost all writers on political economy, have assumed an increasing population as one of the principal objects which the internal regulations of a country should be calculated to promote. A very different view of the subject has been lately given by Mr. Malthus, who, adopting as a principle, "the constant tendency in all animated life to increase beyond the nourishment prepared for it," traces to this source a very considerable portion of the vice and misery, and of that unequal distribution of the bounties of nature, which it has been the unceasing object of the enlightened philanthropist in all ages to correct. The subject will perhaps be seen in a clearer light, if we endeavour to ascertain, what would be the natural increase of population, if left to exert itself with perfect freedom; and what might be expected to be the rate of increase in the productions of the earth, under the most favourable circumstances of human industry. It will be allowed, that no country has hitherto been known, where the manners were so pure and simple, and the means of subsistence so abundant, that no check whatever has existed to early marriages, from the difficulty of providing for a family; and no waste of the human species has been occasioned afterwards by vicious customs, by towns, by unhealthy occupations, or too severe labour; consequently in no state that we have yet known, has the power of population been left to exert itself with perfect freedom. In the northern states of America, where the means of subsistence have been more ample, the manners of the people more pure, and the checks to early marriages fewer, than in any of the modern states of Europe, the population was found to double itself for some successive periods, every twenty-five years. In the back settlements, this effect took place in fifteen years. Sir W. Petty supposed a doubling possible in so short a time as ten years; but to be sure of being within the truth, Mr. Malthus takes the slowest of these rates of increase, and thus assumes that population, when unchecked, goes on doubling itself every twenty-five years, or increases in a geometrical ratio. The rate according to which the productions of the earth may be supposed to increase, is not so easily determined; but it is certain, that when acre has been added to acre, till all the fertile land is occupied, the yearly increase of food must depend upon the amelioration of the land already in cultivation; this is a stream which, from the nature of all soils, instead of increasing, must be gradually diminishing; but population, could it be supplied with food, would go on with unexhausted vigour, and the increase of one period would furnish the power of a greater increase the next, and this without any limit. In order to illustrate this point, let it be supposed that by the best possible policy, and great encouragements to agriculture, the annual produce of Great Britain could be doubled in the first twenty-five years; in the next twenty-five years, it is impossible to suppose, that the produce could be quadrupled; it would be contrary to all knowledge of the properties of land. Let it then be supposed, that the yearly additions which might be made to the former average produce, instead of decreasing, which they certainly would do, were to remain the same; and that the produce of Great Britain might be increased every twenty-five years, by a quantity equal to what it at present produces. The most enthusiastic speculator cannot suppose a greater increase than this; in a few centuries it would make every acre of land in the island like a garden. If this supposition is applied to the whole earth, it will appear that the means of subsistence, under circumstances the most favourable to human industry, could not possibly be made to increase faster than in an arithmetical ratio.

Mr. Malthus shews the necessary effects of these two different rates of increase, and observes, that taking the whole earth, by which means emigration is excluded, and supposing the present population equal to a thousand millions, the human species would increase as the numbers 1, 2, 4, 8, 16, 32, 64, 128, 256, and subsistence as 1, 2, 3, 4, 5, 6, 7, 8, 9. In two centuries, the population would be to the means of subsistence as 256 to 9; in three centuries, as 4096 to 13; and in two thousand years the difference would be almost incalculable. In this supposition, no limits whatever are placed to the produce of the earth. It may increase for ever, and be greater than any assignable quantity; yet still the power of population being in every period so much superior, the increase of the human species can only be kept down to the level of the means of subsistence, by the constant operation of the strong law of necessity, acting as a check upon the greater power.

From these principles, Mr. Malthus deduces the following propositions: 1. Population is necessarily limited by the means of subsistence. 2. Population invariably increases, where the means of subsistence increase, unless prevented by some very powerful and obvious checks. 3. The checks which repress the superior power of population, and keep its effects on a level with the means of subsistence, are all resolvable into moral restraint, vice, and misery.

Moral restraint, or the determination to defer or decline matrimony from a consideration of the inconveniences or deprivations to which a large portion of the community would subject themselves by pursuing the dictate of nature, Mr. Malthus denominates the preventive check; and whatever contributes to shorten the natural duration of human life (as all unwholesome occupations, severe labour, and exposure to the seasons; extreme poverty, bad nursing of children, great towns, excesses of all kinds, the whole train of common diseases and epidemics, wars, pestilence, plague, and famine) are the positive checks to population. From a review of the former and present state of society in different countries, it appears, that in modern Europe, the positive checks to population prevail less, and the preventive check more, than in past time, and in the more uncivilized parts of the world.

In the actual state of every society, the natural progress of population has thus been constantly and powerfully restrained; and as no form of government, however excellent, no plans of emigration, no benevolent institutions, no degree or direction of national industry, can prevent the action of a great check to increase in some form or other; as we must submit to it as an inevitable law of nature; it becomes highly desirable to ascertain how it may take place with the least possible prejudice to the virtue and happiness of human society. Now, as it is clearly better that the check to population should arise from a foresight of the difficulty of rearing a family, and the fear of dependant poverty, than from the actual presence of pain and sickness; moral restraint is a virtue, the practice of which is most earnestly to be encouraged. If no man was to marry, who had not a fair prospect of providing for the presumptive issue of his marriage, population would be kept within bounds by the preventive check; men and women would marry later in life, but in the full hope of their reward; they would acquire habits of industry and frugality, and inculcate the same in the minds of their children. Mr. Malthus does not go so far as to propose, that any restraint upon marriage between two persons of proper age should be enforced by law, but insists, that the contract of marriages between persons who have no other prospect of providing for their offspring than by throwing them on a parish, should not be, as it is at present, encouraged by law. One of the effects of the poor-laws, is to encourage marriage between persons of this description; who well know that, if they cannot provide for their own children, the parish must take them off their hands. These laws thus create mouths, but are perfectly incompetent to procure food for them: instead of raising the real price of labour, by increasing the demand for labourers, they tend to overstock the market, to reduce the demand, and diminish the value. They raise the price of provisions by increasing the consumption, and by supplying the parochial pensioners with the means of obtaining them. In consequence of this, the class of industrious labourers who are above soliciting assistance, are oftentimes sunk in the scale of misery, much lower than others who have thrown off all sense of shame, and all the honest feelings of independance. In a moral point of view, the effects of these laws are equally injurious to the best interests of society. Mr. Malthus, however, is aware, that the immediate and abrupt abolition of the present system, would produce much temporary distress; he suggests therefore a plan for the gradual abolition of these laws, by proposing, that no child born from any marriage taking place after the expiration of a year from the date of the law, and no illegitimate child born two years from the same date, should be entitled to parish-assistance. This, he remarks, would operate as a fair, distinct, and precise notice, which no man could mistake; and without pressing hard upon any particular individual, would at once throw off the rising generation from that miserable and helpless dependance upon the government and the rich, the moral as well as the physical consequences of which, are almost incalculable.

The progress of the population of the world, and its present total amount, cannot be ascertained with much precision; as there are no sufficient grounds on which such a computation can be formed, till within a very late period, and that only in a few countries. Sir W. Petty, in 1682, stated the population of the world at only 320 millions: it has been estimated by some writers at about 730 millions, by others at upwards of 900 millions. Mr. Wallace, of Edinburgh, conjectured it might amount to 1000 millions; and this number has since been generally adopted by those who have noticed the subject. It is a point on which accuracy cannot be expected, but a nearer approximation to the truth appears by no means impracticable. A strong presumption that the inhabitants of the earth at present exceed considerably a thousand millions, arises from the circumstance, that, in almost every country where the people have been numbered, or sufficient data furnished for computing their number, it has been found considerably greater than it had been previously supposed. In Great Britain, the most correct estimates did not make the population exceed seven or eight millions; whereas, by the late enumeration, it appears to amount to very near eleven millions. France, the population of which was estimated by Mr. Susmilch at sixteen millions, by M. Deslandes and by Mr. Gibbon at 20 millions, and which M. Messance endeavoured to prove amounted to near 24 millions, appeared from the returns of births and burials, to contain at the commencement of the revolution near 30 millions of inhabitants. Spain, which with Portugal had been estimated by M. Deslandes to contain only six millions of persons, and by Mr. Gibbon eight millions, was found by the enumeration in 1787, to contain alone 10,409,879. Russia, about the year 1765, was supposed to contain about 15 millions of inhabitants; but according to the calculation given by Mr. Coxe, grounded upon an authentic list of the persons paying the poll-tax, they amounted to 26,766,360, and including the provinces not subject to the poll-tax, the calculation for the year 1796 amounted to 36,000,000 inhabitants. A great part of this vast empire is in Asia; but there appears from these and similar accounts great reason to conclude, that the population of Europe, which has usually been supposed to be about 100 millions, is considerably greater; and the following statement is probably not far from the truth:

Spain -	10,500,000
Portugal - -	2,300,000
France - -	25,000,000
Italy and its islands -	11,000,000
Switzerland - -	1,800,000
Germany - -	20,000,000
Holland - - -	2,800,000
Flanders - -	1,800,000
Great Britain and Ireland	15,100,000

Denmark and Norway	-	3,700,000
Sweden	-	3,000,000
Prussia	-	6,000 000
Russia in Europe	-	20,000,000
Turkey in Europe	-	7,000,000
	Total	130,000,000.

The act for ascertaining the population of Great Britain, was passed on the last day of the year 1800; it directed a general enumeration of houses, families, and persons; and the proper officers of the several parishes and places were ordered to take the account, on the 10th of March, 1801, in England and Wales; and in Scotland as soon as possible after that day. This difference was necessary, because in the colder climate of Scotland, it was not certain that all parts of the country would be easily accessible so early in the year. An abstract of the returns was laid before both houses of parliament; and the summary of the enumeration appeared to be as follows:

	HOUSES. Inhabited.	HOUSES. By how many families occupied.	HOUSES. Uninhabited.	PERSONS. Males.	PERSONS. Females.	PERSONS. Total.
England - - -	1,472,873	1,787,520	53,965	3,987,935	4,343,499	8,331,434
Wales - - -	108,053	118,303	5,511	257,178	284,368	541,546
Scotland - - -	294,553	364,379	9,537	734,581	864,487	1,599,068
Army, including Militia - -	—	—	—	198,351	—	198,351
Navy, including Marines - -	—	—	—	126,279	—	126,279
Seamen in registered shipping	—	—	—	144,558	—	144,558
Convicts on board the hulks -	—	—	—	1,410	—	1,410
Total - - -	1875,456	2,269,902	67,013	5,450,292	5,492,354	10,942,646

The total population of Great Britain probably exceeds the number of persons specified in the above summary, as there were some parishes from which no returns were received. The islands of Guernsey, Jersey, Alderney, and Sark, the Scilly islands, and the isle of Man, were not comprised in the enumeration; the total population of these islands has been usually estimated at about 80,000 persons.

The number of houses in Ireland has been nearly ascertained by the collection of a hearth-money tax, from which it has been computed, that the population of that part of the United Kingdom somewhat exceeds four millions of persons.

On these considerations, with a very moderate allowance for omissions in the returns, the total population of the united kingdom of Great Britain and Ireland, amounts to 15,100,000 persons; and, besides these, its eastern and western possessions and colonies contain many natives of the British isles.

The proportion of persons to a house appeared by the returns to be as follows:

In England	- - -	$5\frac{2}{3}$
Wales	- - -	5
Scotland	- - -	$5\frac{2}{7}$
Great Britain	- -	$5\frac{5}{9}$

Population of the principal Sea Ports and Manufacturing Towns of Great Britain, and of France.

GREAT BRITAIN.	Inhabitants.	FRANCE.	Inhabitants.
London - -	864,845	Paris - - -	546,856
Manchester -	84,020	Bourdeaux	112 844
Edinburgh -	82,560	Lyons - - -	109,500
Liverpool -	77,653	Marseilles	111,130
Glasgow - -	77,385	Rouen - -	87,000
Birmingham -	73,670	Nantes - -	73,649
Bristol - -	63,645	Brussels - -	66,227
Leeds - - -	53,162	Lisle - - -	54,756
Plymouth -	43,194	Toulouse - -	50,171
Norwich - -	36,832	Strasburg	49,056
Portsmouth -	32,166	Cologne - -	38,844
Sheffield - -	31,314	Bruges - -	33,760
Hull - - -	29,516	Dunkirk - -	21,158
Nottingham -	28,861	Brest - -	27,000
Newcastle -	28,366	Toulon - -	20,500

POPULUS, the POPLAR, a genus of the octandria order, in the diœcia class of plants; and in the natural method ranking under the 50th order, amentaceæ. The calyx of the amentum is a lacerated, oblong, and squamous leaf; the corolla is turbinated, oblique, and entire. The female has the calyx of the amentum and corolla the same as in the male; the stigma is quadrifid; the capsule bilocular, with many pappous seeds. There are eleven species; the most noted are:

1. The alba, or abele-tree, grows naturally in the temperate parts of Europe. Its leaves are large, and divided into three, four, or five lobes, indented on their edges, of a very dark colour on their upper side, but very white and downy on the under side; standing upon footstalks an inch long. The young branches have a purple bark, and are covered with a white down; but the bark of the stem and older branches is grey. 2. The major, or white poplar, has its leaves rounder than the first, and not much above half their size; they are indented on their edges, and are downy on their under side, but not so white as those of the former, nor are their upper surfaces of such a deep green colour. 3. The nigra, or black poplar, has oval heart-shaped leaves, slightly crenated on their edges; they are smooth on both sides, and of a light-green colour. 4. The tremula, or aspen-tree, has roundish, angularly indented leaves: they are smooth on both sides, and stand on long footstalks, and so are shaken by the least wind; whence it has the title of the trembling poplar, or aspen-tree. 5. The balsamifera, or Carolina poplar, is a native of Carolina, where it becomes a large tree. The shoots of this sort grow very strong in Britain, and are generally angular; with a light green bark like the willow. The leaves on young trees, and also those on the lower shoots, are very large, almost heart-shaped, and crenated; but those upon the older trees are smaller: as the trees advance, their bark becomes lighter, approaching to a greyish colour. 6. The tacamahaca grows naturally in Canada and other parts of North America. This is a tree of a middling growth, sending out on every side many short thick shoots, which are covered with a light-brown bark, with leaves differing from one another in shape and size; most of them are almost heart-shaped, but some are oval, and others nearly spear-shaped; they are whitish on their under side, but green on the upper. 7. The Lombardy poplar (deletata), well known.

These trees may be propagated either by layers or cuttings, as also from the suckers which the white poplars send up from their roots in great plenty. The best time for transplanting these suckers is in October, when their leaves begin to decay.

The wood of these trees, especially of the abele, is good for laying flowers, where it will last for many years, and, on account of its extreme whiteness, is by many preferred to oak; yet, on account of its soft contexture, being very subject to take the impression of nails, &c. it is less proper on this account than the harder woods. The abele likewise deserves particular notice, on account of the virtue of its bark in curing intermitting fevers, as stated by the reverend Mr. Stone, in Phil. Trans. vol. liii. p. 195. This bark will also tan leather.

The inner bark of the black poplar is used by the inhabitants of Kamtschatka as a material for bread; and paper has sometimes been made of the cottony down of the seeds. The roots have been observed to dissolve into a kind of gelatinous substance, and to be coated over with a tubular crustaceous spar, called by naturalists osteocolla, formerly imagined to have some virtue in producing the callus of a fractured bone. The buds of the sixth species are covered with a glutinous resin, which smells very strong, and is the gum tacamahaca of the shops. The best, called (from its being collected in a kind of gourd-shells) tacamahaca in shells, is somewhat unctuous and softish, of a pale yellowish or greenish colour, an aromatic taste, and a fragrant delightful smell, approaching to that of lavender or ambergris. This sort is very rare; that commonly found in the shops is in semitransparent globes or grains, of a whitish, yellowish, brownish, or greenish colour, of a less grateful smell than the foregoing. This resin is said to be employed externally by the Indians for discussing and maturating tumours, and abating pains in the limbs. It is an ingredient in some anodyne, hysteric, cephalic, and stomachic plasters; but the fragrance of the finer sort sufficiently points out its utility in other respects.

M. Fougeroux de Bondaroy, from a set of experiments on the subject, gives an account of the uses of the several kinds of poplar, the substance of which is as follows: He finds that the wood of the black poplar is good and useful for many purposes; that the Lombardy poplar, is of very little value; that the Virginia poplar, populus Virginiana, affords a wood of excellent quality, that may be applied to many uses. The Carolina poplar, populus Carolinensis heterophylla (Lin.), is a very quick grower; beautiful when sound, but liable to be hurt by cold. Its wood appears to M. de Bondaroy to be of little value; but M. Malesherbes, who cu down a large tree of this sort, was assured by his carpenter that the wood was very good. That the tacamahaca is a dwarfish plant of little value. That the liard, populus Canadensis, is a large tree, the wood light, not easy to be split, and fit for several uses. That the white poplar, is a large-growing tree, affording a wood of excellent quality, and is among the most valuable of this species. That the trembling poplar is neither so large a tree, nor affords such good wood, as the former. These are in few words the principal results of the experiments of this gentleman on this class of plants. A few other sorts are mentioned, but nothing decisive with regard to them is determined.

From some experiments made by M. Dambourney, it appears that the poplar may be usefully employed in dyeing. The Italian or Lombardy poplar gives a dye of as fine a lustre, and equally durable, as that of the finest yellow wood, and its colour is more easily extracted. It is likewise very apt to unite with other colours in composition. Besides this, M. Dambourney tried also the black poplar, the Virginian, the balsam or liard, the white, and the trembling poplar; and found that all these dyed wool of a nut-colour, fawn-colour (vigogne), Nankin, musk, and other grave shades, according to the quantity of wood employed, and the length of time it was boiled.

PORANA, a genus of the monogynia order, in the pentandria class of plants. The corolla is campanulated; the calyx is quinquefid, and larger than the fruit; the style semibifid, long, and permanent; the stigmata globular; the perianthium bivalved. There is one species, a shrub of the East Indies.

PORCELAIN, a fine kind of earthenware, chiefly manufactured in China, and thence called China-ware. All earthenwares which are white and semitransparent are generally called porcelain; but amongst these so great differences may be observed, that, notwithstanding the similarity of their external appearance, they cannot be considered as matters of the same kind. These differences are so evident, that even persons who are not connoisseurs in this way prefer much the porcelain of some countries to that of others.

The word porcelain is of European derivation; none of the syllables which compose it can even be pronounced or written by the Chinese, whose language comprehends no such sounds. It is probable that we are indebted to the Portuguese for it; the word porcellana, however, in their language, signifies properly a cup or dish; and they themselves distinguish all works of porcelain by the general name of loca. Porcelain is called in China tsé-ki.

The art of making porcelain is one of those in which Europe has been excelled by the Oriental nations. The first porcelain that was seen in Europe was brought from Japan and China. The whiteness, transparency, fineness, neatness, and even magnificence of this pottery, which soon became the ornament of sumptuous tables, did not fail to excite the admiration and industry of Europeans; and their attempts have succeeded so well, that in different parts of Europe earthenwares have been made so like the Oriental, that they have acquired the name of porcelain. The first European porcelains were made in Saxony and in France; and afterwards in England, Germany, and Italy; but as all these were different from the Japanese, so each of them had its peculiar character.

The finest and best porcelain of China is made in a village called King-te-tching, in the province of Kiang-si. This celebrated village is a league and a half in length, and we are assured that it contains a million of inhabitants. The workmen of King-te-tching, invited by the attracting allurements of the European trade, have established manufactories also in the provinces of Fo-kien and Canton; but this porcelain is not esteemed.

We are indebted to father d'Entrecolles, a Romish missionary, for a very accurate account of the manner in which porcelain is made in China; and as he lived in King-te-tching, his information must have been the very best possible. We shall therefore give his account of the Chinese manner of making it, as abridged by Grosier in his General Description of China. The principal ingredients of the fine porcelain are pe-tun-tse and kao-lin, two kinds of earth, from the mixture of which the paste is produced. The kao-lin is intermixed with small shining particles; the other is purely white, and very fine to the touch. These first materials are carried to the manufactories in the shape of bricks. The pe-tun-tse, which is so fine, is nothing else but fragments of rock taken from certain quarries, and reduced to powder. Every kind of stone is not fit for this purpose. The colour of that which is good, say the Chinese, ought to incline a little towards green. A large iron club is used for breaking these pieces of rock: they are afterwards put into mortars; and, by means of levers headed with stone bound round with iron, they are reduced to a very fine powder. These levers are put in action either by the labour of men, or by water, in the same manner as the hammers of our paper-mills. The dust afterwards collected is thrown into a large vessel full of water, which is strongly stirred with an iron shovel. When it has been left to settle for some time, a kind of cream rises on the top, about four inches in thickness, which is skimmed off, and poured into another vessel filled with water; the water in the first vessel is stirred several times; and the cream which arises is still collected, until nothing remains but the coarse dregs, which, by their own weight, precipitate to the bottom; these dregs are carefully collected, and pounded anew.

With regard to what is taken from the first vessel, it is suffered to remain in the second until it is formed into a kind of crust at the bottom. When the water above it seems quite clear, it is poured off by gently inclining the vessel, that the sediment may not be disturbed; and the paste is thrown into large moulds proper for drying it. Before it is entirely hard, it is divided into small square cakes, which are sold by the hundred. The colour of this paste, and its form, have occasioned it to receive the name of pe-tun-tse.

The kao-lin, which is used in the composition of porcelain, requires less labour than the pe-tun-tse. Nature has a greater share in the preparation of it. There are large mines of it in the bosoms of certain mountains, the exterior strata of which consist of a kind of red earth. These mines are very deep, and the kao-lin is found in small lumps, that are formed into bricks after having gone through the same process as the pe-tun-tse. Father d'Entrecolles thinks, that the earth called terre de Malte, or St. Paul's earth, has much affinity to the kao-lin, although those small shining particles are not observed in it which are interspersed in the latter.

It is from the kao-lin that fine porcelain derives all its strength; if we may be allowed the expression, it stands it in the stead of nerves. It is very extraordinary, that a soft earth should give strength and consistency to the pe-tun-tse, which is procured from the hardest rocks. A rich Chinese merchant told father d'Entrecolles, that the English and Dutch had purchased some of the pe-tun-tse, which they transported to Europe with a design of making porcelain; but having carried with them none of the kao-lin, their attempt proved abortive, as they have since acknowledged. "They wanted," said this Chinese laughing, "to form a body, the flesh of which should support itself without bones."

The Chinese have discovered, within these few years, a new substance proper to be employed in the composition of porcelain. It is a stone, or rather species of chalk, called hoa-che, from which the physicians prepare a kind of draught that is said to be detersive, aperient, and cooling. The manufacturers of porcelain have thought proper to employ this stone instead of kao-lin. It is called hoa, because it is glutinous, and has a great resemblance to soap. Porcelain made with hoa-che is very rare, and much dearer than any other. It has an exceedingly fine grain; and with regard to the painting, if it is compared with that of the common porcelain, it appears to surpass it as much as vellum does paper. This porcelain is, besides, so light, that it surprises those who are accustomed to handle other kinds; it is also much more brittle; and it is very difficult to hit upon the proper degree of tempering it.

Hoa-che is seldom used in forming the body of the work; the artist is contented sometimes with making it into a very fine size, in which the vessel is plunged when dry, in order that it may receive a coat before it is painted and varnished; by these means it acquires a superior degree of beauty.

When hoa-che is taken from the mine, it is washed in rain or river water, to separate it from a kind of yellow earth which adheres to it. It is then pounded, put into a tub filled with water to dissolve it, and afterwards formed into cakes like kao-lin. We are assured that hoa-che, when prepared in this manner, without the mixture of any other earth, is alone sufficient to make porcelain. It serves instead of kao-lin; but it is much dearer. Kao-lin costs only ten-pence sterling; the price of hoa-che is half-a-crown; this difference, therefore, greatly enhances the value of porcelain made with the latter.

To pe-tun-tse and kao-lin, the two principal elements, must be added the oil or varnish from which it derives its splendour and whiteness. This oil is of a whitish colour, and is extracted from the same kind of stone which produces the pe-tun-tse; but the whitest is always chosen, and that which has the greenest spots. The oil is obtained from it by the same process used in making the pe-tun-tse: the stone is first washed and pulverised; it is then thrown into water, and after it has been purified it throws up a kind of cream. To 100 pounds of this cream is added one pound of che-kao, a mineral something like alum, which is put into the fire till it becomes red-hot, and then pounded. This mineral is a kind of runnet, and gives a consistence to the oil, which is however carefully preserved in its state of fluidity. The oil thus prepared is never employed alone; another oil must be mixed with it, which is extracted from lime and fern-ashes, to 100 pounds of which is also added a pound of che-kao. When these two oils are mixed, they must be equally thick; and in order to ascertain this, the workmen dip into each of them some cakes of the pe-tun-tse, and, by inspecting their surfaces closely after they are drawn out, thence judge of the thickness of the liquors. With regard to the quantity necessary to be employed, it is usual to mix ten measures of stone-oil with one measure of the oil made from lime and fern-ashes.

In forming vessels of porcelain, the first thing is to purify the pe-tun-tse and kao-lin, which, for the first, is done after the manner already described in preparing the squares; for the second it is sufficient to plunge it into an urn of water, in an open basket, as it will easily dissolve. The dregs that remain are perfectly useless, and are emptied out of the work-house when a quantity is got together.

To make a just mixture of pe-tun-tse and kao-lin, regard must be had to the fineness of the porcelain to be made; for the finer porcelain they use equal quantities; four parts of kao-lin to six of pe-tun-tse for moderate ones; and never less than one of kao-lin to three of pe-tun-tse for the coarsest. The hardest part of the work is the kneading and tewing the two earths together, which is done till the mass is well mixed, and grows hard, by the workmen trampling it continually with their feet. Then being taken out of the basons or pits wherein it is kneaded, it is done over a second time, but piecemeal, and with the hands, on large slates for that purpose: and on this preparation it is, that the perfection of the work depends; the least heterogeneous body remaining in the matter, or the least vacuity that may be found in it, being enough to spoil the whole. The porcelain is fashioned or formed either with the wheel like our earthenware, or in moulds. See Stone-ware.

Smooth pieces, as urns, cups, dishes, &c. are made with the wheel; the rest, such as are in relievo, as figures of men, animals, &c. are formed in moulds, but finished with the chisel. The large pieces are made at two operations: one piece is raised with the wheel by three or four workmen, who hold till it has acquired its proper figure: which done, they apply to it the other half, which has been formed in the same manner, uniting the two with porcelain-earth made liquid by adding water to it, and polishing the juncture with a kind of iron spatula. After the same manner it is that they join the several pieces of porcelain formed in moulds, or by the hand; and that they add handles, &c. to the cups, and other works formed by the wheel.

The moulds are made after the same manner with those of our sculptors, viz. of divers pieces which severally give their respective figure to the several parts of the model to be represented, and which are afterwards united to form a mould for an entire figure. The earth they are made of is yellow, and fat. Is is kneaded like potter's-earth; and when sufficiently mellow, fine, and moderately dry, beating it stoutly, they form it into moulds, according to the works required, either by hand, or on the wheel.

All the works that are made in moulds are finished by the hands, with several instruments proper to dig, smooth, polish, and to touch up, the strokes that escape the mould, so that it is rather a work of sculpture than of pottery. There are some works whereon relievos are added, ready-made, as dragons, flowers, &c. others that have an impression in creux, which last are engraved with a kind of puncheons. In general, all porcelain-works are to be sheltered from the cold; their natural humidity making them liable to break when they dry unequally.

PORCH. See Architecture.

PORCUPINE. See Histrix.

PORE, *in anatomy*, a little interstice or space between the parts of the skin, serving for perspiration. See Cutis, Perspiration, Physiology, &c.

PORELLA, in botany, a genus of mosses, the anthera of which is multilocular and foraminose.

POROSTEMA, a genus of the polyadelphia polyandria class and order. The calyx is six-parted; no corolla; filaments nine, with four anthers on each; capsules covered, six-celled. There is one species, a tree of Guiana.

PORPHYRY, a genus of stones belonging to the order of saxa. It is found of several different colours, as green, deep red, purple, black, dark brown, and grey. Under the name of porphyry, Mr. Kirwan and M. de Saussure include those stones which contain either feltspar, schoerl, quartz, or mica, with other species of crystallized stone on a siliceous or calcareous ground. There are a great many different kinds. M. Ferber describes twenty varieties under four species; but in general it is considered with relation to its ground, which is met with of the colours already mentioned. When the ground is of jasper, the porphyry is commonly very hard; the red generally contains feltspar in small white dots or specks, and frequently, together with these, black spots of schoerl. The green is often magnetic, and is either a jasper or schoerl, with spots of quartz. Sometimes a porphyry of one colour contains a fragment of another of a different colour. Those that have chert for their ground are fusible per se. The calcareous porphyry consists of quartz, feltspar, and mica, in separate grains, united by a calcareous cement; and, lastly, the micaceous porphyry consists of a greenish grey micaceous ground, in which red feltspar and greenish soap-rock are inserted.

The porphyry of the antients is a most elegant mass of an extremely firm and compact structure, remarkably heavy, and of a fine strong purple, variegated more or less with pale red and white; its purple is of all degrees, from the claret-colour to that of the violet; and its variegations are rarely disposed in veins, but spots, sometimes very small, and at others running into large blotches. It is less fine than many of the ordinary marbles; but it excels them all in hardness, and is capable of a most elegant polish. It is still found in immense strata in Egypt. The hard red lead coloured porphyry, variegated with black, white, and green, is a most beautiful and valuable substance. It has the hardness and all the other characters of the Oriental porphyry; and even greatly excels it in brightness and in the beauty and variegation of its colours. It is found in great plenty in the island of Minorca; and is well worth importing, being greatly superior to all the Italian marbles. The hard, pale-red porphyry, variegated with black, white, and green, is of a pale flesh-colour, often approaching to white. It is variegated in blotches from half an inch to an inch broad. It takes a high polish, and emulates all the qualities of the Oriental porphyry. It is found in immense strata in Arabia Petræa, and in the Upper Egypt; and in separate nodules in Germany, England, and Ireland.

Ficoroni takes notice of two exquisitely fine columns of black porphyry in a church at Rome. In Egypt there are three celebrated obelisks or pillars of porphyry; one near Cairo, and two at Alexandria. The French call them aguglias, and in England they are called Cleopatra's needles.

The art of cutting porphyry, practised by the antients, appears now to be lost. Indeed it is difficult to conceive what tools they used for fashioning those huge columns and other porphyry-works, in some of the antient buildings in Rome.

Da Costa, however, supposes, that the method used by the antients in cutting and engraving porphyry was extremely simple, and that it was performed without the aid of any scientific means that are now lost. He imagines, that, by unwearied diligence, and with numbers of common tools at great expence, they rudely hewed or broke the stone into the intended figures, and by continued application reduced them into more regular designs; and that they completed the work by polishing it with great labour, by the aid of particular hard sands found in Egypt. And he thinks, that in the porphyry-quarries there were layers of grit or loose disunited particles, analogous to the porphyry, which they carefully sought for, and used for this work.

PORT, a harbour or place of shelter, where ships arrive with their freight, and customs from goods are taken.

Port-holes, in a ship, are the holes in the side of the vessel, through which are put the muzzles of the great guns. These are shut up in storms, to prevent the water from driving through them. The English, Dutch, and French ships, have the valves or casements fastened at the top of the port-holes, and the Spanish vessels aside of them.

Port-royal, the name of two monasteries of cistercian nuns, in the diocese of Paris; the one near Chevreuse, at the distance of five leagues from Paris, called Port royal of the fields, and the other in Paris, in the suburbs of St. James's.

The nuns of the former of these monasteries, proving refractory, were dispersed; when many ecclesiastics, and others, who were of the same sentiments as these religious, retired to Port Royal, took apartments there, and printed many books; hence the name of Port-royalists was given to all their party, and their books were called books of Port-royal; hence we say the writers of Port-royal, messieurs de Port-royal, and the translations and grammars of Port-royal.

PORTA, or VENA PORTA. See ANATOMY.

PORTERAGE. By stat. 39 Geo. III. c. 58, no inn-keeper, warehouse-keeper, or other person, to whom any box, basket, package, parcel, truss, game, or other thing whatsoever, not exceeding fifty-six pounds weight, or any porter or other person employed by such inn-keeper, warehouse-keeper, or other person, in porterage, or delivery of any such box, parcel, &c. within the cities of London, Westminster, or borough of Southwark, and their respective suburbs, and other parts contiguous, not exceeding half a mile from the end of the carriage-pavement, in the several streets and places within the abovementioned limits, shall ask or demand, or receive or take, in respect of such porterage or delivery, any greater rate or price than as follows:

Not exceeding a	quarter of a mile	3*d*.
————	half a mile	4*d*.
————	one mile	6*d*.
————	one mile and a half	8*d*.
————	two miles	10*d*.

For every further distance, not exceeding half a mile, three-pence additional.

Persons asking or receiving more than the above rates, shall for every such offence, forfeit a sum not exceeding 20*s*. nor less than 5*s*.

PORTICO. See ARCHITECTURE.

PORTLAND STONE is a dull whitish species much used in buildings about London. It is composed of a coarse grit, cemented together by an earthy spar. It will not strike fire with steel, but makes a violent effervescence with nitric acid. See FREESTONE.

PORTLANDIA, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking with those of which the order is doubtful. The corolla is elevated and funnel-shaped; the antheræ are longitudinal; the capsule pentagonal, and retuse at top, bilocular, and crowned with a pentaphyllous calyx. There are four species. The grandiflora has been particularly described by Dr. Browne, who has also given a good figure of it. It has frequently flowered in the royal garden at Kew, and in Dr. Pitcairn's at Islington. The external bark is remarkably rough, furrowed, and thick: it has no taste. The inner bark is very thin, and of a dark-brown colour. Its taste is bitter and astringent, and its virtues are the same as those of the Jesuits' bark. Infused in spirits or wine with a little orange-peel, it makes an excellent stomachic tincture.

PORTRAIT. See PAINTING.

PORTULACA, *purslane*, a genus of the monogynia order, in the dodecandria class of plants, and in the natural method ranking under the 13th order, succulentæ. The corolla is pentapetalous; the calyx bifid; the capsule unilocular, and cut round. There are 12 species, but the two following are the most remarkable: 1. The oleracea, annual, or common culinary purslane. There are two varieties; one with deep-green leaves, the other with yellow leaves; both of which rise from the same seed. 2. The anacampseros, perennial, or shrubby Cape purslane. Both these plants are of a succulent nature: the first is an herbaceous annual, for culinary uses; and the second a shrubby perennial, raised by the curious for variety. They are both exotics of a tender quality, of the temperature of greenhouse or stove plants. The common culinary purslane is raised annually from seed for summer use, and is an excellent ingredient in summer salads, but improper for winter on account of its cold moist nature. The plant being tender, must be raised either on a hotbed or in a warm border.

PORTULACARIA, a genus of the class and order pentandria trigynia. The calyx is two-leaved; the petals five; seed one, three-sided and winged. There is one species, called purslane-tree.

POSITION. See ARCHITECTURE.

POSITION, or the *rule of false position*, otherwise called the *rule of falsehood*, in arithmetic, is a rule so called, because in calculating on several false numbers taken at random, as if they were the true ones, and from the differences found therein, the number sought is determined. This rule is either single or double. Single position is when there happens in the proposition some partition of numbers into parts proportional, in which case the question may be resolved at one operation, by this rule: Imagine a number at pleasure, and work therewith according to the tenor of the question, as if it were the true number; and what proportion there is between the false conclusion and the false proportion, such proportion the given number has to the number sought.

Therefore the number found by argumentation, shall be the first term of the rule of three; the second number supposed, the second term; and the given number, the third. See ARITHMETIC. Or the result is to be regulated by this proportion, viz. As the total arising from the error, to the true total, so is the supposed part, to the true one. Example: A, B, and C, designing to buy a quantity of lead to the value of 140*l*. agree that B shall pay as much again as A, and C as much again as B; what then must each pay?

Now suppose A to pay 10*l*. then B must pay 20*l*. and C 40*l*. the total of which is 70*l*. but it should be 140*l*. Therefore, if 70*l*. should be 140*l*. what should 10*l*. be?

Answer, 20*l*. for A's share, which doubled, makes 40*l*. for B's share, and that again doubled, gives 80*l*. for C's share, the total of which is 140*l*.

Double position, is when there can be no partition in the numbers to make a proportion. In this case, therefore, you must make a supposition twice, proceeding therein according to the tenor of the question. If neither of the supposed numbers solves the proportion, observe the errors, and whether they are greater or less than the supposition requires, and mark the errors accordingly with the sign + or —. See CHARACTER.

Then multiply contrariwise the one position by the other error; and if the errors are both too great, or both too little, subtract the one product from the other, and divide the difference of the products by the difference of the errors. If the errors are unlike, as the one + and the other —, add the products, and divide the sum thereof by the sum of the errors added together; for the proportion of the errors is the same with the proportion of the excesses or defects of the numbers supposed to be the numbers sought; or the suppositions and their errors being placed as before, work by this proportion as a general rule, viz. as the difference of the errors if alike, or their sum if alike, to the difference of the suppositions, so either error, to a fourth number; which accordingly added to or subtracted from the supposition against it, will answer the question.

POSITION, in geometry, is a term sometimes used in contradistinction to magnitude: thus, a line is said to be given in position, positione data, when its situation, bearing, or direction, with regard to some other line, is given; on the contrary, a line is given in magnitude when its length is given, but not its situation.

POSSE COMITATUS. See POWER OF THE COUNTY.

POSSESSION is two-fold, actual and in law. Actual possession is when a man actually enters into lands and tenements to him descended. Possession in law, is when the lands or tenements are descended to a man, and he has not as yet actually entered into them. Staundf. 198.

POST, a military station. Thus the detachments established in front of the army are termed out-posts; the stations on the wings of the army are said to be the posts of honour, as being the most conspicuous and most exposed. But in the operations of a campaign, a post properly signifies any spot of ground capable of lodging soldiers; or any situation, whether fortified or not, where a body of men may make a stand and engage the enemy to advantage. The great advantages of good posts, in carrying on war, as well as the mode of securing them, are only learned by experience. Barbarous nations disdain the choice of posts, or at least are contented with such as immediately fall in their way; they trust solely or chiefly to strength and courage: and hence the fate of a kingdom may be decided by the event of a battle. But enlightened and experienced officers make the choice of posts a principal object of attention. The use of them is chiefly felt in a defensive war against an invading enemy; as, by carrying on a war of posts in a country where this can be done to advantage, the most formidable army may be so harassed and reduced, that all its enterprises may be rendered abortive.

In the choice of a post, the general rules to be attended to are, that it should be convenient for sending out parties to reconnoitre, surprise, or intercept the enemy; that if possible it may have some natural defence, as a wood, a river, or a morass, in front or flank, or at least that it be difficult of access, and susceptible of speedy fortification; that it shall be so situated as to preserve a communication with the main army, and have covered places in the rear to favour a retreat; that it may command a view of all the approaches to it, so that the enemy cannot advance unperceived and rest concealed, while the detachment stationed in the posare forced to remain under arms; that it is not commanded by any neighbouring heights; and proportioned in extent to the number of men who are to occupy and defend it. It is not to be expected that all these advantages will often be found united; but those posts ought to be selected which offer the greatest number of them.

POST, an operation in book-keeping. See BOOK-KEEPING.

POST, a conveyance for letters or dispatches. England appears to be the first country in Europe, which formed a regular establishment for this purpose: though it was not till a late period that it assumed any thing like a regular form even here. In the reign of Edward VI., however, some species of posts must have been set up, as an act of parliament passed in 1548, fixing the rate of post-horses at one penny per mile: the post-horses here referred to were, it is probable, chiefly for travelling, and the carriage of letters or packets only an occasional service. In 1581, we find in Camden's Annals mention made of a chief postmaster for England being appointed. How his office was managed, does not clearly appear; the limited state of the correspondence of the country probably rendered it of trifling consequence. King James I. originally erected a post-office under the controul of one Matthew de Quester, or de l'Equester, for the conveyance of letters to and from foreign parts; which office was afterwards claimed by lord Stanhope, but was confirmed and continued to William Frizel and Thomas Witherings, by king Charles I., in 1632. Previous to this time, it would appear that private persons were in the habit of conveying letters to and from foreign parts; all such interference with the postmaster's office is, therefore, expressly prohibited. King Charles, in 1635, erected a letter-office for England and Scotland, under the direction of the above Thomas Witherings. The rates of postage then established were, two-pence for every single letter for a distance under 80 miles; four-pence from 80 to 140 miles; six-pence above 140 miles. The allowance to the post-masters on the road for horses employed in these posts, was fixed at two-pence halfpenny per mile for every single horse. All private inland posts were discharged at this time; and in 1637, all private foreign posts were in like manner prohibited. The posts thus established, however, extended only to a few of the principal roads; and the times of transmission were not in every case so certain as they ought to have been.

Witherings was superseded for abuses in the execution of his offices in 1640, and they were sequestrated into the hands of Philip Burlamachy, to be exercised under the care and oversight of the king's principal secretary of state. On the breaking out of the civil war, great confusions and interruptions were necessarily occasioned in the conduct of the letter-office; but it was about that time that the outline of the present more extended and regular plan seems to have been conceived by Mr. Edmond Prideaux, who was afterwards appointed attorney-general to the commonwealth. He was chairman of a committee in 1642, for considering the rate of postage to be set upon inland letters; and some time was appointed postmaster by an ordinance of both houses of parliament, in the execution of which office he first established a weekly conveyance of letters into all parts of the nation. In 1653, this revenue was farmed for 10,000*l.* for England, Scotland, and Ireland; and after the charge of maintaining postmasters, to the amount of 7000*l.* per annum was saved to the public. Prideaux's emoluments being considerable, the common council of London endeavoured to erect another post-office in opposition to his; but they were checked by a resolution of the house of commons, declaring that the office of postmaster is, and ought to be, in the sole power and disposal of the parliament. This office was farmed by one Maubey, in 1654. In 1656, a new and regular general post-office was erected by the authority of the Protector and his parliament, upon nearly the same model that has been ever since adopted, with the following rates of postage: for 80 miles distance, a single letter two-pence; for a greater distance, not out of England, three-pence; to Scotland, four-pence. By an act of parliament passed soon after the Restoration in 1660, the regulations settled in 1656 were re-established, and a general post-office similar to the former, but with some improvements, was erected. In 1663, the revenue of the post-office was found to produce 21,500*l.* annually. In 1685, it was made over to the king, as a branch of his private income, and was then estimated at 65,000*l.* per annum. The year after the Revolution, the amount of the post-office revenue was 90,504*l.* 10*s.* 6*d.* At the Union, the produce of the English post-office was stated to be 101,101*l.* In 1711, the former establishments of separate post-offices for England and Scotland were abolished; and by the stat. 9 Anne, c. 10. one general post-office, and one postmaster-general, were established for the whole united kingdom; and this postmaster was empowered to erect chief letter-offices at Edinburgh, at Dublin, at New York, and other proper places in America, and the West Indies. The rates of postage were also increased at this time, as follows: In England, for all distances under 80 miles, three-pence; above 80 miles, four-pence. From London to Edinburgh, six-pence. In Scotland, under 50 miles, two-pence; from 50 to 80 miles, three-pence; above 80 miles, four-pence. In Ireland, under 40 miles, two-pence; above 40 miles, four-pence. By the above act, all persons, except those employed by the postmaster, were strictly prohibited from conveying letters. That year the gross amount of the post-office was 111,461*l.* 17*s.* 10*d.* The net amount, on a medium of the three preceding years, was, in the printed report of the commissioners for the equivalent, stated to be for England, 62,000*l.*, and for Scotland, 2000*l.* In 1754, the gross revenue of the post-office for Great Britain amounted to 210,663*l.*; in 1764, to 281,535*l.*; and in 1774 to 345,321*l.* The privilege of franking letters had been enjoyed by members of parliament from the first erection of the post-office; the original design of this exemption was, that they might correspond freely with their constituents on the business of the nation. By degrees the privilege came to be shamefully abused, and was carried so far, that it was not uncommon for the servants of members of parliament to procure a number of franks for the purpose of selling them; an abuse which was easily practised, as nothing more was required for a letter's passing free than the subscription of a member on the cover. To restrain these frauds, it was enacted, in 1764, that no letter should pass free unless the whole direction was of the member's writing, and his subscription annexed. Even this was found too great a latitude; and by a new regulation in 1784, no letter was permitted to go free, unless the date was marked on the cover in the member's own handwriting, and the letter put into the office the same day. That year the rates of postage were raised in the following proportions: an addition of one penny for a single stage; one penny from London to Edinburgh; one penny for any distance under, and two-pence for any distance above 150 miles. An addition to the revenue of 120,000*l.* was estimated to arise from these regulations and additional rates. In all the statements of duties upon postage of letters given in this account, the rates mentioned are those upon single letters: double letters pay double, treble letters treble, an ounce weight quadruple postage; all above are charged by the weight, in the same proportion.

About the year 1784, a great improvement was made in the mode of conveying the mails, upon a plan first suggested in 1782, by Mr. John Palmer. Diligences and stage-coaches, he observed, were established to every town of note in the kingdom; and he proposed that government, instead of sending the mails in the old mode, by a boy on horseback, and in carts, should contract with the masters of these diligences to carry the mail, along with a guard for its protection. This plan, he shewed, could not fail to ensure much more expeditious conveyance, the rate of travelling in diligences being far quicker than the rate of the post; and it was easy to carry it into execution with little additional expence, as the coach-owners would have a strong inducement to contract at a cheap rate for conveying the mail, on account of the additional recommendation to passengers, their carriages would thereby acquire in point of security, regularity, and dispatch. Though government heartily approved of this plan, and the public at large were satisfied of its utility, yet, like all new schemes however beneficial, it met with a strong opposition: it was represented by a number of the oldest and ablest officers in the post-office, not only as impracticable, but dangerous to commerce and the revenue. Notwithstanding this opposition, however, it was at last established, and gradually extended to many different parts of the kingdom; and, upon a fair comparison, it appeared that the revenue was very considerably improved, though Mr. Palmer's numerous reforms, and the great number of new appointments which they rendered necessary, greatly increased the former expence of management. The conveyance of the mails on the new plan was contracted for, after the two first years trial, at 20,000*l.* per annum less than the sum first estimated by Mr. Palmer.

The present establishment of the general post-office for Great Britain, consists of a postmaster-general, to the duties of which station there have, for many years past, been two persons appointed, under the title of joint postmasters-general; a secretary; upwards of 150 assistants and clerks for the head letter-office in London, under the direction of a superintending president of the inland-letter department; and a comptroller of the foreign-letter office. Near 600 deputy-postmasters, throughout the kingdom, act under one principal and nine riding surveyors. There are also distinct offices and clerks, acting under an accountant-general and a receiver-general; as well as a separate establishment for the two-penny, formerly the penny-post, which, since the abolition of Mr. Palmer's appointment of surveyor and comptroller-general, has been new modelled and greatly improved in all its branches. There is likewise a postmaster-general of Scotland, with a secretary, comptroller, surveyors, and a separate establishment of all the requisite officers and clerks at Edinburgh, acting under the orders of the joint postmasters-general in London. The annual expence of management is about 150,000*l.* and the gross produce exceeds 700,000*l.* a year.

For the present rates of postage, and the laws respecting franking, see Letter.

No action can be maintained against the postmaster-general for the loss of bills or articles sent in letters by the post, and lost. Many attempts have been made by postmasters in country towns, to charge an halfpenny or penny each letter, on delivery at the houses in the town, above the parliamentary rates, under pretence that they were not obliged to carry letters out of the office gratis; but it has been repeatedly decided, that such demand is illegal, and that they are bound to deliver the letters to the inhabitants within the usual and established limits of the town, without any addition to the rate of postage. 5 Bur. 5709.

Post *two-penny*, a post established for the benefit of London, and other parts adjacent, whereby any letter or small parcel is speedily and safely conveyed to and from all places within the bills of mortality, or within ten miles of the city. It is now managed by the general post-office, and receiving-houses are established in most of the principal streets for the more convenient transmission of the letters.

Letters were originally conveyed by this office at the rate of one-penny; but the rate has been lately raised to two-pence, and for letters off the stones the rate is three-pence.

Post, a particular mode of travelling. A person is said to travel post, in contradistinction to common journey travelling, when, in place of going on during his whole journey in the same vehicle, and with the same horses, he stops at different stages, to provide fresh horses or carriages, for the sake of greater convenience and expedition. As he thus uses the same mode of travelling that is employed for the common post, he is said to travel post, or in post, *i. e.* in the manner of a post.

In tracing the origin of posts, it appears that the more antient establishments of this kind were fully as much for travelling stations as the conveyance of letters. The relays of horses provided at these public stations for the messengers of the prince, were occasionally, by special licence, allowed to be used by other travellers who had sufficient interest at court. Frequent demands of this nature would suggest the expedient of having in readiness supplies of fresh horses or carriages over and above what the public service required, to be hired out to other travellers on payment of an adequate price. We find, therefore, that in former times, the postmasters alone were in use to let out horses for riding post, the rates of which were fixed in 1548, by a statute of Edward VI., at one penny per mile. In what situation the state of the kingdom was with regard to travelling post for more than a century after this period, we cannot now certainly discover; but in the statute re-establishing the post-office in 1660, it is enacted, that none but the postmaster, his deputies, or assigns, shall furnish post-horses for travellers; with a proviso, however, that if he has them not ready in half an hour after being demanded, the traveller shall be at liberty to provide himself elsewhere. The same prohibition is contained in the act establishing the Scots post-office in 1695, as well as in the subsequent act of queen Anne, erecting the general office for the united kingdom. It is doubtful, however, whether it ever was strictly enforced. By an explanatory act of 26 Geo. II. the prohibition is confined to post horses only, and every person declared to be at liberty to furnish carriages of every kind for riding post. This regulation has, in fact, done away the prohibition, as hardly any person now thinks of travelling post, except in a carriage.

The rate fixed by the act 1695, in Scotland, for a horse riding post, was three-pence per Scotch mile. By the act 9. Anne, c. 10. three-pence a mile without, and four-pence a mile with, a guide, was the sum fixed for each horse riding post. The increase of commerce, and necessity for a speedy communication between different parts of the kingdom, have brought the mode of travelling post so much into use, that upon every great road in the kingdom, post chaises are now in readiness at proper distances; and the convenience of posting is enjoyed in Britain to a degree far superior to what is to be met with in any other country whatever.

Posting at last appeared to the legislature a proper object of taxation. In 1779 the first act was passed, imposing duties on horses hired either by themselves or to run in carriages travelling post; the duties were, one penny per mile on each horse if hired by the mile or stage, and one shilling per day if hired by the day. Every person letting out such horses was also obliged to take out a licence at five shillings per annum. These duties were next year repealed, and new duties imposed, of one penny per mile on each horse hired by the mile or stage, and one shilling and six-pence on each if hired by the day. A number of additional regulations were at the same time enacted for securing these duties. An addition of one halfpenny per mile, or three-pence per day, for each horse riding post, was imposed in 1785, by stat. 25 Geo. III. c. 51. The duty is secured by obliging every letter of horses to deliver to the person hiring them a ticket, expressing the number of horses hired, and either the distance in miles to be travelled, or that the horses are hired by the day, as the case happens to be. These tickets must be delivered to the bar-keeper at the first turnpike through which the traveller passes; and the turnpike-keeper gives, if demanded, what is termed an exchange ticket, to be produced at the next turnpike. The stamp-office issues to the person licenced to let post horses such a number of these tickets as is required, and these must be regularly accounted for by the person to whom they are issued. As an effectual check upon his account, the turnpike-keeper is obliged to return back to the stamp-office all the tickets he takes up from travellers. Evasions are by these means rendered difficult to be practised without running a great risk of detection. In 1787, for the more effectually levying the post-horse duties, a law was passed authorising the commissioners of the stamp-office to let them to farm by public auction, for a sum not less than the produce in the year ending 1st August 1786.

In the advertisement published by the commissioners in consequence of this law, previous to the receiving proposals for farming them, the total amount of the duty for Great Britain is stated to have been, at the period above referred to, 119,873*l.* The sum for which that duty was farmed in 1794, amouted in all to 140,030*l.* of which the district of North Britain was 6000*l.*

POST DISSEISIN, a writ for him that having recovered land or tenements by præcipe quod reddat, upon default of reddition is again disseised by the former disseisor.

POSTEA, is the return of the proceedings by nisi prius into the court of common pleas after a verdict, and there afterwards recorded. Plowd. 211.

POSTERN, in fortification, is a small gate generally made in the angle of the flank of a bastion, or in that of the curtin, or near the orillon, descending into the ditch; by which the garrison may march in and out unperceived by the enemy, either to relieve the works, or to make private sallies, &c.

POSTULATE, in mathematics, &c., is described to be such an easy, and self-evident supposition, as needs no explication or illustration to render it intelligible; as, that a right line may be drawn from one point to another.

POTAMOGETON, *pond-weed*, a genus of the tetrandria tetragynia class of plants, the corolla whereof consists of four roundish obtuse, hollow, patent, and unguiculated petals: there is no pericarpium; the seeds are four in number, roundish and accuminated, gibbous on one side, and compressed and angulated on the other. This plant has a refrigerating virtue, and is recommended in the cure of old ulcers. There are 14 species.

POTASS. If a sufficient quantity of wood is burnt to ashes, and these ashes afterwards washed repeatedly with water till it comes off free from any taste, and if this liquid is filtrated and evaporated to dryness, the substance which remains behind is potass; not, however, in a state of purity, for it is contaminated with several other substances, but sufficiently pure to exhibit many of its properties. In this state it occurs in commerce under the name of potash. When heated to redness, many of its impurities are burnt off; it becomes much whiter than before, and is then known in commerce by the name of pearl-ash. Still, however, it is contaminated with many foreign bodies, and is itself combined with carbonic acid gas, which blunts all its properties. It may be obtained perfectly pure by the following process:

1. Mix it with twice its weight of quick-lime, and ten times its weight of pure water. Boil the mixture for some hours in a clean iron vessel, or allow it to remain for 48 hours in a close glass vessel, shaking it occasionally. Then pass it through a filter. Boil the liquid obtained in a silver vessel very rapidly, till it is so much concentrated as to assume when cold the consistence of honey. Then pour upon it a quantity of alcohol equal in weight to one-third of the pearl-ash employed. Shake the mixture, put it on the fire, let it boil for a minute or two, then pour it into a glass ves-

sel and cork it up. The solution gradually separates itself into two strata: the lowest consists of the impurities, partly dissolved in water and partly in a solid state; the uppermost consists of the pure potass dissolved in alcohol, and is of a reddish-brown colour. Decant this alcohol solution into a silver bason, and evaporate it rapidly till a black charry crust forms on the surface, and the liquid below acquires such consistence as to become solid on cooling. Then remove the black crust, and pour the solution into a porcelain vessel. When cold, it concretes into a fine white substance, which is pure potass. It must be broken to pieces, and put into an air-tight phial.

For this process we are indebted to Berthollet. The following, which was proposed by Lowitz of Petersburgh, is less expensive. The potash of commerce and quicklime are to be boiled together as above described. The filtered liquor is then to be evaporated till a thick pellicle appears on its surface, and afterwards allowed to cool; and all the crystals which have formed are to be separated, for they consist of foreign salts. The evaporation is then to be continued in an iron pot; and, during the process, the pellicle which forms on the surface is to be carefully taken off with an iron skimmer. When no more pellicle appears, and when the matter ceases to boil, it is to be taken off the fire, and must be constantly agitated with an iron spatula while cooling. It is then to be dissolved in double its own weight of cold water. This solution is to be filtered and evaporated in a retort (not of glass, because potass in this state dissolves glass), till it begins to deposit regular crystals. If the mass consolidates ever so little by cooling, a small quantity of water is to be added, and it must be heated again. When a sufficient number of crystals have been formed, the liquor which swims over them, and which has assumed a very brown colour, must be decanted off, and kept in a well-closed bottle till the brown matter has subsided, and then it may be evaporated as before, and more crystals obtained.

The theory of these processes is obvious: the lime separates the carbonic acid, for which it has a stronger affinity; and the alcohol or the evaporation separate all the other foreign ingredients.

As potass is never obtained at first in a state of purity, but always combined with carbonic acid, it was long before chemists understood to what the changes produced upon it by lime were owing. At last, in 1756, Dr. Black proved, by the most ingenious and satisfactory analysis, that the potass which the world had considered as a simple substance, was really a compound, consisting of potass and carbonic acid; that lime deprived it of this acid; and that it became more active by becoming more simple.

That potass was known to the antient Gauls and Germans cannot be doubted, as they were the inventors of soap, which, Pliny informs us, they composed of ashes and tallow. These ashes (for he mentions the ashes of the beech tree particularly), were nothing else but potass; not, however, in a state of purity. The κονια, too, mentioned by Aristophanes and Plato, appears to have been a ley made of the same kind of ashes. The alchymists were well acquainted with it; and it has been in every period very much employed in chemical researches. It was long distinguished among us by the name of vegetable alkali, because it is obtained from vegetables, and because it was long thought to be peculiar to the vegetable kingdom; but this is now known to be a mistake. It was called also salt of tartar, because it may be obtained by burning the salt called tartar. Mr. Kirwan has given it the name of tartarin, Dr. Pearson has called it vegalkali, Klaproth kali, and Dr. Black lixiva. By most British chemists it is called potash: but this term, in common language, signifies the carbonat of potass, or the potass of commerce. For in fact, till Berthollet published his process in the year 1786, chemists had never examined potass in a state of complete purity.

2. Potass is a brittle substance of a white colour, and a smell resembling that which is perceived during the slacking of quicklime. Its taste is remarkably acrid; and it is so exceedingly corrosive, that when applied to any part of the body, it destroys it almost instantaneously. On account of this property, it has been called caustic, and is often used by surgeons under the name of the potential cautery, to open abcesses, and to destroy useless or hurtful excrescences. Its specific gravity is 1.70.

When heated it melts; at a red heat it swells, and evaporates slowly in a white acrid smoke. A strong heat gives it a greenish tinge, but produces no other alteration in it. Potass is not altered by exposure to light.

When exposed to the air, it soon attracts moisture, and is converted into a liquid; at the same time it combines with carbonic acid, for which it has a strong affinity.

3. It has a very strong affinity for water. At the common temperature of the air, one part of water dissolves two parts of potass. The solution is transparent, very dense, and almost of the consistence of oil. It is in this state that potass is usually employed by chemists. When four parts of potass in powder, and one of snow are mixed together, the mixture becomes liquid, and at the same time absorbs a quantity of caloric. This mixture was employed by Lowitz to produce artificial cold. When the aqueous solution of potass is evaporated to a proper consistency, the potass crystallizes. The shape of its crystals is very different, according to the way in which they have been produced. When allowed to form spontaneously, they are octahedrons in groups, and contain 0.43 of water. When formed by evaporation on the fire, they assume the figure of very thin transparent blades of extraordinary magnitude, which, by an assemblage of lines crossing each other in prodigious numbers, present an aggregate of cells or cavities, commonly so very close, that the vessel may be inverted without losing one drop of the liquid which it contains.

4. Potass shews no disposition to unite with oxygen, neither is it altered by the action of any of the compounds into which oxygen enters, though it has a strong tendency to unite with several of these compounds.

5. It unites with none of the simple combustibles except sulphur. Carbon and hydrogen do not act upon it at all; neither does it produce any alteration in them, but it acts upon phosphorus with considerable energy.

When three parts of sulphur and one of potass are triturated together in a glass mortar, the sulphur acquires a green colour, the mixture becomes hot, and exhales an aliaceous odour. It gradually attracts moisture from the air, and is totally soluble in water. When two parts of potass and one of sulphur are heated in a crucible, they melt and combine, and form sulphuret of potass. The potash of commerce may be also employed; for the carbonic acid separates in the form of a gas during the combination of the potass and sulphur. When the fusion is complete, the sulphuret is to be poured upon a marble slab; and as soon as it congeals, it must be broken to pieces, and set by into a well-corked phial.

Sulphuret of potass, thus prepared, is of a brown colour, not unlike the liver of animals. Hence it was formerly called hepar sulphuris, "liver of sulphur;" but when exposed to the air, it soon becomes green, and even white. It is hard, brittle, and has a glassy fracture. Its taste is acrid, caustic, and bitter, and it leaves a brown stain upon the skin. It has no other smell than that of sublimed sulphur. When exposed to a violent heat the sulphur sublimes, and the potass remains in a state of purity. This sulphuret converts vegetable blues to green, and soon destroys them. When heated with charcoal, it dissolves, and combines with it.

When sulphuret of potass is exposed to the air, or when it is moistened with water, its properties very soon change. It acquires a green colour, and exhales the odour of sulphureted hydrogen gas. This change is owing to the formation of a quantity of sulphureted hydrogen, in consequence of the decomposition of the water. This new-formed substance combines with the sulphuret, and converts it into hydrogenated sulphuret of potass, which is soluble in water, and has a brownish green colour. It may be formed also by boiling in water two parts of potass and one part of sulphur. Sulphuret of potass produces no change upon air, but hydrogenated sulphuret gradually absorbs oxygen. When inclosed in a vessel with a quantity of air, it soon absorbs all the oxygen of that portion, and leaves nothing but azotic gas. This fact, which was first observed by Scheele, induced him to use hydrogenated sulphuret to measure the quantity of oxygen contained in any given portion of atmospheric air. Hydrogenated sulphuret is capable of oxydizing and dissolving almost all the metals. We are indebted to M. Berthollet for the first accurate account of the difference between these two substances.

Potass cannot be combined with phosphorus by any method at present known. But when potass, dissolved in water, is heated over phosphorus in a retort, the water is gradually decomposed, part of the phosphorus is converted into phosphoric acid, and a great quantity of phosphureted hydrogen gas is emitted, which takes fire as usual as soon as it comes into contact with the air of the atmosphere. It was by this process that Gemgembre first obtained phosphureted hydrogen gas.

6. It does not appear that potass is capable of uniting with azote, or even of acting on it at all; but with muriatic acid it unites very readily, and forms the compound known by the name of muriat of soda.

7. Potass does not combine with any of the metals; but some of the metals which

have a strong affinity for oxygen, when put into a solution of potass in water, especially if heat is applied, are gradually oxydized. This is the case with molybdenum, zinc, and iron. Tin also is oxydized in a very small proportion; and this seems also to be the case with manganese.

It is capable of dissolving a considerable number of the metallic oxides; and in some cases it deprives them of a dose of their oxygen. Thus, when poured upon the red oxide of iron it soon converts it into the black. The cause of this change is unknown. It has been ascertained, that the oxides of the following metals are soluble in potass.

Tin,	Arsenic,
Nickel,	Cobalt,
Zinc,	Manganese,
Antimony,	Tungsten,
Tellurium,	Molybdenum.

But the nature of these solutions has not hitherto been examined with any degree of attention; though the subject is remarkably curious, and promises to throw light both upon the nature of alkalies and metals.

The affinities of potass are as follow:

Sulphuric acid,	Citric,
Nitric,	Lactic,
Muriatic,	Benzoic,
Phosphoric,	Sulphurous,
Fluoric,	Acetic,
Oxalic,	Saclactic,
Tartaric,	Boracic,
Arsenic,	Carbonic,
Succinic,	Prussic.

Potass has never yet been decomposed. Several chemists, indeed, have conjectured, that it is a compound of lime and azote; and some persons have even endeavoured to prove this by experiment; but none of their proofs are at all satisfactory. We ought, therefore, perhaps, in strict propriety, to have assigned it a place among our enumeration of simple bodies in the article chemistry; but as it is excluded by most of the foreign chemists, we thought it least likely to promote confusion to follow their arrangement. Besides, we are certain, from a variety of facts, that all the alkalies are compounds. One of them has actually been decompounded; and the other two have been detected in the act of formation, though the ingredients which compose them have not hitherto been discovered. Morveau and Desormes indeed announced, some time ago, that they considered potass as a compound of hydrogen and lime. Their chief proofs were the appearance of lime, when the salt, composed of hyperoxygenized muriatic acid and potass, is strongly heated with phosphoric acid in a crucible of platinum; and a manifest combustion together with the deposition of lime, when charcoal and potass are in like manner exposed to a strong heat in a platinum crucible. But these, and the other experimental proofs, being examined by Darracq, that accurate chemist ascertained that the results obtained by Desormes and Morveau were owing, in most cases, to the impurity of the potass with which they had made their experiments; while in others, they had drawn wrong inferences from mistaken resemblances. Their hypothesis of course cannot be maintained.

Potass is of the highest importance, not only in chemistry, where it is employed for a great variety of purposes, but also in many arts, and manufactures; as washing, bleaching, dying, glass-making, and others, as will appear on an inspection of these articles. It is employed also in surgery and medicine.

POTATOE. See SOLANUM.

POTENT, or POTENCE, in heraldry, a term for a kind of a cross, whose ends all terminate like the head of a crutch.

POTENTILLA, *silver-weed, wild tansey*, or *cinquefoil*, a genus of the pentagynia order, in the icosandria class of plants, and in the natural method ranking under the 35th order senticosæ. The calyx is decemfid; there are five petals; the seeds roundish, naked, and affixed to a small dry receptacle. There are 32 species, the most noted are:

1. The fruticosa, or shrubby potentilla, commonly called shrub-cinquefoil. This is a beautiful deciduous flowering shrub, worthy a place in every curious collection. It grows wild in Yorkshire, and other northern parts of England, &c. but has been long cultivated in gardens as an ornamental shrub. 2. The reptans, or creeping common five-leaved potentilla, or five-leaved grass. 3. The rupestris, or mountain upright cinquefoil, having the stalks terminated by small white flowers. 4. The recta, or erect seven-lobed yellow cinquefoil, has the stalks terminated by corymbose clusters of yellow flowers. 5. The fragaroides, or strawberry-like trailing potentilla. This species bears a great resemblance to the small sterile strawberry plants. 6. The argentea, silvery upright potentilla, with small yellow flowers,

All these plants flower in June and July; the flowers are composed each of five roundish petals, and about 20 stamina. They are all very hardy, and may be employed in the different compartments of the pleasure ground. Their propagation is very easy.

POTERIUM, *garden burnet*, a genus of the polyandria order, in the monœcia class of plants, and in the natural method ranking under the 54th order, miscellaneæ. The male calyx is tetraphyllous; the corolla quadripartite; and there are from 30 to 40 stamina. The female calyx is tetraphyllous; the corolla quadripartite; there are two pistils; the berry is formed of the indurated tube of the corolla. There are five species, the most remarkable are: 1. The sanguisorba, or common garden burnet. This species grows wild in England in chalky soils, but has been long cultivated as a sallad-herb for winter and spring use, it being of a warm nature; the young leaves are the useful parts. It is perennial in root, and retains its radical leaves all the year, but the stalks are annual. 2. The hybridum, hybrid agrimony-leaved Montpelier burnet. This species often proves biennial; but, by cutting down some of the stalks before they flower, it will cause it to multiply at bottom, and become abiding. 3. Poterium spinosum, shrubby spinous burnet of Crete.

Burnet is of a cordial nature; in summer, the leaves are used for cool tankards, to give the wine an agreeable flavour. The powder of the root of the first species is commended against spitting of blood, bleeding at the nose, dysenteries, and diseases attended with violent secretions. In winter and spring, the young tender leaves are used in salads. Its uses as food for cattle are well known.

POTHOS, a genus of the polyandria order, in the gynandria class of plants. The spatha or sheath is a simple spadix covered; there is no calyx, but four petals, and as many stamina; the berries dispermous.

POTSTONE, a mineral found in nests and beds, and is always amorphous. Its structure is often slaty; fracture undulatingly foliated, greasy and brittle. Specific gravity from 2.85 to 3.02. Colour grey, with a shade of green, and sometimes of red or yellow, sometimes leek-green and sometimes speckled with red. Potstone is not much affected by the fire, and is made into utensils for boiling water: hence its name. It consists of

38	magnesia
38	silica
7	alumina
5	iron
1	carbonat of lime
1	fluoric acid.

POTTERY, the manufacture of earthen ware, or the art of making earthen vessels. In a general sense, therefore, it applies to all the different branches. See DELFT-WARE, STONE-WARE, and PORCELAIN, &c. In a more particular sense it is confined to the coarser kinds, such as the making of garden-pots, &c. The wheel and lathe are the chief and almost the only instruments in pottery: the first for large works, and the last for small. The potter's wheel consists principally in the nut, which is a beam or axis, whose foot or pivot, plays perpendicularly on a freestone sole or bottom. From the four corners of this beam, which does not exceed two feet in height, arise four iron bars, called the spokes of the wheel; which forming diagonal lines with the beam, descend, and are fastened at bottom to the edges of a strong wooden circle, four feet in diameter, perfectly like the felloe of a coach-wheel, except that it has neither axis nor radii, and is only joined to the beam, which serves it as an axis by the iron bars. The top of the nut is flat, of a circular figure, and a foot in diameter; and on this is laid the clay which is to be turned and fashioned. The wheel thus disposed is encompassed with four sides of four different pieces of wood fastened on a wooden frame; the hind-piece, which is that on which the workman sits, is made a little inclining towards the wheel; on the fore-piece is placed the prepared earth; on the side-pieces he rests his feet, and these are made inclining to give him more or less room. Having prepared the earth, the potter lays a round piece of it on the circular head of the nut, and, sitting down, turns the wheel with his feet till it has got the proper velocity; then, wetting his hands with water, he presses his fist or his fingers-ends into the middle of the lump, and thus forms the cavity of the vessel, continuing to widen it from the middle; and thus turning the inside into form with one hand, while he proportions the outside with the other, the wheel constantly turning all the while, and he wetting his hands from time to time. When the vessel is too thick, he uses a flat piece of iron, somewhat sharp on the edge, to pare off what is redundant; and when it is finished, it is taken off from the circular head by a wire passed under the vessel.

The potter's lathe is also a kind of wheel, but more simple and slight than the former; its three chief members are an iron beam or axis three feet and a half high, and two feet and a half in diameter, placed horizontally at the top of the beam, and serving to form the vessel upon; and another larger wooden wheel, all of a piece, three inches thick, and two or three feet broad, fastened to the same beam at the bottom, and parallel to the horizon. The beam or axis turns by a pivot at the bottom in an iron stand. The workman gives the motion to the lathe with his feet, by pushing the great wheel alternately with each foot, still giving it a greater or lesser degree of motion as his work requires. They work with the lathe with the same instruments, and after the same manner as with the wheel. The mouldings are formed by holding a piece of wood or iron, cut in the form of the moulding to the vessel, while the wheel is turning round; but the feet and handles are made by themselves, and set on with the hand; and if there is any sculpture in the work, it is usually done in wooden moulds, and stuck on piece by piece on the outside of the vessel. For the glazing of the work, see GLAZING, Vol. 1, page 853.

POUNCE, gum sandarach pounded and sifted very fine, to rub on paper, in order to preserve it from sinking, and to make it more fit to write upon. Pounce is also a little heap of charcoal dust, inclosed in a piece of muslin or some other open stuff, to be passed over holes pricked in a work, in order to mark the lines or designs on paper, silk, &c. placed underneath; which are to be afterwards finished with a pen and ink, a needle, or the like. This kind of pounce is much used by embroiderers, to transfer their patterns upon stuffs; by lace-makers, and sometimes also by engravers.

POUND, a standard-weight, for the proportion and subdivisions of which, see WEIGHT.

POUND also denotes a money of account; so called because the antient pound of silver weighed a pound troy. See MONEY.

POURSUIVANT, or PURSUIVANT, in heraldry, the lowest order of officers at arms. The poursuivants are properly attendants on the heralds, when they marshal public ceremonies. Of these, in England, there were formerly many, but at present there are only four, viz. blue-mantle, rouge-cross, rouge-dragon, and portcullice. In Scotland, there is only one king at arms, who is stiled lion, and has no less than six heralds, and as many poursuivants, and a great many messengers at arms under him.

POWER, in mechanics, denotes any force, whether of a man, a horse, a spring, the wind, water, &c. which being applied to a machine, tends to produce motion.

POWERS, in arithmetic and algebra, are nothing but the products arising from the continual multiplication of a number, or quantity, into itself: thus, 2, 4, 8, 16, 32, &c. are the powers of the number 2; and a, a^2, a^3, a^4, &c. the powers of the quantity a; which operation is called involution.

Powers of the same quantity are multiplied by only adding their exponents, and making their sum the exponent of the product: thus, $a^4 \times a^5 = a^{4+5} = a^9$. Again, the rule for dividing powers of the same quantity, is to subtract the exponents, and make the difference the exponent of the quotient: thus, $\frac{a^6}{a^4} = a^{6-4} = a^2$.

Negative powers, as well as positive, are multiplied by adding, and divided by subtracting their exponents, as above. And, in general, any positive power of a, multiplied by a negative power of a, of an equal exponent, gives unit for the product; for the positive and negative destroy each other, and the product is a^0, which is equal to unit. Likewise, $\frac{a^{-5}}{a^{-2}} = a^{-5+2} = a^{-3} = \frac{1}{a^3}$; and $\frac{a^{-2}}{a^{-5}} = a^{-2+5} = a^3 = \frac{1}{a^{-3}}$. And, in general, any quantity placed in the denominator of a fraction, may be transposed to the numerator, if the sign of its exponent be changed: thus, $\frac{1}{a^3} = a^{-3}$, and $\frac{1}{a^{-3}} = a^3$.

The quantity a^m expresses any power of a, in general; the exponent m being undetermined: and a^{-m} expresses $\frac{1}{a^m}$, or a negative power of a, of an equal exponent: and $a^m \times a^{-m} = a^{m-m} = a^0 = 1$. Again, a^n expresses any other power of a; and $a^m \times a^n = a^{m+n}$, and $\frac{a^m}{a^n} = a^{m-n}$.

To raise any simple quantity to its second, third, or fourth power, is to add its exponent twice, thrice, or four times to itself; so that the second power of any quantity is had by doubling its exponent; and the third, by tripling its exponent; and, in general, the power expressed by m, of any quantity, is had by multiplying the exponent by m: thus the second power, or square of a, is $a^{2\times1} = a^2$; its third power, $a^{3\times1} = a^3$; and the mth power of a, is $a^{m\times1} = a^m$. Also the square of a^4, is $a^{2\times4} = a^8$; the cube of a^4, is $a^{3\times4} = a^{12}$; and the mth power of a^4, is $a^{4\times m}$. The square of abc, is $a^2b^2c^2$; its cube $a^3b^3c^3$; and the mth power, $a^m b^m c^m$. See ALGEBRA.

POWER, in law, is an authority which one man gives to another to act for him; and it is sometimes a reservation which a person makes in a conveyance for himself to do some acts, as to make leases or the like. 2 Lil. Abr. 339. Thus power of attorney, an instrument or deed whereby a person is authorized to act for another, either generally, or in a specific transaction. See AGENT, BROKER, DEED.

POWER *of the county*, contains the aid and attendance of all knights, gentlemen, yeomen, labourers, servants, apprentices, and all others above the age of fifteen years within the county. This the sheriff at any time may raise to assist him in the execution of a precept of restitution. The power of the county is also called the posse comitatus.

POX, or SMALL-POX. See MEDICINE.

PRACTICE, or rules of practice, are certain compendious ways of working the rule of proportion, or golden rule. See ARITHMETIC.

PRÆCIPE, a writ commanding the defendant to do the thing required, or to shew cause why he hath not done it.

PRÆMUNIRE. This punishment is inflicted upon him who denies the king's supremacy the second time; upon him who affirms the authority of the pope, or refuses to take the oath of supremacy; upon such as are seditious talkers of the inheritance of the crown; and upon such as affirm that there is any obligation by any oath, covenant, or engagement whatsoever, to endeavour a change of government either in church or state; or that both or either house or parliament have or has a legislative power without the king, &c.

The judgment in præmunire at the suit of the king, against the defendant being in prison, is, that he shall be out of the king's protection; that his lands and tenements, goods and chattles, shall be forfeited to the king; and that his body shall remain in prison at the king's pleasure; but if the defendant is condemned upon his default of not appearing, whether at the suit of the king or party, the same judgment shall be given as to the being out of the king's protection and the forfeiture; but instead of the clause that the body shall remain in prison, there shall be an award of a capiatur. Co. Lit. 129. Upon an indictment of a præmunire, a peer of the realm shall not be tried by his peers. 12 Co. 92.

PRAGMATIC SANCTION, in the civil law, is defined to be a rescript, or answer of the sovereign, delivered by advice of his council, to some college, order, or body of people, upon consulting him on some case of their community. The like answer given to any particular person, is called simply rescript.

The term pragmatic sanction, is chiefly applied to a settlement of Charles VI. emperor of Germany, who, in the year 1722, having no sons, settled his hereditary dominions on his eldest daughter, the archduchess Maria Theresa, which was confirmed by the diet of the empire, and guaranteed by Great Britain, France, the States-General, and most of the powers in Europe.

PRASE, in mineralogy. See QUARTZ.

PRASIUM, in botany, a genus of the gymnospermia order, in the didynamia class of plants, and in the natural method ranking under the 42d order verticillatæ. There are four monospermous berries. There are two species.

PREBENDARY, an ecclesiastic who enjoys a prebend. The difference between a prebendary and a canon is, that the former receives his prebend in consideration of his officiating in the church; but the latter merely by his being received into the cathedral or college.

PRECEDENCE, or PRECEDENCY, a place of honour to which a person is entitled: this is either of courtesy or of right. The former is that which is due to age, estate, &c. which is regulated by custom and civility: the latter is settled by authority, and when broken in upon gives an action at law. The following table will exhibit the order of precedency:

A table of precedency of men and women.

The king.
Prince of Wales.
King's sons.
King's brothers.
King's uncles.
King's grandsons.
King's brothers or sisters sons.

Archbishop of Canterbury, lord primate of all England.
Lord high chancellor, or lord keeper.
Archbishop of York, primate of England.
Lord high treasurer. | Being of the degree of barons.
Lord president of the privy council,
Lord privy seal,
Lord high constable.
Earl marshal.
Lord high admiral.
Lord steward of his majesty's household.
Lord chamberlain of his majesty's household.
Dukes according to their patents.
Marquisses according to their patents.
Dukes eldest sons.
Earls according to their patents.
Marquisses eldest sons.
Dukes younger sons.
Viscounts according to their patents.
Earls eldest sons.
Marquisses younger sons.
Bishops of London, Durham, Winchester, and all other bishops according to their seniority of consecration.
Barons according to their patents.
Speaker of the house of commons.
Viscounts eldest sons.
Earls younger sons.
Barons eldest sons.
Knights of the garter.
Privy councillors.
Chancellor of the exchequer.
Chancellor of the duchy of Lancaster.
Lord chief justice of the king's bench.
Master of the rolls.
Lord chief justice of the common pleas.
Lord chief baron of the exchequer.
Judges and barons of the degree of the coife of the said court according to seniority.
Bannerets made by the king himself in person under the royal standard displayed in an army royal, in open war, for the term of their lives and no longer.
Viscounts younger sons.
Barons younger sons.
Baronets.
Bannerets not made by the king himself in person.
Knights of the Bath.
Knights batchelors.
Eldest sons of the younger sons of peers.
Baronets eldest sons.
Knights of the garter's eldest sons.
Bannerets eldest sons.
Knights of the bath's eldest sons.
Knights eldest sons.
Baronets younger sons.
Esquires of the king's body.
Gentlemen of the privy-chamber.
Esquires of the knights of the bath.
Esquires by creation.
Esquires by office.
Younger sons of knights of the garter.
Younger sons of bannerets of both kinds.
Younger sons of knights of the bath.
Younger sons of knights batchelors.
Gentlemen entitled to bear arms.
Clergymen, barristers at law, officers in the navy and army, who are all gentlemen by profession.
Citizens.
Burgesses.

A table of precedency of women.

The queen.
Princess of Wales.
Princesses daughters of the king.
Princesses and duchesses, wives of the king's sons.
Wives of the king's brothers.
Wives of the king's uncles.
Wives of the eldest sons of dukes of the blood royal.
Daughters of dukes of the blood royal.
Wives of the king's brothers or sisters sons.
Duchesses.
Marchionesses.
Wives of the eldest sons of dukes.
Daughters of dukes.
Countesses.
Wives of the eldest sons of marquisses.
Daughters of marquisses.
Wives of the youngest sons of dukes.
Viscountesses.
Wives of the eldest sons of earls.
Daughters of earls.
Wives of the younger sons of marquisses.
Baronesses.
Wives of the eldest sons of viscounts.
Daughters of viscounts.
Wives of the younger sons of earls.
Wives of the eldest sons of barons.
Daughters of barons.
Maids of honour.
Wives of the younger sons of viscounts.
Wives of the younger sons of barons.
Baronetesses.
Wives of knights of the garter.
Wives of bannerets of each kind.
Wives of the knights of the bath.
Wives of knights batchelors.
Wives of the eldest sons of the younger sons of peers.
Wives of the eldest sons of baronets.
Daughters of baronets.
Wives of the eldest sons of knights of the garter.
Daughters of knights of the garter.
Wives of the eldest sons of bannerets.
Daughters of bannerets.
Wives of the eldest sons of knights of the bath.
Daughters of knights of the bath.
Wives of the eldest sons of knights bachelors.
Daughters of knights bachelors.
Wives of the younger sons of baronets.
Daughters of knights.
Wives of the esquires of the king's body.
Wives of the esquires to the knights of the bath.
Wives of esquires by creation.
Wives of esquires by office.
Wives of the younger sons of knights of the garter.
Wives of the younger sons of bannerets.
Wives of the younger sons of knights of the bath.
Wives of the younger sons of knights bachelors.
Wives of gentlemen entitled to bear arms.
Daughters of esquires entitled to bear arms, who are gentlewomen by birth.
Daughters of gentlemen entitled to bear arms, who are gentlewomen by birth.
Wives of clergymen, barristers at law, officers in the navy and army.
Wives of citizens.
Wives of burgesses.

PRECEPT, in law, a command in writing sent by a chief justice, justice of the peace, &c. for bringing a person, record, or other matter, before him.

Precept is also used for the command or incitement by which one man stirs up another to commit felony, theft, &c.

PRECESSION. See EQUINOXES.

PRECIPITATION, a process in chemistry, which is a separation whereby the particles of a body dissolved and suspended in any liquor, are detached from it and fall down to the bottom of the vessel. See CHEMISTRY.

PRECORDIA. See ANATOMY.

PREDIAL TITHES, those which are paid of things arising and growing from the ground only, as corn, hay, fruit of trees, and the like.

PREDICATE, in logic, that part of a proposition which affirms or denies something of the subject: thus, in these propositions, snow is white, ink is not white, whiteness is the predicate which is affirmed of snow, and denied of ink. See PROPOSITION.

It is a celebrated law in predicates, that nothing is esteemed to be absolutely affirmed of another, unless it is affirmed in such a manner as wants nothing either in the subject, predicate, or copula to make it true. This also is a noted property of a predicate, that it contains in some measure its own subject; thus, metal contains gold, silver, copper, &c. of which it is predicated. Every predicate is indeed an attribute; but every attribute is not a predicate; thus, soul, learning, are attributed to man, but not predicated of him.

PREGNANCY, is a plea in stay of execution, when a woman is convicted of a capital crime, alledging that she is with child; in which case, the judge must direct a jury of twelve discreet women to enquire of the fact; and if they bring in their verdict quick with child (for barely with child is not sufficient), execution shall be staid generally, till either she is delivered, or proves by the course of nature, not to have been with child. 4 Black. 395.

PREHNITE. Though this stone had been mentioned by Sage, Romé de Lisle, and other mineralogists, Werner was the first who properly distinguished it from other minerals, and made it a distinct species. The specimen which he examined was brought from the Cape of Good Hope by Colonel Prehn; hence the name prehnite, by which he distinguished it. It was found near Dunbarton by Mr. Grotche; and since that time it has been observed in other parts of Scotland.

It is both amorphous and crystallized. The crystals are in groups, and confused; they seem to be four-sided prisms with dihedral summits. Sometimes they are irregular six-sided plates, and sometimes flat rhomboidal parallelopipeds

Its texture is foliated; fracture uneven; internal lustre pearly; brittle. Specific gravity 2.6 to 2.69. Colour apple green, or greenish grey. Before the blow-pipe it froths more violently than zeolite, and melts into a brown enamel. A specimen of prehnite, analysed by Klaproth, was composed of

43.83	silica
30.33	alumina
18.33	lime
5.66	oxide of iron
1.16	air and water
99.31.	

Whereas Mr. Hassenfratz found in another specimen

50.0 silica
20.4 alumina
23.3 lime
4.9 iron
.9 water
.5 magnesia

100.0.

The mineral known by the name of koupholite is a variety of the prehnite.

PREMISSES, is that part of the beginning of a deed, the office of which is to express the grantor and grantee, and the land or thing granted. 5 Rep. 55. See DEED.

PREMNA, a genus of the didynamia angiospermia class and order. The calyx is two-lobed; corolla four-cleft; berry four-celled; seeds solitary. There are two species, small trees of the East Indies.

PREMUNIRE. See PRÆMUNIRE.

PREANTHES, in botany, a genus of the polygamia æqualis order, in the syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The receptacle is naked; the calyx calyculated; the pappus is simple, and almost sessile; the florets are placed in a single series. There are 19 species, some of them natives of England.

PREPENSE, in law, denotes fore-thought: thus, when a man is slain upon a sudden quarrel, if there was malice prepense formerly between them, it makes it murder.

PREPUSE. See ANATOMY.

PREROGATIVE, is a word of large extent, including all the rights and privileges which by law the king has as chief of the commonwealth, and as intrusted with the execution of the laws. 4 Back. Abr. 149.

All jurisdiction exercised in these kingdoms that are in obedience to our king, is derived from the crown; and the laws, whether of a temporal, ecclesiastical, or military nature, are called his laws; and it is his prerogative to take care of the due execution of them. Hence all judges must derive their authority from the crown, by some commission warranted by law; and must exercise it in a lawful manner, and without any the least deviation from the known and stated forms.

The king, as the fountain of justice, has an undoubted prerogative in erecting officers, and all officers are said to derive their authority mediately, or immediately from him; but though all such officers derive their authority from the crown, and whence the king is termed the universal officer or disposer of justice, yet it has been held, that he has not the office in him to execute it himself, but is only to grant or nominate; nor can the king grant any new powers or privileges to any such officers, but they must execute their offices according to the rules established and prescribed them by law. Co. Lit. 114.

PREROGATIVE COURT, the court wherein all wills are proved, and all administrations taken which belong to the archbishop by his prerogative; that is in case where the deceased had goods of any considerable value out of the diocese wherein he died; and that value is ordinarily 5*l.* except it is otherwise by composition between the said archbishop and some other bishop, as in the diocese of London it is 10*l.* and if any contention grow between two or more, touching any such will or administration, the cause is properly debated and decided in this court. 4 Inst. 335.

PRESBYTERIANS, a sect of protestants, so called from their maintaining that the government of the church appointed in the new testament was by presbyteries; that is, by ministers and ruling elders, associated for its government and discipline.

The presbyterians affirm that there is no order in the church as established by Christ and his apostles, superior to that of presbyters; that all ministers being ambassadors of Christ, are equal by their commission; and that elder or presbyter, and bishop are the same in name and office, for which they alledge, Acts xx. 28, &c. The only difference between them and the church of England, relates to discipline and church government. Their highest assembly is a synod, which may be provincial, national, or œcumenical; and they allow of appeals from inferior to superior assemblies, according to Acts xv. 2, 6, 22, 23. The next assembly is composed of a number of ministers and elders, associated for governing the churches within certain bounds. This authority they found upon Acts xi. 30, Acts xv. 4, 6, &c. The lowest of their assemblies or presbyteries, consists of the minister and elders of a congregation, who have power to cite before them any member, and to admonish, instruct, rebuke, and suspend him from the eucharist. They have also a deacon, whose office is to take care of the poor.

The ordination of their ministers is by prayer, fasting, and imposition of the hands of the presbytery. This is now the discipline of the church of Scotland.

But the appellation presbyterian, is in England appropriated to a large denomination of dissenters, who have no attachment to the Scotch mode of church government any more than to episcopacy among us; and, therefore, to this body of Christians the term presbyterian is improperly applied. English presbyterians adopt the same mode of church government with the independents. See INDEPENDENTS.

PRESCRIPTION, in law, is a right or title acquired by use and time, introduced for assuring the property of effects, in favour of persons who have for a certain time had them in their possession. Prescription has been called a penalty imposed by the laws upon negligence; but the law of prescription does not punish the indolence of proprietors, but only interprets their silence for their consent, presuming that a man who neglects to assert his right for a series of years, gives it up. In the common law, prescription is usually understood of a possession from time immemorial, or beyond the memory of man; but in the civil law, and even in our statute law, there are prescriptions of a much shorter date. The things a person may make title to by prescription are, a fair, market, toll, way, water, rent, common, park, warren, franchise, court-leet, waifs, estrays, &c. There is likewise a prescription against actions and statutes: thus, by the 31 Eliz. c. 1. it is ordained that all actions, &c. that are brought upon statutes, the penalty whereof belongs to the king, shall be brought within two years after the offence is committed, or shall be void. By our statutes also, a judge or clerk convicted of false entering of pleas, &c. may be sued within two years; but the crime of maintenance or embracery, whereby perjury is committed by a jury, must be prosecuted within six days, or otherwise the parties prescribe. See the article LIMITATION.

PRESENTATION, in law, the act of a patron offering his clerk to be instituted in a benefice of his gift, the same being void. All persons that have ability to make a purchase or grant, may also present to vacant benefices in their gift; though where a clergyman is patron of a church, he cannot present himself, but may pray to be admitted by the bishop, and the admission shall be effectual. An infant of any age may also present in his own name; but a presentation by a feme covert must be in the name of both husband and wife. As coparceners make but one patron, they are either to present jointly, or the eldest may present first, and the rest in their turn. Joint-tenants must also join in a presentation; and when a corporation presents, it must be under their common seal. Aliens born and papists cannot present to benefices, which are presented to by the universities; but a popish recusant may grant his patronage to another, who may present where there is no fraud. A patron may revoke his presentation before institution, but not afterwards; and a right of presenting to the next avoidance of a church, whether granted by will or deed, will pass; but a presentation whilst the church is full, is judged void.

PRESENTMENT *of offences*, is that which the grand jury find of their own knowledge, and present to the court, without any bill of indictment laid before them at the suit of the king, as a presentment of a nuisance, a libel, and the like, upon which the officer of the court must afterwards frame an indictment before the party presented can be put to answer it. There are also presentments by justices of the peace, constables, surveyors of the highways, church-wardens, &c.

PRESIDENT, an officer created or elected to preside over a company, in contradistinction to the other members, who are called residents.

The lord president of the council is the fourth great officer of the crown, as antient as king John, when he was stiled conciliarius capitalis. His office is to attend on the king, propose business at the council table, and report the transactions there to the king.

The lord president of the court of session in Scotland, is the first of the fifteen lords who presides in that august assembly, which is the supreme court of justice in that kingdom.

PRESS, in the mechanic arts, a machine made of iron or wood, serving to squeeze or compress any body very close. The ordinary presses consists of six members, or pieces, viz. two flat smooth planks, between which the things to be pressed are laid; two screws or worms, fastened to the lower plank, and passing through two holes in the upper; and two nuts, in form of an S, serving to drive the upper plank, which is moveable, against the lower, which is stable, and without motion.

PRESS *used by inlayers*, resembles the joiner's press, except that the pieces of wood are thicker, and that only one of them is moveable; the other, which is in form of a tressel, being sustained by two legs or pillars, jointed into it at each end. This press serves them for sawing and cleaving the pieces of wood required in marquetry or inlaid work.

PRESS, *founder's*, is a strong square frame, consisting of four pieces of wood firmly joined together with tenons, &c. This press is of various sizes, according to the sizes of the moulds; two of them are required to each mould, at the two extremes whereof they are placed; so as that, by driving wooden wedges between the mould and the sides of the presses, the two parts of the mould wherein the metal is to be run may be pressed close together.

PRESS, *printing*. See PRINTING-PRESS.

PRESS, *rolling*, is a machine used for the taking off prints from copper plates. It is much less complete than that of the letter-printers. See its description and use under the article *Rolling-press* PRINTING.

PRESS, *in coining*, is one of the machines used in striking of money, differing from the balance in that it has only one iron bar to give it motion, and press the moulds or coins: it is not charged with lead at its extremes, nor drawn by cordage. See COINING.

Binder's cutting-PRESS, is a machine used equally by bookbinders, stationers, and pasteboard-makers; consisting of two large pieces of wood, in form of cheeks, connected by two strong wooden screws, which, being turned by an iron bar, draw together, or set asunder, the cheeks, as much as is necessary for the putting in the books or paper to be cut. The cheeks are placed lengthwise on a wooden stand, in the form of a chest, into which the cuttings fall. Aside of the cheeks are two pieces of wood, of the same length with the screws, serving to direct the cheeks, and prevent their opening unequally. Upon the cheeks the plough moves, to which the cutting-knife is fastened by a screw; which has its key, to dismount it on occasion to be sharpened.

The plough consists of several parts; among the rest a wooden screw or worm, which, catching within the nuts of the two feet that sustain it on the cheeks, brings the knife to the book or paper which is fastened in the press between two boards. This screw, which is pretty long, has two directories, which resemble those of the screws of the press. To make the plough slide square and even on the cheeks, so that the knife may make an equal paring, that foot of the plough where the knife is not fixed, slides in a kind of groove, fastened along one of the cheeks. Lastly, the knife is a piece of steel, six or seven inches long, flat, thin, and sharp, terminating at one end in a point, like that of a sword, and at the other in a square form, which serves to fasten it to the plough. See BOOKBINDING.

As the long knives used by us in the cutting of books or paper are apt to jump in the cutting thick books, the Dutch are said to use circular knives, with an edge all round, which not only cut more steadily, but last longer without grinding.

PRESS, *in the woollen manufactory*, is a large wooden machine, serving to press cloths, serges, rateens, &c. thereby to render them smooth and even, and to give them a gloss. This machine consists of several members; the principal whereof are the cheeks, the nut, and the worm or screw, accompanied with its bar, which serves to turn it round, and make it descend perpendicularly on the middle of a thick wooden plank, under which the stuffs to be pressed are placed. The calender is also a kind of press, serving to press or calender linens, silks, &c.

PRESSES used for expressing of liquors are of various kinds; some, in most respects, the same with the common presses, excepting that the under plank is perforated with a great number of holes, to let the juice expressed run through into a tub or receiver underneath.

Plate, Presses, fig. 1, is a simple packing press, described by M. Buschendorf, in Les Annales des Arts. ABD is a strong frame of wood; through the upper bar D a strong iron rack E, similar to a saw, slides a small click *e*, pushed by a spring, prevents it rising after the lever F has pressed it down: the lower end of this rack has the bed of the press K fixed to it, under which the goods G to be pressed are put. The lever F has a mortise through it, to admit the rack E; and a click *f*, which takes into its teeth the lever, moves round a bolt *g*, as a centre, which can be put through any of the holes in the beam, according to the quantity of the goods to be pressed. The machine operates as follows. When the lever F is lifted up, its click *f* slips over the sloping side of the teeth, and when it is pulled down, the click takes hold of the teeth and draws the rack down with it another tooth: the click *e* then holds it, while the lever is raised to take another tooth as before. The only objection to this simple press is a want of power for pressing many articles, and that the teeth of the rack could not be made fine enough for a man to press down a whole tooth without resting. To remedy the first inconvenience, it has occurred to us that a bolt *h* might be put through two of the beams, and the end of a common handspike H put under it. This handspike might be connected with F by an endless chain put over both: this chain might have a hook at the end, so as to shorten or lengthen it by hooking it into another link, as occasion required. For the second inconvenience a plate of iron *i*, with teeth in it, might be fastened to the lever F, and a long click I, connected with the frame, might fall into them, so as to prevent the lever rising. By this means each tooth of the rack may be divided into four or five parts; and when the click *e* takes hold of a new tooth, the long click I may be lifted up, and the lever raised. As before, the click might be hooked up when the press I is used as above described: the chain or handspike may be taken away, and replaced in a very short time.

Fig. 2. is a screw-press, used for expressing some kinds of oil; the frame ADB is formed of one piece of cast-iron, the upper piece has a brass nut fixed in it, through which the screw E works; the screw has holes through its lower end, to put in a long iron lever F, by which the screw is turned. The substance from which the oil is to be pressed is tied up in horse-hair bags, and laid under the bed of the press G, with a warm iron plate between each bag; the screw is then turned by men, as long as they can move it: a rope is then hooked to the end of the lever, and the power of a windlass or capstan is used to assist the lever: the oil weeps out of the bags, and runs down through a spout into the reservoir H, placed to raise it.

Fig. 3. is a representation of the hydrostatic press for which Mr. Bramah took out a patent in 1796. The frame of this is like a common press; the bed A is fastened to the piston B of a stout brass barrel D, the lower end of which communicates by a pipe E, with a forcing pump within the cylindric vessel F; the piston *f f* of this is cut hollow, and has the connecting rod *g* jointed within side of it. The lever *b*, which works the pump, is jointed to the lower end of this rod, so that the circular motion of the lever is allowed by the connecting rod *g* moving in or out of the hollow in the piston rod; and the parallelism of the piston is preserved by a collar H.

Fig 4. explains the construction of the pump within the cistern F; I is the barrel of brass, this has the piece J screwed into it lower, and this piece J is screwed into the end of the pipe E, and contains within it a valve opening downwards. To the part L of the barrel, the piece K containing a valve opening inwards is screwed; this is open to the water, oil, &c. contained in the cistern F, when the lever G is raised, the barrel fills with water through the valve K, and when it is pushed down, the valve K shuts, J opens, and the water is forced through the pipes E into the large barrel D, and by pushing out its piston B, presses the goods laid upon the bed A of the press. When the goods are sufficiently pressed, the lever G is pushed down, and the lower end of the piston opens the valves JK, and the dettent *k* pushes towards the piston, opens the valves K, which allows the water to pass back into the reservoir, the bed of the press falls down, the valves are composed of a small brass cone, fig. 4. which exactly fits its seat, and is kept in its place by a wire fastened to it; this wire is cut flat on one side to allow the water to pass through when the valve is open, and a small spiral spring closes it.

PRESS *used by joiners*, to keep close the pieces they have glued, especially pannels, &c. of wainscot, is very simple, consisting of four members, viz. two screws, and two pieces of wood, four or five inches square, and two or three feet long; whereof the holes at the two ends serve for nuts to the screws.

PRESSING, in the manufactures, is the violently squeezing a cloth, stuff, &c. to render it smooth and glossy There are two methods of pressing, viz. cold or hot. As to the former, or cold-pressing, after the stuff has been scoured, fulled, and shorn, it is folded square in equal plaits, and a skin of vellum, or pasteboard, put between each plait. Over the whole is laid a square wooden plank, and so put into the press, which is screwed down tight by means of a lever. After it has lain a sufficient time in the press, they take it out, removing the pasteboards, and lay it up to keep. Some only lay the stuff on a firm table, after plaiting and pasteboarding, cover the whole with a wooden plank, and load it with a proper weight.

The method of pressing hot is this: when the stuff has received the above preparations, it is sprinkled a little with water, sometimes gum-water, then plaited equally, and between each two plaits are put leaves of pasteboard; and between every sixth or seventh plait, as well as over the whole, an iron or brass-plate well heated in a kind of furnace. This done, it is laid upon the press, and forcibly screwed down. Under this press are laid five, six, &c. pieces at the same time, all furnished with their pasteboards and iron-plates. When the plates are well cold, the stuffs are taken out and stitched a little together to keep them in the plaits. This manner of pressing was only invented to cover the defects of the stuffs; and accordingly it has been frequently prohibited.

PREVARICATION, in the civil law, is where the informer colludes with the defendants, and so makes only a sham prosecution.

PRICKING, in the sea-language, is to make a point on the plan or chart, near about where the ship then is, or is to be at such a time, in order to find the course they are to steer.

PRIMÆ VIÆ, among physicians, denote the whole alimentary duct; including the oesophagus, stomach, and intestines, with their appendages.

PRIMATES, the first order of mammalia in the Linnean system; they are distinguished by fore-teeth cutting, upper four parallel (except in some species of bats, which have two or none); tusks solitary, that is, one on each side, in each jaw; teats two, pectoral; feet two, are hands; nails, usually flattened, oval; food fruits, except a few that use animal food. There are four genera, viz. homo, lemur, simia, and vespertilio.

PRIMING, or *prime of a gun*, is the gunpowder put into the pan or touch-hole of a piece, to give it fire thereby; and this is the last thing done in charging.

For pieces of ordnance they have a pointed iron-rod, to pierce the cartridge through the touch-hole, called primer or priming-iron.

PRIMOGENITURE, the right of first-born. This right seems to be an unjust prerogative, and contrary to the natural right; for since it is birth alone gives children a title to the paternal succession, the chance of primogeniture should not throw any inequality among them.

It was not till the race of Hugh Capet, that the prerogative of succession to the crown was appropriated to the first-born. By the antient custom of gavel-kind, still preserved in some parts of our island, and we believe throughout the United States of America, primogeniture is of no account, the paternal estate being equally shared among the sons. See Gavel-kind.

PRIMULA, the *primrose*, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 21st order, preciæ. The involucrum lies under a simple umbel; the tube of the corolla cylindrical, with the mouth or limb patulous. This genus, including also the polyanthus and auricula, furnishes an excellent collection of low, fibrous-rooted, herbaceous, flowery perennials, extending to 20 species, of which the most remarkable are:

1. The primula vulgaris, or spring primrose, has thick and very fibrous roots, crowned by a cluster of large oblong indented rough leaves, and numerous flower-stalks, from about three or four, to five or six inches high, each terminated commonly by one flower. The varieties are, common yellow-flowered primrose of the woods, white primrose, paper white, red, double red, double yellow, and double white. All these flower abundantly in March and April, and continue for a month or six weeks. 2. Primula officinalis. The paigle or cowslip has very thick fibrous roots, crowned by a cluster of oblong, indented, round leaves, and upright, firm flower stalks five or six inches high, terminated each by a cluster of small flowers. The varieties are, common single yellow cowslip of the meadows, double yellow cowslip, scarlet cowslip, ho e and hose-cowslip; one flower growing out of the bosom of another, the lowermost serving as a calyx, all of which varieties have the flower-stalks crowned by many flowers in branches. They flower in April and May, continuing in succession a month or six weeks. 3. Primula elatis, the great cowslip, oxcip. The polyanthus, so long and so much cultivated in English gardens, is a variety of these. The polyanthus is one of the noted prize flowers among the florists, many of whom are remarkably industrious in raising a considerable variety of different sorts, as well as in using every art to blow them with all requisite perfection; for among the virtuosi, a polyanthus must possess several peculiar properties in order to be admitted in their collections. The chief properties required in a florist's polyanthus, are: 1. The stem or flower-stalk shall be upright, moderately tall, with strength in proportion, and crowned by a good regular bunch of flowers on short pedicles, strong enough to support them nearly in an upright position. 2. The florets of each branch should be equally large, spreading open flat, with the colours exquisite, and the stripes and variegations lively and regular. 3. The eye in the centre of each floret should be large, regular, and bright; and the antheræ, by the florists called the thrum, should rise high enough to cover the mouth of the tube or hollow part in the middle of the florets, and render them what they call thrum-eyed; but when the style elevates the stigma above the antheræ, the eye of the tube generally appears hollow, showing the stigma in the middle, like the head of a pin, and is rejected as an incomplete flower, though its other properties should be ever so perfect. This pin-eyed polyanthus, however, though rejected by the florists, is the flower in its most perfect state, and great numbers of them are of as beautiful forms and colours as the thrum-eyed varieties.

4. Primula auricula has a thick fibrous root, crowned by a cluster of oblong, fleshy, broad, serrated, smooth leaves, resembling the shape of a bear's ear; and amidst them upright flower-stalks from about three or four to six or eight inches high, terminated by an umbellate cluster of beautiful flowers, of many different colours in the varieties. All of these have a circular eye in the middle of each flower, and of which there are different colours; whence the auriculas are distinguished into yellow-eyed, white-eyed, &c. The petals of most of the kinds are powdered with an exceeding fine farina or mealy powder, which contributes greatly to the beauty of the flower. They all flower in April or May, continuing a month or six weeks in beauty, and ripening plenty of seeds in June.

All the varieties of the common spring primrose multiply so fast by the roots, that it is scarcely worth while to raise them from seeds. However, though many single kinds may be raised from seed, yet parting the roots is the only method by which the double kind can be preserved; and the same thing is to be observed of all the rest.

PRINCE's METAL, a mixture of copper and zinc, in imitation of gold. See Zinc.

PRINCIPAL POINT. See Perspective.

PRINCIPLE EXTRACTIVE. See Plants, *physiology of*.

PRINOS, a genus of the monogynia order, in the hexandria class of plants, and in the natural method ranking under the 43d order, dumosæ. The calyx is sexfid; the corolla monopetalous, and rotaceous; the belly hexaspermous. There are seven species, natives of the West Indies.

PRINT, the impression taken from a copper-plate. See Printing.

A print may be taken off, so as that the outlines and principal strokes may be exactly copied for engraving, in the following manner. If the print is not above a year or two old, the paper need only be well moistened with water, as for printing, but if it is more antient, it should be laid to soak all night in water, and afterwards hung in the air till it becomes dry enough for the press. The paper thus prepared is to be laid with its printed side next to the plate, thinly cased over with white wax; and is thus to be communicated to the rolling-press, whereby an impression of the cut will be gained.

PRINTING, the art of taking impressions from characters or figures moveable, or immoveable, on paper, linnen, silk, &c. There are three kinds of printing, the one from moveable letters for books; the other from copper-plates for pictures; and the last from blocks, in which the representation of birds, flowers, &c. are cut for printing calicoes, linnens, &c. the first, called common press-printing, the second rolling press-printing, and the last calico, &c. printing. The principal difference between the three consists in this, that the first is cast in relievo in distinct pieces, the second engraven in creux, and the third cut in relievo, and generally stamped, by placing the block upon the materials to be printed and striking upon the back of it. See Calico Printing.

Printing, *progress of.* Who the first inventors of the European method of printing books were, in what city, and what year it was set on foot, are questions long disputed among the learned. In effect, as the Grecian cities contended for the birth of Homer, so do the German for that of printing. Mentz, Haerlem, and Strasburg, are the warmest on this point of honour, and these are left in possession of the question, which is not yet decided: though it must be owned that Mentz has always had the majority of voices. John Guttemburg, and John Fust of Mentz, John Mentel of Strasburg, and L. John Koster of Haerlem, are the persons to whom this honour is severally ascribed, by their respective countrymen; and they have all their advocates among the learned. However, their first essays were made on wooden blocks, after the Chinese manner. The book at Haerlem, the vocabulary called Catholicon, and the pieces in the Bodleian library, and that of Bennet college, are all performed in this way; and the impression appears to have been only given on one side of the leaves; after which the two blank sides were pasted together. But they soon found the inconveciences of this method, and therefore an improvement was suggested, which was, by making single letters distinct from one another, and these being first done in wood, gave room for a second improvement, which was making them of metal; and in order to that, forming moulds, matrices, &c. for casting them. See TYPE.

From this ingenious contrivance we ought to date the origin of the present art of printing, contradistinguished from the method practised by the Chinese. And of this Schoeffer, or Scheffer, first servant, and afterwards partner and son-in-law of Fust, at Mentz, above-mentioned, is generally allowed to be the inventor; so that he may properly be reckoned the first printer, and the Bible which was printed with moveable letters in 1450, the first printed book; the next was Augustine de Civitate Dei, then Tully's Offices, printed about the year 1461. In these books they left the places of the initial letters blank, and gave them to the illuminers to have them ornamented and painted in gold and azure, in order to render the work more beautiful, and, as some think, to make their books pass for manuscripts. Thus at present, in some curious works, the initial letter at the beginning of a book or chapter, is sometimes left out, and a space is left for its being afterwards printed with various ornaments from a copper-plate.

Some authors tell us, that Fust carrying a parcel of Bibles with him to Paris, and offering them to sale as manuscripts; the French, upon considering the number of books, and their exact conformity to each other, even to a point, and that it was impossible for the best book-writers to be so exact, concluded there was witchcraft in the case, and by their actually indicting him as a conjurer, or threatening to do so, extorted from him the secret; and hence the origin of the popular story of Dr. Faustus.

From Mentz, the art of printing soon spread itself throughout a good part of Europe; Haerlem and Strasburg had it very early; from Haerlem it passed to Rome in 1467; and into England in 1468, by means of Thos. Bourchier, archbishop of Canterbury, who sent W. Turner, master of the robes, and W. Caxton, merchant, to Haerlem to learn the art. These privately prevailing with Corseilles, an under-workman, to come over, a press was set up at Oxford, and an edition of Ruffinus on the Creed was printed the same year in octavo. From Oxford, Caxton brought it to London about the year 1470, and the same year it was carried to Paris. Hitherto there had been nothing printed but in Latin, and the vulgar tongues; and this first in Roman characters, then in Gothic, and at last in Italic; but in 1480, the Italians cast a set of Greek types, and they have also the honour of the first Hebrew editions, which were printed about the same time with the Greek. Towards the end of the sixteenth century there appeared various editions of books in Syriac, Arabic, Persian, Armenian, Coptic, or Egyptian characters, some to gratify the curiosity of the learned, and others for the use of the Christians of the Levant. Out of Europe, the art of printing has been carried into the three other parts of the world.

PRINTING, *method of:* the printing-letters, or types as they are sometimes called, are described, as well as the method of forming and casting them, under the article TYPE.

The workmen employed in the art of printing are of two kinds; compositors, who range and dispose the letters into words, lines, pages, &c. according to the copy delivered them by the author; and pressmen, who apply ink upon the same, and take off the impression. The types being cast, the compositor distributes each kind by itself among the divisions of two wooden frames, an upper and an under one, called cases, each of which is divided into little cells or boxes. Those of the upper case are in number ninety-eight; these are all of the same size, and in them are disposed the capitals, small capitals, accented letters, figures, &c. the capitals being placed in alphabetical order. In the cells of the lower case, which are fifty-four, are placed the small letters with the points, spaces, &c. The boxes are here of different sizes, the largest being for the letters most used; and these boxes are not in alphabetical order, but the cells which contain the letters oftenest wanted, are nearest the compositor's hand. Each case is placed a little aslope, that the compositor may the more easily reach the upper boxes. The instrument in which the letters are set is called a composing-stick, see Plate Miscel. fig. 193; which consists of a long and narrow plate of brass or iron, &c. *c*, on the right side of which arises a ledge *bb*, which runs the whole length of the plate, and serves to sustain the letters, the sides of which are to rest against it: along this ledge is a row of holes, which serve for introducing the screw *a* in order to lengthen or shorten the extent of the line, by moving the sliders *bc* farther from, or nearer to, the short ledge at the end *d*. Where marginal notes are required in a work, the two sliding-pieces *bc* are opened to a proper distance from each other; in such a manner as that while the distance between *b* and *c* forms the length of the line in the text, the distance between the two sliding-pieces forms the length of the lines for the notes on the side of the page. Before the compositor proceeds to compose, he puts a rule, or thin slip of brass plate, cut to the length of the line, and of the same height as the letter, in the composing stick, against the ledge, for the letter to bear against. Things thus prepared, the compositor having the copy lying before him, and his stick in his left hand, his thumb being over the slider *c*; with the right he takes up the letters, spaces, &c. one by one, and places them against the rule, while he supports them with his left thumb by pressing them to the end of the slider *c*, the other hand being constantly employed in setting in more letters: the whole being performed with a degree of expedition and address not easy to be imagined.

A line being thus composed, if it ends with a word or syllable, and exactly fills the measure, there needs no farther care; otherwise more spaces are to be put in, or else the distances lessened between the several words, in order to make the measure quite full; so that every line may end even. The spaces here used are pieces of metal exactly shaped like the shanks of the letters; these are of various thicknesses, and serve to support the letters, and to preserve a proper distance between the words; but not reaching so high as the letters, they make no impression when the work is printed. The first line being thus finished, the compositor proceeds to the next; in order to which he moves the brass rule from behind the former, and places it before it, and thus composes another line against it, after the same manner as before; going on thus till his stick is full, when he empties all the lines contained in it into the galley; which is a frame formed of an oblong square board, with a ledge on three sides, and a groove to admit a false bottom. The compositor then fills and empties his composing-stick as before, till a complete page is formed; when he ties it up with a cord or packthread, and setting it by, proceeds to the next, till the number of pages to be contained in a sheet is completed; which done, he carries them to the imposing-stone, there to be ranged in order, and fastened together in a frame called a chase, and this is termed imposing. The chase is a rectangular iron frame, of different dimensions according to the size of the paper to be printed; having two cross pieces of the same metal, called a long and short cross, mortised at each end, so as to be taken out occasionally. By the different situation of these crosses the chase is fitted for different volumes; for quartos and octavos, one traverses the middle lengthwise, the other broadwise, so as to intersect each other in the centre; for twelves and twenty-fours the short cross is shifted nearer to one end of the chase; for folios the long cross is left entirely out, and the short one left in the middle; and for broadsides both crosses are set aside. To dress the chase, or range and fix the pages therein, the compositor makes use of a set of furniture, consisting of slips of wood of different dimensions, and about half an inch high that they may be lower than the letters: some of these are placed at the top of the pages, and called head-sticks; others between them to form the inner margin; others on the sides of the crosses to form the outer margin, where the paper is to be doubled; and others in the form of wedges to the sides and bottom of the pages. Thus all the pages being placed at their proper distances, and secured from being injured by the chase and furniture placed about them, they are all untied, and fastened together by driving small pieces of wood called quoins, cut in the wedge-form, up between the slanting side of the foot and side-sticks and the chase, by means of a piece of hard wood and a mallet; and all being thus bound fast together, so that none of the letters will fall out, it is ready to be committed to the pressman. In this condition the work is called a form; and as there are two of these forms required for every sheet, when both sides are to be printed, it is necessary that the distances between the pages in each form should be placed with such exactness, that the impression of the pages in one form shall fall exactly on the back of the pages of the other, which is called register.

As it is impossible but that there must be some mistakes in the work, either through the oversight of the compositor, or by the casual transposition of letters in the case, a sheet is printed off, which is called a proof, and given to the corrector, who reading it over, and rectifying it by the copy, by making the alterations in the margin, it is delivered back to the compositor to be corrected. For the characters used in correcting a sheet for the compositor, see CORRECTION.

The compositor then unlocking the form upon the correcting-stone, by loosening the quoins or wedges which bound the letters together, rectifies the mistakes by picking out the faulty or wrong letters with a slender sharp-pointed steel bodkin, and puts others into their places; but when there are considerable alterations, and particularly where insertions or omissions are to be made, he is under a necessity of over-running. Thus, if one or more words to be inserted in a line cannot be got in by changing the spaces for lesser ones, part of the line must be put back into the close of the preceding one, or forward into the beginning of the subsequent one, and this continued till the words are got in. After this another proof is made, sent to the author, and corrected as before: and, lastly, there is another proof, called a revise, which is made in order to see whether all the mistakes marked in the last proof are corrected.

The pressman's business is, to work off the forms thus prepared and corrected by the compositor; in doing which there are four things required, paper, ink, balls, and a press. To prepare the paper for use, it is to be first wetted by dipping several sheets together in water; these are afterwards laid in a heap over each other; and to make them take the water equally, they are all pressed close down with a weight at the top. The ink is made of oil and lamp-black, for the manner of preparing which see INK.

The balls by which the ink is applied on the forms, are a kind of wooden funnels with handles, the cavities of which are filled with wool or hair; also a piece of alum-leather or pelt is nailed over the cavity, and made extremely soft by soaking in urine, and by being well rubbed. One of these the pressman takes in each hand, and applying one of them to the ink-block, dabs and works them together to distribute the ink equally; and then blackens the form which is placed on the press, by beating with the balls upon the face of the letter.

The printing-press represented in the Plate, fig. 194, is a very curious, though complex machine; the body consists of two strong cheeks *aa*, placed perpendicularly, and joined together by four cross-pieces; the cap *b*; the head *c*, which is moveable, being partly sustained by two iron pins or long bolts, that pass the cap; the till or shelf *dd*, by which the spindle and its apparatus are kept in their proper position; and the winter *e*, which bears the carriage, and sustains the effort of the press beneath. The spindle *f* is an upright piece of iron pointed with steel, having a male screw which goes into the female one in the head about four inches. Through the eye *g* of this spindle is fastened the bar *k*, by which the pressman makes the impression. The spindle passes through a hole in the middle of the till; and its point works into a brass pan or nut, supplied with oil, which is fixed to an iron plate let into the top of the platten. The body of the spindle is sustained in the centre of an open frame of polished iron, 1, 1, 2, 2, 3, 3, fixed to it in such a manner, as, without obstructing its free play, to keep it in a steady direction, and at the same time to serve for suspending the platten. This frame consists of two parts; the upper, called the garter, 1, 1; and the under, called the crane, 2, 2. These are connected together by two short legs or bolts, 3, 3, which being fixed below in the two ends of the crane, pass upwards through two holes in the till, and are received at top into two eyes at the ends of the garter, where they are secured by screws. The carriage *ll* is placed a foot below the platten, having its fore part supported by a prop called the fore stay, while the other rests on the winter. On this carriage, which sustains the plank, are nailed two long iron bars or ribs; and on the plank are nailed short pieces of iron or steel, called cramp-irons, equally tempered with the ribs, and which slide upon them when the plank is turned in or out. Under the carriage is fixed a long piece of iron called the spit, with a double wheel in the middle, round which leather girths are fastened, nailed to each end of the plank; and to the outside of the spit is fixed a rounce *m*, or handle, to turn round the wheel. Upon the plank is a square frame or coffin, in which is inclosed a polished stone, on which the form *n* is laid; at the end of the coffin are three frames, viz. the two tympans and frisket; the tympans *o* are square, and made of three slips of very thin wood, and at the top a piece of iron still thinner; that called the outer tympan is fastened with hinges to the coffin; they are both covered with parchment; and between the two are placed blankets, which are necessary to take off the impression of the letters upon the paper. The frisket *p* is a square frame of thin iron, fastened with hinges to the tympan: it is covered with paper cut in the necessary places, that the sheet which is put between the frisket and the great or outward tympan may receive the ink, and that nothing may hurt the margins. To regulate the margins, a sheet of paper is fastened upon this tympan, which is called the tympan-sheet; and on each side is fixed an iron point, which makes two holes in the sheet, which is to be placed on the same points when the impression is to be made on the other side. In preparing the press for working, the parchment which covers the outer tympan is wetted till it is very soft, in order to render the impression more equable; the blankets are then put in, and secured from slipping by the inner tympan: then while one pressman is beating the letter with the balls *q*, covered with ink taken from the ink-block, the other man places a sheet of white paper on the tympan-sheet, turns down the frisket upon it to keep the paper clean and prevent its slipping, then bringing the tympans upon the form, and turning the rounce, he brings the form with the stone, &c. weighing about 300lbs. weight, under the platten; pulls with the bar, by which means the platten presses the blankets and paper close upon the letter, whereby half the form is printed; then easing the bar, he draws the form still forward, gives a second pull; and letting go the bar, turns back the form, takes up the tympans and frisket, takes out the printed sheet, and lays on a fresh one; and this is repeated till he has taken off the impression upon the full number of sheets the edition is to consist of. One side of the sheet being thus printed, the form for the other is laid upon the press, and worked off in the same manner. See STEREOTYPE.

PRINTING, *Chinese*, is performed from wooden planks or blocks, cut like those used in printing of callico, paper, cards, &c.

PRINTING, *rolling-press*, is employed in taking off prints or impressions from copper-plates engraved, etched, or scraped, as in mezzotintos. See ENGRAVING. This art is said to have been as antient as the year 1540; and to owe its origin to Finiguerra, a Florentine goldsmith, who pouring some melted brimstone on an engraved plate, found the exact impression of the engraving left in the cold brimstone, marked with black taken out of the strokes by the liquid sulphur: upon this he attempted to do the same on silver plates with wet paper, by rolling it smoothly with a roller, and this succeeded: but this art was not employed in England till the reign of king James I., when it was brought from Antwerp by Speed. The form of the rolling-press, the composition of the ink used in it, and the manner of applying both in taking off prints, are as follow:

The rolling-press AL, Plate 195, may be divided into two parts, the body and carriage; the body consists of two wooden cheeks PP, placed perpendicularly on a stand or foot LM, which sustains the whole press. From the foot likewise rise four other perpendicular pieces *c*, *c*, *c*, *c*, joined by other cross or horizontal ones *d*, *d*, *d*, which serve to sustain a smooth even plank or table HIK, about four feet and a half long, two feet and a half broad, and an inch and a half thick. Into the cheeks go two wooden cylinders or rollers, DEFG, about six inches in diameter, borne up at each end by the cheeks; whose ends, which are lessened to about two inches diameter, and called trunnions, turn in the cheeks about two pieces of wood in form of half-moons, lined with polished iron to facilitate their motion. Lastly, to one of the trunnions of the upper roller is fastened a cross, consisting of two levers AB, or pieces of wood, traversing each other: the arms of which cross serve instead of the bar or handle of the letter-press, by turning the upper roller; and when the plank is between the two rollers, giving the same motion to the under one, by drawing the plank forward and backward.

The ink used for copper-plates is a composition made of the stones of peaches and apricots, the bones of sheep, and ivory, all well burnt, and called Frankfort black, mixed with nut-oil that has been well boiled, and ground together on a marble in the same manner as painters do their colours.

The method of printing from copper-plates is as follows: They take a small quantity of this ink on a rubber made of linen rags strongly bound about each other, and with it smear the whole face of the plate as it lies on a grate over a charcoal fire. The plate being sufficiently inked, they first wipe it over with a foul rag, then with the palm of their left hand, and then with that of the right; and to dry the hand and forward the wiping, they rub it from time to time in whiting. In wiping the plate perfectly clean, yet without taking the ink out of the engraving, the address of the workman consists. The plate thus prepared, is laid on the plank of the press; over the plate is laid the paper, first well moistened to receive the impression; and over the paper two or three folds of flannel. Things thus disposed, the arms of the cross are pulled, and by that means the plate with its furniture is passed through between the collars; which pinching very strongly, yet equally, press the moistened paper into the strokes of the engraving, whence it absorbs the ink

PRISM, in geometry, an oblong solid, contained under more than four planes, whose bases are equal, parallel, and alike situated. See GEOMETRY.

PRISM, in dioptrics. See OPTICS.

PRISON, a gaol, or place of confinement. See GAOL. Lord Coke observes, that a prison is only a place of safe custody, salva custodia, not a place of punishment. Any place where a person is confined may be said to be a prison: and when a process is issued against one, he must, when arrested thereon, either be committed to prison, or be bound in a recognizance with sureties, or else give bail, according to the nature of the case, to appear at a certain day in court, there to make answer to what is alleged against him. When a person is taken and sent to prison in a civil case, he may be released by the plaintiff in the suit; but if it is for treason or felony, he may not regularly be discharged until he is indicted of the fact and acquitted.

The good policy of imprisonment for debt has been frequently called in question (probably by those who were most in danger of suffering from it). We are of opinion, however, that it is in the whole productive of salutary consequences in a state, and the terror of a gaol is is many cases an useful moral restraint. The following paper, however, set forth by the laudable society for the discharge and relief of persons imprisoned for small debts, will excite various reflections in different readers; and without any comment we submit it as a curious document to the statesman, or political arithmetician, as throwing some light on the manners and character of the age.

A summary view of the money annually expended by the society for the discharge and relief of persons imprisoned for small debts, Craven-street, Strand, from the institution in 1772, to the 31st of March, 1804.

1772 to	No. of debtors discharged and relieved.	Expended. £.	s.	d.
1774	1772 for the sum of	4622	17	1
1775	966	1724	1	11
1776	673	1842	13	3
1777	877	1729	19	7
1778	779	1764	0	11
1779	811	1611	15	3
1780	628	1288	17	1
1781	321	828	15	9
1782	389	935	3	9
1783	547	1121	12	0
1784	535	996	12	3
1785	463	904	9	1
1786	339	715	8	9
1787	343	719	9	10
1788	710	1566	4	2¼
1789	612	1926	3	3½
1790	798	2303	9	3
1791	666	1777	0	6
1792	460	1297	14	7
1793	568	1870	1	5
1794	540	1844	14	9½
1795	434	1438	6	1
1796	481	1756	0	5
1797	490	1606	15	0
1798	645	2001	13	6
1799	578	1553	14	5
1800	648	2106	16	10
1801	1885	2870	4	4
1802	1125	2607	11	1
1803	927	2892	14	0
1804	916	2586	2	1

20,906 debtors, who had 12,546 wives and 35,699 children } 69,115 persons immediately benefited for 54781*l.* 3*s.* 5½*d.*

The average for the debts of the above 20,905 debtors is 2*l.* 12*s.* 4½*d.* each, and for each individual relieved 15*s.* 1*d.*

PRISTIS, or saw-fish, a genus of fishes of the order chondropterigii: the generic character is, snout long, flat, spinous down the edges, spiracles lateral; body oblong, roundish, covered with a rough, coriaceous skin; mouth beneath; nostrils before the mouth, half-covered with a membranaceous flap; behind the eyes two oval orifices; ventral fins approximate. There are five species:

1. Pristis antiquorum. The head is rather flat at top; the eyes large, with yellow irides; behind each is a hole, which some have supposed may lead to an organ of hearing. The mouth is well furnished with teeth, but they are blunt, serving rather to bruise its prey than to divide it by cutting. Before the mouth are two foramina, supposed to be the nostrils. The rostrum, beak, or snout, is in general about one-third of the total length of the fish, and contains in some eighteen, in others twenty-three or twenty-four, spines on each side; these are very stout, much thicker at the back part, and channelled, inclining to an edge forwards. The fins are seven in number, viz. two dorsal, placed at some distance from each other; two pectoral, taking rise just behind the breathing-holes, which are five in number; two ventral, situated almost underneath the first dorsal; and lastly, the caudal, occupying the tail both above and beneath, but longest on the upper part. The general colour of the body is a dull grey, or brownish, growing paler as it approaches the belly, where it is nearly white. 2. Pectinatus, which, with the former species, grows to the largest size of any that have yet come under the inspection of the naturalist, some specimens measuring 15 feet in length. The pectinatus differs from the pristis antiquorum, in having the snout more narrow in proportion at the base, and the whole of it more slender in all its parts; whereas the first is very broad at the base, and tapers considerably from thence to the point. The spines on each side are longer and more slender, and vary from twenty-five to thirty-four in the different specimens: we have indeed been informed of one which contained no less than thirty-six spines on each side of the snout; but we must confess that we have never been fortunate enough to have seen such a specimen. 3. Cuspidatus, of which we have only seen two specimens, the one about a foot and a half in length, and the other more than two feet and a half. In both of these were twenty-eight spines on each side; but the distinguishing feature is in the spines themselves being particularly flat and broad, and shaped at the point more like the lancet used by surgeons in bleeding, than any other figure. We believe that no other author has hitherto taken notice of this species. 4. Microdon, of which the total length is twenty-eight inches, the snout occupying ten; from the base of this to that of the pectoral fins four inches; between the pectoral and ventral fins six. The two dorsal fins occupy nearly the same proportions in respect to each other; but the hinder one is the smallest, and all of them are greatly hollowed out at the back part, much more so than in the two first species. The snout differs from that of every other, in several particulars: it is longer in proportion, being more than one-third of the whole fish. The spines do not stand out from the sides more than a quarter of an inch, and from this circumstance seem far less capable of doing injury than any other species yet known. 5. Cirratus, of which we have only met with one specimen, which was brought from Port Jackson in New Holland. It is a male, and the total length about 40 inches; the snout, from the tip of it to the eye, eleven: the spines widely different from any of the others; they are indeed placed, as usual, on the edge, but are continued on each side even beyond the eyes. The longer ones are slender, sharp, somewhat bent, and about twenty in number; and between these are others not half the length of the primal ones, between some three or four, between others as far as six; and in general the middle one of these smaller series is the longest: beside these a series of minute ones may be perceived beneath, at the very edge. In the snout likewise another singularity occurs:—about the middle of it, on each side, near the edge, arises a flexible, ligamentous cord, about three inches and a half in length, appearing not unlike the beards at the mouth of some of the gadus or cod genus, and no doubt as pliant in the recent state. The colour of the fish is a pale brown; the breathing apertures four in number; the mouth furnished with five rows of minute, but very sharp teeth.

PRIVET, in botany. See LIGUSTRUM.

PRIVILEGE, in law, some peculiar benefit granted to certain persons or places, contrary to the usual course of the law.

Privileges are said to be personal or real. Personal privileges are such as are extended to peers, ambassadors, members of parliament and of the convocation, and their menial servants, &c. A real privilege is that granted to some particular place; as the king's palace, the courts at Westminster, the universities, &c.

PRIVY, in law, denotes one who is partaker, or has an interest, in an affair.

PRIVY COUNCIL, is the principal council belonging to the king, and is generally called by way of eminence the council.

Privy counsellors are made by the king's nomination without either patent or grant; and on taking the necessary oaths, they become immediately privy counsellors during the life of the king that chooses them, but subject to removal at his discretion. No inconvenience now arises from the extension of the number of the privy council, as those only attend who are especially summoned for that particular occasion.

PRIVY SEAL, is a seal that the king uses to such grants, or other things, as pass the great seal.

PRIZE, or PRISE, in maritime affairs, a vessel taken at sea from the enemies of a state, or from pirates; and that either by a ship of war, a privateer, &c. having a commission for that purpose.

Vessels are looked on as prize, if they fight under any other standard than that of the state from which they have their commission; if they have no charter-party, invoice, or bill of lading, aboard; if loaded with effects belonging to the king's enemies, or with contraband goods. Those of the king's subjects recovered from the enemy, after remaining twenty-four hours in their hands, are deemed lawful prize.

Vessels that refuse to strike, may be constrained; and if they make resistance and fight, become lawful prize if taken.

In ships of war, the prizes are to be divided among the officers, seamen, &c. as his majesty shall appoint by proclamation; but among privateers, the division is according to the agreement between the owners.

By stat. 13 Geo. II. c. 4. judges and officers, failing of their duty, in respect to the condemnation of prizes, forfeit five hundred pounds, with full costs of suit: one moiety to the king, and the other to the informer.

PROA, *flying*, in navigation, is a name given to a vessel used in the South Seas, because with a brisk trade-wind it sails near twenty miles an hour. In the construction of the proa, the head and stern are exactly alike, but the sides are very different; the side intended to be always the lee-side being flat; and the windward side made rounding, in the manner of other vessels; and to prevent her oversetting, which from her small breadth, and the straight run of her leeward side, would, without this precaution, infallibly happen, there is a frame laid out of her from windward, to the end of which is fastened a log, fashioned in the shape of a small boat and made hollow. The weight of the frame is intended to balance the proa, and the small boat is by its buoyancy (as it is always in the water) to prevent her oversetting to windward; and this frame is usually called an outrigger. The body of the vessel is made of two pieces joined endwise, and sewed together with bark, for there is no iron used about her; she is about two inches thick at the bottom, which at the gunwale is reduced to less than one. The sail is made of matting, and the mast, yard, boom, and outriggers, are all made of bamboo.

PROBABILITY of an event, in the doctrine of chances, is greater or less according to the number of chances by which it may happen or fail. (See EXPECTATION.) The probability of life is liable to rules of computation. In the Encyclopedie Methodique, we find a table of the probabilities of the duration of life, constructed from that which is to be found in the seventh volume of the Supplemens à l'Histoire de M. de Buffon, of which the following is an abridgement.

Of 23,994 children born at the same time, there will probably die,

$\frac{1}{3}$	In one year -	7998
$\frac{2}{3}$	Remaining $\frac{2}{3}$ or 15996	
$\frac{1}{2}$	In eight years -	11297
$\frac{1}{2}$	Remaining $\frac{1}{2}$ or 11997	
$\frac{2}{3}$	In thirty-eight years -	15996
$\frac{1}{3}$	Remaining $\frac{1}{3}$ or 7998	
$\frac{3}{4}$	In fifty years -	17994
$\frac{1}{4}$	Remaining $\frac{1}{4}$ or 5999	
$\frac{5}{6}$	In sixty-one years -	19995
$\frac{1}{6}$	Remaining $\frac{1}{6}$ or 3992	
$\frac{9}{10}$	In seventy years - -	21595
$\frac{1}{10}$	Remaining $\frac{1}{10}$ or 2399	
$\frac{39}{40}$	In eighty years - -	22395
$\frac{1}{40}$	Remaining $\frac{1}{40}$ or 599	
$\frac{299}{300}$	In ninety years - -	23914
$\frac{1}{300}$	Remaining $\frac{1}{300}$ or 80	
	In a hundred years - -	23992
	Remaining $\frac{1}{10000}$ or 2.	

PROBATE. See WILL.

PROBE, a surgeon's instrument for examining the circumstances of wounds, &c. See SURGERY.

PROBLEM, in logic, a proposition that neither appears absolutely true nor false; and consequently may be asserted either in the affirmative or negative.

PROBLEM, in geometry, is a proposition wherein some operation or construction is required; as to divide a line or angle, erect or let fall perpendiculars, &c. See GEOMETRY.

PROBLEM, in algebra, is a question or proposition which requires some unknown truth to be investigated, and the truth of the discovery demonstrated.

PROBLEM, *Kepler's*, in astronomy, is the determining a planet's residence from the time; so called from Kepler, who first proposed it. It was this: to find the position of a right line, which, passing through one of the foci of an ellipsis, shall cut off an area described by its motion, which shall be in any given proportion to the whole area of the ellipsis.

The proposer knew no way of solving the problem but by an indirect method; but sir Isaac Newton, Dr. Keil, &c. have since solved it directly and geometrically several ways.

PROBLEMATICAL RESOLUTION, in algebra, a method of solving difficult questions by certain rules, called canons.

PROBOSCIS, in natural history, is the trunk or snout of an elephant, and some other beasts and insects.

PROCEDENDO, in law, a writ whereby a plea or cause, formerly called from an inferior court to the court of chancery, king's bench, or court of common pleas, by writ of privilege, habeas corpus, or certiorari, is released, and returned to the other court to be proceeded in, upon its appearing that the defendant has no cause of privilege, or that the matter in the party's allegation is not well proved.

PROCELLARIA, in ornithology; a genus of birds, belonging to the order of anseres. The beak is somewhat compressed, and without teeth; the mandibles are equal, the superior one being crooked at the point; the feet are palmated, the hind claw being sessile, without any toe. Mr. Latham enumerates twenty-four species, which are principally distinguished by their colour. The most remarkable are:

1. The onicrea, petrel, or fulmar. The size of this bird is rather superior to that of the common gull: the bill very strong, much hooked at the end, and of a yellow colour. The nostrils are composed of two large tubes, lodged in one sheath: the head, neck, whole under side of the body, and tail, are white; the back and coverts of the wings ash-coloured; the quill-feathers dusky; and the legs yellowish. In lieu of a back toe, it has only a sort of spur, or sharp straight nail. These birds feed on the blubber or fat of whales, &c. which being soon convertible into oil, supplies them constantly with means of defence, as well as provision for their young, which they cast up into their mouths. They are likewise said to feed on sorrel, which they use to qualify the unctuous diet they live on. This species inhabits the isle of St. Kilda; makes its appearance there in November, and continues the whole year, except September and October; it lays a large, white, and very brittle egg, and the young are hatched the middle of June. No bird is of such use to the islanders as this: the fulmar supplies them with oil for their lamps, down for their beds, a delicacy for their tables, a balm for their wounds, and a medicine for their distempers. The fulmar is also a certain prognosticator of the change of the wind: if it comes to land, no west wind is expected for some time; and the contrary when it returns and keeps the sea. The whole genus of petrels have a peculiar faculty of spouting from their bills to a considerable distance, a large quantity of pure oil; which they do by way of defence, into the face of any one that attempts to take them; so that they are, for the sake of this panacea, seized by surprise; as this oil is subservient to the above-mentioned medical purposes. Martin tells us, it has been used in London and Edinburgh with success in rheumatic cases. Frederick Martens, who had the opportunity of seeing vast numbers of these birds in Spitzbergen, observes, that they are very bold, and resort after the whale-fishers in great flocks; and that, when a whale is taken, they will, in spite of all endeavours, light on it and pick out large lumps of fat, even when the animal is alive: that the whales are often discovered at sea, by the multitudes of them flying; and that, when one of the former is wounded, prodigious multitudes immediately follow its bloody track. He adds, that it is a most gluttonous bird, eating till it is forced to disgorge itself.

2. The puffinus, or shear-water, is fifteen inches in length; the breadth thirty-one; the weight seventeen ounces; the bill is an inch and three quarters long; nostrils tubular, but not very prominent; the head, and whole upper sides of the body, wings, tail, and thighs, are of a sooty blackness; the under side from chin to tail, and inner coverts of the wings, white; the legs weak, and compressed sideways; dusky behind, whitish before. These birds are found in the Calf of Man; and, as Mr. Ray supposes, in the Scilly isles. They resort to the former in February, take a short possession of the rabbit-burrows there, and then disappear till April. They lay one egg, white, and blunt at each end; and the young are fit to be taken the beginning of August, when great numbers are killed by the person who farms the island; they are salted and barrelled; and when they are boiled, are eaten with potatoes. During the day they keep at sea, fishing; and towards evening return to their young, whom they feed by discharging the contents of their stomachs into their mouths, which by that time is turned into oil: from the backward situation of their legs, they sit quite erect. They quit the island the latter end of August, or beginning of September; and we have reason to imagine that, like the

storm-finch, they are dispersed over the whole Atlantic ocean.

3. The pelagica, or stormy petrel, is about the bulk of the house-swallow; the length six inches; the extent of wings thirteen. The whole bird is black, except the coverts of the tail and vent-feathers, which are white; the bill is hooked at the end; the nostrils tubular; the legs slender and long. It has the same faculty of spouting oil from its bill as the other species; and Mr. Brunnich tells us, that the inhabitants of the Ferroe islands make this bird serve the purposes of a candle, by drawing a wick through the mouth and rump, which being lighted, the flame is fed by the fat and oil of the body. Except in breeding-time, it is always at sea, and is seen all over the vast Atlantic ocean, at the greatest distance from land; often following the vessels in great flocks, to pick up any thing that falls from on board: for trial sake, chopped straw has been flung over, which they would stand on with expanded wings, but were never observed to settle or swim in the water: it presages bad weather, and cautions the seamen of the approach of a tempest, by collecting under the stern of the ships; it braves the utmost fury of the storm, sometimes skimming with incredible velocity along the hollows of the waves, sometimes on the summits.

PROCESS, is the manner of proceeding in every cause, being the writs and precepts that proceed or go forth upon the original in every action, being either original or judicial. Britton, 138. Process is only meant to bring the defendant into court, in order to contest the suit, and abide the determination of the law. See Impey's Practice.

PROCKIA, a genus of the polyandria monogynia class and order. The cal. is three-leaved; cor. none; berry five-cornered, many-seeded. There is one species, a shrub of Santa Cruz.

PROCLAMATION, a public notice given of any thing of which the king thinks proper to advertise his subjects. Proclamations are a branch of the king's prerogative, and no person can make them without the king's authority, except mayors of towns, &c. by custom or privilege. Proclamations which require the people to do, or not to do, certain things, have the force of laws; but then they are supposed to be consistent with the laws already in being, otherwise they are superseded.

PROCREATION. See PHYSIOLOGY.

PROCTOR, a person commissioned to manage another person's cause in any court of the civil or ecclesiastical law. The proctors of the clergy, are the representatives chosen by the clergy to sit in the lower house of convocation; of these there are two for each diocese, and one for each collegiate church.

PROCURATOR, a person who has a charge committed to him to act for another. Thus the proxies of the lords in parliament are, in our law-books, called procurators; the bishops are sometimes called procuratores ecclesiarum; and the representatives sent by the clergy to convocation, procuratores cleri. The word is also used for a vicar or lieutenant; and we read of a procurator regni, who was an antient magistrate. Those who manage causes in Doctors' Commons, are also called procurators or proctors. In our statutes, he who gathers the fruits of a benefice for another is particularly called a procurator, and the instrument impowering him to receive them is termed a procuracy.

PROCYON, in astronomy, a fixed star of the second magnitude in the constellation called Canis minor. See CANIS.

PRODUCING, in geometry, signifies the drawing out a line farther till it has any assigned length.

PRODUCT, in arithmetic and geometry, the factum of two or more numbers, or lines, &c. into one another: thus $5 \times 4 = 20$ the product required.

In lines it is always (and in numbers sometimes) called the rectangle between the two lines, or numbers, multiplied by one another.

PROFILE, the draught of a building, fortification, &c. See ARCHITECTURE.

PROFILE also denotes the outline of a figure, building, member of architecture, &c.

PROFILE, in sculpture and painting, denotes a head, portrait, &c. when represented sideways, or in a side view. On almost all medals, faces are represented in profile.

PROGRESSION, an orderly advancing or proceeding in the same manner, course, tenor, proportion, &c.

Progression is either arithmetical, or geometrical.

Arithmetical PROGRESSION, is a series of quantities proceeding by continued equal differences, either increasing or decreasing. Thus,

increasing 1, 3, 5, 7, 9, &c. or
decreasing 21, 18, 15, 12, 9, &c;

where the former progression increases continually by the common difference 2, and the latter series or progression decreases continually by the common difference 3.

1. And hence, to construct an arithmetical progression, from any given first term, and with a given common difference; add the common difference to the first term, to give the 2d; to the 2d, to give the 3d; to the 3d, to give the 4th; and so on; when the series is ascending or increasing: but subtract the common difference continually, when the series is a descending one.

2. The chief property of an arithmetical progression, and which arises immediately from the nature of its construction, is this; that the sum of its extremes, or first and last terms, is equal to the sum of every pair of intermediate terms that are equidistant from the extremes, or to the double of the middle term when there is an uneven number of the terms.

Thus,

	1,	3,	5,	7,	9,	11,	13,
	13,	11,	9,	7,	5,	3,	1,
Sums	14	14	14	14	14	14	14,

where the sum of every pair of terms is the same number, 14.

Also,	a.	$a+d$,	$a+2d$,	$a+3d$,	$a+4d$,
	$a+4d$,	$a+3d$,	$a+2d$,	$a+d$,	a
sums	$2a+4d$	$2a+4d$	$2a+4d$	$2a+4d$	$2a+4d$.

3. And hence it follows, that double the sum of all the terms in the series, is equal to the sum of the two extremes multiplied by the number of the terms and consequently, that the single sum of all the terms of the series, is equal to half the said product. So the sum of the 7 terms

$$1,\ 3,\ 5,\ 7,\ 9,\ 11,\ 13,$$

$$\text{is } \overline{1+13} \times \tfrac{7}{2} = \tfrac{14}{2} \times 7 = 49.$$

And the sum of the five terms

$$a,\ a+d,\ a+2d,\ a+3d,\ a+4d.$$

$$\text{is } \overline{a+a+4d} \times \tfrac{5}{2}.$$

4. Hence also, if the first term of the progression is 0, the sum of the series will be equal to half the product of the last term multiplied by the number of terms: *i. e.* the sum of

$$0 + d + 2d + 3d + 4d \text{ - - - - - - } \overline{n-1}\,.\,d$$
$$= \tfrac{1}{2}n\,.\,\overline{n-1}\,.\,d,$$

where n is the number of terms, supposing 0 to be one of them. That is, in other words, the sum of an arithmetical progression, whether finite or infinite, whose first term is 0, is to the sum of as many times the greatest term, in the ratio of 1 to 2.

5. In like manner, the sum of the squares of the terms of such a series, beginning at 0, is to the sum of as many terms each equal to the greatest, in the ratio of 1 to 3. And,

6. The sum of the cubes of the terms of such a series, is to the sum of as many times the greatest term, in the ratio of 1 to 4.

7. And universally, if every term of such a progression is raised to the mth power, then the sum of all those powers will be to the sum of as many terms equal to the greatest, in the ratio of $m+1$ to 1. That is,

$$\text{the sum } 0 + d + 2d + 3d \text{ - - - - - - } l,$$
$$\text{is to } l^m + l^m + l^m + l^m \text{ - - - - - - } l^m,$$

in the ratio of 1 to $m+1$.

8. A synopsis of all the theorems, or relations, in an arithmetical progression, between the extremes or first and last term, the sum of the series, the number of terms, and the common difference, is as follows: viz. if

a denotes the least term,
z the greatest term,
d the common difference,
n the number of terms,
s the sum of the series;

then will each of these five quantities be expressed in terms of the others, as below:

$$a = z - \overline{n-1}\,.\,d = \frac{2s}{n} - z = \frac{s}{n} - \frac{n-1}{2}d = \sqrt{\overline{\tfrac{1}{2}d+z}|^2 - 2ds} + \tfrac{1}{2}d.$$

$$z = a + \overline{n-1}\,.\,d = \frac{2s}{n} - a = \frac{s}{n} + \frac{n-1}{2}d = \sqrt{\overline{\tfrac{1}{2}d-a}|^2 + 2ds} - \tfrac{1}{2}d.$$

$$d = \frac{z-a}{n-1} = \frac{s-na}{n-1}\,.\,\frac{2}{n} = \frac{nz-s}{n-1}\,.\,\frac{2}{n} = \frac{z+a\,.\,z-a}{2s-a-z}.$$

$$n = \frac{z-a}{d} + 1 = \frac{2s}{a+z} = \frac{\tfrac{1}{2}d - a + \sqrt{\overline{\tfrac{1}{2}d-a}|^2 + 2ds}}{d} = \frac{\tfrac{1}{2}d + z - \sqrt{\overline{\tfrac{1}{2}d+z}|^2 - 2ds}}{d}$$

$$\frac{a+z}{2}n = \frac{a+z}{2}\,.\,\frac{z-a+d}{d} = \frac{2a+\overline{n-1}\,.\,d}{2}n = \frac{2z-\overline{n-1}\,.\,d}{2}n.$$

And most of these expressions will become much simpler if the first term is 0 instead of a.

Geometrical PROGRESSION, is a series of quantities proceeding in the same continual ratio or proportion, either increasing or decreasing; or it is a series of quantities that are continually proportional; or which increase by one common multiplier, or decrease by one common divisor; which common multiplier or divisor is called the common ratio. As,

increasing, 1, 2, 4, 8, 16, &c.
decreasing, 81, 27, 9, 3, 1, &c.;

where the former progression increases continually by the common multiplier 2, and the latter decreases by the common divisor 3.

Or ascending, $a,\ ra,\ r^2a,\ r^3a$, &c.

or descending, $a,\ \frac{a}{r},\ \frac{a}{r^2},\ \frac{a}{r^3}$, &c;

where the first term is a, and common ratio r.

1. Hence, the same principal properties obtain in a geometrical progression, as have been remarked of the arithmetical one, using only multiplication in the geometricals for addition in the arithmeticals, and division in the former for subtraction in the latter. So that, to construct a geometrical progression, from any given first term, and with a given common ratio; multiply the 1st term continually by the common ratio for the rest of the terms, when the series is an ascending one; or divide continually by the common ratio, when it is a descending progression.

2. In every geometrical progression, the product of the extreme terms is equal to the product of every pair of the intermediate terms that are equidistant from the extremes, and also equal to the square of the middle term when there is a middle one, or an uneven number of the terms.

Thus,	1,	2,	4,	8,	16,
	16	8	4	2	1
prod.	16	16	16	16	16.
Also,	a,	ra,	r^2a,	r^3a,	r^4a,
	r^4a	r^3a	r^2a	ra	a
prod.	r^4a^2	r^4a^2	r^4a^2	r^4a^2	r^4a^2.

3. The last term of a geometrical progression, is equal to the first term multiplied, or divided, by the ratio raised to the power whose exponent is less by 1 than the number of terms in the series; so $z = ar^{n-1}$, when the series is an ascending one, or $z = \frac{a}{r^{n-1}}$, when it is a descending progression.

4. As the sum of all the antecedents, or all the terms except the least, is to the sum of all the consequents, or all the terms except the greatest, so is 1 to r, the ratio. For,

if $a + ra + r^2a + r^3a$ are all except the last, then $ra + r^2a + r^3a + r^4a$ are all except the first; where it is evident that the former is to the latter as 1 to r, or the former multiplied by r gives the latter. So that, z denoting the last term, a the first term, and r the ratio, also s the sum of all the terms; then $s - z : s - a :: 1 : r$, or $\overline{s - a} = \overline{s - z} \cdot r$. And from this equation all the relations among the four quantities a, z, r, s, are easily derived; such as, $s = \frac{rz - a}{r - 1}$; viz. multiply the greatest term by the ratio, subtract the least term from the product, then the remainder divided by 1 less than the ratio, will give the sum of the series. And if the least term a is 0, which happens when the descending progression is infinitely continued, then the sum is barely $\frac{rz}{r-1}$. As in the infinite progression $1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8}$ &c. where $z = 1$, and $r = 2$, it is s or $\frac{rz}{r-1} = \frac{2}{2-1} = \frac{2}{1} = 2$.

5. The first or least term of a geometrical progression, is to the sum of all the terms, as the ratio minus 1, to the nth power of the ratio minus 1; that is, $a : s :: r - 1 : r^n - 1$.

Other relations among the five quantities a, z, r, n, s, where

a denotes the least term,
z the greatest term,
r the common ratio,
n the number of terms,
s the sum of the progression,

are as below; viz.

$$a = \frac{z}{r^{n-1}} = zr - (r-1)s = \frac{r-1}{r^n - 1}s.$$

$$z = ar^{n-1} = \frac{a + (r-1)s}{r} = \frac{r-1}{r^n - 1}sr^{n-1}.$$

$$r = \frac{s-a}{s-z} = \sqrt[n-1]{\frac{z}{a}}.$$

$$n = \frac{\log \frac{rz}{a}}{\log. r} = \frac{\log. \frac{a + (r-1)s}{a}}{\log. r} = \frac{\log. \frac{rz}{rz - (r-1)s}}{\log. r} = \frac{\log. \frac{s-a \cdot z}{s-z \cdot a}}{\log. \frac{s-a}{s-z}}.$$

$$s = \frac{rz - a}{r-1} = \frac{r^n - 1}{r-1}a = \frac{r^n - 1}{r-1} \cdot \frac{z}{r^{n-1}} = \frac{\sqrt[n-1]{z^n} - \sqrt[n-1]{a^n}}{\sqrt[n-1]{z} - \sqrt[n-1]{a}}.$$

And the other values of a, z, and r, are to be found from these equations, viz.

$$(s-z)^{n-1}z = (s-a)^{n-1}a,$$

$$r^n - \frac{s}{a}r = 1 - \frac{s}{a},$$

$$r^n - \frac{s}{s-z}r^{n-1} = \frac{z}{s-z}.$$ See SERIES.

PROHIBITION, is a writ properly issuing only out of the court of king's bench, being the king's prerogative writ; but, for the furtherance of justice, it may now also be had in some cases out of the court of chancery, common pleas, or exchequer, directed to the judge and parties of a suit in an inferior court, commanding them to cease from the prosecution thereof, upon a suggestion, that either the cases originally, or some collateral matter arising therein, does not belong to that jurisdiction, but the cognizance of some other court. 3 Black. 112.

Upon the court being satisfied that the matter alleged by the suggestion is sufficient, the writ of prohibition immediately issues; commanding the judge not to hold, and the party not to prosecute, the plea. And if either the judge or party shall proceed after such prohibition, an attachment may be had against them for the contempt, by the court that awarded it, and an action will lie against them to repair the party in damages. 3 Black. 113.

PROJECTILE, or PROJECT, in mechanics, is any body which, being put into a violent motion by an external force impressed upon it, is dismissed from the agent, and left to pursue its course; such as a stone thrown out of the hand or a sling, an arrow from a bow, a ball from a gun, &c.

PROJECTILES, the science of the motion, velocity, flight, range, &c. of a projectile put into violent motion by some external cause, as the force of gunpowder, &c. This is the foundation of gunnery, under which article may be found all that relates peculiarly to that branch.

All bodies, being indifferent as to motion or rest, will necessarily continue the state they are put into, except so far as they are hindered, and forced to change it by some new cause. Hence, a projectile, put in motion, must continue eternally to move on in the same right line, and with the same uniform or constant velocity, were it to meet with no resistance from the medium, nor had any force of gravity to encounter.

In the first case, the theory of projectiles would be very simple indeed; for there would be nothing more to do, than to compute the space passed over in a given time by a given constant velocity: or either of these, from the other two being given.

But by the constant action of gravity, the projectile is continually deflected more and more from its right-lined course, and that with an accelerated velocity: which, being combined with its projectile impulse, causes the body to move in a curvilineal path, with a variable motion, which path is the curve of a parabola, as will be proved below; and the determination of the range, time of flight, angle of projection, and variable velocity, constitutes what is usually meant by the doctrine of projectiles, in the common acceptation of the word.

What is said above, however, is to be understood of projectiles moving in a non-resisting medium; for when the resistance of the air is also considered, which is enormously great, and which very much impedes the first projectile velocity, the path deviates greatly from the parabola, and the determination of the circumstances of its motion becomes one of the most complex and difficult problems in nature.

In the first place, therefore, it will be proper to consider the common doctrine of projectiles, or that on the parabolic theory, or as depending only on the nature of gravity and the projectile motion, as abstracted from the resistance of the medium.

Little more than 200 years ago, philosophers took the line described by a body projected horizontally, such as a bullet out of a cannon, while the force of the powder greatly exceeded the weight of the bullet, to be a right line, after which they allowed it became a curve. Nicholas Tartaglia was the first who perceived the mistake; maintaining that the path of the bullet was a curved line through the whole of its extent. But it was Galileo who first determined what particular curve it is that a projectile describes; shewing that the path of a bullet projected horizontally from an eminence, was a parabola, the vertex of which is the point where the bullet quits the cannon. And the same is proved generally, in the 2d article following, when the projection is made in any direction whatever, viz. that the curve is always a parabola, supposing the body moves in a non-resisting medium.

The Laws of the Motion of PROJECTILES.

I. If a heavy body is projected perpendicularly, it will continue to ascend or descend perpendicularly; because both the projecting and the gravitating force are found in the same line of direction.

II. If a body is projected in free space, either parallel to the horizon, or in any oblique direction; it will, by this motion in conjunction with the action of gravity, describe the curve line of a parabola. (Fig. 1.)

For, let the body be projected from A, in the direction AD, with any uniform velocity; then in any equal portions of time it would, by that impulse alone, describe the equal spaces AB, BC, CD, &c. in the line AD, if it was not drawn continually down below that line by the action of gravity. Draw BE, CF, DG, &c. in the direction of gravity, or perpendicular to the horizon; and take BE, CF, DG, &c. equal to the spaces through which the body would descend by its gravity in the same times in which it would uniformly pass over the spaces AB, AC, AD, &c. by the projectile motion. Then, since by these motions, the body is carried over the space AB in the same time as the space BE, and the space AC in the same time as the space CF, and the space AD in the same time as the space DG, &c.; therefore, by the composition of motions, at the end of those times the body will be found respectively in the points E, F, G, &c. and consequently the real path of the projectile will be the curve line AEFG, &c. But the spaces AB, AC, AD, &c. being described by uniform motion, are as the times of description; and the spaces BE, CF, DG, &c. described in the same times by the accelerating force of gravity, are as the squares of the times; consequently the perpendicular descents are as the squares of the spaces in AD,

that is, - - - - BE, CF, DG, &c,
are respectively propor-
tional to - - - AB^2, AC^2, AD^2, &c.

which is the same as the property of the parabola. Therefore the path of the projectile is the parabolic line AEFG, &c. to which AD is a tangent at the point A.

Hence, 1. The horizontal velocity of a projectile is always the same constant quantity, in every point of the curve; because the horizontal motion is in a constant ratio to the motion in AD, which is the uniform projectile motion; viz. the constant horizontal velocity being to the projectile velocity, as radius to the cosine of the angle DAH, or angle of elevation or depression of the piece above or below the horizontal line AH.

2. The velocity of the projectile in the direction of the curve, or of its tangent, at any point A, is as the secant of its angle BAI of direction above the horizon. For the motion in the horizontal direction AI being constant, and AI being to AB as radius to the secant of the angle A; therefore the motion at A, in AB, is as the secant of the angle A.

3. The velocity in the direction DG of gravity, or perpendicular to the horizon, at any point G of the curve, is to the first uniform projectile velocity at A, as 2GD to AD. For the times of describing AD and DG being equal, and the velocity acquired by freely descending through DG being such as would carry the body uniformly over twice DG in an equal time, and the spaces described with uniform motions being as the velocities, it follows that the space AD is to the space 2DG, as the projectile velocity at A is to the perpendicular velocity at G.

III. The velocity in the direction of the curve, at any point of it, as A, is equal to that which is generated by gravity in freely descending through a space which is equal to one-fourth of the parameter of the diameter to the parabola at that point. (Fig. 2.)

Let PA or AB be the height due to the velocity of the projectile at any point A, in the direction of the curve or tangent AC, or the velocity acquired by falling through that height; and complete the parallelogram ACDB. Then is CD = AB or AP, the height due to the velocity in the curve at A; and CD is also the height due to the perpendicular velocity at D, which will therefore be equal to the former: but, by the last corollary, the velocity at A is to the perpendicular velocity at D, as AC to 2CD; and as these velocities are equal, therefore AC or BD is equal to 2CD or 2AB; and hence AB or AP is equal to $\frac{1}{2}$BD, or $\frac{1}{4}$ of the parameter of the diameter AB, by the nature of the parabola.

Hence, 1. If through the point P, the line PL is drawn perpendicular to AP; then the velocity in the curve at every point, will be equal to the velocity acquired by falling through the perpendicular distance of the point from the said line PL; that is, a body falling freely through

PA, acquires the velocity in the curve at A,
EF, - - - - - at F,
KD, - - - - - at D,
LH, - - - - - at H.

The reason of which is, that the line PL is what is called the directrix of the parabola; the property of which is, that the perpendicular to it, from every point of the curve, is equal to one-fourth of the parameter of the diameter at that point, viz.

PA = $\frac{1}{4}$ the parameter of the diameter at A,
EF = - - - - - at F,
KD = - - - - - at L,
LH = - - - - - at H.

2. If a body, after falling through the height PA, which is equal to AB, and when it arrives at A, if its course is changed, by reflection from a firm plane AI, or otherwise, into any direction AC, without altering the velocity; and if AC is taken equal to 2AP or 2AB, and the parallelogram is completed; the body will describe the parabola passing through the point D.

3. Because AC = 2AB, or 2CD, or 2AP; therefore AC^2 = 2AP . 2CD, or AP . 4CD; and because all the perpendiculars EF, CD, GH, are as AE^2, AC^2, AG^2 therefore, also AP . 4EF = AE^2, and AP . 4GH = AG^2, &c.; and because the rectangle of the extremes is equal to the rectangle of the means, of four proportionals, therefore it is always,

AP : AE :: AE : 4EF,
and AP : AC :: AC : 4CD,
and AP : AG :: AG : 4GH,
and so on.

IV. Having given the direction of a projectile, and the impetus or altitude due to the first velocity; to determine the greatest height to which it will rise, and the random or horizontal range. (Fig. 3.)

Let AP be the height due to the projectile velocity at A, or the height which a body must fall to acquire the same velocity as the projectile has in the curve at A; also AG the direction, and AH the horizon. Upon AG let fall the perpendicular PQ, and on AP the perpendicular QR; so shall AR be equal to the greatest altitude CV, and 4RQ equal to the horizontal range AH. Or, having drawn PQ perpendicular to AG, take AG = 4AQ, and draw GH perpendicular to AH; then AH is the range.

For, by the last cor. AP : AG :: AG : 4GH,
and by sim. triangles, AP : AG :: AQ : GH,
or AP : AG :: 4AQ : 4GH;

therefore AG = 4AQ; and, by similar triangles, AH = 4RQ.

Also, if V is the vertex of the parabola, then AB or $\frac{1}{2}$AG = 2AQ, or AQ = QB; consequently AR = BV, which is = CV by the nature of the parabola.

Hence, 1. Because the angle Q is a right angle, which is the angle in a semicircle: therefore if upon AP as a diameter a semicircle is described, it will pass through the point Q. (Fig. 4.)

2. If the horizontal range and the projectile velocity are given, the direction of the piece so as to hit the object H will be thus easily found: Take AD = $\frac{1}{4}$AH, and draw DQ perpendicular to AH, meeting the semicircle described on the diameter AP in Q and q: then either AQ or Aq will be the direction of the piece. And hence it appears, that there are two directions AB and Ab which, with the same projectile velocity, give the very same horizontal range AH: and these two directions make equal angles qAD and QAP with AH and AP, because the arc PQ is equal to the arc Aq.

3. Or if the range AH and direction AB are given, to find the altitude and velocity or impetus: Take AD = $\frac{1}{4}$AH, and erect the perpendicular DQ meeting AB in Q; so shall DQ be equal to the greatest altitude CV. Also erect AP perpendicular to AH, and QP to AQ so shall AP be the height due to the velocity.

4. When the body is projected with the same velocity, but in different directions; the horizontal ranges AH will be as the sines of double the angles of elevation; or, which is the same thing, as the rectangle of the sine and cosine of elevation. For AD or RQ, which is $\frac{1}{4}$AH, is the sine of the arc AQ, which measures double the angle QAD of elevation.

And when the direction is the same, but the velocities different, the horizontal ranges are as the square of the velocities, or as the height AP, which is as the square of the velocity; for the sine AD or RQ, or $\frac{1}{4}$AH, is as the radius, or as the diameter AP.

Therefore, when both are different, the ranges are in the compound ratio of the squares of the velocities, and the sines of double the angles of elevation.

5. The greatest range is when the angle of elevation is half a right angle, or 45°. For the double of 45 is 90°, which has the greatest sine. Or the radius OS, which is $\frac{1}{4}$ of the range, is the greatest sine.

And hence the greatest range, or that at an elevation of 45°, is just double the altitude AP, which is due to the velocity, or equal to 4VC. And consequently, in that case, C is the focus of the parabola, and AH its parameter.

And the ranges are equal at angles equally above and below 45°.

6. When the elevation is 15°, the double of which, or 30°, having its sine equal to half the radius, consequently its range will be equal to AP, or half the greatest range at the elevation of 45°; that is, the range at 15° is equal to the impetus or height due to the projectile velocity.

7. The greatest altitude CV, being equal to AR, is as the versed sine of double the angle of elevation, and also as AP or the square of the velocity. Or as the square of the sine of elevation, and the square of the velocity; for the square of the sine is as the versed sine of the double angle.

8. The time of flight of the projectile, which is equal to the time of a body falling freely through GH or 4CV, 4 times the altitude, is therefore as the square root of the altitude, or as the projectile velocity and sine of the elevation.

9. And hence may be deduced the following set of theorems, for finding all the circumstances relating to projectiles on horizontal planes, having any two of them given. Thus, let

s, c, t = sine, cosine, and tang. of elevation,
S, v = sine and vers. of double the elevation,

R the horizontal rage, T the time of flight, V the projectile velocity, H the greatest height of the projectile, $g = 16\frac{1}{12}$ feet, and a = the impetus or the altitude due to the velocity V. Then,

$$R = 2aS = 4asc = \frac{SV^2}{2g} = \frac{scV^2}{g} = \frac{gcT^2}{s} = \frac{gT^2}{t}$$
$$= \frac{4H}{t}.$$

$$V = \sqrt{4ag} = \sqrt{\frac{2gR}{S}} = \sqrt{\frac{gR}{sc}} = \frac{gT}{s} = \frac{2\sqrt{gH}}{s}$$

$$T = \frac{sV}{g} = 2s\sqrt{\frac{a}{g}} = \sqrt{\frac{tR}{g}} = \sqrt{\frac{sR}{gc}} = 2\sqrt{\frac{H}{g}}$$

$$H = as^2 = \tfrac{1}{2}av = \tfrac{1}{4}tR = \frac{sR}{4c} = \frac{sV^2}{4g} = vV^4$$
$$= \frac{gT^2}{4}.$$

And from any of these, the angle of direction may be found.

V. To determine the range on an oblique plane; having given the impetus or the velocity, and the angle of direction.

Let AE be the oblique plane, at a given angle above or below the horizontal plane AH; AG the direction of the piece; and AP the altitude due to the projectile velocity at A. (Fig. 5.)

By the last prop. find the horizontal range AH to the given velocity and direction draw HE perpendicular to AH, meeting the oblique plane in E; draw EF parallel to the direction AG, and FI parallel to HE; so shall the projectile pass through I, and the range on the oblique plane will be AI. This is evident from the properties of the parabola: see CONIC SECTIONS, where it is proved, that if AH, AI, are any two lines terminated at the curve, and IF, HE, are parallel to the axis; then is EF parallel to the tangent AG. (Figs. 6 and 7.)

Hence, 1. If AO is drawn perpendicular to the plane AI, and AP is bisected by the perpendicular STO; then with the centre O describing a circle through A and P, the same will also pass through q; because the angle GAI, formed by the tangent AG and AI, is equal to the angle APq, which will therefore stand upon the same arc Aq.

2. If there are given the range and velocity, or the impetus, the direction will then be easily found thus: Take $Ak = \frac{1}{4}$AI; draw kq perpendicular to AH, meeting the circle described with the radius AO in two points q and q; then Aq or Aq will be the direction of the piece. And hence it appears that there are two directions, which, with the same impetus, give the very same range AI, on the oblique plane. And these two directions make equal angles with AI and AP, the plane and the perpendicular, because the arc Pq = the arc Aq. They also make equal angles with a line drawn from A through S, because the arc Sq = the arc Sq.

3. Or, if there are given the range AI, and the direction Aq, to find the velocity or impetus. Take $Ak = \frac{1}{4}$AI; and erect kq perpendicular to AH, meeting the line of direction in q; then draw qP, making the angle AqP = the angle Akq; so shall AP be the impetus, or altitude due to the projectile velocity.

4. The range on an oblique plane, with a given elevation, is directly as the rectangle of the cosine of the direction of the piece above the horizon, and the sine of the direction above the oblique plane, and reciprocally as the square of the cosine of the angle of the plane above or below the horizon.

For, put s = sin. ∠ qAI or APq,
c = cos. ∠ qAH or sin. PAq,
C = cos. ∠ IAH or sin. Akd or Akq or AqP.

Then, in the tri. APq, C : s :: AP : Aq,
and in the trian. Akq, C : c :: Aq : Ak,
therefore by compos. $C^2 : cs$ :: AP : $Ak = \frac{1}{4}$AI,
so that the oblique range $AI = \frac{cs}{C^2} \times 4AP$.

Hence the range is the greatest when Ak is the greatest, that is, when kq touches the circle in the middle point S; and then the line of direction passes through S, and bisects the angle formed by the oblique plane and the vertex. Also the ranges are equal at equal angles above and below this direction for the maximum.

5. The greatest height cv or kq of the projectile, above the plane, is equal to $\frac{s^2}{c^2} \times$ AP. And therefore it is as the impetus and square of the sine of direction above the plane directly, and square of the cosine of the plane's inclination reciprocally.

For, C (sin. AqP) : s (sin. APq) :: AP : Aq,
and C (sin. Akq) : s (sin. kAq) :: Aq : kq,
therefore by comp. $C^2 : s^2$ :: AP : kq.

6. The time of flight in the curve AvI is $= \frac{2s}{c}\sqrt{\frac{AP}{g}}$, where $g = 16\frac{1}{12}$ feet. And therefore it is as the velocity and sine of direction above the plane directly, and cosine of the plane's inclination reciprocally. For the time of describing the curve, is equal to the time of falling freely through GI, or $4kq$, or $\frac{4s^2}{c^2} \times$ AP. Therefore, the time being as the square root of the distance, $\sqrt{g} : \frac{2s}{c}\sqrt{AP} :: 1'' : \frac{2s}{c}\sqrt{\frac{AP}{g}}$ the time of flight.

7. From the foregoing corollaries may be collected the following set of theorems, relating to projectiles made on any given inclined planes, either above or below the horizontal plane; in which the letters denote as before, namely,

c = cos. of direction above the horizon,
C = cos. of inclination of the plane,
s = sin. of direction above the plane,
R the range on the oblique plane,
T the time of flight,
V the projectile velocity,
H the greatest height above the plane,
a the impetus, or alt. due to the velocity V,
$g = 16\frac{1}{12}$ feet. Then

$$R = \frac{cs}{C^2} \times 4a = \frac{cs}{C^2 g}V^2 = \frac{gC}{s}T^2 = \frac{4c}{s}H.$$

$$H = \frac{s^2}{C^2}a = \frac{s^2V^2}{4gC^2} = \frac{sR}{4c} = \frac{g}{4}T^2.$$

$$V = \sqrt{4ag} = C\sqrt{\frac{gR}{cs}} = \frac{gC}{s}T = \frac{2C}{s}\sqrt{gH}.$$

$$T = \frac{2s}{C}\sqrt{\frac{a}{g}} = \frac{sV}{gC} = \sqrt{\frac{sR}{gc}} = 2\sqrt{\frac{H}{g}}.$$

And from any of these, the angle of direction may be found.

Of the Path of PROJECTILES, *as depending on the Resistance of the Air.*

For a long time after Galileo, philosophers seemed to be satisfied with the parabolic theory of projectiles, deeming the effect of the air's resistance on the path as of no consequence. In process of time, however, as the true philosophy began to dawn, they began to suspect that the resistance of the medium might have some effect upon the projectile curve, and they set themselves to consider this subject with some attention.

Huygens, supposing that the resistance of the air was proportional to the velocity of the moving body, concluded that the line described by it would be a kind of logarithmic curve.

But Newton, having clearly proved, that the resistance to the body is not proportional to the velocity itself, but to the square of it, shews, in his Principia, that the line a projectile describes, approaches nearer to an hyperbola than a parabola.

Mr. Robins has shewn that, in some cases, the resistance to a cannon-ball amounts to more than 20 times the weight of the ball; and Dr. Hutton, having prosecuted this subject far beyond any former example, has sometimes found this resistance amount to near 100 times the weight of the ball, viz. when it moved with a velocity of 2000 feet per second, which is a rate of almost 23 miles in a minute.

Mr. Robins has not only detected the errors of the parabolic theory of gunnery, which takes no account of the resistance of the air, but shews how to compute the real range of resisted bodies.

There is an odd circumstance which often takes place in the motion of bodies projected with considerable force, which shews the great complication and difficulty of this subject; namely, that bullets in their flight are not only depressed beneath their original direction by the action of gravity, but are also frequently driven to the right or left of that direction by the action of some other force.

Now if it was true that bullets varied their direction by the action of gravity only, then it ought to happen that the errors in their flight to the right or left of the mark they were aimed at, should increase in the proportion of the distance of the mark from the piece only. But this is contrary to all experience: the same piece which will carry its bullet within an inch of the intended mark at 10 yards distance, cannot be relied on to 10 inches in 100 yards, much less to 30 in 300 yards.

And this inequality can only arise from the track of the bullet being incurvated sideways as well as downwards; for by this means the distance between the incurvated line and the line of direction, will increase in a much greater ratio than that of the distance; these lines coinciding at the mouth of the piece, and afterwards separating in the manner of a curve from its tangent, if the mouth of the piece is considered as the point of contact.

This is put beyond a doubt from the experiments made by Mr. Robins; who found also that the direction of the shot in the perpendicular line was not less uncertain, falling sometimes 200 yards short of what it did at other times, although there was no visible cause of difference in making the experiment. See RIFLE.

PROJECTION, in mechanics, the act of giving a projectile its motion.

If the direction of the force, by which the projectile is put in motion, is perpendicular to the horizon, the projection is said to be perpendicular; if parallel to the apparent horizon, it is said to be an horizontal projection; and if it makes an oblique angle with the horizon, the projection is oblique. In all cases, the angle which the line of direction makes with the horizontal line, is called the angle of elevation of the projectile, or of depression when the line of direction points below the horizontal line.

PROJECTION, in perspective, denotes the appearance or representation of an object on the perspective plane. So, the projection of a point, is a point where the optic ray passes from the objective point through the plane to the eye; or it is the point where the plane cuts the optic ray. And hence it is easy to conceive what is meant by the projection of a line, a plane, or a solid.

PROJECTION *of the Sphere in Plano*, is a representation of the several points or places of the surface of the sphere, and of the circles described upon it, upon a transparent plane placed between the eye and the sphere, or such as they appear to the eye placed at a given distance. For the laws of this projection, see PERSPECTIVE: the projection of the sphere being only a particular case of perspective.

The chief use of the projection of the sphere, is in the construction of planispheres, maps, and charts; which are said to be of this or that projection, according to the several situations of the eye, and the perspective plane, with regard to the meridians, parallels, and other points or places to be represented.

The most usual projection of maps of the world, is that on the plane of the meridian, which exhibits a right sphere; the first meridian being the horizon. The next is that on the plane of the equator, which has the pole in the centre, and the meridians the radii of a circle, &c. and this represents a parallel sphere. See MAP.

The projection of the sphere is usually divided into orthographic and stereographic; to which may be added gnomonic.

PROJECTION *orthographic*, is that in which the surface of the sphere is drawn upon a plane, cutting it in the middle; the eye being placed at an infinite distance vertically to one of the hemispheres. And, PROJECTION *stereographic* of the sphere, is that in which the surface and circles of the sphere are drawn upon the plane of a great circle, the eye being in the pole of that circle.

PROJECTION *gnomonical of the sphere*, is that in which the surface of the sphere is drawn upon a plane withoutside of it, commonly touching it, the eye being at the centre of the sphere.

Laws of the orthographic projection.—1. The rays coming from the eye, being at an infinite distance, and making the projection, are parallel to each other, and perpendicular to the plane of projection.

2. A right line perpendicular to the plane of projection, is projected into a point where that line meets the said plane. (Fig. 8.)

3. A right line, as AB, or CD, not perpendicular, but either parallel or oblique to the plane of the projection, is projected into a right line, as EF or GH, and is always comprehended between the extreme perpendiculars AE and BF, or CG and DH.

4. The projection of the right line AB is the greatest, when AB is parallel to the plane of the projection.

5. Hence it is evident, that a line parallel to the plane of the projection, is projected into a right line equal to itself; but a line that is oblique to the plane of projection, is projected into one that is less than itself. (Fig. 9.)

6. A plane surface, as ACBD, perpendicular to the plane of the projection, is projected into the right line, as AB, in which it cuts that plane. Hence it is evident, that the circle ACBD perpendicular to the plane of projection, passing through its centre, is projected into that diameter AB in which it cuts the plane of the projection. Also any arch as C*c* is projected into O*o*, equal to *ca*, the right sine of that arch; and the complemental arc *c*B is projected into *o*B, the versed sine of the same arc *c*B.

7. A circle parallel to the plane of the projection, is projected into a circle equal to itself, having its centre the same with the centre of the projection, and its radius equal to the cosine of its distance from the plane. And a circle oblique to the plane of the projection, is projected into an ellipsis, whose greater axis is equal to the diameter of the circle, and its less axis equal to double the cosine of the obliquity of the circle to a radius equal to half the greater axis.

Properties of the stereographic projection.—1. In this projection a right circle, or one perpendicular to the plane of projection, and passing through the eye, is projected into a line of half-tangents.

2. The projections of all other circles, not passing through the projecting point, whether parallel or oblique, are projected into circles. Figs. 10, 11, and 12.

Thus, let ACEDB represent a sphere, cut by a plane RS, passing through the centre I, perpendicular to the diameter EH, drawn from E the place of the eye; and let the section of the sphere by the plane RS be the circle CFDL, whose poles are H and E. Suppose now AGB is a circle on the sphere to be projected, whose pole most remote from the eye is P; and the visual rays from the circle HGB meeting in E, form the cone AGBE, of which the triangle AEB is a section through the vertex E, and diameter of the base AB; then will the figure *agbf*, which is the projection of the circle AGB, be itself a circle. Hence, the middle of the projected diameter is the centre of the projected circle, whether it is a great circle or a small one: also the poles and centres of all circles parallel to the plane of projection, fall in the centre of the projection: and all oblique great circles cut the primitive circle in two points diametrically opposite.

3. The projected diameter of any circle subtends an angle at the eye equal to the distance of that circle from its nearest pole, taken on the sphere; and that angle is bisected by a right line joining the eye and that pole. Thus, let the plane RS (fig. 13) cut the sphere HFEC through its centre I; and let ABC be any oblique great circle, whose diameter AC is projected into *ac*; and KOL any small circle parallel to ABC, whose diameter KL is projected in *kl*. The distances of those circles from their pole P, being the arcs AHP, KHP, and the angles *a*E*c*, *k*E*l*, are the angles at the eye, subtended by their projected diameters, *ac* and *kl*. Then is the angle *a*E*c* measured by the arc AHP, and the angle *k*E*l* measured by the arc KHP; and those angles are bisected by EP.

3. Any point of a sphere is projected at such a distance from the centre of projection, as is equal to the tangent of half the arc intercepted between that point and the pole opposite to the eye, the semidiameter of the sphere being radius. Thus, let C*b*EB (fig. 14) be a great circle of the sphere, whose centre is *c*; GH the plane of projection cutting the diameter of the sphere in *b* and B; also E and C the poles of the section by that plane; and *a* the projection of A. Then *ca* is equal to the tangent of half the arc AC, as is evident by drawing CF = the tangent of half that arc, and joining *c*F.

4. The angle made by two projected circles, is equal to the angle which these circles make on the sphere. For let IACE (fig. 15) and ABL be two circles on a sphere intersecting in A; E the projecting point; and RS the plane of projection, in which the point A is projected in *a*, in the line IC, the diameter of the circle ACE. Also let DH and FA be tangents to the circles ACE and ABL. Then will the projected angle *daf* be equal to the spherical angle BAC.

5. The distance between the poles of the primitive circle and an oblique circle, is equal to the tangent of half the inclination of those circles; and the distance of their centres is equal to the tangent of their inclination, the semidiameter of the primitive being radius. For let AC (fig. 16) be the diameter of a circle, whose poles are P and Q, and inclined to the plane of projection in the angle AIF; and let *a*, *c*, *p*, be the projections of the points A, C, P; also let H*a*E be the projected oblique circle, whose centre is *q*. Now when the plane of projection becomes the primitive circle, whose pole is I, then is I*p* = tangent of half the angle AIF, or of half the arch AF; and I*q* = tangent of AF, or of the angle FH*a* = AIF.

6. If through any given point in the primitive circle, an oblique circle is described, then the centres of all other oblique circles passing through that point, will be in a right line drawn through the centre of the first oblique circle, and perpendicular to a line passing through that centre, the given point, and the centre of the primitive circle. Thus, let GACE (fig. 17) be the primitive circle, and ADEI a great circle described through D, its centre being B. HK is a right line drawn through B, perpendicular to a right line CI passing through D and B and the centre of the primitive circle. Then the centres of all other great circles, as FDG, passing through D, will fall in the line HK.

7. Equal arcs of any two great circles of the sphere will be intercepted between two other circles drawn on the sphere through the remotest poles of those great circles. For let PBEA (fig. 18) be a sphere, on which AGB and CFD are two great circles, whose remotest poles are E and P; and through these poles let the great circle PBEC and the small circle PGE be drawn, cutting the great circles AGB and CFD in the points B, G, D, F. Then are the intercepted arcs BG and DF equal to one another.

8. If lines are drawn from the projected pole of any great circle, cutting the peripheries of the projected circle and plane of projection, the intercepted arcs of those peripheries are equal; that is, the arc BG = *df*.

9. The radius of any lesser circle, whose plane is perpendicular to that of the primitive circle, is equal to the tangent of that lesser circle's distance from its pole; and the secant of that distance is equal to the distance of the centres of the primitive and lesser circle. For let P (fig. 19) be the pole and AB the diameter of a lesser circle, its plane being perpendicular to that of the primitive circle, whose centre is C: then *d* being the centre of the projected lesser circle, *da* is equal to the tangent of the arc PA, and *d*C = the secant of PA.

PROJECTURE. See ARCHITECTURE.

PROLAPSUS. See SURGERY.

PROLATE, in geometry, an epithet applied to a spheroid produced by the revolution of a semi-ellipsis about its larger diameter.

PROMISE, is where, upon a valuable consideration, persons bind themselves by words to do or perform such a thing agreed on: it is in the nature of a verbal covenant, and wants only the solemnity of writing and sealing to make it absolutely the same. Yet for the breach of it, the remedy is different; for instead of an action of covenant, there lies only an action upon the case, the damages whereof are to be estimated and determined by the jury.

PROMISSORY NOTE. See BILLS OF EXCHANGE.

PRONOUN, in grammar, a declinable part of speech, which being put instead of a noun, points out some person or thing.

PROOF, the shewing or making plain the truth of any matter alleged; either in giving evidence to a jury on a trial, or else on interrogatories or by copies of records, or exemplifications of them. See EVIDENCE.

PROOF *of artillery and small arms*, is a trial whether they stand the quantity of powder allotted for that purpose. The rule of the board of ordnance is, that all guns under 24-pounders are loaded with powder as much as their shot weighs; that is, a brass 24-pounder with 21 lb. a brass 32-pounder with 26 lb. 12 oz. and a 42-pounder with 31 lb. 8 oz. the iron 24-pounder with 18 lb. the 32-pounder with 21 lb. 8 oz. and the 42-pounder with 25 lb.

The brass light field-pieces are proved with powder that weighs half as much as their shot, except the 24-pounder, which is loaded with 10 lb. only.

Government allows 11 bullets of lead in the pound for the proof of muskets; and 14.5, or twenty-nine in two, for service; seventeen in the pound for the proof of carbines, and twenty for service; twenty-eight in the pound for the proof of pistols, and thirty-four for service.

When guns of a new metal, or of lighter construction, are proved; then, besides the common proof, they are fired 200 or 300 times, as quick as they can be loaded with the common charge given in actual service. Our light six-pounders were fired 300 times in three hours and twenty-seven minutes, loaded with 1 lb. 4 oz., without receiving any damage.

PROOF *of powder*, is in order to try its goodness and strength. See GUNPOWDER.

PROOF *of cannon*, is made to ascertain their being well cast, their having no cavities in the metal, and in a word, their being fit to resist the effort of their charge of powder. In making this proof, the piece is laid upon the ground, supported only by a piece of wood in the middle, of about five or six inches thick, to raise the muzzle a little, and then the piece is fired against a solid butt of earth.

Proof *of mortars and howitzers,* is made to ascertain their being well cast, and of strength to resist the effort of their charge. For this purpose the mortar or howitzer is placed upon the ground, with some part of the trunnions or breech sunk below the surface, and resting on wooden billets at an elevation of about seventy degrees. The mirror is generally the only instrument to discover the defects in mortars and howitzers. In order to use it, the sun must shine; the breech must be placed towards the sun, and the glass over-against the mouth of the piece which illuminates the bore and chamber sufficiently to discover the flaws in it.

Proof *of foreign brass artillery.* 1st, The Prussians. Their battering-train and garrison artillery are proved with a quantity of powder equal to half the weight of the shot, and fired seventy-five rounds as fast as in real service; that is, two or three rounds in a minute. Their light field-train, from a 12-pounder upwards, are proved with a quantity of powder = 1-3d of the weight of the shot, and fired 150 rounds, at three or four rounds in a minute. From a 12-pounder downwards, are proved with a quantity = 1-5th of the shot's weight, and fired 300 rounds, at five or six rounds each minute, properly spunged and loaded. Their mortars are proved with the chambers full of powder, and the shells loaded. Three rounds are fired as quick as possible. 2d, The Dutch prove all their artillery by firing each piece five times: the two first rounds with a quantity of powder = 2-3ds of the weight of the shot; and the three last rounds with a quantity of powder = half the weight of the shot. 3d, The French the same as the Dutch.

Proof, in brandy and other spirituous liquors, is a little white froth which appears on the top of the liquor when poured into a glass. This froth, as it diminishes, forms itself into a circle called by the French the chapelet, and by the English the bead or bubble.

PROPOLIS. See Resins.

PROPORTION, in arithmetic, &c. See Algebra, p. 54.

Proportion is often confounded with ratio; but they are quite different things. For, ratio is properly the relation of two magnitudes or quantities of one and the same kind; as the ratio of 4 to 8, or of 15 to 30, or of 1 to 2 and so implies or respects only two terms or things. But proportion respects four terms or things, or two ratios which have each two terms; though the middle term may be common to both ratios, and then the proportion is expressed by three terms only, as 4, 8, 64, where 4 is to 8 as 8 to 64.

Proportion is also sometimes confounded with progression. In fact, the two often coincide; the difference between them only consisting in this, that progression is a particular species of proportion, being indeed a continued proportion, or such as has all the terms in the same ratio, viz. the 1st to the 2d, the 2d to the 3d, the 3d to the 4th, &c; as the terms 2, 4, 8, 16, &c. so that progression is a series or continuation of proportions. See Progression.

Proportion is either continual, or discrete, or interrupted.

The proportion is continual when every two adjacent terms have the same ratio, or when the consequent of each ratio is the antecedent of the next following ratio, and so all the terms form a progression: as 2, 4, 8, 16, &c.; where 2 is to 4 as 4 to 8, and as 8 to 16, &c.

Discrete or interrupted proportion, is when the consequent of the first ratio is different from the antecedent of the 2d, &c.; as 2, 4, and 3, 6.

Proportion is also either direct or inverse.

Direct proportion is when more requires more, or less requires less; as it will require more men to perform more work, or fewer men for less work, in the same time.

Inverse or reciprocal proportion, is when more requires less, or less requires more. As it will require more men to perform the same work in less time, or fewer men in more time. Ex. If 6 men can perform a piece of work in 15 days, how many men can do the same in 10 days? Then,

reciprocally as $\frac{1}{15}$ to $\frac{1}{10}$ so is $6 : 9$ } the an-
or inversely as 10 to 15 so is $6 : 9$ } swer.

Proportion, again, is distinguished into arithmetical, geometrical, and harmonical.

Arithmetical proportion is the equality of two arithmetical ratios, or differences: as in the numbers 12, 9, 6; where the difference between 12 and 9, is the same as the difference between 9 and 6, viz. 3.

And here the sum of the extreme terms is equal to the sum of the means, or to double the single mean when there is but one. As $12 + 6 = 9 + 9 = 18$.

Geometrical proportion is the equality between two geometrical ratios, or between the quotients of the terms. As in the three 9, 6, 4, where 9 is to 6 as 6 is to 4, thus denoted $9 : 6 :: 6 : 4$; for $\frac{9}{6} = \frac{6}{4}$, being each equal $\frac{2}{3}$ or $1\frac{1}{2}$.

And in this proportion, the rectangle or product of the extreme terms, is equal to that of the two means, or the square of the single mean when there is but one. For $9 \times 4 = 6 \times 6 = 36$.

Harmonical proportion, is when the first term is to the third, as the difference between the 1st and 2d is to the difference between the 2d and 3d; or in four terms, when the 1st is to the 4th, as the difference between the 1st and 2d is to the difference between the 3d and 4th; or the reciprocals of an arithmetical proportion are in harmonical proportion. As 6, 4, 3; because $6 : 3 :: 6 - 4 = 2 : 4 - 3 = 1$ or because $\frac{1}{5}, \frac{1}{4}, \frac{1}{3}$, are in arithmetical proportion, making $\frac{1}{6} + \frac{1}{3} = \frac{1}{4} + \frac{1}{4} = \frac{1}{2}$. Also the four 24, 16, 12, 9, are in harmonical proportion, because $24 : 9 :: 8 : 3$.

PROPORTIONAL *compasses*, are compasses with two pair of opposite legs, like a St. Andrew's cross, by which any space is enlarged or diminished in any proportion.

Proportional *scales*, called also logarithmic scales, are the logarithms, or artificial numbers, placed on lines, for the ease and advantage of multiplying and dividing, &c. by means of compasses, or of sliding rulers. These are in effect so many lines of numbers, as they are called by Gunter, but made single, double, triple, or quadruple; beyond which they seldom go.

PROPORTIONALS, are the terms of a proportion: consisting of two extremes, which are the first and last terms of the set, and the means, which are the rest of the terms. These proportionals may be either arithmeticals, geometricals, or harmonicals, and in any number above two, and also either continued or discontinued.

Pappus gives this beautiful and simple comparison of the three kinds of proportionals, arithmetical, geometrical, and harmonical, viz. a, b, c, being the first, second, and third terms in any such proportion, then

In the arithmeticals, $a : a$ }
in the geometricals, $a : b$ } $:: a - b : b - c$.
in the harmonicals, $a : c$ }

Continued proportionals form what is called a progression. See Progression.

I. *Properties of arithmetical proportionals.*

For what respects progressions and mean proportionals of all sorts, see Mean and Progression.

1. Four arithmetical proportions, as 2, 3, 4, 5, are still proportionals when inversely 5, 4, 3, 2; or alternately, thus, - 2, 4, 3, 5; or inversely and alternately, thus, 5, 3, 4, 2.

2. If two arithmeticals are added to the like terms of other two arithmeticals, of the same difference or arithmetical ratio, the sums will have double the same difference or arithmetical ratio.

So, to	3 and 5, whose difference is	2,
add	7 and 9, whose difference is also	2,
the sums	10 and 14 have a double diff. viz.	4.

And if to these sums are added two other numbers also in the same difference, the next sums will have a triple ratio or difference; and so on. Also, whatever are the ratios of the terms that are added, whether the same or different, the sums of the terms will have such arithmetical ratio as is composed of the sums of the others that are added.

So	3 ,	5, whose diff. is	2
and	7 ,	10, whose diff. is	3
and	12 ,	16, whose diff. is	4
	—	—	—
make	22 ,	31, whose diff. is	9.

On the contrary, if from two arithmeticals are subtracted others, the difference will have such arithmetical ratio as is equal to the differences of those.

So from	12 and	16, whose dif. is	4
take	7 and	10, whose dif. is	3
	—	—	—
leaves	5 and	6, whose dif. is	1
	—	—	—
Also from	7 and	9, whose dif. is	2
take	3 and	5, whose dif. is	2
	—	—	—
leaves	4 and	4, whose dif. is	0

Hence, if arithmetical proportionals are multiplied or divided by the same number, their difference, or arithmetical ratio, is also multiplied or divided by the same number.

II. *Properties of geometrical proportionals.*

The properties relating to mean proportionals are given under the term Mean Proportional; some are also given under the article Proportion; and some additional ones are as below:

1. To find a 3d proportional to two given numbers, or a 4th proportional to three, in the former case, multiply the 2d term by itself, and divide the product by the 1st; and in the latter case, multiply the 2d term by the 3d, and divide the product by the 1st.

So $2 : 6 :: 6 : 18$, the 3d prop. to 2 and 6:
and $2 : 6 :: 5 : 15$, the 4th prop. to 2, 6, and 5.

2. If the terms of any geometrical ratio are augmented or diminished by any others in the same ratio, or proportion, the sums or differences will still be in the same ratio or proportion.

So if $a : b :: c : d$,
then is $a : b :: a \pm c : b \pm d :: c : d$.

And if the terms of a ratio, or proportion, are multiplied or divided by any one and the same number, the products and quotients will still be in the same ratio, or proportion.

Thus, $a : b :: na : nb :: \frac{a}{n} : \frac{b}{n}$.

3. If a set of continued proportionals are either augmented or diminished by the same part or parts of themselves, the sums or differences will also be proportionals.

Thus if a, b, c, d, &c. are propors. then are $a \pm \frac{a}{n}$, $b, \pm \frac{b}{n}$, $c, \pm \frac{c}{n}$, &c. also proportionals, where the common ratio is $1 \pm \frac{1}{n}$.

And if any single quantity is either augmented or diminished by some part of itself, and the result is also increased or diminished by the same part of itself, and this third quantity treated in the same manner, and so on; then shall all these quantities be continued proportionals. So, beginning with the quantity a, and taking always the nth part, then shall

a, $a \pm \frac{a}{n}$, $\pm \frac{2a}{n} + \frac{a^2}{n^2}$, &c. be proportionals, or a, $a \pm \frac{a}{n}$, $(a \pm \frac{a}{n})^2$, $(a \pm \frac{a}{n})$, &c. proportionals the common ratio being $1 \pm \frac{a}{n}$.

4. If one set of proportionals is multiplied or divided by any other set of proportionals, each term by each, the products or quotients will also be proportionals.

Thus, if $a : na :: b : nb$,
and $c : mc :: d : md$;
then is $ac : mnac :: bd : mnbd$,
and $\frac{a}{c} : \frac{na}{mc} :: \frac{b}{d} : \frac{nb}{mb}$.

5. If there are several continued proportionals, then whatever ratio the 1st has to the 2d, the 1st to the 3d shall have the duplicate of the ratio, the 1st to the 4th the triplicate of it, and so on.

So in a, na, n^2a, n^3a, &c. the ratio being n;
then $a : n^2a$, or 1 to n^2, the duplicate ratio,
and $a : n^3a$, or 1 to n^2, the triplicate ratio,
and so on.

6. In three continued proportionals, the difference between the 1st and 2d term, is a mean proportional between the 1st term and the second difference of all the terms.

Thus, in the three propor. a, na, n^2a;

Terms	1st difs.	2d dif.
n^2a		
na	$n^2a - na$	
a	$na - a$	$n^2a - 2na + a$,

then $a : na - a :: na - a : n^2a - 2na + a$.

Or in the numbers 2, 6, 18;

18		
6	12	8 the 2d difference;
2	4	

then 2, 4, 8 are proportionals.

7. When four quantities are in proportion, they are also in proportion by inversion, composition, division, &c.; thus, a, na, b, nb, being in proportion, viz.

1.	$a : na :: b : nb$; then by	
2. Inversion	$na : a :: nb : b$;	
3. Alternation	$a : b :: na : nb$;	
4. Composition	$a + na : na :: b + nb : nb$;	
5. Conversion	$a + na : a :: b + nb : b$;	
6. Division	$a - na : a :: b - nb : b$;	
	$a - na : na :: b - nb : nb$;	

III. *Properties of harmonical proportionals.*

1. If three or four numbers in harmonical proportion, are either multiplied or divided by any number, the products or quotients will also be harmonical proportions.

Thus, 6, 3, 2, being harmon. propor.
then 12, 6, 4, are also harmon. propor.
and $\frac{6}{2}$, $\frac{3}{2}$, $\frac{2}{2}$ are also harmon. propor.

2. In the three harmonical proportionals, a, b, c, when any two of these are given, the third can be found from the definition of them, viz. that $a : c :: a - b : b - c$; for hence

$b = \frac{2ac}{a + c}$ the harmonical mean and

$c = \frac{ab}{2a - b}$ the third harmon. to a and b.

3. And of the four harmonicals, a, b, c, d, any three being given, the fourth can be found from the definition of them, viz. that $a : d :: a - b : c - d$; for thence the three b, c, d, will be thus found, viz.

$b = \frac{2ad - ac}{d}$; $c = \frac{2ad - bd}{a}$; $d = \frac{ab}{2a - b}$.

4. If there are four numbers disposed in order, as 2, 3, 4, 6, of which one extreme and the two middle terms are in arithmetical proportion, and the other extreme and the same middle terms are in harmonical proportion; then are the four terms in geometrical proportion: so here

the three 2, 3, 4 are arithmeticals,
and the three 3, 4, 6 are harmonicals,
then the four 2, 3, 4, 6 are geometricals.

5. If between any two numbers, as 2 and 6, there are interposed an arithmetical mean 4, and also a harmonical mean 3, the four will then be geometricals, viz. $2 : 3 :: 4 : 6$.

6. Between the three kinds of proportion, there is this remarkable difference viz. that from any given number there can be raised a continued arithmetical series increasing ad infinitum, but not decreasing; while the harmonical can be decreased ad infinitum, but not increased; and the geometrical admits of both.

PROPORTIONS of the human body. See DRAWING.

PROPORTIONS of the antique statues. See STATUES, and SCULPTURE.

PROPOSITION, in logic, part of an argument wherein some quality, either negative or positive, is attributed to a subject; or according to Chauvinus, it is a complete consistent sentence, indicating or expressing something either true or false, without ambiguity; as, God is just.

PROPOSITION, in mathematics, is either some truth advanced and shewn to be such by demonstration, or some operation proposed and its solution shewn. If the proposition is deduced from several theoretical definitions compared together, it is called a theorem; if from a praxis, or series of operations, it is called a problem.

PROSERPINACA, a genus of the trigynia order, in the triandria class of plants; and in the natural method ranking under the 15th order, inundatæ. The calyx is tripartite superior; there is no corolla; there is one trilocular seed. There is one species, a marsh plant of Virginia.

PROSODY, that part of grammar which treats of the quantities and accents of syllables, and the manner of making verses.

PROSOPIS, a genus of the monogynia order, in the decandria class of plants. The calyx is hemispherical and quadridentate; the stigma is simple, the legumen inflated and monospermous. There is one species, a tree of the East Indies.

PROSOPOPŒIA, a figure in rhetoric, whereby we raise qualities, or things inanimate, into persons. See RHETORIC.

PROSTATÆ. See ANATOMY.

PROSTYLE, in antient architecture, a range of columns in front of a temple.

PROTEST, when one openly affirms, that he does either not at all, or but conditionally, yield his consent to any act, or unto the proceeding of a judge in court wherein his jurisdiction is doubtful, or to answer upon his oath any farther than by law he is bound.

PROTEST, is also that act by which the holder of a foreign bill of exchange declares that such bill is dishonoured.

PROTEST, is also that act of a master, on his arrival with his ship from parts beyond the seas, to save him and his owners harmless and indemnified from any damage sustained in the goods of her lading, on account of storms. See BILLS OF EXCHANGE, and INSURANCE.

PROTESTANT, a name first given in Germany to those who adhered to the doctrine of Luther; because in 1529, they protested against a decree of the emperor Charles V. and the diet of Spires; declaring that they appealed to a general council. The same name also has been given to those of the sentiments of Calvin, and is now become a common denomination for all those of the reformed churches.

PROTEA, the *silver-tree*, a genus of the monogynia order, in the tetrandria class of plants; and in the natural method ranking under the 47th order, stellatæ. There is one quadrifid petal surrounding the germ; there is no proper calyx; the receptacle is paleaceous. There are sixty-four species, chiefly natives of the Cape of Good Hope; of which the most remarkable are, 1. The conifera, with linear, spear-shaped, entire leaves, grows to the height of ten or twelve feet, with a straight regular stem. The branches naturally form a large regular head. The leaves are long and narrow, of a shining silver-colour, and, as they remain the whole year, make a fine appearance in the greenhouse. 2. The argentea, commonly called silver-tree, has a strong upright stem covered with purplish bark, dividing into several branches which grow erect, with broad, shining, silvery, leaves, which make a fine appearance when intermixed with other exotics. Through the whole year it exhibits its glossy white or silvery leaves. It has at first a very uncommon and beautiful appearance; and sometimes in the course of twelve or fifteen years, reaches the height of twenty feet, which it never exceeds. In a rich soil it grows twice as quick, and is by far the largest of the protea kind. They are generally planted near some farms, and very seldom grow wild; Mr. Sparrman thinks it was probably brought to the Cape of Good Hope from Anamaqua; for he had travelled over the whole north-east side of Hottentots' Holland, without finding it either in its wild state or planted. 3. The nitida, or wageboom, greatly resembles the second sort; the leaves are very silky and white, with erect purple branches.

All these plants being tender exotics, require to be continually kept in the greenhouse during winter. The first may be propagated by cuttings, which should be cut off in April, just before the plants begin to shoot; the second and third sorts may be propagated by seeds.

PROTHONOTARY, a term which properly signifies first notary, and which was antiently the title of the principal notaries of the emperors of Constantinople.

Prothonotary with us is used for an officer, in the courts of king's bench and common pleas; the former of which courts has one, and the latter three. The prothonotary of the king's bench, records all civil actions sued in that court, as the clerk of the crown-office does all criminal causes. The prothonotaries of the common pleas enter and inrol all declarations, pleadings, assizes, judgments and actions; they also make out all judicial writs, except writs of habeas-corpus, and distringas jurator, for which there is a particular office, called the habeas corpora office; they likewise enter recognizances acknowledged, and all common recoveries; make exemplifications of records, &c.

PROTOXIDE, in chemistry, a term used to denote the minimum of oxidizement. See OXIDE.

PROTRACTION, the same with plotting. See SURVEYING.

PROTRACTOR, the name of an instrument used for protracting or laying down on paper the angles of a field, or other figure. See INSTRUMENT.

PROVISO, in law, a condition inserted in a deed, upon the observance whereof the validity of the deed depends.

PROVOST, an officer, whereof there are divers kinds, civil, military, &c.

PROVOST of a city or town, is the chief municipal magistrate in several trading cities, particularly Edinburgh, Glasgow, &c. being much the same with mayor in other places He presides in city-courts, and, together with the baillies, who are his deputies, determines in all differences that arise among citizens.

PROVOST *marshal of an army*, is an officer appointed to seize and secure deserters, and all other criminals. He is to hinder soldiers from pillaging, to indict offenders, and see the sentence passed on them executed. He also regulates the weights and measures, and the price of provisions, &c. in the army. For the discharge of his office, he has a lieutenant, a clerk, and a troop of marshalmen on horseback, as also an executioner. There is also a provost marshal in the navy, who has charge over prisoners, &c.

PROW, in navigation, denotes the head or fore part of a ship, particularly in a galley, being that which is opposite the poop or stern.

PRUNELLA, self-hue, a genus of the gymnospermia order, in the didynamia class of plants; and in the natural method ranking under the 12th order, holoraceæ. The filaments are bifurcated, with an anthera only on one point; the stigma is bifid. There are three species, herbs of Europe.

PRUNELLÆ *sal*, in pharmacy, a preparation of purified saltpetre.

PRUNES, in commerce, are plums dried in the sunshine, or in an oven.

PRUNING *wall-trees*. Of this "master work of gardening," it has been said, "that gentlemen prune too little, and gardeners too much;" these extremes are to be avoided, as attended with peculiar evils, equally mischievous: wall-trees are presently spoiled by either practice. If they are too full of wood, the shoots and fruits cannot be properly ripened: and if they are too thin (the greater evil of the two), the consequence of the cutting that has made them so, is the production of wood rather than fruit; forcing out shoots, where otherwise blossom-buds would have been formed. The designation of trees to a wall (from the superabundant heat) necessarily occasions cutting, and on the skilful use of the knife much depends.

Every one who has wall-trees cannot keep a professed gardener; nor is every one who calls himself so, qualified to prune. It is a great mortification to a man who wishes to see his trees in order, not to be able to procure an operator to attend them; let him then resolve to learn the art himself, and the ability will be very gratifying to him.

As many words must be used on this article of pruning, for the sake of order, the business of managing wall-trees may be, 1. Concerning the form. 2. The health. 3. The fruitfulness of them.

1. As to the form, or general appearances of the wall-trees. If a tree is young and newly planted, the first thing is to head it down, by cutting off (if it is a nectarine, peach, or apricot) all the shoots, and the stem itself, down to a few eyes, that the lower part of the wall may be furnished with new and strong wood. Make the cut sloping, and behind the tree, taking care (by placing the foot on the root, and the left hand on the stem) not to disturb the tree by the pull of the knife. Plaster the part with a bit of cow-dung, clay, or stiff earth. It is evident from this that maiden stocks are the best to plant.

The heading down is to be made so as to leave two or three eyes, or four if a high wall, on each side of the stem, from which shoots will come properly placed for training. The number of eyes may be also according to the strength of the tree, and its roots If there are not two well-placed eyes on each side of the stem, two shoots, thus situated, may be left, cutting them short to two or three eyes each. Eyes or shoots behind or before, consider as of no use, and let them be early displaced by rubbing or cutting. This work is to be performed in spring, when the tree is putting forth shoots; *i. e.* about the beginning of April.

If towards the end of May there should be wanting shoots on either side the tree, having perhaps only one put forth where two were expected, this one shoot should be cut, or pinched down, to two or three eyes; and before summer is over there will be found good shoots from them, and thus a proper head be obtained. This work of shortening shoots of the year may be done any time before Midsummer; but in this case, all ill-placed or superfluous growths must be rubbed off as soon as seen, that those to be reserved may be the stronger, receiving more nourishment.

As the lateral shoots grow, let them be timely nailed to the wall, close, straight, and equidistant, but use no force. If they are quite well placed, they will need no bending; but sometimes shoots must be laid in which are not perfectly so. Lay in as many good moderate-sized shoots as may be throughout the summer, for choice at winter pruning, yet do not crowd the tree. As the shoots proceed in length, nail them to the wall, that no material dangling of them may be seen; but avoid using too many shreds.

In the formation of a tree, keep each side as nearly as can be equal in wood; and the shoots inclining downwards, which is a mode of training necessary to fill the lower part of the wall (none of which should be lost), and to check the too free motion of the sap, which wall-trees are liable to from their warm situation and continual cutting. All the branches should have an horizontal tendency, though the upper cannot have it so much as the lower ones. Those that are perpendicular, or nearly so, mount the wall too fast, and run away with the food that should pass to the horizontals; which being impoverished by the vigorous middle branches, gradually become too weak to extend themselves, and nourish the fruit. The pruner, therefore, must be content to have some of the wall, over the middle of the tree, unoccupied; or, at least, suffer none but weak or very moderate shoots to find a place there.

The idea of a well-formed tree is somewhat represented by the ribs of a spread fan, or the fingers of the hand extended. Regularity is allowed to be so necessary to the beauty of a wall-tree, that some have even drawn lines for a guide to train by; but nature (ever free and easy) will not submit to so much formality, and such a perfect disposition of the branches is not necessary. A tree may be regular without being linear, and the proper useful shoots are not to be sacrificed to a fanciful precision. Though crossing of branches is against rule, yet cases may happen (as in want of wood or fruit) where even this awkwardness may be permitted. The object is fruit; and to obtain this end, form must sometimes give place.

All foreright and back shoots, and other useless wood, should be displaced in time, for they exhaust the strength of the tree to no purpose, and occasion a rude appearance. It is a very expeditious method to displace superfluous young shoots, by pushing or breaking them off; but when they get woody it is apt to tear the bark, and in this case the knife must be used: the better way is to disbud by rubbing; yet a young luxuriant tree should be suffered to grow a little wild to spend the sap. There is one evil, however, attending on disbudding, and rubbing off young forerights, that some fruit spurs are thus lost; for apricots are apt to bear on little short shoots of from half an inch to an inch (or more), and there are peaches which do the same; so that it is a rule with some pruners to wait to distinguish spurs from shoots, and then to use the knife, yet use it as little as may be in summer.

In regulating a tree at any time, begin at the bottom and middle, and work the way orderly upward and outward. Never shorten in summer (which would produce fresh shoots), except a forward shoot where wood may be wanting; but where the tree is really too thick, cut clean out what may be spared. None of the shoots produced after midsummer should be nailed in, except where wood is wanting to fill a naked place. They never bear fruit.

2. The health of wall-trees is greatly provided for by observing the directions already given concerning their form; for if observed, each shoot will have the proper benefit of sun and air, to concoct its juices and prepare it for fruiting.

It injures a tender shoot when it presses hard against a nail. If the hammer strikes a shoot, and bruises the bark, it often spoils if not kills it, by the part cankering. The shreds may be too tight, so that the shoot cannot properly swell; and if shreds are too broad and too numerous, they are apt to occasion sickness, and prove a harbour for insects and filth: let the number be lessened at all opportunities. A slip of the knife may wound a neighbouring branch, and make it gum, canker, or die. It will require care, and some practice, to avoid this accident; and in order to it, keep the point of the knife sharp, and mind the position of it when cutting. Cut close and sloping behind the eye; neither so near as to injure it, nor so wide as to leave a stub.

The bending of a branch much is a violence to be avoided; so that every shoot should be kept from the first in the direction it is to grow in.

Luxuriant wood must be particularly attended to, to get rid of it in time, before it has robbed the weaker branches too much. That is luxuriant wood which, according to the general habit of the tree, is much larger than the rest; for a shoot that is deemed luxuriant in one tree may not be so in another. If strong wood, that is not very luxuriant, happens to be at the bottom of the tree, so that it can be trained quite horizontally, it may often be used to good purpose, as this position checks the sap. A luxuriant shoot may be kept in summer where it is not designed to retain it, merely to cut it down at winter-pruning to two or three eyes, for getting wood where wanted the next year; or this shortening may take place in June, to have new shoots the present year. Luxuriant shoots may be sometimes retained for a time, merely as waste pipes.

All diseased, damaged, very weak, or worn out branches (as they occur), should be cut out, to make way for better; but if a tree is generally diseased, some caution must be used not to cut out too much at once, if there is any hope of restoring it. A very old tree, or a young one that does not thrive, may be cut a great deal; but prune it so as to have a general sprinkling of the best of the branches, and keep short lengths of an eye or two of the weaker ones, in a sort of alternate order.

Young trees are very apt to decline, and sometimes die, if suffered to overbear themselves the first year or two of fruiting. The remedy is obvious, and should resolutely be applied.

A weak tree is helped much by training it more erectly than usual, as less check is thus given to the sap, and so the shoots are more likely to swell: such a tree should be kept thin of branches, and always pruned early in autumn, keeping the top free from such wood as is stronger than that which is in general below, and all the shoots shorter than usual.

Old decaying trees should be lessened a little every year, and constantly watched, to observe where young and strong shoots are putting out below, in order to cut down to them; and though the time for doing this is commonly at autumn or winter pruning, yet it may be best done in summer, as the shoots would thrive the better; observing to put some grafting-clay or cow-dung to the part, to prevent gumming, which summer pruning is apt to occasion. A judicious pruner may bring the oldest and most ill-conditioned tree to a healthy and bearing state if all is but right at the root, it having a good soil about it.

Keep all wall-trees clean, and particularly weak ones, from moss, cobwebs, or other filth; and attend to insects, snails, caterpillars, and smother flies. Any bark that is decayed by cracks, &c. must be cleared away to the quick, either by rubbing, or the knife, as filth and insects are apt particularly to gather there: wipe the part clean with spunge and soap.

Consider the soil about an unthrifty tree, and if it is thought bad, improve it by moving away as much of the old as conveniently can be done. The roots may be laid carefully quite bare, and examined, in order to cut off decayed or cankered parts, and to apply immediately to them some fine and good fresh earth, with a little thorough-rotten dung in it, and a sprinkling of soot or wood ashes. Hog-dung applied fresh is said to have a peculiar efficacy in recovering weak trees; and cow-dung may reasonably be expected to do good if the soil is a warm or hungry one; and if not so, the hog-dung is not so proper, as it is a cold dressing. If the soil is a strong one, a compost of fowl's or sheep's dung, lime, with any fresh light earth, (one part of each of the former, and three of the latter, mixed with the soil that is taken off,) will be a proper manure, to which a little sharp sand may be added. All these applications should be made late in autumn, or early in spring.

The constitution of a tree is sometimes naturally barren; or the soil that the roots have got into may be so deleterious that no pains or perseverance will avail any thing; but continuing fruitless and sickly, admonishes the owner to take it up and try another plant, rectifying the soil thoroughly if the evil is thought to arise there. The smother-fly sometimes repeatedly attacks the same tree, which is a sign of inherent weakness, for the juices of a sickly tree are sweeter than those of a sound one, and so more liable to such attacks. Sometimes a tree of this kind, when removed to a good soil, and pruned greatly down, does very well. A soil too rich of dung often occasions trees to be blighted, and the remedy is to impoverish it with a sharp sand.

In order to health and strength, a tree must not be kept too full during summer, as it prevents the proper ripening of the wood, and makes the shoots long-jointed. If more than one shoot proceeds from the same eye, reserve only the strongest and best-situated. A crowded tree cannot be healthy, and it becomes both lodging and food for insects. The blossom-buds of a tree being always formed the year before, they will be few and weak in a thicket of leaves, as debarred of the necessary sun and air; but in order to avoid an over-fulness, do not make any great amputations in summer.

In clearing a tree of superabundant wood, take care not to cut off the leading shoot of a branch. All shoots after midsummer should be displaced as they arise, except where wanted to fill up a vacancy. In a too vigorous tree, the midsummer shoots may be left for a while on those branches that are to be cut out at winter pruning, as cutting such trees in summer is to be avoided as much as possible; so that a little rudeness in a luxuriant tree may be permitted as a necessary evil, provided it becomes not too shady or unsightly. Watering wall-trees with an engine smartly on a summer's evening is conducive to their health, and frees them from insects.

3. The fruitfulness of wall-trees (the ultimate object of planting and training them) comes now to be spoken of. Their proper form and health being good, the foundation is laid, but several things are yet to be done to obtain the end proposed; and this chiefly regards the principal cutting, or what is called winter or spring pruning.

If trees have been planted far enough asunder, it is a happy circumstance, as the proper horizontal form, and the open middle, may be preserved. The longer the horizontals are, the more necessary it is to be careful to suffer none but weak branches in the centre uprightly. If trees are confined as to length of wall, they of course take a more erect form, but still strong wood should not mount just in the middle.

A tree is to be thinned of damaged, unpromising, and ill-placed shoots, and of woody branches that are decaying or reach far without fruitful shoots on them, and always some of the old wood should be cut out where there is young to follow or supply its place. Of the fair and well-placed shoots also, the superabundance is to be taken away, so as generally to leave the good ones at four, five, or six inches asunder, according to the size of the wood and fruit.

Luxuriant wood, *i. e.* those shoots that are gigantic, must be taken out from the rest, as they would impoverish the good, and destroy the weak branches, and are never fruitful; but if a tree is generally luxuriant it must be borne with; and the less it is cut, comparatively speaking, the better. Such a tree, after a few years, may come to bear well; and when it begins to shoot moderately, some of the largest wood may be taken out each year, or shortened down to two or three eyes, and so brought into order. The more horizontally free-shooting trees are trained, the better, as the bending of the shoots checks the sap.

As the pruner is to begin below, and towards the stem, so the object in thinning must be to prefer and to leave those shoots that are placed lowest on the branches, that so the tree may be furnished towards the centre. See that those left are sound, and not too weak or over-strong, for the moderate shoots generally bear best. Weak shoots are always more fruitful than strong ones; and if they are furnished with fair blossoms, should be kept where a tree is full of wood, and even preferred to moderate ones on a very flourishing tree.

The next object is, to furnish a tree. In order to this, the thinning of old wood, young being ready (or easily to be procured) to follow, has already been mentioned; but the principal step is the shortening of the shoots, which occasions them to throw out below the cut, for future use. If they were not to be shortened, the tree would presently extend a great way, bearing chiefly at the extremities; and all over the middle it would be very thin of fruit, and thus a great part of the wall lost.

The mode of bearing in peaches, nectarines, and apricots, is on the last year's wood; which makes it necessary to shorten, in order to a certain supply of shoots for bearing the next year, and thus to have succession-wood in every part of the tree.

The rule for shortening is this: Consider the strength of the tree; and the more vigorous the shoots are, cut off the less. If a luxuriant tree was to have its shoots much shortened, it would throw out nothing but wood; and if a weak tree was not pretty much cut, it would not have strength to bear. From vigorous shoots one-fourth may be cut off; from middling ones one-third; and from weak ones one-half.

In shortening, make the cut at a leading shoot-bud, which is known by having a blossom-bud on the side of it, or, which is better, one on each side. Blossom-buds are rounder and fuller than leaf-buds, and are discernible even at the fall of the leaf, and plainly seen early in the spring. It is desirable to make the cut at twin blossoms, yet as this cannot always be done, the due proportion of length must generally determine. It often happens, that the blossom-buds are chiefly, and sometimes all, at the end of the shoot; but still it should be shortened if it is at all long. Never cut where there is only a blossom-bud; and prefer those shoots that are shortest-jointed, and have the blossoms most in the middle. The shoots that lie well and are fruitful or healthy, and but a few inches long, may be left whole. Always contrive to have a good leader at the end of every principal branch.

Young trees (as of the first year of branching) should have the lower shoots left longer in proportion, and the upper shorter, in order to form the tree better to the filling of the wall: the lower shoots may have three or four eyes more than the upper.

In furnishing a tree, consider where it wants wood, and cut the nearest unbearing branch (or if necessary, a bearing one) down to one, two, or more eyes, according to the number of shoots desired, for in such close shortening, a shoot will come from each eye. With a view to wood for filling up a naked place, a shoot formed after midsummer may be thus shortened; though the general rule is, to displace all such late shoots as useless, the dependance for blossoms being on the early-formed shoots.

The time for the principal, or winter pruning, is by some gardeners held indifferent, if the weather is mild at the time; but a moderate winter's day is often quickly followed by a severe frost, which may hurt the eye and blossom next the cut. The best time is February, if it is mild, or as soon after as possible; for when the blossom-buds get swelled, they are apt to be knocked off by a little touch or jar of the hammer.

Apricots should not be so much shortened as peaches, nor do they so well endure the knife. Shoots of the apricot, if under a foot, may be left uncut, if there is room. The spurs of apricots should be spared, if not too long or numerous, for they bear well, and continue for years. Some sorts of peaches are also apt to put out fruit-spurs, and must be managed accordingly.

Vines require frequent attention, as to pruning and training; but all will avail little if they have not a warm soil and full sun, or some accidental advantage, as being planted at the back of a warm chimney; and though they will grow and bear leaves any where, they will not fruit well in England without a favourable season, or hot summer.

Young new-planted vines should be pruned quite short for two or three years, that they may get strong. If the plant has a weak root, not above one shoot ought to grow the first year, which should be cut down in autumn, or to two or three eyes.

The best time for the principal, or winter pruning of vines, is as soon as the fruit is off, or the leaves falling. November does very well, and if this month passes, February should be adopted rather than quite in the winter. Late in the spring they are apt to bleed by cutting, which greatly weakens them.

The mode of bearing in vines is only on shoots of the present year, proceeding from year-old wood. The rule, therefore, at winter pruning is, to reserve those shoots of the year that are best situated as to room, for training of those shoots that are to come from them, which will be almost one from every eye. Make choice of those that are placed most towards the middle, or stem of the vine, that all the wall may be covered with bearing wood; and every year cut some old wood out that reaches far, to make room for younger to follow.

The shortening of the shoots should be according to their strength, and the space there is for training those shoots that will be produced, which always grow very long. If there is room, three, four, or five eyes may be left; but not more to any shoot, except it is desirable to extend some shoot to a distance to fill up a particular space: and then eight or nine eyes may be left, which being repeated again another year, and so on, a vine will soon reach far.

Sometimes vines are trained on low walls by a long-extended horizontal branch, a few inches from the ground, as a mother-bearer. Those shoots that come from this horizontal are to be trained perpendicularly, and cut down to one or two eyes every year, that they may not encroach too fast on the space above them. If the vine is confined to a narrow but lofty space, it is to be trained to an extended perpendicular mother-bearer, having short lateral shoots pruned down to a single eye, or at most two. The management of vines requires severe cutting, that they may not be too full in the summer, for they put out a great deal of wood, and extend their shoots to a great length; and therefore the young pruner must resolve to cut out enough.

An alternate mode of pruning vines is practised by some, one shoot short, and another long, *i. e.* one with two eyes, and another with four or five. Severe cutting does not hurt vines, and make them unfruitful, as it does other trees; and therefore, where short of room, they may be pruned down to a single bud, as the case requires.

The summer management of vines must be carefully attended to. As soon as the young shoots can be nailed to the wall, let them not be neglected; but remember they are very tender, and will not bear much bending: train in only the well-placed shoots, rubbing or breaking off the others. The embryo fruit is soon seen in the bosom of the shoot; and those thus furnished are of course to be laid in, as many as can be found room for, in preference to those shoots that are barren; which nevertheless should also be trained, if they are strong and well placed, and there is space for them. Rub off all shoots from old wood, except any tolerable one that proceeds from a part where wood is wanting to fill up some vacant space. If two shoots proceed from one eye, displace the weakest, or the outermost if they are both alike, and the fruit should not direct otherwise. Vines grow rapidly; and must be nailed to the wall, from time to time, as they proceed, that there may be no rude dangling, which would not only have a slovenly appearance, but in several respects be injurious.

The stopping of the shoots is to take place, both as to time and measure, according to the strength and situation of them, or whether fruitful or barren. Those weak shoots that have fruit, and are rather ill placed, or confined for room, may be stopped at the second, or even first, joint above the fruit, early in the summer; but those shoots that are strong and have room to grow, should not be stopped till they are in flower (in July), and at the third or fourth joint above the fruit. In shortening the shoots of the vine, do it about half an inch above an eye, sloping behind a plump and sound one. The barren shoots are to be trained at full length, and not stopped at all if there is room for them, or, at least, but a little shortened towards autumn, as in August, because they would put out a number of useless and strong side-shoots if cut before.

The side-shoots, *i. e.* those little ones put out by the eyes that are formed for next year, are commonly directed to be immediately displaced by rubbing off, as soon as they appear; and if the vine is large, and the shoots slender, it is very proper; but if otherwise, their being left to grow awhile (so as not to get too rude and crowding) is rather an advantage, in detaining the sap from pushing the shoots out immoderately long; and when these are taken off, the lower eye of each may be left with the same view. But the side shoot that proceeds from the top of each shortened branch, should be left on, and when it gets long, then shortened down to an eye or two.

In order to fruitfulness, vines will need dressing with some sort of manure; for though they grow in vineyard countries on rocky hills, and in very shallow soils, and have done so on some chalky, hot, gravelly hills in England, yet some warm manure they must generally have applied, or they will produce little good fruit.

Some people are very fond of exposing the fruit of the vine to the full sun, by stripping off leaves; but this should not be practised till the bunches have attained their proper size, needing only to be ripened, and even then but little should be done in this way. The loss of leaves is an injury to every plant, as it prevents the elaborating of the saccharine juices necessary to perfect the fruit.

Fig-trees are best pruned early in spring, as after an autumn cutting (if late) they are apt to die down. The mode of bearing in the fig is, that fruit chiefly comes the present year on the little shoots from wood of the preceding, and that towards the ends of the branches, which circumstances dictate the rules for pruning. Two-years-old wood will bear some, but older wood never.

The shoots, during summer, are to be laid in at full length, plentifully, as room will permit. The weak, ill-placed, or superabundant ones, cut clean out; yet rather break, or rub them off, in an early state of growth, for cutting branches or shoots in summer is apt to make them bleed as it is called, *i. e.* the sap run; when cut in autumn, the fig will sometimes bleed for a day, but if late-cut in spring, the oozing will continue perhaps a week.

At the principal pruning, the strongest and the closest-jointed shoots are to be preferred, and left about seven or eight inches asunder, without shortening. Let the spare shoots be cut out close and smooth, and as much of the old wood as may be; for the tree will increase too fast, and get too naked of bearing wood in the middle, if this is not freely done; and the essential point in the management of the fig-tree is (as indeed of all wall-trees) to have young wood all over it, and particularly in the middle, and towards the bottom. Wood is seldom wanted in a fig-tree; but where it is, the shortening of a shoot, properly situated (by taking off the leading bud, or cutting lower, as the case requires), is sure to produce it. Do this in April, as the best time.

When hard frosts are expected, strew some ashes and some litter over the roots of fig-trees. Mats should be nailed over their branches (first pulling off the figs), as the succulent nature of their wood makes them tender. These coverings are to remain till the frosts are judged to be over, and then let them be covered up at night, and not by day, for a week or two, to harden them by degrees.

But fig-trees will mostly survive hard winters when in standards, without covering; and though shoots trained to a wall are tenderer, yet peas-haulm hung close among the branches (at the approach of sharp frosts) will preserve them. This sort of protection, as affording plenty of air, is by many good gardeners preferred to the more common practice of matting. But if mats were contrived to roll up and down, or kept a little distance from the tree, so as to give more or less air as the weather is, the health and fruitfulness of the tree would be better ensured, for too close (and, as it commonly happens in consequence, too long) covering is injurious to both. Fig-trees that have been close covered are often hurt by an early uncovering, and yet the spring air, as soon as possible, is desirable.

Pears being planted against a wall in autumn, should not be cut down till spring, when the head is to be reduced according to the goodness of the root, and so as to lay a proper foundation for covering the wall.

The mode of bearing in pear-trees is on short spurs, which appear first towards the ends, and then form themselves all along the branches, which do not produce blossoms for three or four years from planting, and sometimes (according to the sort, or perhaps soil) for several years more. When they are come to fruiting, some pears bear pretty much on year-old wood, some on two, others on three. The same branches continue to bear on spurs from year to year, and most when five or six years old; but as in course of time the branches may become diseased and barren, and not produce so fine fruit as younger wood, it is always proper to procure a succession of young bearers, as the opportunity of good shoots offer, cutting out old wood.

The time for general or winter pruning of pear-trees ought to be November, as the blossoms are then very discernible, and at spring pruning they get so turgid and tender, that almost the least touch knocks them off, or even the jarring of the tree.

Apples are sometimes planted against walls, and what has been said of pruning and managing pears is applicable to them; the branches, however, may be laid in somewhat closer, as they will not require so much room; yet they ought to have from twenty-five feet in length of a low wall, or on a high one something less.

Mulberries require good room, as their mode of bearing is mostly at the end of the trained shoots, which are therefore not to be shortened. Twenty or twenty-five feet should be allowed them, and a new-planted tree is to be headed down as directed for pears, &c. A succession of new wood must be always coming forward, and of course some old taken out, for the fruit is produced chiefly on year and two-year old wood; and as it comes on spurs, and also small shoots of the same year, the leaving short stubs (of moderate wood) in pruning, seems justified, though by some condemned.

Cherry-trees, if against a wall, should be trained at length, four or five inches asunder. The fruit comes from spurs all along the shoots, on one and two years old wood, which will continue to bear. In pruning, have an eye, however, to some fair shoots for successors to those that are getting diseased, or worn out. Some cut all superfluous shoots clean away, and others leave a sprinkling of short stubs, which may be allowed; but let them not advance far foreright.

Plums of the finer sorts are often planted against walls, and deserve a good one. For the pruning of plum-trees, the directions given for cherries apply to them, only that the branches should be laid somewhat wider, *i. e.* at five or six inches, according to the sort, as free or less free in their growth.

Currants and gooseberries bear fruit upon young wood, and on little spurs of the old. Superfluous shoots are to be cut down to little stubs or spurs, about half an inch long, which will throw out fruit-shoots and spurs. The mother-branches of currants and gooseberries will last many years; but when good young wood can be brought in for principals, a renewal every three or four years is necessary to produce fine fruit.

The work of pruning espalier-trees is much the same as for wall-trees.

As trees planted for espalier training should be young, let great care be taken to set them off right at first, by regular shoots, full furnished immediately from the stem, which is effected by proper heading down. Apples, pears, plums, cherries, &c. in general, need not to be so much freed of all branches at planting, as peaches, nectarines, and apricots. There are, however, gardeners who prune down to the stem all sorts of wall and espalier trees, as peaches are.

The principle of pruning standard trees is the same, whether full, half, or dwarf standards; and the object is, to form a compact handsome round and open head, rather small than large, equal on all sides, with tolerably erect wood, capable (as far as the art of the pruner can go) of supporting the fruit without much bending. Perfect symmetry indeed is not necessary: but confusion of branches, weak and crossing, crowded and dangling, is to be prevented by pruning; for a proper use of the knife is capable of doing much towards the beauty and fruitfulness of standard trees. A little pruning of standards every year, and a general one every three or four years, to cut out what is decayed, and some of the older wood where a successional supply of young may be obtained to succeed, is the way to keep them in vigour, and have the best of fruit; for that which grows on old wood gets small and austere. To take off large branches, a thin broad chisel is proper; but if a saw is used, smooth the part with a knife.

Clear trees from moss, by scraping them with a long narrow-bladed blunt knife, on a bit of hard wood; and cut or rub off bits of decayed bark, in which insects are apt to breed, and wipe the part clean. Some use a scouring-brush, the long end-hairs of which are well adapted to clean the forky parts. A bit of hair cloth is also used for the purpose; and a finish is properly made to do the business well, with a brush and soap and water.

Of pruning shrubs. Many shrubs are cultivated for their ornament, and some for their fruit; of the latter kind are raspberries and barberries.

Raspberries bear fruit on little side shoots of the present year, proceeding from stems of the last, and sometimes produce a little on those of the same year. To prune or dress the shrub, therefore, first cut out all the old bearers, whose wood dies; then cut out, close to the stool, all the new shoots, except three or four of the strongest, which may be carefully twisted from the bottom upwards, or tied together at the top, or if upright and strong, left to support themselves singly.

The barberry is a beautiful and somewhat large shrub, which should be suffered to grow with a full head, like a dwarf standard tree. It bears along the sides of both young and old wood, but chiefly towards the ends, and its branches should therefore not be shortened, except with a view to throw out wood. Keep the root free from suckers, and the stem from shoots in its lower part, and prune out weak, luxuriant, straggling, and crossing branches, forming it to a somewhat round head, which keep moderately open. Let the stem be freed from lower branches to the height of three, four, or five feet, according as the shrub may be desired to approach to a tree.

Flowering shrubs are of great variety, and the method of pruning them is to be determined according to the several modes of bearing, of which consider chiefly these; that is, whether they produce their flowers upon the last year's shoots or the present, on the ends or the sides of their branches. If a shrub bears on the last year's shoots, it is evident that it must be cut away no more than is necessary to keep it within bounds, open and handsome as to its form; in this case it is the business to cut clean out, or very low, what is to be spared. If a shrub bears on the present year's shoots, the old wood may and must be cut down freely, so however as to leave eyes enough for new shoots to proceed from, to make a sufficient head and show. If the shrub bears altogether or chiefly at its ends, no shortening must take place; but if some of the branches are too long, they may be either cut out, or quite low, leaving the shorter ones to bear. If the shrub bears along its sides, the shortening is of no consequence, and the desired form may be freely provided for at pleasure.

The season for pruning shrubs is generally the spring; but autumn is better, if not too near winter, as at this time sharp weather might occasion some of the sorts (as jasmines and honeysuckles) to die down. The time of flowering must in some measure direct the time of pruning. Shrubs that flower in winter (as the laurustinus) should be cut in spring. Those that flower in spring may be pruned immediately after their blow, or in summer. Those that flower in summer should be pruned in autumn; and those that flower in autumn should be pruned either soon after flowering, or in spring.

Be sure to take off in time, *i. e.* as soon as discovered, all suckers and over-strong shoots from shrubs; for by their luxuriancy they greatly impoverish the proper-sized branches, which are the fruitful ones, and such large sappy wood looks very unsightly.

The height of shrubs in certain situations is material, and to provide for this, the art of pruning is in a great measure competent. To keep them low, cutting down is of course necessary; but it will be well also to make the soil poor if too rich. To encourage them to mount, keep trimming off close the lower branches, and improve the ground by digging and dressing occasionally.

Roses bear upon shoots of the present year, and upon those formed after midsummer in the past year, but chiefly upon the former. Therefore they may, or rather should, be cut down low, leaving only three or four eyes to a shoot; except some of those short shoots formed the last year too late to blow then, leave whole. If rose-trees are not close pruned, they will be unable to support their flowers properly. Use a sharp knife, and cut close behind an eye or bud. Roses for forcing should be pruned in July and August.

Honeysuckles flower on shoots of the present year, and therefore whether trained to walls, or kept in bushes, should be also pruned close; but not so short in the latter case as the former, for those against walls should be cut down to an eye or two, and those in bushes to three or four eyes.

Sweetbriars flower on shoots of the present year, and therefore should be cut after the manner of honeysuckles. These shrubs (and most others) are seldom pruned down enough, so that in a few years they get very rambling and unsightly; but if kept compact, we have beauty as well as sweetness, to recompense our care. In all cases, a less number of fine flowers obtained by short and open pruning, is certainly preferable to many indifferent ones.

Lilacs bear their flowers at the ends of shoots of the last year, so of course at spring must not be shortened. If rambling and crowded, cut either clean out, or very low, what may be superfluous. If they need much reduction, let them be cut down as soon as (or somewhat before) they have got off flower.

To enter further into the detail of shrubs would be inconsistent with our limits. The reader will find some directions occasionally under the separate articles, and will commonly act safely under the general directions above.

PRUNUS, a genus of the monogynia order, in the icosandria class of plants; and in the natural method ranking under the 36th order, pomaceæ. The calyx is quinquefid, inferior; there are five petals; the fruit is a plum, having a kernel with prominent sutures. There are thirty-three species, of which six are cultivated in Britain: they are originally natives of America and Siberia.

1. The domestica, or common plum-tree, grows 20 or 30 feet high, with oval spear-shaped leaves, and with the pedunculi for the most part single, terminated by flowers, succeeded by plums of many different colours, sizes, and shapes, in the varieties. 2. The insititia, wild-plum, or bullace-tree grows 12 or 15 feet high; the branches somewhat spinous; the leaves oval, hairy underneath; and the pedunculi by pairs, terminated by white flowers succeeded by small, round, plum-like fruit, of different colours in the varieties. 3. The spinosa, black-thorn, or sloe-tree, grows 10 or 12 feet high, very branchy and bushy quite from the bottom, armed with strong, sharp spines, small, spear-shaped, smooth leaves, pedunculi growing singly, terminated by flowers, succeeded by small, round, black cherries in autumn. It grows wild every where in hedges and woods; and is very proper for planting field-hedges, being of very quick and close growth. 4. The cerasus, or common cherry-tree, grows 20 feet or more in height, with oval clusters of lanceolate smooth leaves, umbellate flowers, succeeded by clusters of red roundish fruit, of different sizes and properties in the varieties. Hanbury says, "were this tree scarce, and with much difficulty propagated, every man, though possessed of a single tree only, would look upon it as a treasure; for besides the charming appearance these trees have when besnowed, as it were, all over with bloom in the spring, can any tree in the vegetable tribe be conceived more beautiful, striking, and grand, than a well-grown and healthy cherry-tree, at that period when the fruit is ripe?"

The cherry-trees afford an almost endless variety; all differing in some respect in their manner of shooting, leaves, flowers, and fruit: two in particular demand admission into the pleasure-garden, the double-blossomed and the red-flowering. The pleasing show the common cherry-tree makes when in blow is known to all; but that of the double-blossomed is much more enchanting. It blossoms like the other in May; the flowers are produced in large and noble clusters; for each separate flower is as double as a rose, is very large, and placed on long and slender footstalks, so as to occasion the branches to have an air of ease and freedom. They are of a pure white; and the trees will be so profusely covered with them, as to charm the imagination. Standards of these trees, when viewed at a distance, have been compared to balls of snow; and the nearer we approach, the greater pleasure we receive. These trees may be kept as dwarfs, or trained up to standards; so that there is no garden or plantation to which they will not be suitable. By the multiplicity of the petals, the organs of generation are destroyed: so that those flowers which are really full are never succeeded by any fruit.

The red-flowering cherry-tree differs in no respect from the common cherry-tree, only that the flowers are of a pale-red colour, and by many are esteemed on that account. Besides the ornament and utility afforded us by the flowers and fruit of the cherry, its timber is a further inducement for propagating it; more especially that of the small black wilding sort, which may perhaps with propriety be considered as the genuine species, and a native of this island. Be this as it may, it will grow in a soil and situation it affects, to be a large timber-tree; and if taken in its prime before it becomes tainted at the heart, will turn out perhaps not less than a ton of valuable materials, peculiarly adapted to the purposes of furniture. The grain is fine, and the colour nearly approaching to that of mahogany, to which valuable wood it comes nearer than any other which this country produces. 5. The avium, or great wilding cherry-tree, grows 40 or 50 feet high, having oval or spear-shaped leaves, downy underneath, with umbellate sessile clusters of white flowers, succeeded by small round fruit of different properties in the varieties. 6. The padus, or common bird cherry-tree, grows 15 or 20 feet high, of a shrub-like growth, with a spreading head, large, oblong, rough, serrated leaves, having two glands at the back of the base like the other, and with shorter, more compact, clusters of flowers, succeeded by large red fruit. This grows wild in hedges in the north part of England. 7. The Virginiana, or Virginian bird-cherry, grows 30 feet high, dividing into a very branchy head, having a dark-purple bark, oval, slightly serrated, shining green leaves, having two glands at the fore part of the base, and long clusters of white flowers, succeeded by small, round, berry-like, black fruit. 8. Canadensis, or Canada dwarf bird-cherry, grows but four or five feet high, branching horizontally near the ground with smooth branches; broad, spear-shaped, rough, downy leaves without glands; and long clusters of white flowers, succeeded by small, round, berry-like black fruit, ripe in autumn. 9. The mahaleb, or perfumed cherry, grows 10 or 15 feet high, with smooth whitish branches, small, oval, shining, green leaves, and corymbous clusters of white flowers, succeeded by small fruit. 10. The armeniaca, or apricot-tree, grows 20 feet high, with a large spreading head, having reddish shoots, large, nearly heart-shaped leaves, close-sitting pale-red flowers rising all along the sides of the young branches, succeeded by large roundish fruit of a yellow and reddish colour in different varieties. The fruit and the kernels of the prunus Siberica, when eaten, excite a continued head-ache: the kernels, infused in brandy, communicate an agreeable flavour.

All the different varieties of plums have at first been raised from the stones, and are afterwards preserved by budding and grafting on any plum-stock. The same method is applicable to cherries; only these are grafted to most advantage upon stocks of the wild black and red cherry raised from the stones of the fruit. The apricot-trees are propagated by budding on any kind of plum-stocks.

PRUSSIATS, salts formed with prussic acid. Of these the most important are,

1. *Prussiat of lime*, formed by dissolving lime in prussic acid, filtring the solution, and separating the uncombined lime. It is decomposed by all the other acids, and by alkalies.

2. *Prussiat of magnesia.* This salt may be formed by putting pure magnesia into prussic acid. In a few days the earth is dissolved, and the compound formed. The magnesia is precipitated by the alkalies and lime, and by exposure to the air.

3. *Prussiats of iron.* As the prussiats of iron enter as ingredients into the triple salts formed by the prussic acid, it will be necessary to give some account of them before entering upon the consideration of these triple salts.

It has been demonstrated by chemists, that there are no fewer than four prussiats of iron; namely,

1. White prussiat,
2. Blue prussiat,
3. Yellow prussiat,
4. Green prussiat.

The white prussiat discovered by Mr. Proust is composed of prussic acid and protoxide of iron. It becomes gradually blue when exposed to the atmosphere, because the oxide absorbs oxygen, and is converted into peroxide.

Blue prussiat, or Prussian blue, is composed of prussic acid and peroxide of iron. It is a deep-blue powder, insoluble in water, and scarcely soluble in acids. It is composed, according to the most accurate experiments hitherto made, of equal parts of oxide of iron and prussic acid. It is not affected by exposure to the air. Heat decomposes it by destroying the acid, and the oxide of iron remains behind. The Prussian blue of commerce, besides other impurities, contains mixed with it a great quantity of alumina.

Yellow prussiat is composed of prussic acid combined with an excess of peroxide of iron: it is therefore a sub-prussiat of iron. This prussiat is soluble in acids. It may be obtained by digesting the alkalies or alkaline earths with Prussian blue. Part of the acid is carried off by these bodies, and the yellow prussiat remains in the state of a powder.

Green prussiat, first discovered by Mr. Berthollet, is composed of oxyprussic acid, and peroxide of iron. It is therefore in fact an oxyprussiat.

4. *Prussiat of barytes and iron.* For the first accurate description of this salt, we are indebted to the ingenious Mr. William Henry. It may be formed by adding Prussian blue to hot barytes water till it ceases to be discoloured. The solution, when filtred and gently evaporated, yields crystals of prussiat of barytes and iron.

These crystals have the figure of rhomboidal prisms: they have a yellow colour, and are soluble in 1920 parts of cold water, and in about 100 parts of boiling water. In a red heat they are decomposed, the acid being destroyed. They are soluble in nitric and muriatic acids: sulphuric acid occasions a precipitate of sulphat of barytes.

5. *Prussiat of lime and iron.* This salt was perhaps first mentioned by Mr. Hagen; but we are indebted to Morveau for the first accurate account of its properties and preparation.

Upon two parts of Prussian blue of commerce, previously well washed with a sufficient quantity of boiling water to separate all the foreign salts, about 56 parts of lime-water are to be poured, and the mixture must be boiled for a short time till the lime is saturated with the prussic acid, which is known by its no longer altering paper stained with turmeric: it is then to be filtred.

This liquid, which contains the triple prussiat of lime in solution, has a greenish-yellow colour: its specific gravity is 1.005; and it has an unpleasant bitterish taste. When evaporated to dryness, it yields small crystalline grains, soluble without alteration in water. It is insoluble in alcohol.

This triple prussiat may be used with advantage as a test to ascertain the presence of metals held in solution. The only impurity which it contains is a little sulphat of lime.

6. *Prussiat of potass and iron.* This salt, known also by the names of Prussian alkali, phlogisticated alkali, Prussian test, triple prussiat of potass, &c. has been chosen by chemists as the best combination of prussic acid for detecting the presence of metals, and more especially for detecting the existence of iron. To chemists and mineralogists, it is one of the most important instruments ever invented; as, when properly prepared, it is capable of indicating whether any metallic substance (platinum excepted) is present in any solution whatever, and even of pointing out the particular metal, and of ascertaining its quantity. This it does by precipitating the metals from their solution in consequence of the insoluble compound which it forms with them; and the colour of the precipitate indicates the particular metal, while its quantity enables us to judge of the proportion of metallic oxide contained in any solution.

In order to be certain of the accuracy of these results, it is necessary to have a Prussian alkali perfectly pure, and to be certain beforehand of the quantity, or rather of the proportions, of its ingredients. To obtain a test of this kind has been the object of chemists ever since the discoveries of Macquer pointed out its importance. It is to the use of impure tests that a great part of the contradictory results of mineralogical analysis by different chemists is to be ascribed.

The great object of chemists at first was to obtain this prussiat entirely free from iron; but their attempts uniformly failed, because the oxide of iron is one of its necessary component parts. This was first properly pointed out by Morveau.

There are two ways in which this test may be rendered impure, besides the introduction of foreign ingredients, which it is needless to mention, because it is obvious that it must be guarded against. 1. There may be a superabundance of alkali present, or, which is the same thing, there may be mixed with the Prussian test a quantity of pure alkali: or, 2. There may be contained in it a quantity of yellow prussiat of iron, for which prussiat of potass has also a considerable affinity.

If the Prussian test contains a superabundance of alkali, two inconveniences follow. This superabundant quantity will precipitate those earthy salts which are liable to contain an excess of acid, and which are only soluble by that excess: hence alumina and barytes will be precipitated. It is to the use of impure tests of this kind that we owe the opinion, that barytes and alumina are precipitated by the Prussian alkali, and the consequent theories of the metallic nature of these earths. This mistake was first corrected by Meyer of Steint.

Another inconvenience arising from the superabundance of alkali in the Prussian test is, that it gradually decomposes the blue prussiat which the test contains, and converts it into yellow prussiat. In what manner it does this will be understood, after what has been said, without any explanation.

On the other hand, when the Prussian alkali contains a quantity of yellow prussiat of iron, as great inconveniences follow. This yellow prussiat has an affinity for prussic acid, which, though inferior to that of the potass, is still considerable; and, on the other hand, the potass has a stronger affinity for every other acid than for the prussic. When, therefore, the test is exposed to the air, the carbonic acid which the atmosphere always contains, assisted by the affinity between the yellow prussiat and the prussic acid, decomposes the prussiat of potass in the test, and the yellow prussiat is precipitated in the form of Prussian blue; and every other acid produces the same effect. A test of this kind would indicate the presence of iron in every mixture which contains an acid (for a precipitation of Prussian blue would appear), and could not therefore be employed with any confidence.

To describe the various methods proposed by chemists for preparing this salt would be unnecessary, as the greater number do not answer the purpose intended. The method practised by Klaproth, first made known to chemists by Westrum, and afterwards described in our language by Kirwan, is considered as one of the best. It is as follows:

Prepare pure potass, by gradually projecting into a large crucible, heated to whiteness, a mixture of equal parts of purified nitre and crystals of tartar; when the whole is injected, let it be kept at a white heat for half an hour, to burn off the coal. Detach the alkali thus obtained from the crucible, reduce it to powder, spread it on a muffle, and expose it to a white heat for half an hour. Dissolve it in six times its weight of water, and filtre the solution while warm. Pour this solution into a glass receiver, placed in a sand-furnace heated to 170° or 180°; and then gradually add the best Prussian blue in powder, injecting new portions according as the former become grey, and supplying water as fast as it evaporates; continue until the added portions are no longer discoloured, then increase the heat to 212°, and continue it for half an hour. Filtre the ley thus obtained, and saturate it with sulphuric acid moderately diluted; a precipitate will appear: when this ceases, filtre off the whole, and wash the precipitate. Evaporate the filtred liquor to about one quarter, and set it by to crystallize: after a few days, yellowish crystals of a cubic or quadrangular form will be found, mixed with some sulphat of potass and oxide of iron; pick out the yellowish crystals, lay them on blotting-paper, and re-dissolve them in four times their weight of cold water, to exclude the sulphat of potass.

Assay a few drops of this solution with barytes water, to see whether it contains any sulphuric acid, and add some barytes water to the remainder if necessary: filtre off the solution from the sulphat of barytes, which will have precipitated, and set it by to crystallize for a few days; that the barytes, if any should remain, may be precipitated. If the crystals now obtained are of a pale yellow colour, and discover no blueish streaks when sprinkled over with muriatic acid, they are fit for use; but if they still discover blueish or green streaks, the solutions and crystallizations must be repeated.

These crystals must be kept in a well-stopped bottle, which, to preserve them from the air, should be filled with alcohol, as they are insoluble in it.

Before they are used, the quantity of iron they contain should be ascertained, by heating 100 grains to redness for half an hour in an open crucible: the prussic acid will be consumed, and the iron will remain in the state of a reddish-brown magnetic oxide, which should be weighed and noted. This oxide is half the weight of the Prussian blue afforded by the Prussian alkali: its weight must therefore be subtracted from that of metallic precipitates formed by this test. Hence the weight of the crystals, in a given quantity of the solution, should be noted, that the quantity employed in precipitation may be known. Care must be taken to continue the calcination till the oxide of iron becomes brown; for while it is black, it weighs considerably more than it should.

Another good method of preparing this salt has been lately given by Mr. Henry; but it is rather too expensive for general use. It consists in first forming a triple prussiat of barytes, and adding it in crystals to a solution of carbonat of potass till the solution no longer restores the colour of reddened litmus paper. After digesting the mixture for half an hour, filtre the liquid, and evaporate it gently. The triple prussiat of potass crystallizes.

PRUSSIC ACID, is one of the most important instruments which the chemist possesses. It was discovered about a century ago by Diésbach at Berlin; and a method of preparing it was published by Woodward in the Philosophical Transactions for 1724, which he said he had got from one of his friends in Germany. This method was as follows: Detonate together four ounces of nitre and as much tartar, in order to procure an extemporaneous alkali; then add four ounces of dried bullock's blood; mix the ingredients well together, and put them into a crucible covered with a lid, in which there is a small hole; calcine with a moderate fire till the blood emits no more smoke or flame capable of blackening any white body exposed to it: increase the fire towards the end, so that the whole matter contained in the crucible shall be moderately but sensibly red. In this state throw it into two pints of water, and boil it for half an hour. Decant off this water, and continue to pour on more till it comes off insipid. Add all these liquids together, and boil them down to two pints. Dissolve two ounces of sulphat of iron and eight ounces of alum in two pints of boiling water; mix this with the former liquor while both are hot. An effervescence takes place, and a powder is precipitated, of a green colour mixed with blue. Separate this precipitate by filtration, and pour muriatic acid upon it till it becomes of a beautiful blue; then wash it with water and dry it.

Different explanations were given of the nature of this precipitate by different chemists. All of them acknowledged that it contained iron; but to account for the colour was the difficult point. Brown, and Geoffroy, and Neuman, discovered in succession, that a great many other animal substances besides blood communicated to alkalies the property of forming Prussian blue; but the theories by which they attempted to account for its formation were altogether nugatory. At last a very important step was made in the investigation of this compound by Macquer, who published a dissertation on it in the year 1752.

This celebrated chemist ascertained the following facts: 1. When an alkali is added to a solution of iron in any acid, the iron is precipitated of a yellow colour, and soluble in acids; but if iron is precipitated from an acid by an alkali prepared by calcination with blood (which has been called a Prussian alkali), it is of a green colour. 2. Acids dissolve only a part of this precipitate, and leave behind an insoluble powder, which is of an intense blue colour. The green precipitate, therefore, is composed of two different substances, one of which is Prussian blue. 3. The other is the brown or yellow oxide of iron; and the green colour is owing to the mixture of the blue and yellow substances. 4. When heat is applied to this Prussian blue, its blue colour is destroyed, and it becomes exactly similar to common oxide of iron. It is composed, therefore, of iron and some other substance, which heat has the property of driving off. 5. If it is boiled with a pure alkali, it loses its blue colour also, and at the same time the alkali acquires the property of precipitating of a blue colour solutions of iron in acids, or it has become precisely the same with the Prussian alkali. 6. Prussian blue, therefore, is composed of iron and something which a pure alkali can separate from it, something which has a greater affinity for alkali than for iron. 7. By boiling a quantity of alkali with Prussian blue, it may be completely saturated with this something, which may be called colouring matter. 8. No acid can separate this colouring matter from iron after it is once united with it. 9. When iron dissolved in an acid is mixed with an alkali saturated with the colouring matter, a double decomposition takes place, the acid unites with the alkali, and the colouring matter with the iron, and forms Prussian blue. 10. The reason that, in the common method of preparing Prussian blue, a quantity of yellow oxide is precipitated, is, that there is not a sufficient quantity of colouring matter (for the alkali is never saturated with it) to saturate all the iron displaced by the alkali; a part of it, therefore, is mixed with Prussian blue. Muriatic acid dissolves this oxide, carries it off, and leaves the blue in a state of purity.

Such were the conclusions which Macquer drew from his experiments; experiments which not only discovered the composition of Prussian blue, but threw a ray of light on the nature of affinities, which has contributed much towards the advancement of that important branch of chemistry.

The nature of the colouring matter, however, was still unknown. At length, in 1772, Morveau announced his suspicion that the colouring matter was probably an acid.

Such was the knowledge of chemists respecting the nature of this colouring matter, when Scheele all at once removed the veil, and explained its properties and composition. He observed that the Prussian alkali, after being exposed for some time to the air, lost the property of forming Prussian blue; the colouring matter must therefore have left it. He put a small quantity of it into a large glass globe, corked it up, and kept it some time; but no change was produced either in the air or the Prussian alkali. Something must therefore displace the colouring matter when the alkali is exposed to the open air, which is not present in a glass vessel. Was it carbonic acid gas? To ascertain this, he put a quantity of Prussian alkali into a glass globe filled with that gas, and in 24 hours the alkali was incapable of producing Prussian blue. It is therefore carbonic acid gas which displaces the colouring matter. He repeated this experiment with this difference, that he hung in the globe a bit of paper which had been previously dipped into a solution of sulphat of iron, and on which he had let fall two drops of an alkaline lixivium in order to precipitate the iron. This paper was taken out in two hours, and became covered with a fine blue on adding a little muriatic acid. Carbonic acid, then, has the property of separating the colouring matter from alkali without decomposing it.

He found also that other acids produce the same effect. Hence he concluded, that the colouring matter might be obtained in a separate state. Accordingly he made a great many attempts to procure it in that state, and at last discovered the following method, which succeeds perfectly:

Mix together ten parts of Prussian blue in powder, five parts of the red oxide of mercury, and thirty parts of water, and boil the mixture for some minutes in a glass vessel. The blue colour disappears, and the mixture becomes yellowish-green. Pour it upon a filtre; and after all the liquid part has passed, pour ten parts of hot water through the filtre to wash the residuum completely. The oxide of mercury decomposes Prussian blue, separates its colouring matter, and forms with it a salt soluble in water. The liquid, therefore, which has passed through the filtre contains the colouring matter combined with mercury. The other component parts of the Prussian blue, being insoluble, do not pass through the filtre. Pour this mercurial liquid upon 2½ parts of clean iron filings, quite free from rust. Add at the same time one part of concentrated sulphuric acid, and shake the mixture. The iron filings are dissolved, and the mercury formerly held in solution is precipitated in the metallic state. The cause of this sudden change is obvious: the iron deoxidizes the mercury, and is at the same instant dissolved by the sulphuric acid, which has a stronger affinity for it than the colouring matter has. There remain in solution, therefore, only sulphat of iron and the colouring matter.

Now the colouring matter being volatile, which the sulphat of iron is not, it was easy to obtain it apart by distillation. Accordingly he distilled the mixture in a gentle heat: the colouring matter came over by the time that one-fourth of the liquor had passed into the receiver. It was mixed, however, with a small quantity of sulphuric acid; from which he separated it by distilling a second time over a quantity of carbonat of lime. The sulphuric acid combines with the lime, and remains behind, which the colouring matter cannot do, because carbonic acid has a stronger affinity for lime than it has. Thus he obtained the colouring matter in a state of purity.

It remained now to discover its component parts. He formed a very pure Prussian blue, which he distilled, and increased the fire till the vessel became red. The small quantity of water which he had put into the receiver contained a portion of the blue colouring matter and of ammonia; and the air of the receiver consisted of azote, carbonic acid gas, and the colouring matter. He concluded, from this and other experiments, that the colouring matter is a compound of ammonia and oil. But when he attempted to verify this theory by combining together ammonia and oil, he could not succeed in forming colouring matter. This obliged him to change his opinion; and at last he concluded that the colouring matter is a compound of ammonia and charcoal. He mixed together equal quantities of pounded charcoal and potass, put the mixture into a crucible, and kept it red-hot for a quarter of an hour: he then added a quantity of sal ammoniac in small pieces, which he pushed to the bottom of the melted mixture, kept it in the fire for two minutes till it had ceased to give out vapours of ammonia, and then threw it into a quantity of water. The solution possessed all the properties of the Prussian alkali. Thus Mr. Scheele succeeded in forming the colouring matter.

This colouring matter was called prussic acid by Morveau, in the first volume of the chemical part of the Encyclopedie Methodique; an appellation which is now generally received.

These admirable experiments of Scheele were repeated and carried still farther, by Berthollet in 1787, who applied to the explanation of the composition of the colouring matter the light which had resulted from his previous experiments on the component parts of ammonia. This illustrious chemist, scarcely inferior to Scheele in ingenuity and address, ascertained, in the first place, that the prussic alkali is a triple salt, composed of prussic acid, the alkali, and oxide of iron; that it may be obtained in octahedral crystals; and that when mixed with sulphuric acid, and exposed to the light, it lets fall a precipitate of Prussian blue. His next object was, to ascertain the component parts of prussic acid. When oxymuriatic acid is poured into prussic acid obtained by Scheele's process, it loses its oxygen, and is converted into common muriatic acid. At the same time the prussic acid becomes more odorous and more volatile, less capable of combining with alkalies, and precipitates iron from its solutions, not blue, but green. Thus prussic acid, by combining with oxygen, acquires new properties, and is converted into a new substance, which may be called oxyprussic acid. If more oxymuriatic acid gas is made to pass into prussic acid, and it is exposed to the light, the prussic acid separates from the water with which it was combined, and precipitates to the bottom in the form of an aromatic oil; which heat converts into a vapour insoluble in water, and incapable of combining with iron. When the green precipitate, composed of oxyprussic acid and iron, is mixed with a pure fixed alkali, the oxyprussic acid is decomposed, and converted into carbonat of ammonia.

From these experiments, Berthollet concluded, that prussic acid does not contain ammonia ready-formed; but that it is a triple compound of carbon, hydrogen, and azote, in proportions which he was not able to ascertain. This conclusion has been still farther verified by Mr. Clouet, who found that when ammoniacal gas is made to pass through a red-hot porcelain tube containing charcoal, a quantity of prussic acid is formed. This experiment does not succeed unless a pretty strong heat is applied to the tube.

Fourcroy and several other chemists believe, that the prussic acid contains also a portion of oxygen in its composition, resting chiefly upon the following experiments of Vauquelin:

Exper. I. Put into a retort 100 parts of the muriat of ammonia, 50 parts of lime, and 25 parts of charcoal in fine powder; adapt to the retort a receiver containing a slight solution of the sulphat of iron, and immerse into it the beak of the retort; then apply a brisk heat, and continue the action of the fire until nothing more is disengaged.

Exper. II. Put into a retort 100 parts of the muriat of ammonia, 50 parts of semivitreous oxide of lead, and 25 parts of charcoal: adapt a receiver containing a solution of sulphat of iron, and proceed as before. Stir well the liquors contained in the receivers, and expose them to the air for several days, in order that the combination between the oxide of iron and the prussic acid may be perfect, and that the prussiat of iron may absorb as much oxygen as is necessary for its passing to the state of blue prussiat, and for its being proof against acids: then pour into these liquors equal quantities of sulphuric acid well diluted with water, and you will have Prussian blue, the quantities of which will be as one to six; that is to say, the Prussian blue of the experiment in which Vauquelin employed oxide of lead, was six times more abundant than that of the experiment in which he employed only lime to disengage the ammonia.

Having thus traced the gradual progress of philosophers in ascertaining the nature of the prussic acid, it only remains to give an account of its properties, which were first examined by the indefatigable Scheele.

Prussic acid obtained by Scheele's process is a colourless liquid like water. It has a strong odour, resembling that of the flowers of the peach, or of bitter almonds. Its taste is sweetish, acrid, and hot, and apt to excite cough. It does not alter the colour of vegetable blues.

It is exceedingly volatile, and evidently capable of assuming the gaseous form; though it has never been obtained apart, nor examined in that state. At a high temperature (when united to a base), it is decomposed and converted into ammonia, carbonic acid, and carbureted hydrogen gas.

It unites difficultly with alkalies and earths, and is separated from them much more easily than from metallic oxides. More exposure to the light of the sun, or to a heat of 110°, is sufficient for that purpose. These combinations are decomposed also by all the acids.

It has no action on metals; but it unites with their oxides, and forms with them salts, which are almost all insoluble, if we except prussiats of mercury and manganese. These compounds are not decomposed by acids. Yet the prussic acid is not capable of taking the metallic oxides from the other acids.

Prussic acid has a great tendency to enter into triple compounds, combining at once with an alkali and a metallic oxide; and these compounds are much more permanent and difficult to decompose than its single combinations.

The affinities of this acid, as far as they have been ascertained, are as follows:

Barytes,
Strontian,
Potass,
Soda,
Lime,
Magnesia,
Ammonia.

It does not seem capable of combining with alumina.

This acid is of great importance to the chemist, in consequence of the property which it has of forming insoluble compounds with metallic oxides, and almost with metallic oxides alone. This puts it in our power to ascertain the presence of a metallic body held in solution. When the prussic acid is dropt in, a precipitate appears if a metal is present. The colour of this precipitate indicates the metal, and the quantity of it enables us to ascertain the quantity of metal contained in the solution. It is used especially to indicate the presence of iron, which it does by the blue colour that the solution assumes; and to free solutions from iron, which it does by precipitating the iron in the form of Prussian blue.

It is evident, however, that the pure prussic acid cannot be employed for these purposes, because it is incapable of taking metallic oxides from other acids. It is always employed combined with an alkaline or earthy basis. In that state it decomposes all metallic salts by a compound affinity. The base most commonly employed is potass or lime; and indeed it is most usually employed in the state of a triple salt, composed of prussic acid, potass, and oxide of iron, which is preferred because it is not apt to be decomposed by the action of the atmosphere.

Of all the metallic solutions tried by Scheele, pure prussic acid occasioned only a precipitate in three, namely,

1. Nitrat of silver precipitated white.
2. Nitrat of mercury . . . black.
3. Carbonat of iron . . . green becoming blue.

It has no action on the oxides of

Platinum,	Antimony,
Iron,	Manganese,
Tin,	Arsenic acid,
Lead,	Molybdic acid.
Bismuth,	

Gold precipitated by the alkaline carbonats, is rendered white by this acid.

It disengages carbonic acid from the oxide of silver precipitated by the same alkalies; but the oxide remains white.

It dissolves red oxide of mercury, and forms with it a salt which may be obtained in crystals.

Oxide of copper precipitated by carbonat of potass, effervesces in it, and acquires a slight orange-yellow colour.

Oxide of iron precipitated from the sulphat of iron by carbonat of potass, effervesces in it, and becomes blue.

Oxide of cobalt precipitated by the same alkali, gives in it some marks of effervescence, and becomes yellowish-brown.

The compounds which prussic acid makes with zirconia and yttria, seem also to be insoluble; for these earths are precipitated from their solutions by prussiat of potass; a circumstance in which they differ from all the other earths and alkalies, and which indicates a coincidence between them and the metallic oxides.

PRYTANEUM, in Grecian antiquity, a large building in Athens, where the council of the prytanes, or presidents of the senate, assembled, and where those who had rendered any signal service to the commonwealth were maintained at the public expence.

PSIDIUM, the *guava*, a genus of the monogynia order, in the icosandria class of plants, and in the natural method ranking under the 19th order, hesperideæ. The calyx is quinquefid, superior: there are five petals: the berry is unilocular and monospermous. There are eight species. The most remarkable are:

1. The pyriferum, or white guava. 2. The pomiferum, or red guava. Both these are however thought by some to be only varieties of the same plant. The red guava rises to the height of 20 feet, and is covered with a smooth bark; the branches are angular, covered with oval leaves, having a strong midrib, and many veins running towards the sides, of a light-green colour, standing opposite upon very short footstalks. From the wings of the leaves the flowers come out upon footstalks an inch and a half long: they are composed of five large roundish concave petals, within which are a great number of stamina shorter than the petals, and tipped with pale-yellow tops. After the flower is past, the germen becomes a large oval fruit shaped like a pomegranate.

A decoction of the roots of guava is employed with success in dysenteries: a bath of a decoction of the leaves is said to cure the itch, and other cutaneous eruptions. Guayava, or guava, is distinguished from the colour of the pulp, into the two species abovementioned, the white and the red; and, from the figure of the fruit, into the round and the pear-fashioned or perfumed guava. The latter has a thicker rind, and a more delicate taste, than the other. The fruit is about the bigness of a large tennis-ball; the rind or skin generally of a russet stained with red. The pulp within the thick rind is of an agreeable flavour, and interspersed with a number of small white seeds. The rind, when stewed, is eaten with milk, and preferred to any other stewed fruit. From the same part is made marmalade; and from the whole fruit is prepared a fine jelly. The fruit is very astringent, and nearly of the same quality with the pomegranate, and should be avoided by all who are subject to costiveness. The seeds are so hard as not to be affected by the fermentation in the stomachs of animals; so that when voided with the excrements, they take root, germinate, and produce thriving trees. Whole meadows in the West Indies are covered with guavas, which have been propagated in this manner. The buds of guava, boiled with barley and liquorice, produce an excellent ptisan for diarrhœas, and even the bloody flux, when not too inveterate. The wood of the tree, employed as fuel, makes a lively, ardent, and lasting fire.

PSITTACUS, or *parrot*, a genus belonging to the order of picæ. The bill in this genus is hooked from the base; and the upper mandible is moveable: the nostrils are round, placed in the base of the bill, which in some species is furnished with a kind of cere; the tongue is broad, and blunt at one end; the head is large, and the crown flat; the legs are short, the toes placed two before and two behind. It might seem a wonder why nature has destined to this, which is not naturally a bird of prey, but feeds on fruits and vegetable substances, the crooked beak allotted to the hawk and other carnivorous birds; but the reason seems to be, that the parrot being a heavy bird, and its legs not very fit for service, it climbs up and down trees by the help of this sharp and hooked bill, with which it lays hold of any thing and secures itself before it stirs a foot; and besides this, it helps itself forward very much, by pulling its body on with this hold.

Parrots are found almost every where within the tropics; and in their natural state they live on fruits and seeds, though, when tame, they will eat flesh and even fish.

In the East and West Indies they are very common; and in such warm climates are very brisk and lively: here, however, they lose much of their vigour. They seldom make nests, but breed like owls in hollow trees: they lay two eggs. At particular times they fly in very large troops, but still they keep two and two together. The genus consists of infinite variety, not so much owing to mixture of species, however, as might be supposed. They seem to run vastly into one another, so as to appear to be related, though received from different parts of the world; this, however, may possibly be occasioned by their being carried from one place to another for the sake of sale.

Buffon ranges the parrot in two great classes; the first of which comprehends those of the Old Continent, and the second those of the New. The former he subdivides into five families; the cockatoos, the parrots properly so called, the lories, the long-tailed paroquets, and the short-tailed ones; and the latter into six, viz. the macaos, the amazonians, the creeks, the popinjays, the long-tailed paroquets, and the short-tailed ones.

Mr. Latham has increased the genus from 47 to 163; and since the time he wrote his Index, at least 20 more have been discovered. They are very generally divided into three kinds: 1. The larger, which are as big as a moderate fowl, called macaos and cockatoos; these have very long tails. 2. The middle-sized ones, commonly called parrots, which have short tails, and are a little larger than a pigeon. And, 3. The small ones, which are called paroquets, and have long tails, and are not larger than a lark or blackbird. The following are the most remarkable:

1. The psittacus macao, or red and blue macao, is red, except the wing-quills, which above are blue, before rufous; the scapular feathers are variegated with blue and green; the cheeks are naked and wrinkled. It is about two feet seven inches and a half long, and about as big as a capon. Edwards says, when perfect, it will measure a full yard from bill to tail. It inhabits Brasil, Guiana, and other parts of South America. It was formerly very common in St. Domingo, but is now rarely found there. It generally lives in moist woods, especially such as are planted with a particular kind of palm, perhaps what is called the macaw-tree. It does not in general learn to speak, and its voice is particularly rough and disagreeable. The flesh is hard, black, and unsavoury, but makes good soup, and is much used by the inhabitants of Cayenne and other places. This species, in common with other parrots, is subject to fits when tamed; and though it will live for many years, yet if the returns are pretty frequent, it will generally fall a victim to that disease at last. The Americans call it gonzalo.

2. The psittacus ararauna, or blue and yellow macaw, is blue above, and yellow below, and the cheeks are naked, with feathery lines. It is about the same size with the last, and inhabits Jamaica, Guiana, Brasil, and Surinam.

3. The psittacus severus, or Brasilian green macaw, is black, with a greenish splendour; the bill and eyes are reddish, and the legs are yellow. It is about one foot and five inches long, and is common in Jamaica, Guiana, and Brasil. It is however comparatively rare: it is extremely beautiful, and of a very amiable and sociable temper when familiar and acquainted; but it can neither bear strangers nor rivals: its voice is not strong, nor does it articulate very distinctly the word ara. See Plate Nat. Hist. figs. 338, 339.

4. The psittacus aurora, or yellow amazon, is about 12 inches long, of a green colour, with blue wing-quills, and a white front; its orbits are snowy. It inhabits Mexico or Brasil; but in all probability the latter, from the one which Salerne saw, and which pronounced Portuguese words. The psittacus guineensis, or yellow lory, is about ten inches long, and is an inhabitant of Guinea. The bill is of a black colour; the cere, the throat, and space about the eyes, are white; above the eye there is a patch of yellow, and the rest of the head and neck is crimson. The breast is yellow, wing-coverts green, and the quills are blue, edged with yellow. Under the wings, belly, thighs, vent, and to the under part of the tail, the colour is white, which last is tipped with red; the legs are dusky, and the claws black.

PSOPHIA, a genus belonging to the order gallinæ. The bill is moderate; the upper mandible is convex; the nostrils are oblong, sunk, and pervious; the tongue is cartilaginous, flat, and fringed at the end; and the legs are naked a little above the knees. The toes are three before and one behind; the last of which is small, with a round protuberance beneath it, which is at a little distance from the ground. Mr. Latham only enumerates two species:

1. Psophia crepitans, or gold-breasted trumpeter. See Plate Nat. Hist. fig. 340. Its head and breast are smooth and shining green. By the Spaniards of Maynas it is called trompetero, and by the French at Cayenne agami, under which last name Buffon describes it. It inhabits parts of South America, Brasil, Guiana, Surinam, &c. but it is most plenty in the Amazons' country. It is about 20 inches long, being about the size of a large fowl, and lays eggs rather larger, of a blue-green colour. It is met with in the Carribee islands, where it is called a pheasant, and its flesh is reckoned as good as that of a pheasant. The most characteristic and remarkable property of these birds consists in the wonderful noise they make either of themselves, or when urged by the keepers of the menagerie. Some have supposed it to proceed from the anus, and some from the belly. It is now certain, however, that this noise proceeds from the lungs. Another very remarkable circumstance is, that they follow people through the streets, and out of town, and sometimes even perfect strangers. It is difficult to get rid of them; for if you enter a house, they will wait your return, and again join you, though often after an interval of three hours. "I have sometimes (says M. de la Borde) betaken myself to my heels; but they ran faster, and always got before me; and when I stopped, they stopped also. I know one (continues he) which invariably follows all the strangers who enter his master's house, accompanies them into the garden, takes as many turns as they do, and attends them back again."

2. Psophia undulata, or undulated trumpeter, is about the size of a goose. The upper part of the body is of a pale reddish brown-colour, beautifully undulated with black. The head is adorned with a dependant crest. On each side of the neck, beneath the ears, begins a list of black, widening as it descends, and meeting on the lower part before, where the feathers become greatly elongated, and hang loosely down. The under parts are generally white; the legs are of a dusky blue colour, like the bill. It is a native of Africa. Mr. Latham's specimen came from Tripoli.

PSORA. See MEDICINE.

PSORALEA, a genus of the decandria order, in the diadelphia class of plants, and in the natural method ranking under the 32d order, papilionaceæ. The calyx is powdered with callous points, and as long as the monospermous legumen. There are 33 species. The most remarkable are:

1. The pinnata, or pinnated psoralea, with a woody soft stem, branching five or six feet high, pinnated leaves of three or four pair of narrow lobes terminated by an odd one, and at the axillas close-sitting blue flowers with white keels. It is a native of Ethiopia.

2. The bituminosa, or bituminous trifoliate psoralea, rises with a shrubby stalk, branching sparingly about two or three feet high, with ternate or three-lobed leaves of a bituminous scent, and blue flowers in close heads. It grows in Italy and in France.

3. The aculeata, or aculeated prickly psoralea, rises with a shrubby branching stem three or four feet high, with ternate leaves, having wedge-shaped lobes, terminating in a recurved sharp point, and the branches terminated by roundish heads of blue flowers. It grows in Ethiopia. These plants flower here every summer; the first sort the greatest part of that season, and the others in July and August; all of which are succeeded by seeds in autumn. Keep them in pots in order for removing into the greenhouse in winter. They are propagated by seeds, sown in a hotbed in the spring; and when the plants are two or three inches high, prick them in separate small spots, and gradually harden them to the open air, so as to bear it fully by the end of May or beginning of June. They may also be propagated by cuttings any time in summer, planted in pots, and plunged in a little heat; or covered close with hand-glasses, shaded from the sun, and watered.

PSYCHOTRIA, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 47th order, stellatæ. The calyx is quinquedentate, persisting, and crowning the fruit; the corolla is tubulated; the berry globose, with two hemispherical sulcated seeds. The species are 39, chiefly shrubs of the West Indies.

PTARMICA, *sneeze-wort*, a genus of the syngenesia polygamia superflua class of plants, the compound flower whereof is radiated, and the peculiar hermaphrodite ones of a funnel-shape, with a patulous quinquefid limb; the stamina are five capillary very short filaments; and the seeds, one of which succeeds each hermaphrodite flower, are contained in the cup. The leaves of this plant are sometimes used in sallad; and when dried and reduced to powder, they make a good sternutatory.

PTELEA, *shrub-trefoil*, a genus of the monogynia order, in the tetrandria class of plants, and in the natural method ranking with those of which the order is doubtful. The corolla is tetrapetalous; the calyx quadripartite inferior; the fruit is monospermous, with a roundish membrane in the middle.

There is one species, viz. the trifoliata, or Carolina shrub-trefoil. It has a shrubby upright stem, dividing into a branchy head eight or ten feet high, covered with a smooth purplish bark, trifoliate leaves, formed of oval spear-shaped folioles, and the branches terminated by large bunches of greenish-white flowers, succeeded by roundish, bordered capsules. It is a hardy deciduous shrub, and a proper plant for the shrubbery and other ornamental plantations to increase the variety. It is propagated by seeds, layers, and cuttings.

PTERIS, a genus of the order of filices, in the cryptogamia class of plants. The fructifications are in lines under the margin. There are 34 species. The most remarkable is the aquilina, or common female fern. The root of this is viscid, nauseous and bitterish; and like all the rest of the fern tribe, has a salt, mucilaginous taste. It creeps under the ground in some rich soils to the depth of five or six feet, and is very difficult to be destroyed. Frequent mowing in pasture-grounds, plentiful dunging in arable lands, and above all, pouring urine upon it, are the most approved methods of killing it. It has, however, many good qualities to counterbalance the few bad ones. Fern cut while green, and left to rot upon the ground, is a good improver of land; and its ashes, if burnt, will yield the double quantity of salt that most other vegetables will. Fern is also an excellent manure for potatoes; for if buried beneath their roots, it never fails to produce a good crop. Its astringency is so great, that it is used in many places abroad in dressing and preparing kid and chamois leather. In several places in the north, the inhabitants mow it green, and, burning it to ashes, make those ashes up into balls, with a little water, which they dry in the sun, and make use of them to wash their linen instead of soap. In many of the Western Isles, the people gain a very considerable profit from the sale of the ashes to soap and glass-makers. In Glen Elg in Inverness-shire, and other places, the people thatch their houses with the stalks of this fern, and fasten them down with ropes made either of birch, bark, or heath. Swine are fond of the roots, especially if boiled in their wash. In some parts of Normandy we read that the poor have been reduced to the miserable necessity of mixing them with their bread; and in Siberia, and some other northern countries, the inhabitants brew them in their ale, mixing one-third of the roots to two-thirds of malt. The antients used the root of this fern, and the whole plant, in decoctions and diet-drinks, in chronic disorders of all kinds, arising from obstructions of the viscera and the spleen. Some of the moderns have given it a high character in the same intentions, but it is rarely used in the present practice. The country-people, however, still continue to retain some of its antient uses; for they give the powder of it to destroy worms, and look upon a bed of the green plant as a sovereign cure for the rickets in children.

PTEROCARPUS, a genus of the decandria order, in the diadelphia class of plants, and in the natural method ranking under the 32d order, papilionaceæ. The calyx is quinquedentate; the capsule falcated, filiaceous, varicose. The seeds are few and solitary. There are six species. The most remarkable are:

1. Draco. 2. Ecastaphyllum. 3. Lunatus. And, 4. Santalinus. This last is called red saunders; and the wood is brought from the East Indies in large billets, of a compact texture, a dull red, almost blackish colour on the outside, and a deep brighter red within. This wood has no manifest smell, and little or no taste.

The principal use of red saunders is as a colouring drug; with which intention it is employed in some formulæ, particularly in the tinctura lavendulæ composita. It communicates a deep red to rectified spirit, but gives no tinge to aqueous liquors; a small quantity of the resin, extracted by means of spirit, tinges a large one of fresh spirit of an elegant blood-red. There is scarcely any oil, that of lavender excepted, to which it communicates its colour. Geoffroy and others take notice, that the Brazil woods are sometimes substituted for red saunders; and the college of Brussels are in doubt whether all that is sold among them for saunders is not really a wood of that kind.

PTERONIA, a genus of the polygamia æqualis order, in the syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The receptacle is full of multipartite bristles; the pappus a little plumy; the calyx imbricated. There are 18 species, shrubs of the Cape.

PTEROSPERMUM, a genus of the polyandria order, in the monadelphia class of plants, and in the natural method ranking under the 37th order, columniferæ. The calyx is quinquepartite; the corolla consists of five oblong spreading petals. The filaments are about fifteen, which unite towards the base into a tube. The style is cylindrical; the capsule is oval, woody, and quinquelocular, each of which are bivalved, containing many oblong, compressed, and winged seeds. There are two species, natives of the East Indies; the wood of which is very hard, and very like that of the holly-tree.

PTEROTRACHEA, a genus of the vermes mollusca. Body detached, gelatinous, with a moveable fin at the abdomen or tail; eyes two, placed within the head. There are four species, that inhabit chiefly the Archipelago.

PTINUS, a genus of insects belonging to the order coleoptera. The generic character is, antennæ filiform, with the three last joints largest; thorax roundish, without distinct margin, receiving occasionally the head.

The genus ptinus, like that of dermestes, consists of small insects, which, in general, have similar habits, living both in their larva and complete state among dry animal substances; and some species in dry wood, committing great havoc among the older articles of furniture, which they pierce with innumerable holes, thus causing their gradual destruction.

To this genus belongs the celebrated insect, distinguished by the title of the death-watch, or ptinus fatidicus. Among the popular superstitions which the almost general illumination of modern times has not been able to obliterate, the dread of the death-watch may well be considered as one of the most predominant, and still continues to disturb the habitations of rural tranquillity with groundless fears and absurd apprehensions. It is not indeed to be imagined that those who are engaged in the more important cares of providing the immediate necessaries of life, should have either leisure or inclination to investigate with philosophic exactness the causes of a particular sound; yet it must be allowed to be a very singular circumstance that an animal so common should not be more universally known, and the peculiar noise which it occasionally makes be more universally understood. It is chiefly in the advanced state of spring that this alarming little animal commences its sound, which is no other than the call or signal by which the male and female are led to each other, and which may be considered as analogous to the call of birds, though not owing to the voice of the insect, but to its beating on any hard substance with the shield or fore-part of its head. The prevailing number of distinct strokes which it beats is from seven to nine or eleven; which very circumstance may perhaps still add in some degree to the ominous character which it bears among the vulgar. These sounds or beats are given in pretty quick succession, and are repeated at uncertain intervals; and in old houses where the insects are numerous, may be heard at almost every hour of the day, especially if the weather is warm. The sound exactly resembles that which may be made by beating moderately hard with a nail on a table. The insect is of a colour so nearly resembling that of decayed wood, viz. an obscure greyish brown, that it may for a considerable time elude the search of the enquirer. It is about a quarter of an inch in length, and is moderately thick in proportion, and the wing-shells are marked with numerous irregular variegations of a lighter or greyer cast than the ground-colour.

We must be careful not to confound this animal, which is the real death-watch of the vulgar, emphatically so called, with a much smaller insect of a very different genus, which makes a sound like the ticking of a watch, and continues it for a long time without intermission. It belongs to a totally different order, and is the termes pulsatorium of Linnæus.

We cannot conclude this slight account of the death-watch without quoting a sentence from that celebrated work the Pseudodoxia Epidemica of the learned sir Thomas Brown, who on this subject expresses himself in words like these: "He that could eradicate this error from the minds of the people, would save from many a cold sweat the meticulous heads of nurses and grandmothers."

A very destructive little species of ptinus is often seen in collections of dried plants, &c. remarkable for the ravages it commits both in its larva and perfect state. The larva resembles that of a beetle in miniature, being about the eighth of an inch long, and of a thickish form, lying with the body bent, and is of a white colour. The perfect insect is very small, measuring only about the tenth of an inch, and is slender, of a pale yellowish chesnut-colour, appearing, when magnified, beset with small short hairs, with the wing-covers finely striped by rows of small impressed points or dots. The ravages of the larva are most remarkable during the summer.

The ptinus fur of Linnæus is another very destructive species. Its length is somewhat more than the tenth of an inch, and its colour pale chesnut-brown, sometimes marked on the wing-covers by a pair of greyish bands; the antennæ are rather long and slender; the body remarkably convex; and the thorax, when magnified, appears to have a projecting point on each side. Its larva resembles that of the preceding species, and is found in similar situations.

PTOLEMAIC, or *Ptolemean system of astronomy*, is that invented by Claudius Ptolemæus, a celebrated astronomer and mathematician of Pelusium in Egypt, who lived in the beginning of the second century of the Christian æra.

This hypothesis supposes the earth immoveably fixed in the centre, not of the world only, but also of the universe; and that the sun, the moon, the planets, and stars, all move about it from east to west, once in 24 hours, in the order following, viz. the moon next to the Earth, then Mercury, Venus, the Sun, Mars, Jupiter, Saturn, the fixed stars, the first and second crystalline heavens, and above all, the fiction of their primum mobile.

PUBES. See ANATOMY.

PUCERON. See APHIS.

PULEX, the *flea*, a genus of insects of the order aptera. The generic character is, legs six, formed for leaping; eyes two; antennæ filiform; mouth furnished with an inflected, setaceous snout, concealing a piercer; abdomen compressed.

This genus is one of the most singular in the order aptera. The pulex irritans, or common flea, so well known in its complete state in every region of the globe, is remarkable for undergoing the several changes experienced by the major part of the insect race of other tribes; being produced from an egg, in the form of a minute worm or larva, which changes to a chrysalis, in order to give birth to the perfect animal. The female flea deposits, or rather drops, her eggs at distant intervals, in any favourable situation: they are very small, of an oval shape, of a white colour, and a polished surface. From these, in the space of six days, are hatched the larvæ, which are destitute of feet, of a lengthened worm-like shape, beset with distant hairs, and furnished at the head with a pair of short antennæ or tentacula, and at the tail with a pair of slightly curved forks or holders. Their colour is white, with a reddish cast, and their motions quick and tortuous. These larvæ are very frequently found in the nests of various birds, and, in particular, of pigeons, where they fasten occasionally to the young brood, and saturate themselves with blood. In the space of ten or twelve days, they arrive at their full growth, when they usually measure near a quarter of an inch in length. At this period they cease to feed, and, casting their skin, change into the state of a chrysalis, which is of a white colour, and of an oval shape, with a slightly pointed extremity, and exhibits the immature limbs of the included insect. The larvæ are said to spin themselves up in an oval cotton-like covering before they undergo their change. This, however, is not always the case. After lying for the space of twelve days in chrysalis, the complete insect emerges in its perfect form. It now begins to exert its lively motions; and employs the sharp proboscis with which nature has furnished it, in order to obtain nourishment from the first man, bird, or quadruped, to which it can gain access. The time required for the evolution of this animal varies considerably according to the season of the year, and in the winter months is of much longer duration than the period above-mentioned; the egg scarcely hatching under twelve days, and the larvæ lying nearly twice the usual time in chrysalis.

Among the chief singularities observable in the structure of the flea, may be noticed the extraordinary situation of the first pair of legs, which, instead of being placed beneath the thorax, as in most other insects, are situated immediately beneath the head; the antennæ are short, hairy, and consist of five joints; and at a small distance beneath there is placed the proboscis, which is strong, sharp-pointed, tubular, and placed between a pair of jointed guards or sheaths, which are still farther strengthened at the base by a pair of pointed scales; the eyes are large, round, and black. The general appearance of the animal is too well known to require particular description: it may only be necessary to observe, that the male is considerably smaller than the female, with the back rather sinking than convex, as it always is in the female insect. Nothing can exceed the curious disposition and polished elegance of the shelly armour with which the animal is covered, nor can the structure of the legs be contemplated without admiration.

Though it would perhaps be difficult to prove that there exists in Europe more than one genuine species of flea, yet it is certain that some permanent varieties or races may be traced, which a practised eye can readily distinguish from the common domestic kind. Of these the most remarkable seems to be that infesting some of the smaller quadrupeds, and particularly mice and bats. This variety is of a more slender form than the common flea, and of a paler colour, differing from that insect nearly in the same proportion that a greyhound does from the more common race of dogs.

Pulex penetrans, or chigger, is a native of South America and the West Indian islands. According to Catesby's microscopic figure of this insect, it may properly be arranged under the present genus; but it is probable, from the different descriptions of authors, that some insects of the genus acarus, which excite similar swellings under the skin, have been confounded with it under the general name of chigger or chigoe. Catesby's account runs as follows:

" It is a very small flea, that is found only in warm climates. It is a very troublesome insect, especially to negroes, and others that go barefoot and are slovenly. They penetrate the skin, under which they lay a bunch or bag of eggs, which swell to the bigness of a small pea or tare, and give great pain till taken out; to perform which great care is required, for fear of breaking the bag, which endangers a mortification, and the loss of a leg, and sometimes life itself. This insect, in its natural size, is not above a fourth part so big as the common flea. From the mouth issues a hollow tube like that of the common flea, between a pair of antennæ. It has six jointed legs, and something resembling a tail. The egg is so small as to be scarcely discerned by the naked eye. These chegoes are a nuisance to most parts of America between the tropics."

PULLEY. See Mechanics.

PULMONARIA, *lungwort*, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 41st order, asperifoliæ. The corolla is funnel-shaped, with its throat pervious; the calyx is prismatic and pentagonal. There are seven species, of which the most remarkable is the officinalis, common spotted lungwort, or Jerusalem cowslip. This is a native of woods and shady places in Italy and Germany, but has been cultivated in Britain for medical use. The leaves are of a green colour, spotted with white; and of a mucilaginous taste, without any smell. They are recommended in phthisis, ulcers of the lungs, &c. but their virtues in these diseases are not warranted by experience.

PULSATILLA. See Anemone.

PULSE, in the animal economy, denotes the beating or throbbing of the heart and arteries. See Physiology.

Pulse. See Legumen.

PULTENÆA, a genus of the class and order decandria monogynia. The calyx is five-toothed; corolla papilionaceous; legume one cell, two-seeds. There are six species, shrubs of New Holland.

PUMICE-STONE, or *porous glasses*. When the compact glasses are exposed to the heat of our furnaces, they emit a great number of air-bubbles, which renders them porous: such is the origin of pumice. It has the same base as compact glass. The texture is fibrous; the fibres have a silky lustre. Colours various; white, brown, yellow, black. Before the blow-pipe, they melt into a white enamel. According to Klaproth, the pumice consists of

77.50	silica
17.50	alumina
1.75	oxide of iron
3.00	potass
99.75.	

See Fulmination.

PUMP, an hydraulic machine for raising water by means of the pressure of the atmosphere. It would be an entertaining and not an uninstructive piece of information to learn the progressive steps by which the ingenuity of man has invented the various methods of raising water. A pump must be considered as the last step of this progress. Common as it is, and overlooked even by the curious, it is a very abstruse and refined invention. Nothing like it has been found in any of the rude nations whom the Europeans have discovered, either in the new continent of America or the islands of the Pacific Ocean. Nay, it was unknown in the cultivated empire of China at the time of our arrival there by sea; and it is still a rarity every where in Asia, in places unfrequented by the Europeans. It does not appear to have been known by the Greeks and Romans in early times; and perhaps it came from Alexandria, where physical and mathematical science was much cultivated by the Greek school under the protection of the Ptolemies. The performances of Ctesibius and Hero are spoken of by Pliny and Vitruvius as curious novelties. There are two sorts of pumps, which essentially differ; and all the varieties are but modifications of these. One has a piston with a perforation and valve; the other has a solid piston: to the former is given the name of the common sucking-pump; the latter is denominated the forcing-pump.

Fig. 1. represents the common sucking-pump. AA is a cylinder of cast iron, bored smooth withinside; it has a flanch at the top, by which it is screwed to the wooden cistern B, which conveys the water away from the pump. It has also a flanch D at its lower end, to screw on the pipe E, which brings the water to the pump. In the same flanch is a pair of valves, *aa*; and the bucket or piston F, which slides within the barrel, has another similar pair of valves in it. This bucket is screwed to an iron rod G, which is moved up and down by some machine. When the bucket F descends, its valves *bb* open as in the figure, and allow the water which fills the barrel to pass through them. When the bucket arrives at the bottom of the barrel, it is drawn up again; and as the valves shut, and prevent the water from returning through the bucket, it lifts all the water contained in the barrel into the cistern B. At the same time the bucket, in rising, makes a vacuum beneath it: the pressure of the atmosphere upon the surface of the water in the well, causes it to mount up through the pipe E, open the valves *aa*, and fill the barrel AA. When the bucket begins to descend, the column of water beneath it descends also, till it is stopped by the shutting of the valves *aa*; the valves *bb* then open, and allow the water to pass through as before.

Fig. 2 is a forcing-pump. In this the barrel AA is screwed upon a square box BB, which has a pair of valves *aa* at the top of the pipe C, bringing water from the well; and another similar pair at the lower end of the pipe D, which is likewise screwed to the square box. The plunger E is solid: when it is drawn up it makes a vacuum in the barrel, and draws the water up through the valves *aa* from the well to fill the barrel. The plunger is then forced down, the valves *aa* shut, and as the water has no other way out of the box, it passes through *bb* up the pipe D. The plunger is then drawn up, the valves *bb* shut, and *aa* open to supply the barrel as before.

Fig. 3 is a lift-pump. The barrel AA is screwed by its top to a shorter barrel H, from which the crooked pipe B proceeds. A cover *h* is screwed over the top of the barrel H, with a stuffing-box in the middle of it; which is a box containing cotton, or other light substances, through which the piston-rod E passes. The piston F has two valves *bb* in it, similar to fig. 1; and at the bottom of the barrel are two valves similar to *aa* (fig. 1). When the piston descends, the lower valves prevent the water from going out of the barrel: and the valves *bb* open, to let the water press through them. When the piston returns, the valves in it shut, and it raises the water through the pipe B; the stuffing-box preventing its getting out at the top of the barrel, by the side of the piston-rod, as in fig. 1; and at the same time, by making a vacuum beneath it, filling the barrel through the lower valves in the same manner as the sucking-pump. The piston then descends, the lower valves shut, and *bb* open as before. In all the figures, W represents a hole in the bottom of the pump, to get at the valves to repair them; and when the pump is at work, a cover is screwed over it, as shewn in fig. 3. Pumps constructed as in the drawing are seldom less than one or two feet in the bore of the barrel.

The common sucking-pump may, by a small addition, be converted into a lifting-pump, fitted for propelling the water to any distance, and with any velocity. Fig. 4, is a sucking-pump on a small scale, whose working-barrel AB has a lateral pipe C, connected with it close to the top. This terminates in a main or rising pipe, furnished or not with a valve. The top of the working-barrel AB is shut by a strong plate, having a hollow neck terminating in a small flanch. The piston-rod passes through this neck, and is nicely turned and polished. A number of rings of leather are put over the rod, and strongly compressed round it by another flanch and several screwed bolts. By this contrivance, the rod is closely grasped by the leathers; but may be easily drawn up and down, while all passage of air or water is effectually prevented. The piston is perforated, and furnished with a valve opening upwards. There is also a valve, T, on the top of the suction-pipe; and it will be of advantage, though not absolutely necessary, to put a valve L at the bottom of the rising-pipe. Now, suppose the piston at the bottom of the working-barrel; when it is drawn up, it tends to compress the air above it, because the valve in the piston remains shut by its own weight. The air, therefore, is driven through the valve L, into the rising-pipe, and escapes. In the mean time, the air which occupied the small space between the piston and the valve T, expands into the upper part of the working-barrel; and its elasticity is so much diminished thereby, that the atmosphere presses the water of the cistern into the suction-pipe, where it rises until an equilibrium is again produced. The next stroke of the piston downwards, allows the air which had come from the suction-pipe into the barrel during the ascent of the piston, to get through its valve. Upon drawing up the piston, the air is also drawn off through the rising-pipe. Repeating this process, brings the water at last into the working-barrel, and it is then driven along the rising-pipe by the piston.

This is one of the best forms of a pump. The rarefaction may be very perfect, because the piston can be brought so near to the bottom of the working-barrel: and for forcing water in opposition to great pressures, it appears preferable to the common forcing-pump; because in that, the piston-rod is compressed and exposed to bending, which greatly hurts the pump, by wearing the piston and barrel on one side. This soon renders it less tight, and much water squirts out by the sides of the piston. But in this pump the piston-rod is always drawn, or pulled, which keeps it straight, and rods exert a much greater force in opposition to a pull than to compression. The collar of leather round the piston-rod, is found by experience to be very impervious to water; and though it needs but little repair, yet the whole is very accessible; and in this respect much preferable to the common pump, in deep mines, where every fault of the piston obliges us to draw up some hundred feet of piston-rods. By this addition too, any common pump, for the service of a house, may be converted into an engine for extinguishing fire, or may be made to convey the water to every part of the house; and this without hurting or obstructing its common uses. All that is necessary, is to have a large cock on the upper part of the working-barrel, opposite to the lateral pipe in this figure. This cock serves for a spout, when the pump is used for common purposes; and the merely shutting this cock, converts the whole into an engine for extinguishing fire, or for supplying distant places with water. It is scarcely necessary to add, that, for these services, it will be requisite to connect an air-vessel with some convenient part of the rising-pipe, in order that the current of water may be continual.

It is of considerable importance, that as equable a motion as possible is produced in the main-pipe, which diminishes those strains which it is otherwise liable to. The application of an air-vessel at the beginning of the pipe, answers this purpose. In great works, it is usual to effect this by the alternate action of two pumps. It will be rendered still more uniform, if four pumps are employed, succeeding each other at the interval of one quarter of the time of a complete stroke.

But ingenious men have attempted the same thing with a single pump; and many different constructions for this purpose have been proposed and executed. Fig. 5, represents one of the best. It consists of a working-barrel, *ab*, closed at both ends; the piston *c* is solid, and the piston-rod passes through a collar of leathers at the top of the barrel. This barrel communicates laterally with two pipes, *n* and *k*, the communications being as near to the top and bottom of the barrel as possible. At each of the communications are two valves, opening upwards. The two pipes unite in a larger rising-pipe at *b*, which bends a little back, to give room for the piston-rod. Suppose the piston down close to the entry of the lateral pipe *h*; when it is drawn up, it compresses the air above it, and drives it through the valve in the pipe *k*, whence it escapes through the rising-pipe; at the same time it rarefies the air below it. Therefore the weight of the atmosphere shuts the valve *m*, and causes the water in the cistern to rise through the valve *n*, and fill the lower part of the pump. When the piston is pushed down again, this water is first driven through the valve *m*, because *n* immediately shuts; and then most of the air which was in this part of the pump at the beginning, goes up through it, some of the water coming back in its stead. In the mean time, the air which remained in the upper part of the pump after the ascent of the piston, is rarefied by its descent; because the valve *o* shuts as soon as the piston begins to descend, the valve *p* opens, the air in the suction-pipe *h* expands into the barrel, and the water rises into the pipes by the pressure of the atmosphere. The next rise of the piston must bring more water into the lower part of the barrel, and must drive a little more air through the valve *o*, namely, part of that which had come out of the suction-pipe *h*; and the next descent of the piston must drive more water into the rising-pipe *k*, and along with it, most, if not all, of the air which remained below the piston, and must rarefy still more the air remaining above the piston; and more water will come in through the pipe *h*, and get into the barrel. It is evident, that a few repetitions will at last fill the barrel on both sides of the piston with water. When this is accomplished, there is no difficulty in perceiving how, at every rise of the piston, the water of the cistern will come in by the valve *n*, and the water in the upper part of the barrel will be driven through the valve *o*; and in every descent of the piston, the water of the cistern will come into the barrel by the valve *p*, and the water below the piston will be driven through the valve *m*; and thus there will be a continual influx into the barrel through the valves *n* and *p*, and a continual discharge along the rising-pipe *l* through the valves *m* and *o*.

This machine is certainly equivalent to two forcing-pumps, although it has but one barrel and one piston; but it has no sort of superiority. It is not even more economical, in most cases; because, probably, the expence of the additional workmanship will equal that of the barrel and piston, which is saved. There is, indeed, a saving in the rest of the machinery, because one lever produces both motions. It therefore cannot be called inferior to two pumps; and there is undoubtedly some ingenuity in the contrivance.

Fig. 6, is another pump for furnishing a continued stream, invented by Mr. Noble. AB, the working-barrel, contains two pistons, C and B, which are moved up and down alternately by the rods fixed to the lower F. The rod of the piston B, is carried through the piston or bucket C. This pump is very simple in its principle, and may be executed at little expence.

The pump invented by M. De la Hire, raises water equally quick by the descent as by the ascent of the piston in the pump-barrel.

AA (fig. 7), is a well, in which the lower ends of the pipes B and C are placed. D is the pump-barrel, into the lowermost end of which the top of the open pipe B is soldered, and in the uppermost end the hollow pipe S is soldered, which opens into the barrel; and the top of the pipe C is soldered into that piece. Each of these pipes has a valve on its top, and so have the crooked pipes E and F, whose lower ends are open into the pump-barrrel, and their upper ends into the box G. L is the piston-rod, which moves up and down through a collar of leather in the neck M; K is a solid plunger, fastened to the rod or spear L; the plunger never goes higher than K, nor lower than D; so that from K to D is the length of the stroke.

As the plunger rises from D to K, the atmosphere (pressing on the surface of the water AA in the well) forces the water up the pipe B, through the valve *b*, and fills the pump-barrel with water up to the plunger; and during this time, the valves *e* and S lie close and air-tight on the tops of the pipes E and C.

When the plunger is up to its greatest height, at K, it stops there for an instant, and in that instant the valve *b* falls, and stops the pipe B at top. Then, as the plunger goes down, it cannot force the water between K and D back through the close valve *b*; but forces all that water up the crooked pipe E, through the valve *e*, which then opens upward by the force of the water; and this water, after having filled the box G, rises into the pipe N, and runs off by the spout at O.

During the descent of the plunger K, the valve *f* falls down, and covers the top of the crooked pipe F; and the pressure of the atmosphere on the well AA forces the water up the pipe C, through the valve S, which then opens upward by the force of the ascending water; and this water runs from S into the pump-barrel, and fills all the space in it above the plunger.

When the plunger is down to its lowest descent at D, and stops there for an instant, in that instant the valve S falls down, and shuts the top of the pipe C; and then, as the plunger is raised, it cannot force the water above it back through the valve S, but drives all that water up to the crooked pipe F, through the valve *f*, which opens upward by the force of the ascending water; which water, after filling the box G, is forced up from thence into the pipe N, and runs off by the spout at O.

And thus, as the plunger descends, it forces the water below it up the pipe E; and as it ascends, it forces the water above it up the pipe F: the pressure of the atmosphere filling the pump-barrel below the plunger, through the pipe B, while the plunger ascends; and filling the barrel with water above the plunger, through the pipe C, as the plunger goes down.

Thus there is as much water forced up the pipe N, to the spout O, by the descent of the plunger, as by its ascent; and, in each case, as much water is discharged at O, as fills that part of the pump-barrel which the plunger moves up and down in.

On the top of the pipe O is a close air-vessel P. When the water is forced up above the spout O, it compresses the air in the vessel P; and this air, by the force of its spring acting on the water, causes the water to run off by the spout O, in a constant and (very nearly) equal stream.

Whatever the height of the spout O is above the surface of the well, the top S, of the pipe C, must not be 32 feet above that surface; because if that pipe could be entirely exhausted of air, the pressure of the atmosphere in the well would not force the water up the pipe to a greater height than 32 feet; and if S is within 24 feet of the surface of the well, the pump will be so much the better.

As the collar of leathers within the neck M, is apt to dry and shrink when the pump is not used, and consequently to let air get into the pump-barrel, which would stop the operation of the atmosphere in the pipe C; collars of old hats might be used instead of leathers, as they would not be liable to that inconvenience.

It matters little what the size of the pipe N is, through which the water is forced up to the spout; but a great deal depends on the size of the pump-barrel; and according to the height of the spout O, above the surface of the well, the diameter of the bore of the barrel should be as follows:

For 10 feet high the bore should be 6.9 inches; for 15 feet 5.6; for 20 feet 4.9; for 25 feet 4.4; for 30 feet 4.0; for 35 feet 3.7; for 40 feet 3.5; for 45 feet 3.3; for 50 feet 3.1; for 55 feet 2.9; for 60 feet 2.8; for 65 feet 2.7; for 70 feet 2.6; for 75 feet 2.5; for 80 feet 2.5 will do; for 85 feet 2.4; for 90 feet 2.3; for 95 feet 2.2; and for 100 feet, the diameter of the bore should not exceed 2.1 or 2.2 inches at most. If these proportions are attended to, a man of common strength may raise water 100 feet high by one pump, as easily as he could raise it ten feet high by another.

In this pump the pipes B and C seem to be rather too small; which will cause the water rising in them to have a great deal of friction from the quickness of its motion; and whoever makes such a pump, will find it very difficult to make the leather in the neck M water-tight, so that no water shall be forced out that way when the piston is drawn up.

The hair-rope machine for raising water was invented by sieur Vera:

A (fig. 8), is a wheel four feet over, having an axis and a winch; CC, a hair-rope, near one inch diameter; D, a reservoir to collect the water: E, a spout to convey the water from the reservoir; G, the surface of the water in the well; I, a pulley under which the rope runs, in order to keep it tight.

When the handle is turned about with a considerable velocity, the water which adheres to the rope, in wells of no great depth, is very considerable: the rope thus passes through the tubes in D, which, being five or six inches higher than the bottom of the reservoir, hinders the water from returning back into the well, and is conveyed in a continual stream through the spout E. Some of the above engines, improved by Mr. Stamford, have raised a greater quantity of water than any person unskilful in hydraulics could suppose, in the same time, from such a simple contrivance.

The chain-pump consists of two square, or cylindrical barrels, through which a chain passes, having a great number of flat pistons, or valves, fixed upon it at proper distances. This chain passes round a kind of wheel-work, fixed at one end of the machine. The teeth of this are so contrived as to receive one-half of the flat pistons, which go free of the sides of the barrel by near a quarter of an inch, and let them fold in, and they take hold of the links as they rise. A whole row of the pistons, which go free of the sides of the barrel by near a quarter of an inch, are always lifting when the pump is at work; and as this machine is generally worked with briskness, they bring up a full bore of water in the pump. It is wrought either by one or two handles, according to the labour required.

The many fatal accidents which happen to ships from the choking of their pumps, makes it an important object, in naval affairs, to find some machine for freeing ships from water, not liable to so dangerous a defect. The chain-pump being found least exceptionable in this respect, was adopted in the British navy; but the chain-pump itself is not free from imperfections. If the valves are not well fitted to the cylinder through which they move, much water will fall back; if they are well fitted, the friction of many valves must be considerable, besides the friction of the chain round the sprocket-wheels, and that of the wheels themselves. To which may be added, the great wear of leathers, and the disadvantage which attends the surging and breaking of the chain. The preference, therefore, which has been given to chain-pumps over those which work by the pressure of the atmosphere, must have arisen from one circumstance, that they have been found less liable to choke.

In point of friction, of coolness, and of cheapness, the sucking-pump has so evidently the advantage over the chain-pump, that it will not fail to gain the preference, whenever it shall be no longer liable to be choked with gravel and with chips.

Buchanan's pump, which, like the common pump, acts by the pressure of the atmosphere, is not liable to the defects incident to other pumps upon that principle, being essentially different from any now in use.

The principal object of its invention was to remove the imperfection of its choking. In attaining this important end, a variety of collateral advantages have also been produced, which enhance its utility.

The points in which it differs essentially from the common pump, and by which it excels, are, that it discharges the water below the piston, and has its valves lying near each other.

The advantages of this arrangement are, that the sand or other matter, which may be in the water, is discharged without injuring the barrel or the piston-leathers; so that besides avoiding unnecessary wear and tear, the power of the pump is preserved, and not apt to be diminished or destroyed in moments of danger, as is often the case with the common and chain pumps: that the valves are not confined to any particular dimensions, but may be made capable of discharging every thing that can rise in the suction-piece, without danger of being choked: that if there should happen upon any occasion to be an obstruction in the valves, they are both within the reach of a person's hand, and may be cleared at once, without the disjunction of any part of the pump: and that the pump is rendered capable of being instantaneously converted into an engine for extinguishing fire. Besides, it occupies very little space in the hold, and thus saves room for stowage.

But this pump is not confined to nautical uses alone; its adaptation extends to the raising of water in all situations, and with peculiar advantage where it happens to be mixed with sand or substances which destroy other pumps, as, for instance, in alum-works, in mines, in quarries, or in the clearing of foundations; and in its double capacity it will be very convenient in gardens, bleaching-grounds, in stable and farm yards, and in all manufactories, or other places, where there are a necessity for raising water and the risk of fire.

With all these advantages, it is a simple and durable pump, and may be made either of metal or wood at a moderate expence.

Fig. 9, is a vertical section of the pump, as made of metal, in which A is the suction-piece, B the inner valve, C the outer valve.

The valves are of the kind called clack-valves. Their hinges are generally made of metal, as being more durable than leather.

D is the working-barrel, E the piston, and G the spout.

The following parts are necessary only when the pump is intended to act as a fire-engine:

H an air-vessel, which is screwed like a hose-pipe, that it may, at pleasure, the more readily be fixed or unfixed.

There is a perforated stopple for the spout, made for receiving such pipes as are common to fire-engines. It is oval and tapered, and being introduced transversely, upon being pulled back becomes immediately tight.

These parts being provided, all that is necessary to make the pump act as a fire-engine after having been used as a sucking-pump, is to plug up the spout with the stopple.

No particular mode being essential in the working of this pump, it may, according to choice or circumstances, be wrought by all the methods practised with the common pump. In many cases, however, it may be advantageous to have two of them so connected, as to have an alternate motion; in which case, one air-vessel, and even one suction-piece, might serve both.

Its principles admit of various modifications; but as what is already mentioned may be sufficient to indicate its superiority over the common and chain pumps, and the advantages likely to result from its general use, a further detail is unnecessary.

To this we may add, that the testimonies of several navigators confirm in the fullest manner, the hopes that were conceived of its utility, and warrant the recommendation of it, as the best adapted for the purpose of any pump hitherto invented.

The great desideratum in a piston is, that it is as tight as possible, and has as little friction as is consistent with this indispensable quality.

The common form, when carefully executed, has these properties in an eminent degree, and accordingly keeps its ground amidst all the improvements which ingenious artists have made. It consists of a hollow cylinder, having a piece of strong leather fastened round it, to make it fit exactly the bore of the barrel, and a valve or flap to cover the hole through which the water rises. The greatest difficulty in the construction of a piston, is to give a passage through it for the water, and yet allow a firm support for the valve and fixture for the piston-rod. It occasions a considerable expence of the moving power to force a piston with a narrow perforation through the water lodged in the working-barrel. When we are raising water to a small height, such as 10 or 20 feet, the power so expended amounts to a fourth part of the whole, if the water-way in the piston is less than one-half of the suction of the barrel, and the velocity of the piston two feet per second, which is very moderate. There can be no doubt, therefore, that metal pistons are preferable, because their greater strength allows much wider apertures. For common purposes, however, they are made of wood, as elm or beech.

There are many ingenious contrivances to avoid the friction of the piston in the pumps; but this is of little importance in great works, because the friction which is completely sufficient to prevent all escape of water in a well-constructed pump, is but a very trifling part of the whole force.

In the great pumps which are used in mines, and are worked by a steam-engine, it is very usual to make the pistons and valves without any leather whatever. The working-barrel is bored truly cylindrical, and the piston is made of metal, of a size that will just pass along it without sticking. When this is drawn up with a velocity competent to a properly loaded machine, the quantity of water which escapes round the piston is insignificant. The piston is made without leathers; not to avoid friction, which is also insignificant in such works, but to avoid the frequent necessity of drawing it up for repairs through such a length of pipes.

If a pump absolutely without friction is wanted, the following seems preferable, for simplicity and performance, to any we have seen, when made use of in proper situations. Let NO (fig. 10), be the surface of the water in the pit, and K the place of delivering. The pit must be as deep in water as from K to NO. A is a wooden trunk, round or square, open at both ends, and having a valve, P, at the bottom. The top of this trunk must be in a level with K, and has a small cistern, F. It also communicates laterally with a rising-pipe G, furnished with a valve opening upwards. L is a beam of timber, so fitted to the trunk, as to fill it without sticking, and is of at least equal length. It hangs by a chain from a working-beam, and is loaded on the top with weights exceeding that of the column of water which it displaces.

Now, suppose this beam to descend from the position in which it is drawn in the figure; the water must rise all round it, in the crevice which is between it and the trunk, and also in the rising-pipe; because the valve P shuts, and O opens; so that when the plunger L has got to the bottom, the water will stand at the level of K. When the plunger is again drawn up to the top by the action of the moving power, the water sinks again in the trunk, but not in the rising-pipe, because it is stopped by the valve O. Then allowing the plunger to descend again, the water must again rise in the trunk to the level of K, and it must now flow out at K; and the quantity discharged will be equal to the part of the beam below the surface of the pit-water, deducting the quantity which fills the small space between the beam and the trunk. This quantity may be reduced almost to nothing; for if the inside of the trunk, and the outside of the beam, are made tapering, the beam may be let down till they exactly fit; and as this may be done in square work, a good workman may make it exceeding accurate. But, in this case, the lower half of the beam, and trunk, must not taper; and this part of the trunk must be of sufficient width round the beam, to allow free passage into the rising-pipe; or, which is better, the rising-pipe must branch off from the bottom of the trunk. A discharge may be made from the cistern F, so that as little water as possible may descend along the trunk when the piston is raised.

The requisites of a valve are, that it is tight, and of sufficient strength to resist the great pressures to which it is exposed; that it affords a free passage to the water; and that it does not allow much to go back whilst it is shutting. The clack-valve is of all others the most obvious and common. It consists merely of a leather flap covering the aperture, and having a piece of metal on the upper side, both to strengthen and to make it heavier, that it may shut of itself. Sometimes the hinge is of metal. The hinge being liable to be worn by such incessant motion; and as it is troublesome, especially in deep mines, and under water, to undo the joint of the pump, in order to put in a new valve; it is frequently annexed to a box like a piston, made a little conical on the outside, and dropt into a conical seat made for it in the pipe, where it sticks fast; and to draw it up again, there is a handle like that of a basket, fixed to it, which can be laid hold of by a long grappling-iron. The only defect of this valve is, that by opening very wide when pushed up by the stream of water, it allows a good deal to go back during its shutting again.

The butterfly-valve is free from most of these inconveniences, and seems to be the most perfect of the clack-valves. It consists of two semicircular flaps revolving round their diameters, which are fixed to a bar placed across the opening through the piston. Some engineers make their great valves of a pyramidal form, consisting of four clacks, whose hinges are in the circumference of the water-way, and which meet with their points in the middle, and are supported by four ribs, which rise up from the sides, and unite in the middle. This is a most excellent form, affording a more spacious water-way, and shutting very readily.

There is another form of a valve, called the button or tail valve. It consists of a plate of metal turned conical on the edge, so as exactly to fit the conical cavity of its box. A tail projects from the under side, which passes through a cross bar in the bottom of the box, and has a little knob at the end, to hinder the valve from rising too high. This valve, when nicely made, is unexceptionable. It has great strength, and is therefore proper for all severe strains; and it may be made perfectly tight by grinding. Accordingly, it is used in all cases where tightness is of indispensable consequence. It is most durable, and the only kind that will do for passages where steam or hot water is to pass through.

The pressure on the pipes in pump-work, is in proportion to the standing height of the fluid above the part considered; but the weight incumbent on the bucket (or moving valve) of a pump in action, is nearly proportionable to that of a column of water raised; for though the push of the atmosphere on the surface of the spring, when the bucket rises, is really equal to the weight of 33 feet of water; yet is this resistance counterbalanced exactly by the weight of the atmosphere, ever incumbent on the surface of the water thereby raised; so that in fact, all the advantage to be obtained by hydraulic machines, as well indeed as from all other pieces of mechanism whatever, is only the putting matters into a convenient method of being executed; and the performance depends on the moving power entirely, under the disadvantage of friction always against it.

A pump intended to raise water to any height whatever, will always work as easy, and require no greater power to give motion to the bucket, if both the valves are placed towards the bottom of the pipe, than if they were fixed 33 feet above the surface of the water.

The playing of the piston thus low in the pipe will, besides, prevent an inconvenience which might happen was it placed above, viz. in case of a leak beneath the bucket, which, in a great length of pipe, may very easily happen, the outward air getting through, would hinder the necessary rarefaction of the air in the barrel on moving the piston, and consequently the pump might fail in its operation. This can only effectually be prevented, by placing the pump-work in or near the water; in which case, should any leak happen upward, in will only occasion the loss of some of the water, without any other inconvenience; and the leather valves being kept under water, will always be found supple, pliant, and in condition to perform their office.

Placing the pump-work (that is, the valve and piston) pretty low and near together, will also prevent the inconvenience of not being able in all cases, to fetch up water from the spring by the ordinary pump, when of an equal bore, by reason of the shortness of the stroke; which therefore cannot rarefy the air sufficiently to bring the water up to the piston from the lower valve. For instance: Take a smooth-barrelled pump, 21 feet long, having its piston fetching, suppose a foot stroke, placed above, and the clack or fixed valve at the other end below. By the playing of the piston, admit it possible for water to rise 11 feet; or if you will, let water be poured on the clack, to the height of 11 feet, and refit the piston; there will remain still nine feet of air between it and the water, which cannot be sufficiently rarefied by a foot stroke to open the clack, or fetch up more water: for in this case the air can only be rarefied in the proportion of 9 to 10; whereas, to make a bare equilibrium with the atmosphere, it ought to be as 9 to $13\frac{1}{2}$; since, as 22 (or the complement of 11 to 33 feet of water, the weight of the whole atmosphere), is to 33 feet or the atmosphere, so is the interval spoken of, 9 to $13\frac{1}{2}$; to complete which, the stroke ought to be at least $4\frac{1}{2}$ feet long. However, by filling the whole void between the piston and clack at first with water, this last objection might be removed.

In some cases, the pump cannot be placed conveniently perpendicular to the well. For example: Being to raise water out of the well at A, by means of a pump at B (fig. 11), the best way will be to carry the barrel as low as the spring is, communicating therewith by means of the pipe at C. The bucket then playing in the barrel BC, will have the same effect as if the well was made perpendicular to the pump; because the water, by its proper weight, will always replenish BC.

And if it should happen, from some considerable impediment, that the barrel cannot get down to the well directly, it may be led about any other way for convenience. And then making the pipe of conveyance, E, less in diameter than the barrel, it will sooner be exhausted of air, by moving the piston; and the water will follow very briskly, as by the leaden pump at B.

It will, however, always be more easy to draw water with pipes that are large, and of an equal bore throughout, because the water will have a less velocity in them, and the friction will be in proportion less. Upon this account, the common pumps made by plumbers, do not work so easy as those bored out of trees; because, by making the pipe that brings up water from the spring much less than the bucket, they, as it were, wiredraw the water raised. If the barrel, for instance, is four inches in diameter, and the pipe of conduct one, it will in rising move sixteen times as fast through the latter as it will through the former; and at the expence of needless labour, as well as the great wear and friction of the machine.

In practice, however, it is generally observed, that such leaden pumps as work pleasantly, and are light on the hand, have the water-way in the sucking-pipe nearly equal to one-fourth of the area of the barrel; and accordingly, an inch-and-a-half pipe will pretty well supply a three-inch barrel; and a four-inch barrel should have a leading-pipe nearly two inches in diameter.

In forcing-pumps, it is of the utmost consequence to avoid all contractions in the pipes. The main which leads from the forcing-pumps, should be equal to the working-barrel. If it is only half the diameter, it has but one-fourth of the area; the velocity in the main is four times greater than that of the piston; and the force necessary for discharging the same quantity of water is sixteen times greater.

We shall, before we close the article on pumps, give an account of Mr. Boulton's apparatus raising water. The principle for action of this machinery may be illustrated in the following manner:

A horizontal pipe is formed of iron or any other substance sufficiently strong, expanding at one end like the mouth of a trumpet, and at the other furnished with a valve that may be opened or shut at pleasure; near this smaller extremity is let in a vertical pipe, at right angles to the horizontal one, furnished at the juncture with a valve opening upwards, and open at the other end. This machine is let down into a stream of water, so deep as to cover the horizontal pipe, the trumpet-like mouth of which is placed so as to meet the current: in this situation the valve being open, a current passes through the pipe, of equal velocity with the current of the stream; if the valve is then suddenly closed, the recoil of the current will force open the valve of the vertical pipe, through which will rush a column of water: the force of the recoil soon subsiding, the vertical column will press on the valve at its bottom, and cause it to close the end of the vertical pipe, in which the ascending column of water will be detained. The horizontal valve being then opened, the current will recommence through the horizontal pipe, and upon closing the valve a recoil will happen as before, and an additional quantity of water will rise in the vertical pipe: by a repetition of the above process, the water rising through the pipe will overflow into any vessel placed to receive the water, forming a perpetual pump. The contrivances by which this instrument is made to draw water, from a depth below that of the impelling current, and to raise it to any height, will be mentioned hereafter. The uses to which this engine may be applied, are serious; besides the raising of water for the use of brewers, &c. it may be employed in raising water from the sea for salt-work, in draining marshes and pumping ships, and supplying with water those canals that are carried over or by the side of rivers.

For the more clear description of this invention, it is proper to state its physical principle of action, as follows:

First, when water moves or runs through a pipe, or close channel, or tube, if the end at which the water issues is suddenly stopped, the water will (by its acquired motion, momentum, or impetus) act upon the sides or circumference of the pipe; which being supposed strong enough to resist that impetus, the water will issue, with violence or velocity, at any aperture which may exist in or near the shut end of the pipe; and if to that aperture an ascending pipe is joined, a portion of water will rise in it.

Secondly, if a pipe, open at both ends, with an ascending pipe, such as has been described, is moved along, through standing water, in the direction of its length; upon shutting the hinder part of the pipe, a portion of the water will rise in the ascending-pipe, in the manner which has been stated in the former case, because the water is relatively in motion in respect to the pipe.

Thirdly, if in either of the cases recited, a pipe communicating with water at any lower level is joined to the main pipe, at or near the end at which water enters into it; and if, when such water has acquired motion relatively to that pipe (by the pipe being put in motion), the mouth or end at which the water enters is suddenly shut; the water, continuing its motion relatively to the pipe, will draw or suck up water from the lower level, through the ascending pipe, in order to fill up the vacuity occasioned by the water in the main pipes, persevering in its previous motion. What has been said respecting water, is also true in respect to other fluids.

The several cases above stated are resolvable into the general principle of the resistance which water and other fluids (and in general all bodies) make to a change of their state of rest, or motion, whether absolute or relative; and this principle has heretofore been applied to the raising of water only in a comparatively small and weak degree, and in a defective manner. But the improved apparatus continues its own action when once set going, unless some accident should stop or derange it; and is capable of raising water in great quantities, and to great heights, and they also differ, in other respects, from any thing which has been executed hitherto.

The nature of the said improved invention consists in using valves, of various constructions, instead of cocks, to open or shut the end, or ends, of a main pipe: and in the application of mechanism, or contrivances to assist in opening and shutting the valves at proper times; whereby water is raised independantly of any other power than a current of water through the main pipe.

The manner in which the said invention is to be performed, and the said improved apparatus and methods carried into effect, is as follows, viz.:

The first and most simple method is shewn in fig. 12, in which CC is the main pipe; DD the ascending pipe; A the valve of exit for the water to be raised; B the stop-valve; and E a weight which, by the lever F, attached to the axis G of the stop-valve B, opens it at the proper time. The said apparatus acts in the following manner: The main pipe being situated or fixed in a current or stream of water, either produced by the natural current or declivity of the river or other stream; or (which is preferable) by penning up water by a dam, weir, or bank, and by inserting the end of the main pipe through the said dam, weir, or bank, so as to obtain the greatest head or current of water the natural circumstances admit of; the stop-valve being opened to the position shewn in the figures, the water will run through the main pipe, until, by its action upon the stop-valve in its reclined position, it raises the weight, shuts the stop-valve, and the water, by its impetus or momentum, opens the exit-valve, and a portion of it rises in the ascending pipe; after which, the last-mentioned valve shuts, the water in the main pipe recoils, the weight descends and opens the stop-valves, and the water in the main-pipe regains its velocity. The like operations are repeated, and the water gradually rises in the ascending pipe, until it reaches its summit, and a quantity issues thence every stroke; which quantity is more or less, according as the height to which it is raised is less or greater.

J is an air-vessel, or reservoir of air, whereby the bursting of the pipes is prevented, or the danger thereof much diminished. Into this air-vessel the water from the main pipe enters through the exit-valve, and compresses the air in the vessel; which again, by its expansion or elasticity, acts upon the water (the regress of which is prevented by the shutting of the exit-valve); and the water rises through the ascending pipe, and by repeated strokes acquires the desired height.

The dimensions of the air-vessel, as well as its form and position, whether above, or laterally affixed to, the main pipe, are in great measure arbitrary; but its contents of air ought not to be much less than ten times the quantity of water to be raised through the ascending pipe each stroke; and if much larger still the better, the principal boundary being expence.

The stop-valve may be opened and shut, as has been described in the first method, by the mechanism shewn in the figure, or by any of the mechanism as shall be adapted to the opening of valves.

Another method is shewn by figs. 13, 14, and 15, and is applicable in cases where the water to be raised is below the level of the main pipe, and is to be discharged at that level: which cases occur in the drainage of marshy lands, where the action of the current of water of an embanked river, or other stream or source of water on a higher level, can be employed; or this method can be applied in raising water out of the holds of ships, or other vessels, by the motion of the vessel through the water.

This is explained by figs. 13, 14, and 15, where C is the main-pipe, A is the receiving valve, B the stop-valve, opening outwards, D the ascending or sucking pipe, J the air-vessel, and E the weight.

The water in the main pipe having acquired a proper velocity, the stop-valve shuts: the water in the main pipe, continuing its motion for a time, draws air out of the air-vessel. Then the momentum of the water in the main pipe being expended, the receiving valve shuts, and the stop-valve opens, the water regains its velocity, and the operation is repeated; and thus, in a few strokes, (the exhaustion increasing,) the air-vessel sucks up water from below, by the ascending pipe; and this being continued, the latter pipe fills by degrees to the top; after which, at every successive stroke, a portion of the water from below passes into the main pipe, and is carried off, with the upper water, to the place of delivery.

Air-Pump. See Pneumatics.

PUNCHEON, a little block or piece of steel, on one end whereof is some figure, letter, or mark, engraved either in creux or relievo, impressions of which are taken on metal, or some other matter, by striking it with a hammer on the end not engraved. There are various kinds of these puncheons used in the mechanical arts; such for instance are those of goldsmiths, cutlers, pewterers, &c. See also Coining.

Puncheon, in carpentry, is a piece of timber placed upright between two posts, whose bearing is too great, serving, together with them, to sustain some large weights. This term is also used for a piece of timber raised upright, under the ridge of a building, wherein the little forces, &c are jointed.

Puncheon is also used for the arbor, or principal part of a machine, whereon it turns vertically, as that of a crane, &c.

Puncheon is also a measure for liquids, containing a hogshead and one-third, or eighty-four gallons.

PUNICA, the *pomegranate-tree*: a genus of the monogynia order, in the icosandria class of plants, and in the natural method ranking under the 39th order, pomaceæ. The calyx is quinquefid, superior; there are five petals; the fruit is a multilocular and polyspermous apple.

The species are, 1. The granatum, or common pomegranate, with a tree stem, branching numerously all the way from the bottom, growing eighteen or twenty feet high; with spear-shaped, narrow, opposite leaves; and the branches terminated by most beautiful large red flowers, succeeded by large roundish fruit as big as an orange, having a hard rind filled with soft pulp and numerous seeds. There is a variety with double flowers, remarkably beautiful; and one with striped flowers. 2. The nana, or dwarf American pomegranate, with a shrubby stem, branching four or five feet high, with narrow short leaves, and small red flowers succeeded by small fruit; begins flowering in June, and continues till October. Both these species are propagated by layers: the young branches are to be chosen for this purpose, and autumn is the proper time for laying them.

The dried flowers of the double-flowered pomegranate are possessed of an astringent quality; for which reason they are recommended in diarrhœas, dysenteries, &c. where astringent medicines are proper. The rind of the fruit is also a strong astringent, and as such is occasionally made use of.

Pupil. See Anatomy, Optics, and Physiology.

PURCHASE, in law, the buying or acquiring of lands, &c. with money, by deed or agreement, and not by descent or right of inheritance. A joint purchase is when two or more persons join together in the purchase. Purchasers of lands are to take notice of all charges thereon: there are, however, certain statutes to guard against fraudulent incumbrances. The court of chancery will relieve the purchaser of a term against a title that lay dormant, where money has been laid out on improvements.

Purchase, in the sea-language, is the same as draw in: thus when they say the capstan purchases apace, they only mean it draws in the cable apace.

PURITAN, a name formerly given in derision to the dissenters from the church of England, on account of their professing to follow the pure word of God, in opposition to all traditions and human constitutions.

PURLINS, in building, those pieces of timber that lie across the rafters on the inside, to keep them from sinking in the middle of their length.

PURPLE, a colour composed of a mixture of red and blue.

A beautiful transparent purple for painting may be made by boiling four ounces of rasped Brasil-wood in a pint of stale beer, and half an ounce of logwood, till the liquor is heightened to the colour you desire, which may be known by dipping a piece of paper in it. If you find it too red, add a quarter of an ounce more of logwood, which will render it still deeper; and by this method you may bring it to any degree of purple, by putting either more or less logwood to the former composition, and fixing it with alum. This will produce such a clear purple, as no mixture of reds and blues will produce. Madam Mariana of Amsterdam, famous for painting in miniature, and for her excellent manner of illuminating prints, says, that the best purple that can be made, may be composed between the carmine and indigo; to strengthen which on the red side, you may add lake, between the lighter and darker part: and lake, when it is used in the same way on the foregoing purple, produces a very fine effect. See Dyeing.

PURPURA. See Murca.

PURSER, an officer aboard a man of war, who receives her victuals from the victualler, sees that it is well stowed, and keeps an account of what he every day delivers to the steward. He also keeps a list of the ship's company, and sets down exactly the day of each man's admission, in order to regulate the quantity of provisions to be delivered out; and that the paymaster or treasurer of the navy may issue out the disbursements, and pay off the men, according to his book.

PUS. The liquid called pus is secreted from the surface of an inflamed part, and usually moderates and terminates the inflammation. It assumes different appearances according to the state of the sore. When it indicates a healing sore, it is called healthy or good-conditioned pus. This liquid possesses the following properties:

It is of a yellowish-white colour, and of the consistence of cream. Its taste is insipid, and it has no taste when cold. Before the microscope it exhibits the appearance of white globules swimming in a transparent fluid.

It produces no change on vegetable blues. When exposed to a moderate heat it gradually dries, and assumes the appearance of horn. When exposed to destructive distillation, Bergman obtained first about one-fourth of the pus in the state of insipid water. On increasing the fire, a liquid came over containing abundance of ammonia, and accompanied by gaseous bodies, which were not examined. Some concrete carbonat of ammonia sublimed, accompanied by empyreumatic oil. A light brilliant coal remained of difficult incineration. The ashes gave traces of iron.

When pus is left exposed to the air, it gradually becomes acid, according to Hildebrant; and Haller affirms that it sometimes gives a red colour to litmus even when recent. When thrown into water it sinks to the bottom. When agitated, the mixture becomes milky; but the pus separates again when allowed to remain undisturbed. By repeated agitation, however, and especially by the application of heat, a milky liquid is obtained, which passes in that state through the filtre.

Alcohol thickens pus, but does not dissolve it; neither does pus unite with oils.

Sulphuric acid dissolves it, and forms a purple-coloured solution. When diluted with water, the dark colour disappears, and the pus separates; either sinking to the bottom, or rising to the surface, according to the quantity of water added, and the time that the solution has been allowed to stand. Diluted sulphuric acid does not act upon it.

Concentrated nitric acid effervesces with it, and forms a yellow solution, which when recent is decomposed by water, the pus subsiding in the state of grey flakes.

Muriatic acid dissolves it when heated, and the pus is separated by water.

With the fixed alkaline leys it forms a whitish ropy fluid, which is decomposed by water, the pus precipitating. Pure ammonia reduces it to a transparent jelly, and gradually dissolves a considerable portion of it.

When nitrat of silver is dropt into the solution of pus in water, a white precipitate separates. Nitrat and oxymuriat of mercury occasion a much more copious flaky precipitate.

Such are the properties of healthy pus hitherto observed by chemists. Various observations have been made to enable physicians to distinguish pus from the mucus of the internal cavities, especially of the lungs. In cases of copious expectoration, it is sometimes of consequence to know whether the matter thrown out of the lungs is pus or mucus. Mr. Charles Darwin made a set of experiments on the subject, and pointed out three criteria to distinguish pus: 1. Sulphuric acid dissolves it. When the solution is diluted, the pus precipitates; but mucus treated in the same manner swims. But this distinction depends upon the quantity of water added, and is therefore ambiguous. 2. Pus is diffusible through diluted sulphuric acid, through water, and through brine; but mucus is not. 3. Alkaline leys dissolve pus; water precipitates pus thus dissolved, but not mucus. How far these two last distinctions prevail is rather doubtful. Grasmeyer has proposed the following method, which he considers as complete: Triturate the substance to be tried, with an equal quantity of warm water; then add to it an equal portion of a saturated solution of carbonat of potass, and set the mixture aside. If it contains pus, a transparent jelly subsides in a few hours; but this does not happen if only mucus is present.

2. When the ulcer is ill-continued, the pus secreted in it possesses different properties. It has usually a fetid smell, is much thinner, and to a certain degree acrid. We are in possession of two sets of experiments on this unhealthy pus: one by Mr. Cruickshank on the pus discharged from what is called the hospital sore; another by Dr. Crawford on the matter of cancers.

The pus from the hospital sore possesses most of the properties of healthy pus; but is distinguished by its odour, and by some shades of difference when exposed to the action of the metallic precipitates. Limewater changes its fetid odour, but does not destroy it; sulphuric acid increases it, as do alcohol and the solution of oxide of arsenic in potass. Bark has no effect upon it; but it is destroyed by the nitrat and oxymuriat of mercury, by nitric acid, and by oxymuriatic acid. Nitrat of silver does not destroy it. Mr. Cruickshank supposes that the fetid smell is occasioned by the alteration of some part of true pus. He considers the pus of the hospital sore as a matter sui generis, which is capable of generating more, and even of producing an alteration in the system. Hence to heal the sore the matter must be destroyed, and prevented from appearing again. This was done by washing the sores with nitrat of mercury, diluted nitric acid, and oxymuriatic acid, at every dressing. This method constantly succeeded with Dr. Rollo, except when the sore was too large to admit it to be put in practice completely.

3. The matter of cancer, examined by Dr. Crawford, gave a green colour to syrup of violets. Potass produced no change; but sulphuric acid extricated a gas which possessed many of the properties of sulphureted hydrogen. This gas he supposes to exist in the matter united to ammonia. The presence of this compound explains the effects of the matter of cancer and virulent matter in general upon metallic salts. Dr. Crawford found that the odour of this matter was completely destroyed by oxymuriatic acid; and therefore recommends it as a proper substance for washing cancerous ulcers.

4. Besides the species mentioned above, there are many others which we know from their effects to be peculiar, though we cannot find any chemical distinctions between them sufficiently well marked. But that they are specifically different cannot be doubted, if we consider that every one of them produces a disease peculiar to itself. The matter of small-pox, of venereal ulcers, of cowpox, &c. may be mentioned as instances.

The liquor which fills the cavities of the body in dropsy has a yellowish-green colour, and is sometimes turbid, sometimes nearly transparent. As far as it has been examined, it agrees exactly with the serum of the blood; and the liquid which makes its appearance when the epidermis is raised into blisters, is perfectly transparent and liquid. When the blisters are artificial, it is usually yellow, and has the odour of the blistering-plaster. From the experiments of Margueron, we learn that it is composed of the same constituents as the serum of the blood. From 200 parts of this liquid he obtained

36	albumen
4	muriat of soda
2	carbonat of soda
2	phosphat of lime
156	water
200.	

PUTLOGS, or Putlocks, in building, are short pieces of timber about seven feet long, used in building scaffolds. They lie at right angles to the wall, with one of their ends resting upon it, and the other upon the poles which lie parallel to the side of the wall of the building.

PUTREFACTION. The rapidity with which animal bodies undergo decomposition, and the disgusting fetor which accompanies this decomposition, have long been considered as some of their most striking peculiarities. This spontaneous destruction is denominated putrefaction. Considerable attention has been paid to it by chemists. Becchar and Stahl have described with fidelity the phenomena with which it is attended, and the circumstances necessary for its taking place. To sir John Pringle we are indebted for some important experiments on the method of retarding putrefaction; neither are the experiments of Dr. Macbride less valuable, though the consequences which he drew from them were erroneous. We are indebted also to Crell and Priestley for many valuable facts; and to Berthollet and Lavoisier for the first attempts to determine the real changes which take place, and the manner in which the new products which appear during putrefaction are formed. But notwithstanding the labours of these philosophers, and of many others, much is still wanting to enable us to trace the complicated changes which take place during putrefaction, and to account for them in a satisfactory manner.

It has been ascertained long ago, that putrefaction never takes place in those animal substances which contain only two or three ingredients, such as oils, resins, sugar; they must always be more complicated in their texture; and, perhaps, in all cases, a mixture of two or more compound bodies is necessary for speedy decomposition. But however complicated the animal substance may be, it does not putrefy unless moisture is present; for dry animal substances are not susceptible of alteration. A certain degree of heat is also necessary. Animal bodies may be kept without decomposing for any length of time at the freezing temperature. In general the higher the temperature, the more rapid is the putrefaction, provided the heat is not great enough to reduce the animal body to dryness. It has been observed, too, that putrefaction advances with more rapidity in the open air; but exposure to the air is not necessary, though it modifies the decomposition.

When these conditions are observed, and dead animal matter is left to itself, its colour becomes gradually paler, and its consistence diminishes; if it is a solid part, such as flesh, it softens, and a serous matter sweats out, the colour of which quickly changes; the texture of the part becomes relaxed, and its organization destroyed; it acquires a disagreeable smell; the substance gradually sinks down, and is diminished in bulk; its smell becomes stronger and ammoniacal. If the subject is contained in a close vessel, the progress of putrefaction, at this stage, seems to slacken; no other smell but that of a pungent alkali is perceived; the matter effervesces with acids, and converts syrup of violets to a green. But if the communication with the air is admitted, the urinous exhalation is dissipated, and a peculiar putrid smell is spread around with a kind of impetuosity; a smell of the most insupportable kind, which lasts a long time, and pervades every place, affecting the bodies of living animals after the manner of a ferment, capable of altering the fluids; this smell is corrected, and in a manner confined, by ammonia. When the latter is volatilized, the putrefactive process becomes active a second time, and the substance suddenly swells up, becomes filled with bubbles of air, and soon after subsides again. Its colour changes, the fibrous texture of the flesh being then scarcely distinguishable; and the whole is changed into a soft brown, or greenish matter, of the consistence of a poultice, whose smell is faint, nauseous, and very active on the bodies of animals. The odorant principle gradually loses its force; the fluid portion of the flesh assumes a kind of consistence, its colour becomes deeper, and it is finally reduced into a friable matter, rather deliquescent; which being rubbed between the fingers, breaks into a coarse powder like earth. This is the last state observed in the putrefaction of animal substances; they do not arrive at this term but at the end of a considerable time.

During this decomposition, a variety of gaseous bodies are emitted; these vary according to the substance exposed to putrefaction; but they consist chiefly of hydrogen gas, holding sulphur, phosphorus, and carbon, in solution; of ammonia, water, and carbonic acid, and perhaps also of azotic gas. Nitric acid seems in some cases to be formed and emitted. The earthy-like residuum, which remains after the decomposition is completed, consists of the fixed parts of the animal substance, mixed with charcoal, oil, and ammonia. Thus it appears that putrefaction consists in a total decomposition of the animal body; the elements of which combine together two and two, and thus form a new set of less complicated bodies. But any attempt to explain the manner in which these changes take place would be exceedingly imperfect indeed; not only because we are ignorant of the strength of the affinities of the different elementary parts of animal bodies for each other, but because we do not even know the manner in which these elements are combined, and consequently we cannot know by what particular forces these compounds are destroyed.

In carcases buried in the earth, putrefaction takes place much more slowly; but it is scarcely possible to observe its progress with accuracy. The abdomen is gradually dilated with elastic fluids which make their appearance in it, and at last it bursts and discharges a horribly fetid and noxious gas; at the same time a dark-coloured liquid flows out. If the earth is very dry, and the heat considerable, the moisture is often absorbed so rapidly, that the carcase, instead of putrefying, dries, and is transformed into what is called a mummy.

Such are the phenomena when dead bodies are left to putrefy separately; but when great numbers of carcases are crowded together in one place, and are so abundant as to exclude the action of external air and other foreign agents, their decomposition is entirely the consequence of the reciprocal action of their ingredients themselves upon each other, and the result is very different. The body is not entirely dissipated or reduced to mould, but all the soft parts are found diminished remarkably in size, and converted into a peculiar saponaceous matter. This singular change was first accurately observed in the year 1786.

The burial-ground of the Innocents in Paris having become noxious to those who lived in its neighbourhood, on account of the disagreeable and hurtful odour which it exhaled, it was found necessary to remove the carcases to another place. It had been usual to dig very large pits in the burial-ground, and to fill them with the carcases of the poorer sort of people, each in its proper bier; and when they were quite full, to cover them with about a foot deep of earth, and to dig another similar pit, and fill it in the same manner. Each pit held between one thousand and fifteen hundred bodies. It was in removing the bodies from these pits that this saponaceous substance was found. The grave-diggers had ascertained by long experience, that about thirty years were required before all bodies had undergone this change in its full extent. Every part of the body acquired the properties of this substance. The intestines and viscera of the thorax had completely disappeared; but what is singular enough, the brain had lost but little of its size or appearance, though it was also converted into the same substance.

This sponaceous matter was of a white colour, soft and unctuous to the touch, and melted, when heated, like tallow. It exhibited all the properties of a soap, containing, however, an excess of fatty matter. Fourcroy, who analysed it, found that it was composed of a fatty matter combined with ammonia, and that it contained also some phosphat of lime and ammonia. Diluted acids decomposed it, and separated the fatty matter; alkalies and lime, on the other hand, drove off the ammonia. When exposed to the air, it gradually lost its white colour; the ammonia, in a great measure, evaporated; and what remained had something of the appearance of wax. It absorbed water with great avidity, and did not part with it readily. Its white colour was owing to the presence of that liquid. The oily matter, when separated by means of a diluted acid, was concrete, and of a white colour, owing to the mixture of a quantity of water. When dried, it acquires a greyish-brown colour, with a lamellar and crystalline texture, like that of spermaceti; but if it has been rapidly dried, it assumes the appearance of wax. It melts when heated to 126°; when properly purified, by passing it through a linen cloth while fluid, it has scarcely any smell. Alcohol does not act upon it while cold, but at the temperature of 120° it dissolves it: when the solution cools, the fatty matter precipitates, and forms a gritty mass. With alkalies it forms a soap; and when set on fire it burns precisely like oil or fat, only that it exhales a more unpleasant odour.

Mr. Smith Gibbes found the same substance in the pit into which animal matters are thrown at Oxford after dissection. A small stream of water constantly passes through this pit; a circumstance which induced him to try whether animal muscle exposed to the action of a running stream underwent the same change. The experiment succeeded completely: he attempted, in consequence, to render this substance, to which he gave the name of spermaceti, useful in those manufactures which require tallow; but the fetid odour which it constantly exhales was an insurmountable objection. Attempts were indeed made to get over it; and a manufacture of Mr. Smith Gibbes's spermaceti was even established at Bristol.

Many attempts have been made to retard the destructive progress of putrefaction, in order to preserve animal bodies either as food or for other useful purposes; and several methods have been ascertained which prevent it from operating for a considerable time.

1. The freezing temperature is a complete preservation from putrefaction, as long as the animal substance is exposed to it. Hence the common practice of keeping meat in snow in the frozen climates of the north; and of packing fish in ice, and sending them in that state from Scotland to the London market.

2. Almost all bodies which have a strong affinity for water retard putrefaction for a longer or shorter time, doubtless by depriving the animal substances of their water, or preventing that liquid from acting upon these bodies in its usual manner. In this way the acids, sugar, alcohol, &c. seem to prevent or retard putrefaction.

3. It is well known that common salt is a powerful antiseptic. Hence the practice of salting meat, and the length of time which meat that has undergone this operation may be kept. Several other salts, especially nitre, possess the same property. In what manner these bodies act has not been ascertained; but they undoubtedly produce some chemical change upon the meat; for they alter its taste, its colour, and other sensible properties.

4. Many aromatics, such as camphor, resins, volatile oils, bitumens, and other similar bodies, act with considerable efficacy in preserving animal bodies from putrefaction. Hence their utility in embalming. In what the action of these substances consists has not been ascertained. Part of their efficacy is doubtless owing to the rapidity with which the animal substances to which they are applied lose their moisture; and something may be ascribed likewise to their odour, which keeps insects at a distance, and thus prevents the lodging of excrementitious matter, which always acts powerfully as a putrefactive ferment.

PUTI *caraja*, in botany, is a genus of Indian plants, of which the characters, as given by sir William Jones in the Asiatic Researches, vol. ii. p. 351. are these: The calyx is five-cleft; the corolla has five equal petals; the pericarpium a thorny legumen and two seeds, the leaves oval and pinnated, and the stem armed. "The seeds (says the learned president) are very bitter, and perhaps tonic; since one of them, bruised and given in two doses, will cure the intermittent fever."

PUTTY, in the arts. When tin is melted in an open vessel, its surface soon becomes covered with a grey powder, which is an oxide of the metal. If the heat is continued, the colour of the powder gradually changes, and at last becomes yellow. In this state it is known by the name of putty, and employed in polishing glass and other hard substances.

Putty is also a kind of paste compounded of whiting and linseed-oil, beaten together to the consistence of a thick dough. It is used by glaziers for the fastening in the squares of glass in sash-windows, and by painters for stopping up the crevices and clefts in timber and wainscots, &c.

PUZZULANA or Pozzolana, *terra*, or *terras*, is a greyish kind of earth used in Italy for building under water. The best is found about Puteoli, Baiæ, and Cumæ, in the kingdom of Naples, from the first of which places it derives its name. It is supposed to be a volcanic product, composed of heterogeneous substances, thrown out from the burning mouths of volcanoes in the form of ashes; sometimes in such large quantities, and with so great violence, that whole provinces have been covered with it at a considerable distance. This volcanic earth is of a grey, brown, or blackish colour; of a loose, granular, or dusty and rough, porous, or spongy, texture, resembling a clay hardened by fire, and then reduced to a gross powder. It contains various heterogeneous substances mixed with it. Its specific gravity is from 2500 to 2800; and it is, in some degree, magnetic: it scarcely effervesces with acids, though partially soluble in them. It easily melts per se; but its most distinguishing property is, that it hardens very suddenly when mixed with one-third of its weight of lime and water, and forms a cement which is more durable in water than any other.

According to Bergman's analysis, 100 parts of it contain from 55 to 60 of silica, 20 of alumina, five or six of lime, and from 15 to 20 of iron. Its effects, however, in cement, may perhaps depend only on the iron which has been reduced into a particular substance by means of subterraneous fires; evident signs of which are observable in the places where it is obtained. If the slate in Henneberg or Kennekulle, in the province of Westergottland, should happen to get fire, the uppermost stratum, which now consists of a mixture of iron and different kinds of rocks, called graberg in the account given of them, might perhaps be changed partly into slag and partly into terra puzzolana.

It is evidently a martial argillaceous marl, that has suffered a moderate heat. Its hardening power arises from the dry state of the half-baked argillaceous particles, which makes them imbibe the water very rapidly, and thus accelerates the desiccation of the calcareous part. It is found not only in Italy but in France, and the provinces of Auvergne and Limoges; and also in England and elsewhere.

PYLORUS. See ANATOMY.

PYRAMID, in geometry, a solid standing on a triangular, square, or polygonal basis, and terminating in a point at the top; or according to Euclid, it is a solid figure, consisting of several triangles, whose bases are all in the same plane, and which have one common vertex.

Hence the superficies of a given pyramid is easily found by measuring these triangles separately; for their sum added to the area of the base, is the surface of the pyramid required.

It is no less easy to find the solid content of a given pyramid; for the area of the base being found, let it be multiplied by the third part of the height of the pyramid, or the third part of the base by the height, and the product will give the solid content, as is demonstrated by Euclid, lib. 12. prop. 7.

If the solid content of a frustum of a pyramid is required, first let the solid content of the whole pyramid be found; from which subtract the solid content of the part that is wanting, and the solid content of the frustum or broken pyramid will remain.

Every pyramid is equal to one-third of its subscribing prism, or one that has the same base and height. All pyramids are in a ratio compounded of their bases and altitudes; so that, if their bases are equal, they are in proportion to their altitudes; and vice versa.

Equal pyramids reciprocate their bases and altitudes; that is, the altitude of one is to that of the other, as the base of the one is to that of the other.

PYRAMID, in architecture, a solid massive building, which from a square, triangular, or other base, rises diminishing to a vertex or point.

Pyramids are sometimes used to preserve the memory of singular events; and sometimes to transmit to posterity the glory and magnificence of princes. But as they are esteemed a symbol of immortality, they are most commonly used as funeral monuments. Such are that of Cestius of Rome; and those very celebrated pyramids of Egypt, as famous for the enormity of their size as their antiquity. These are situated on the west side of the Nile, almost opposite to Grand Cairo; the base of the largest covers more than ten acres of ground; and it is, according to some, near seven hundred feet high, though others make it six hundred, and some but little more than five hundred. The pyramid is said to have been, among the Egyptians, a symbol of human life; the beginning of which is represented by the base, and the end by the apex; on which account it was, that they used to erect them over sepulchres.

PYRAMIDALIA CORPORA. See ANATOMY.

PYRITES, a genus of inflammable substances, composed of sulphur, which has dissolved or saturated itself with metals. Thus there are many kinds of pyrites; as of gold, arsenic, iron, &c. It is also the principal ore of sulphur; particularly that called martial pyrites, copperas-stone, or marcasite. This is very common, containing a quantity of sulphur in proportion to the iron; and, when thoroughly inflamed, burns by itself. It is either of a compact texture, steel-grained, coarse-grained, or crystallised. In this last form, it shoots mostly into cube and octahedral figures, though it is met with also in innumerable other forms. The liver-coloured marcasite has an appearance between that of the preceding and the blue copper-ore. The iron predominates in this kind, so that it is less fit than the other for extracting sulphur for it, or for the smelting of copper ores. It is formed of a compact texture, coarse-grained, and steel-grained. See SULPHURETS, IRON, &c.

PYROLA, *winter-green*, a genus of the monogynia order, in the decandria class of plants; and in the natural method ranking under the 18th order, bicornes. The calyx is quinquepartite; there are five petals; the capsule is quinquelocular, opening at the angles. There are six species, natives of Britain.

PYROMETER, an instrument for measuring the expansion of bodies by heat. Muschenbroeck, who was the original inventor of this machine, has given a table of the expansion of the different metals in the same degree of heat. Having prepared cylindric rods of iron, steel, copper, brass, tin, and lead, he exposed them first to a pyrometer with one flame in the middle; then with two flames; and successively to one with three, four, and five flames. But previous to this trial, he took care to cool them equally, by exposing them some time upon the same stone, when it began to freeze, and Fahrenheit's thermometer was at thirty-two degrees. The effects of this experiment are digested in the following table, where the degrees of expansion are marked in parts equal to 1-12500th part of an inch.

Expansion of	*Iron*	*Steel*	*Copp.*	*Brass*	*Tin*	*Lead*
By 1 flame.	80	85	89	110	153	155
By 2 flames placed close together.	117	123	115	220		274
By 2 flames $2\frac{1}{2}$ inches distant.	109	94	92	141	219	263
By 3 flames placed close together.	142	168	193	275		
By 4 flames placed close together.	211	270	273	361		
By 5 flames.	230	310	310	377		

It is to be observed of tin, that it will easily melt when heated by two flames placed together. Lead commonly melts with three flames placed together, especially if they burn long.

From these experiments, it appears at first view that iron is the least rarefied of any of these metals, whether it is heated by one or more flames; and therefore is most proper for making machines or instruments which we would have free from any alterations by heat or cold, as the rods of pendulums for clocks, &c. So likewise the measures of yards or feet should be made of iron, that their length may be as nearly as possible the same in summer and in winter. The expansion of lead and that of tin are nearly the same; that is, almost double of the expansion of iron. It is likewise observable, that the flames placed together, cause a greater rarefaction than when they have a sensible interval between them; iron in the former case being expanded 117 degrees, and only 109 in the latter; the reason of which difference is obvious.

By comparing the expansions of the same metal produced by one, two, three, or more flames, it appears that two flames do not cause double the expansion of one, nor three flames three times that expansion, but always less; and these expansions differ so much the more from the ratio of the number of flames, as there are more flames acting at the same time.

It is also observable, that metals are not expanded equally at the time of their melting, but some more and some less. Thus tin began to run when rarefied 219 degrees; whereas brass was expanded 377 degrees, and yet was far from melting.

Mr. Ellicot found, upon a medium, that the expansion of bars of different metals, as nearly of the same dimensions as possible, by the same degree of heat, were as follow:

Gold,	Silver,	Brass,	Copper,	Iron,	Steel,
73	103	95	89	60	56
Lead					
149					

The great difference between the expansions of iron and brass has been applied with good success to remedy the irregularities in pendulums arising from heat.

Mr. Graham used to measure the minute

alteration in length of metal bars, by advancing the point of a micrometer-screw, till it sensibly stopped against the end of the bar to be measured. This screw, being small and very lightly hung, was capable of agreement within the three or four-thousandth part of an inch. On this general principle Mr. Smeaton contrived his pyrometer, in which the measures are determined by the contact of a piece of metal with the point of a micrometer-screw.

The following table shews how much a foot in length of each metal grows longer by an increase of heat corresponding to 180° of Fahrenheit's thermometer, or to the difference between freezing and boiling water, expressed in parts of which the unit is equal to the 10,000th part of an inch.

1. White glass barometer-tube, -	100
2. Martial regulus of antimony, -	130
3. Blistered steel, - - -	138
4. Hard steel, - - - -	147
5. Iron, - - - - -	151
6. Bismuth, - - - -	167
7. Copper hammered, - -	204
8. Copper eight parts, with tin one	218
9. Cast brass, - - - -	225
10. Brass sixteen parts, with tin one,	229
11. Brass-wire, - - - -	232
12. Speculum-metal, - -	232
13. Spelter-solder, viz. brass two parts, zinc one, - - - -	247
14. Fine pewter, - - -	274
15. Grain tin, - - - -	298
16. Soft solder, viz lead two, tin one,	301
17. Zinc eight parts, with tin one, a little hammered, - -	323
18. Lead, - - - -	344
19. Zinc or spelter, - - - -	353
20. Zinc hammered half an inch per foot, - - - - - -	373

PYROPS, a mineral found in Bohemia, which was formerly distinguished by the name of Bohemian garnet. It is never found crystallized, but only in round or angular fragments, usually small. Colour deep red, which passes to orange when the mineral is exposed to the sun. It is very hard; the specific gravity is from 3.7 to 3.9. Fracture conchoidal and very brilliant. It is composed of

40.00	silica
28.50	alumina
10.00	magnesia
3.50	lime
16.50	oxide of iron
0.25	oxide of manganese.
98.75	

PYROPHORUS, a substance which has the property of catching fire whenever it is exposed to the open air. See SULPHATS.

PYROSTRIA, a genus of the tetrandria monogynia class and order. The cal. is four-toothed; cor. bell-shaped; nuts eight, one-seeded. There is one species, a small tree of Mauritius.

PYROTECHNY, the art of fire, or a science which teaches the management and application of fire in several operations. But the term is more particularly used to denote the doctrine of artificial fireworks.

Of ingredients and compositions.

1. Saltpetre is the principal ingredient in fire-works; but will not answer so well when foul and gross as when purified from its crude and earthy parts, which greatly retard its velocity; when, therefore, any quantity of fire-works are to be made, it should be examined; for if it is not well cleansed, and of a good sort, your works will not have their proper effect; neither will it agree with the standing proportions of compositions.

To refine it, put into a copper, or any other vessel, 100 lb. of rough nitre with 14 gallons of clean water; let it boil gently half an hour, and as it boils take off the scum; then stir it, and before it settles put it into your filtring-bags, which must be hung on a rack, with glazed earthen pans under them, in which must be sticks laid across for the crystals to adhere to: it must stand in the pans two or three days to shoot; then take out the crystals, and let them dry. The water that remains in the pans boil again an hour, and strain it into the pans as before, and the saltpetre will be quite clear and transparent; if not, it wants more refining; to do which proceed as usual, till it is well cleansed of all its earthy parts.

N. B. Those who do not chuse to procure their saltpetre by the above method, may buy it ready-done, which for fire-works in general will answer.

To pulverise saltpetre. Take a copper kettle, whose bottom must be spherical, and put into it 14 lb. of refined saltpetre, with 2 quarts or five pints of clean water: then put the kettle on a slow fire, and when the saltpetre is dissolved, if any impurities arise, skim them off, and keep constantly stirring it with two large spatulas, till all the water exhales; and when done enough, it will appear like white sand, as fine as flour; but if it should boil too fast, take the kettle off the fire, and set it on some wet sand, which will prevent the nitre from sticking to the kettle. When you have pulverised a quantity of saltpetre, be careful to keep it in a dry place.

2. Sulphur is one of the principal ingredients in gunpowder, and almost in all compositions of fire-works; and therefore great care must be taken of its being good, and brought to the highest perfection. To know when sulphur is good, you are to observe that it is of a high yellow; and if, when held in one's hand, it crackles and bounces, it is a sign that it is fresh and good: but as the method of reducing brimstone to a powder is very troublesome, it is better to buy the flour ready-made, which is done in large quantities, and in great perfection; though when a grand collection of fire-works is to be made, the strongest and best sulphur is the lump-brimstone well ground.

3. Charcoal for fire-works must always be soft and well burnt, which may be bought ready-done.

4. See GUNPOWDER in the order of the alphabet. It is mealed or ground in mortars, &c.

5. Camphor may be had in the shops; and is of two kinds, differing in regard to the degree of their purity, and distinguished by the name of rough and refined. Refined camphor must be chosen of a perfectly clean white colour, very bright and pellucid, of the same smell and taste with the rough, but more acrid and pungent.

6. Benjamin is one of the ingredients in odoriferous fire-works, when reduced to a fine flour; which may be done by putting into a deep and narrow earthen pot between three and four ounces of benjamin grossly pounded; cover the pot with paper, which tie very closely round the edge; then set the pot on a slow fire, and once in an hour take off the paper, and you will find some flour sticking to it, which return again in the pot; this you must continue till the flour appears white and fine. There is also an oil of benjamin, which is sometimes drawn from the dregs of the flour; it affords a very good scent, and may be used in wet compositions.

7. Spur-fire. As the beauty of this composition cannot be seen at so great a distance as brilliant fire, it has a better effect in a room than in the open air, and may be fired in a chamber without any danger: it is of so innocent a nature, that, though with an improper phrase, it may be called a cold fire; and so extraordinary is the fire produced from this composition, that, if well made, the sparks will not burn a handkerchief when held in the midst of them; you may hold them in your hand while burning, with as much safety as a candle; and if you put your hand within a foot of the mouth of the case, you will feel the sparks like drops of rain. When any of these spur-fires are fired singly, they are called artificial flower-pots; but some of them placed round a transparent pyramid of paper, and fired in a large room, make a very pretty appearance.

The composition consists of saltpetre 4 lb. 8 oz., sulphur 2 lb. and lamp-black 1 lb. 8 oz.; or, saltpetre, 1 lb., sulphur $\frac{1}{2}$ lb. and lamp-black quarts. This composition is very difficult to mix. The saltpetre and brimstone must be first sifted together, and then put into a marble mortar, and the lamp-black with them, with you work down by degrees with a wooden pestle, till all the ingredients appear of one colour, which will be something greyish, but very near black: then drive a little into a case for trial, and fire it in a dark place; and if the sparks, which are called stars, or pinks, come out in clusters, and afterwards spread well without any other sparks, it is a sign of its being good, otherwise not; for if any drossy sparks appear, and the stars not full, it is then not mixed enough; but if the pinks are very small, and soon break, it is a sign that you have rubbed it too much. The reason of its being called spur-fire, is because the sparks it yields have a great resemblance to the rowel of a spur.

8. To prepare cast iron for gerbes, white fountains, and Chinese fire. Cast iron being of so hard a nature as not to be cut by a file, we are obliged to reduce it into grains, though somewhat difficult to perform; but if we consider what beautiful sparks this sort of iron yields, no pains should be spared to granulate such an essential material: to do which, get at an iron-foundry some thin pieces of iron, such as generally run over the mould at the time of casting: then have a square block made of cast iron, and an iron square hammer about four pounds weight; then, having covered the floor with cloth or something to catch the beatings, lay the thin pieces of iron on the block, and beat them with the hammer till reduced into small grains; which afterwards searce with a very fine sieve, to separate the fine dust, which is sometimes used in small cases of brilliant fire instead of steel-dust; and when you have got

out all the dust, sift what remains with a sieve a little larger, and so on with sieves of different sizes, till the iron passes through about the bigness of small bird-shot: your iron thus beaten and sifted, put each sort into wooden boxes or oiled paper, to keep it from rusting. When you use it, observe the difference of its size, in proportion to the cases for which the charge is intended; for the coarse sort is only designed for very large gerbes of 6 or 8lb.

9. Charges for sky-rockets, &c. Rockets of four ounces. Mealed powder one lb. four oz. saltpetre four oz. and charcoal two oz. Rockets of eight ounces. I. Mealed powder one lb. saltpetre four oz. brimstone three oz. and charcoal one and a half oz. II. Meal-powder one and a half lb. and charcoal four and a half oz. Rockets of one pound. Meal-powder two lb. saltpetre eight oz. brimstone four oz. charcoal two oz. and steel filings one and a half oz. Sky-rockets in general. I. Saltpetre four lb. brimstone one lb. and charcoal one and a half lb. II. Saltpetre four lb. brimstone one and a half lb. charcoal one lb. twelve oz. and meal-powder two oz. Large sky-rockets. Saltpetre four lb. meal-powder one lb. and brimstone one lb. Rockets of a middling size. I. Saltpetre eight lb. sulphur three lb. meal-powder three lb. II. Saltpetre three lb. sulphur two lb. meal-powder one lb. charcoal one lb.

10. For rocket-stars. White stars. Meal-powder four oz. saltpetre twelve oz. sulphur vivum six oz. oil of spike two oz. and camphor five oz. Blue stars. Meal-powder eight oz. saltpetre four, sulphur two, spirit of wine two, and oil of spike two. Coloured or variegated stars. Meal-powder eight drams, rochpetre four oz. sulphur vivum two, and camphor two. Brilliant stars. Saltpetre three and a half oz. sulphur one and a half, and meal-powder three-fourths, worked up with spirits of wine only. Common stars. Saltpetre one lb. brimstone four oz. antimony four and three-fourths, isinglass a half, camphor a half, and spirit of wine three-fourths. Tailed stars. Meal-powder three oz. brimstone two, saltpetre one, and charcoal (coarsely ground) three-fourths. Drove stars. I. Saltpetre three lb. sulphur one lb. brass-dust twelve oz. antimony three. II. Saltpetre one lb. antimony four oz. and sulphur eight. Fixed pointed stars. Saltpetre eight and a half oz. sulphur two, antimony one oz. ten dr. Stars of a fine colour. Sulphur one oz. meal-powder one, saltpetre one, camphor four dr. oil of turpentine four dr.

11. Rains. Gold rain for sky-rockets. I. Saltpetre one lb. meal-powder four oz. sulphur four, brass-dust one, saw-dust two and a quarter, and glass-dust six dr. II. Meal-powder twelve oz. saltpetre two, charcoal four. III. Saltpetre eight oz. brimstone two, glass-dust one, antimony three-fourths, brass-dust one-quarter, and saw-dust 12 dr. Silver rain. I. Saltpetre four oz. sulphur, meal-powder, and antimony, of each two oz. sal prunella one half oz. II. Saltpetre one half lb. brimstone two oz. and charcoal four. III. Saltpetre one lb. brimstone one-quarter lb. antimony six oz. IV. Saltpetre four oz. brimstone one, powder two, and steel-dust three-fourth oz.

12. Water-rockets. I. Meal-powder six lb. saltpetre four, brimstone three, charcoal five. II. Saltpetre one lb. brimstone four and a half oz. charcoal six. III. Saltpetre one lb. brimstone four oz. charcoal twelve. IV. Saltpetre 4 lb. brimstone 1½ lb. charcoal one lb. twelve oz. V. Brimstone two lb. saltpetre four lb. and meal-powder four. VI. Saltpetre one lb. meal-powder four oz. brimstone eight and a half, charcoal two. VII. Meal-powder one lb. saltpetre three, brimstone one; sea-coal one oz. charcoal eight and a half, saw-dust three-fourths, steel-dust one-half, and coarse charcoal one-fourth oz. VIII. Meal-powder one and three-fourths lb. saltpetre three, sulphur one and a half, charcoal twelve oz. saw-dust two. Sinking charge for water rockets. Meal-powder eight oz. charcoal three-fourths oz.

13. Of wheels. Wheel-cases from two ounces to four pounds. I. Meal-powder two lb. saltpetre four oz. iron-filings seven oz. II. Meal-powder 2lb. saltpetre 12 oz. sulphur 4, steel-dust 3. III. Meal-powder four lb. saltpetre one lb. brimstone eight oz. charcoal four and a half. IV. Meal-powder eight oz. saltpetre four, saw-dust one and a half, sea-coal three-fourths. V. Meal-powder one lb. four oz. brimstone four oz. ten dr. saltpetre eight oz. glass-dust two and a half. VI. Meal-powder twelve oz. charcoal one, saw-dust one-half. VII. Saltpetre one lb. nine oz. brimstone four oz. charcoal four and a half. VIII. Meal-powder two lb. saltpetre one, brimstone one-half, and sea-coal two. IX. Saltpetre two lb. brimstone one, meal-powder four, and glass-dust four oz. X. Meal-powder one lb. saltpetre two oz. and steel-dust three and one-half. XI. Meal-powder two lb. and steel-dust two and one-half oz. with two and one-half of the fine dust of beat iron. XII. Saltpetre two lb. thirteen oz. brimstone eight oz. and charcoal. Slow fire for wheels. I. Saltpetre four oz. brimstone two, and meal-powder one and a half. II. Saltpetre four oz. brimstone one, and antimony one oz. six dr. III. Saltpetre four and one-half oz. brimstone one oz. and meal-powder one and a half. Dead fire for wheels. I. Saltpetre one one-fourth oz. brimstone one-fourth, lapis-calaminaris one-fourth, and antimony two dr.

14 Standing or fixed cases. I. Meal-powder four lb. saltpetre two, brimstone and charcoal one. II. Meal-powder two lb. saltpetre one, and steel-dust eight oz. III. Meal-powder one lb. four oz. and charcoal four oz. IV. Meal-powder one lb. and steel-dust four oz. V. Meal-powder two and one-half lb. brimstone four oz. and sea-coal six. VI. Meal-powder three lb. charcoal five oz. and saw-dust one and a half.

15. Sun-cases. I. Meal-powder eight and one-half lb. saltpetre one lb. two oz. steel-dust two lb. ten oz. brimstone four. II. Meal-powder three lb. saltpetre six oz. and steel-dust seven and one-half.

16. A brilliant fire. Meal-powder eleven lb. saltpetre one, brimstone four oz. steel-dust one and a half.

17. Gerbes. Meal-powder six lb. and beat iron two lb. one and a half oz.

18. Chinese fire. Saltpetre twelve oz. meal-powder two lb. brimstone one lb. two oz. and beat iron twelve oz.

19. Tourbillons. Charge for four-ounce tourbillons. Meal-powder two lb. four oz. and charcoal four and one-eighth oz. Eight-ounce tourbillons. Meal-powder two lb. and charcoal four and three-fourths oz. Large tourbillons. Meal-powder two lb. saltpetre one, brimstone eight oz. and beat-iron eight. Tourbillons may be made very large, and of different coloured fires: only you have to observe, that the larger they are, the weaker must be the charge; and, on the contrary, the smaller, the stronger their charge.

20. Water balloons. I. Saltpetre four lb. brimstone two, meal-powder two, antimony four oz. saw-dust four, glass-dust one and one-half. II. Saltpetre nine lb. brimstone three lb. meal-powder six lb. rosin twelve oz. and antimony eight oz.

21. Water squibs. I. Meal-powder one lb. and charcoal one lb. II. Meal-powder one lb. and charcoal nine oz.

22. Mine ports or serpents. I. Meal-powder one lb. and charcoal one oz. II. Meal-powder nine oz. charcoal one oz.

23. *Port-fires.* For firing rockets, &c. I. Saltpetre twelve oz. brimstone four oz and meal-powder two oz. II. Saltpetre eight oz. brimstone four oz. and meal-powder two oz. III. Saltpetre one lb. meal-powder one and one-half and brimstone ten oz. This composition must be moistened with one gill of linseed oil. IV. Meal-powder six oz. saltpetre two lb. two oz. and brimstone ten oz. V. Saltpetre one lb. four oz meal-powder four oz. brimstone five oz. saw-dust eight oz. VI. Saltpetre eight oz. brimstone two oz. and meal-powder two oz. For illuminations. Saltpetre one lb. brimstone eight oz. and meal-powder six oz.

24. *Cones or spiral wheels.* Saltpetre one and one-half lb. brimstone six oz. meal-powder fourteen oz. and glass-dust fourteen oz.

25. *Crowns or globes.* Saltpetre six oz. brimstone two lb. antimony four oz. and camphor two oz.

26. *Air-balloon fuzes.* I. Saltpetre one lb. ten oz. brimstone eight oz. and meal-powder one lb. six oz. II. Saltpetre one and one-half, brimstone eight oz. and meal-powder one lb. eight oz.

27. *Serpents for pots des brins.* Meal-powder one lb. eight oz. saltpetre twelve oz. and charcoal two oz.

28. *Fire pumps.* I. Saltpetre five lb. brimstone one lb. meal-powder one and one-half lb. and glass-dust one lb. II. Saltpetre five lb. eight oz. brimstone two lb. meal-powder one lb. eight oz. and glass-dust one lb. eight oz.

29. *A slow white flame.* I. Saltpetre two lb. brimstone three lb. antimony one lb. II. Saltpetre three and one-half lb. sulphur two and one-half lb. meal-powder one lb. antimony one lb. glass-dust four oz. brass-dust one oz. N. B. These compositions, driven one-fourth inch in a one-oz. case, will burn one minute; which is much longer time than an equal quantity of any composition yet known will last.

30. *Amber lights.* Meal-powder nine oz. amber three oz. This charge may be drove in small cases, for illuminations.

31. *Lights of another kind.* Saltpetre three lb. brimstone one lb. meal powder one lb. antimony ten and one-half oz. All these must be mixed with the oil of spike.

32. *A red fire.* Meal-powder three lb. charcoal twelve oz. and saw-dust eight oz.

33. *A common fire.* Saltpetre three lb. charcoal ten oz. and brimstone two oz.

34. *To make an artificial earthquake.* Mix the following ingredients to a paste with water, and then bury it in the ground, and in a few hours the earth will break and open in several places. The composition: sulphur 4lb. and steel-dust 4lb.

35. *Compositions for stars of different colours.* 1. Meal-powder 4 oz. saltpetre 2 oz. brimstone 2 oz. steel-dust $1\frac{1}{2}$ oz. and camphor, white amber, antimony, and mercury sublimate, of each half an ounce. 2. Rochepetre 10 oz. brimstone, charcoal, antimony, meal-powder, and camphor, of each $\frac{3}{4}$ oz. moistened with oil of turpentine. These compositions are made into stars, by working into a paste, with aqua vitæ, in which has been dissolved some gum tragacanth; after you have rolled them in powder, make a hole through the middle of each, and string them on quick-match, leaving two inches between each. 3. Saltpetre 8 oz. brimstone 2 oz. yellow amber 1 oz. antimony 1 oz. and powder 3 oz. 4. Brimstone $2\frac{1}{2}$ oz. saltpetre 6 oz. olibanum or frankincense in drops 4 oz.; mastic, and mercury sublimate, of each 4 oz. meal-powder 5 oz. white amber, yellow amber, and camphor, of each 1 oz. antimony and orpiment $\frac{1}{2}$ oz. each. 5. Saltpetre 1 lb. brimstone $\frac{1}{2}$ lb. and meal-powder 8 oz. moistened with petrolio-oil. 6. Powder $\frac{1}{2}$ lb. brimstone and saltpetre of each 4 oz. 7. Saltpetre 4 oz. brimstone 2 oz. and meal-powder 1 oz.

Stars that carry tails of sparks. 1. Brimstone 6 oz. antimony crude 2 oz. saltpetre 4 oz. and rosin 4 oz. 2. Saltpetre, rosin, and charcoal, of each 2 oz. brimstone 1 oz. and pitch 1 oz. These compositions are sometimes melted in an earthen pan, and mixed with chopped cotton match, before they are rolled into stars; but will do as well if wetted, and worked up in the usual manner.

Stars that yield some sparks. 1. Camphor 2 oz. saltpetre 1 oz. meal-powder 1 oz. 2. Saltpetre 1 oz. ditto melted $\frac{1}{4}$ oz. and camphor 2 oz. When you would make stars of either of these compositions, you must wet them with gum water, or spirit of wine, in which has been dissolved some gum arabic, or gum tragacanth, that the whole may have the consistence of a pretty thick liquid; having thus done, take 1 oz. of lint, and stir it about in the composition till it becomes dry enough to roll into stars.

Stars of a yellowish colour. Take 4 oz. of gum tragacanth or gum arabic, pounded and sifted through a fine sieve, camphor dissolved in brandy 2 oz. saltpetre 1 lb. sulphur $\frac{1}{2}$ lb. coarse powder of glass 4 oz. white amber $1\frac{1}{2}$ oz. orpiment 2 oz. Being well incorporated, make them into stars after the common method.

Stars of another kind. Take 1 lb. of camphor, and melt it in a pint of spirit of wine over a slow fire; then add to it 1 lb. of gum arabic that has been dissolved; with this liquor mix 1 lb. of saltpetre, 6 oz. of sulphur, and 5 oz. meal-powder; and after you have stirred them well together, roll them into stars proportionable to the rockets for which you intend them.

36. *Colours produced by the different compositions.* As variety of fires adds greatly to a collection of works, it is necessary that every artist should know the different effect of each ingredient. For this reason we shall here explain the colours they produce of themselves, and likewise how to make them retain the same when mixed with other bodies. As, for example, sulphur gives a blue, camphor a white or pale colour, saltpetre a clear white yellow, amber a colour inclining to yellow, sal ammoniac a green, antimony a reddish, rosin a copper-colour, and Greek pitch a kind of bronze, or between red and yellow. All these ingredients are such as show themselves in a flame, viz.

White flame. Saltpetre, sulphur, meal-powder, and camphor: the saltpetre must be the chief part.

Blue flame. Meal-powder, saltpetre, and sulphur vivum; sulphur must be the chief: or meal-powder, saltpetre, brimstone, spirit of wine, and oil of spike; but let the powder be the principal part.

Flame inclining to red. Saltpetre, sulphur, antimony, and Greek pitch: saltpetre the chief.

By the above method may be made various colours of fire, as the practitioner pleases; for, by making a few trials, he may cause any ingredient to be predominant in colour.

37. *Ingredients that show in sparks when rammed in choaked cases.* The set colours of fire produced by sparks are divided into four sorts, viz. the black, white, grey, and red. The black charges are composed of two ingredients, which are meal-powder and charcoal: the white of three, viz. saltpetre, sulphur, and charcoal: the grey of four, viz. meal-powder, saltpetre, brimstone, and charcoal; and the red of three, viz. meal-powder, charcoal, and saw-dust.

38. *Cotton quick-match,* is generally made of such cotton as is put in candles, of several sizes, from one to six threads thick, according to the pipe it is designed for; which pipe must be large enough for the match, when made, to be pushed in easily without breaking it.

The ingredients for the match are, cotton 1 lb. 12 oz. saltpetre 1 lb. spirit of wine 2 quarts, water 3 quarts, isinglass 3 gills, and meal-powder 10lb. To dissolve 4 oz. of isinglass, take 3 pints of water.

39. *Touch-paper for capping of serpents, crackers, &c.* Dissolve in spirit of wine or vinegar, a little saltpetre; then take some purple or blue paper, and wet it with this liquor, and when dry it will be fit for use. When you paste this paper on any of your works, take care that the paste does not touch that part which is to burn.

Of moulds, cases, mixture, instruments, &c.

40. *Rocket-moulds.* As the performance of rockets depends much on their moulds, it is requisite to give a definition of them, and their proportions. They are made and proportioned by the diameter of their orifice, which is divided into equal parts.

Rammers must have a collar of brass at the bottom, to keep the wood from spreading or splitting, and the same proportion must be given to all moulds, from 1 oz. to 6 lb. As to the handles of the rammers, if their diameter is equal to the bore of the mould, and two diameters long, it will be a very good proportion; but the shorter you can use them the better; for the longer the drift, the less will be the pressure on the composition by the blow given with the mallet.

Dimensions for Rocket Moulds, if the Rockets are rammed solid.

Weight of rockets.		Length of the moulds without their feet.	Interior diameter of the moulds	Height of the nipples.
lbs.	oz.	Inches.	Inches.	Inches.
6	0	34,7	3,5	1,5
4	0	38,6	2,9	1,4
2	0	13,35	2,1	1,0
1	0	12,25	1,7	0,85
0	8	10,125	1,333, &c.	0,6
0	4	7,75	1,125	0,5
0	2	6,2	0,9	0,45
0	1	4,9	0,7	0,35
0	$\frac{1}{2}$	3,9	0,55	0,25
6 drams		3,5	0,5	0,225
4 drams		2,2	0,3	0,2

41. *Moulds for wheel-cases or serpents.* This sort of moulds are made of any length or diameter, according as the cases are required; but the diameter of the rollers must be equal to half the bore, and the rammers made quite solid.

42. *To roll rocket and other cases.* Sky-rocket cases are to be made $6\frac{3}{4}$ of their exterior diameter long; and all other cases that are to be filled in moulds must be as long as the moulds, within half its interior diameter. Rocket-cases, from the smallest to 4 or 6 lb. are generally made of the strongest sort of cartridge-paper, and rolled dry; but the large sort are made of pasted pasteboard. As it is very difficult to roll the ends of the cases quite even, the best way will be to keep a pattern of the paper for the different sorts of cases, which pattern should be somewhat longer than the case it is designed for, and on it marked the number of sheets required, which will prevent any paper being cut to waste. Having cut your papers of a proper size, and the last sheet for each case with a slope at one end, so that when the cases are rolled it may form a spiral line round the outside, and that this slope may always be the same, let the pattern be so cut for a guide. Before you begin to roll, fold down one end of the first sheet, so far that the fold will go two or three times round the former; then, on the double edge, lay the former with its handle off the table; and when you have rolled on the paper within two or three turns, lay the next sheet on that part which is loose, and roll it all on. Having thus done, you must have a smooth board, about 20 inches long, and equal in breadth to the length of the case. In the middle of this board must be a handle placed lengthwise. Under this board lay your case, and let one end of the board lie on the table; then press hard on it, and push it forwards, which will roll the paper very tight: do this three or four times before you roll on any more paper. This must be repeated every other sheet of paper, till the case is thick enough; but if the rolling-board is drawn backwards, it will loosen the paper: you are to observe when you roll on the last sheet, that the point of the slope may be placed at the small end of the roller. When the cases are hard to choak, let each sheet of paper (except the first and last, in that part where the neck is formed), be a little moistened with water; immediately after you have struck the concave stroke, bind the neck of the case round with small twine, which must

not be tied in a knot, but fastened with two or three hitches.

Having thus pinched and tied the case so as not to give way, put it into the mould without its foot, and with a mallet drive the former hard on the end piece, which will force the neck close and smooth. This done, cut the case to its proper length, allowing from the neck to the edge of the mouth half a diameter, which is equal to the height of the nipple; then take out the former, and drive the case over the piercer with the long rammer, and the vent will be of a proper size. Wheel-cases must be driven on a nipple with a point to close the neck, and make the vent of the size required; which, in most cases, is generally one-quarter of their interior diameter. As it is very often difficult, when the cases are rolled, to draw the roller out, you may make a hole through the handle, and put in it a small iron pin, by which you may easily turn the former round and pull it out.

Cases are commonly rolled wet, for wheels and fixed pieces; and when they are required to contain a great length of charge, the method of making those cases is thus: your paper must be cut as usual, only the last sheet must not be cut with a slope; having Your paper ready, paste each sheet on one side; then fold down the first sheet as before directed; but be careful that the paste does not touch the upper part of the fold, for if the roller is wetted, it will tear the paper in drawing it out. In pasting the last sheet, observe not to wet the last turn or two in that part where it is to be pinched; for if that part is damp, the pinching-cord will stick to it, and tear the paper; therefore, when you choak those cases, roll a bit of dry paper once round the case before you put on the pinching-cord; but this bit of paper must be taken off after the case is choaked. The rolling-board, and all other methods, according to the former directions for the rolling and pinching of cases, must be used to these as well as all other cases.

43. *To make tourbillon-cases.* This sort of cases are generally made about eight diameters long; but if very large, seven will be sufficient. Tourbillons will answer very well from 4 oz. to 2 lb. but when larger there is no certainty. The cases are best rolled wet with paste, and the last sheet must have a straight edge, so that the case may be all of a thickness. When you have rolled your cases after the manner of wheel-cases, pinch them at one end quite close; then with the rammer drive the ends down flat, and afterwards ram in about one-third of a diameter of dried clay. The diameter of the former for these cases must be the same as for sky-rockets.

44. *Balloon-cases, or paper shells.* First, you must have an oval former turned of smooth wood; then paste a quantity of brown or cartridge paper, and let it lie till the paste has quite soaked through: this done, rub the former with soap or grease, to prevent the paper from sticking to it; then lay the paper on in small slips, till you have made it one-third of the thickness of the shell intended. Having thus done, set it to dry, and when dry, cut it round the middle, and the two halves will easily come off; but observe, when you cut, to leave about one inch not cut, which will make the halves join much better than if quite separated. When you have some ready to join, place the halves even together, paste a slip of paper round the opening to hold them together, and let that dry; then lay on paper all over as before, every where equal, excepting that end which goes downwards in the mortar, which may be a little thicker than the rest; for that part which receives the blow from the powder in the chamber of the mortar consequently requires the greatest strength. When the shell is thoroughly dry, burn a round vent at top, with an iron large enough for the fuze: this method will do for balloons from 4 inches 2-5ths, to 8 inches diameter; but if they are larger, or required to be thrown a great height, let the first shell be turned of elm, instead of being made of paper. For a balloon of 4 inches 2-5ths, let the former be 3 inches 1-8th diameter, and 5¼ inches long. For a balloon of 5½ inches, the diameter of the former must be 4 inches, and 8 inches long. For a balloon of 8 inches, let the diameter of the former be 5 inches and 15-16ths, and 11 inches 7-8ths long. For a 10-inch balloon, let the former be 7 inches 3-16ths diameter, and 14⅘ inches long. The thickness of a shell for a balloon of 4 inches 2-5ths must be half an inch. For a balloon of 5½ inches, let the thickness of the paper be 5-8ths of an inch; for an 8-inch balloon, 7-8ths of an inch; and for a 10-inch balloon, let the shell be 1 inch 1-8th thick. Shells that are designed for stars only, may be made quite round, and the thinner they are at the opening, the better; for if they are too strong, the stars are apt to break at the bursting of the shell. When you are making the shell, make use of a pair of calibres, or a round gage, so that you may not lay the paper thicker in one place than another; and also to know when the shell is of a proper thickness. Balloons must always be made to go easy into the mortars.

Cases for illumination port-fires. These must be made very thin of paper, and rolled on formers from 2 to 5-8ths of an inch diameter, and from 2 to 6 inches long: they are pinched close at one end, and left open at the other. When you fill them, put in but a little composition at a time, and ram it in lightly, so as not to break the case: three or four rounds of paper, with the last round pasted, will be strong enough for these cases.

Cases and moulds for common port-fires. Common port-fires are intended purposely to fire the works, their fire being very slow, and the heat of the flame so intense, that, if applied to rockets, leaders, &c. it will fire them immediately. Port-fires may be made of any length, but are seldom made more than 21 inches long: the interior diameter of port-fire moulds should be 10-16ths of an inch, and the diameter of the former half an inch. The cases must be rolled wet with paste, and one end pinched, or folded down. The moulds should be made of brass, and to take in two pieces lengthwise; when the case is in the two sides, they are held together by brass rings, or hoops, which are made to fit over the outside. The bore of the mould must not be made quite through, so that there will be no occasion for a foot. Those port-fires, when used, are held in copper sockets, fixed on the end of a long stick: these sockets are made like port-crayons, only with a screw instead of a ring.

45. *Of mixing the compositions.* The performance of the principal part of fire-works depends much on the compositions being well mixed; therefore great care must be taken in this part of the work, particularly for the composition for sky-rockets. When you have four or five pounds of ingredients to mix, which is a sufficient quantity at a time, first put the different ingredients together, then work them about with your hands till you think they are pretty well incorporated; after which put them into a lawn sieve with a receiver and top to it; and if, after it is sifted, any remains that will not pass through the sieve, grind it again till fine enough, and if it is twice sifted it will not be amiss; but the compositions for wheels and common works are not so material, nor need be so fine. But in all fixed works, from which the fire is to play regularly, the ingredients must be very fine, and great care taken in mixing them well together; and observe, that in all compositions wherein are steel or iron filings, the hands must not touch: nor will any works which have iron or steel in their charge keep long in damp weather, unless properly prepared, according to the following directions:

46. *To preserve steel or iron filings.* Melt in a glazed earthen pan some brimstone over a slow fire, and when melted throw in some filings, which keep stirring about till they are covered with brimstone: this you must do while it is on the fire; then take it off, and stir it very quick till cold, when you must roll it on a board with a wooden roller till you have broken it as fine as corn-powder; after which sift from it as much of the brimstone as you can. There is another method of preparing filings, so as to keep two or three months in winter: this may be done by rubbing them between the strongest sort of brown paper, which before has been moistened with linseed oil.

47. DIMENSIONS and POISE of ROCKET-STICKS.

Weight h rocket.		Length of the stick.		Thickness at top.	Breadth at top.	Square at bottom.	Poise from the point of the cone.	
lbs.	oz.	ft.	in.	Inches.	Inches.	Inches.	feet.	inch.
6	0	14	0	1,5	1,85	0,75	4	1,5
4	0	12	10	1,25	1,40	0,625	3	9,
2	0	9	4	1,125	1,	0,525	2	9,
1	0	8	2	0,725	0,80	0,375	2	1,
	8	6	6	0,5	0,70	0,25	1	10,5
	4	5	3	0,3750	0,55	0,35	1	8,5
	2	4	1	0,3	0,45	0,15	1	3,
	1	3	6	0,25	0,35	0,10	11	0,
	½	2	4	0,125	0,20	0,16	8	0,
	¼	1	10½	0,1	0,15	0,	5	6,5

To load air-balloons, with the number of stars, serpents, snakes, rain-falls, &c. in shells of each nature.

48. *Mortars to throw aigrettes, &c.* When you fill your shells, you must first put in the serpents, rains, stars, &c. or whatever they are composed of, then the blowing powder; but the shells must not be quite filled. All

those things must be put in at the fuze-hole; but maroons being too large to go in at the fuze-hole, must be put in before the inside shall be joined. When the shells are loaded, glue and drive in the fuzes very tight. For a coehorn balloon, let the diameter of the fuze-hole be $\frac{7}{8}$ths of an inch; for a royal balloon, which is near $5\frac{1}{2}$ inches in diameter, make the fuze-hole 1 inch $\frac{1}{6}$ diameter; for an 8-inch balloon, 1 inch $\frac{2}{8}$ths: and for a 10-inch balloon, 1 inch $\frac{4}{8}$ths.

49. *To make balloon-fuzes.* Fuzes for air-balloons are sometimes turned out of dry beech, with a cup at top to hold the quick-match; but if made with pasted paper, they will do as well. The diameter of the former for fuzes for coehorn balloons must be $\frac{1}{2}$ an inch; for a royal fuze, $\frac{4}{8}$ths of an inch; for an 8-inch fuze, $\frac{3}{4}$ths of an inch; and for a 10-inch fuze, $\frac{7}{8}$ths of an inch. Having rolled your cases, pinch and tie them almost close at one end; then drive them down, and let them dry. Before you begin to fill them, mark on the outside of the case the length of the charge required, allowing for the thickness of the bottom; and when you have rammed in the composition, take two pieces of quick-match about six inches long, and lay one end of each on the charge, and then a little meal-powder, which ram down hard; the loose ends of the match double up into the top of the fuze, and cover it with a paper cap to keep it dry. When you put the shells in the mortars, uncap the fuzes, and pull out the loose ends of the match, and let them hang on the sides of the balloons.

50. *Tourbillons.* Having filled some cases with about $1\frac{1}{2}$ diameter, drive in a ladleful of clay, then pinch their ends close, and drive them down with a mallet. When done, find the centre of gravity of each case, where you must nail and tie a stick, which should be half an inch broad at the middle, and run a little narrow to the ends: these sticks must have their ends turned upwards, so that the cases may turn horizontally on their centres. At the opposite sides of the cases, at each end, bore a hole close to the clay with a gimlet, the size of the neck of a common case of the same nature; from these holes draw a line round the case, and at the under part of the case bore a hole with the same gimlet, within one-half diameter of each line towards the centre; then from one hole to the other draw a right line. When you fire tourbillons, lay them on a smooth table, with their sticks downwards, and burn the leader through the middle with a port-fire. They should spin three or four seconds on the table before they rise, which is about the time the composition will be burning from the side-holes to those at bottom.

To tourbillons may be fixed reports in this manner: In the centre of the case at top make a small hole, and in the middle of the report make another; then place them together, and tie on the report, and with a single paper secure it from fire: this done, your tourbillon is completed. By this method you may fix on tourbillons small cones of stars, rain, &c. but be careful not to load them too much. One-eighth of an inch will be enough for the thickness of the sticks, and their length equal to that of the cases.

51. *Of pots des brins.* These are formed of pasteboard, and must be rolled pretty thick. They are usually made three or four inches in diameter, and four diameters long, and pinched with a neck at one end, like common cases. A number of these are placed on a plank, thus: Having fixed on a plank two rows of wooden pegs, cut in the bottom of the plank a groove the whole length under each row of pegs; then, through the centre of each peg, bore a hole down to the groove at bottom, and on every peg fix and glue a pot, whose mouth must fit tight on the peg; through all the holes run a quick-match, one end of which must go into the pot, and the other into the groove, which must have a match laid in it from end to end, and covered with paper, so that when lighted at one end it may discharge the whole almost instantaneously. In all the pots put about 1 oz. of meal and corn powder, then put in some stars, and in others rains, snakes, serpents, crackers, &c.; when they are all loaded, paste paper over their mouths. Two or three hundred of these pots being fired together make a very pretty show, by affording so great a variety of fires.

52. *Pots des saucissons.* These are generally fired out of large mortars without chambers, the same as those for aigrettes, only somewhat stronger. Saucissons are made of one and two ounce cases, five or six inches long, and choked in the same manner as serpents. Half the number which the mortar contains must be driven $1\frac{1}{2}$ diameter with composition, and the other half two diameters, so that when fired they may give two volleys of reports.

Different kinds of rockets.

53. *To fix one rocket on the top of another.* When sky-rockets are thus managed, they are called towering rockets, on account of their mounting so very high. Towering rockets are made after this manner: Fix on a pound-rocket a head without a collar; then take a four-ounce rocket, which may be headed or bounced, and rub the mouth of it with meal-powder, wetted with spirit of wine; when done, put it in the head of the large rocket with its mouth downwards; but before you put it in, stick a bit of quick-match in the hole of the clay of the pound-rocket, which match should be long enough to go a little way up the bore of the small rocket, to fire it when the large one is burnt out. The four-ounce rocket being too small to fill the head of the other, roll round it as much tow as will make it stand upright in the centre of the head: the rocket being thus fixed, paste a single paper round the opening of the top of the head of the large rocket. The large rocket must have only half a diameter of charge rammed above the piercer; for, if filled to the usual height, it would turn before the small one takes fire, and entirely destroy the intended effect. When one rocket is headed with another, there will be no occasion for any blowing powder; for the force with which it sets off will be sufficient to disengage it from the head of the first-fired rocket. The sticks for these rockets must be a little longer than for those headed with stars, rains, &c.

54. *Caduceus rockets,* in rising, form two spiral lines, or a double worm, by reason of their being placed obliquely, one opposite the other; and their counterpoise in their centre, which causes them to rise in a vertical direction. Rockets for this purpose must have their ends choked close, without either head or bounce, for a weight at top would be a great obstruction to their mounting.

55. *Signal sky-rockets* are made of several kinds, according to the different signals intended to be given; but in artificial fire-works, two sorts only are used, which are one with reports and the other without; but those for the use of the navy and army are headed with stars, serpents, &c. Rockets which are to be bounced must have their cases made $1\frac{1}{2}$ or 2 diameters longer than the common proportion; and after they are filled, drive in a double quantity of clay, then bounce and pinch them after the usual manner, and fix on each a cap. Signal sky-rockets without bounces, are only sky-rockets closed and capped. These are very light, therefore do not require such heavy sticks as those with loaded heads; for which reason you may cut one length of the rocket off the stick, or else make them thinner. Signal rockets with reports are fired in small flights; and often both these, and those without reports, are used for a signal to begin firing a collection of works.

56. *To fire sky-rockets without sticks.* You must have a stand of a block of wood, a foot diameter, and make the bottom flat, so that it may stand steady. In the centre of the top of this block draw a circle $2\frac{1}{2}$ inches diameter, and divide the circumference of it into three equal parts; then take 3 pieces of thick iron wire, each about 3 feet long, and drive them into the block, 1 at each point made on the circle; when these wires are driven in deep enough to hold them fast and upright, so that the distance from one to the other is the same at top as at bottom, the stand is complete. The stand being thus made, prepare your rockets thus: take some common sky-rockets, of any size, and head them as you please; then get some balls of lead, and tie to each a small wire 2 or $2\frac{1}{2}$ feet long, and the other end of each wire tie to the neck of a rocket. These balls answer the purpose of sticks when made of a proper weight, which is about 2-3ds the weight of the rocket; but when they are of a proper size, they will balance the rocket in the same manner as a stick, at the usual point of poise. To fire these, hang them one at a time, between the tops of the wires, letting their heads rest on the point of the wires, and the balls hang down between them. If the wires should be too wide for the rockets, press them together till they fit; and if too close, force them open. The wires for this purpose must be softened, so as not to have any spring, or they will not keep their position when pressed close or opened.

Aquatic fire-works.

57. *Water rockets* may be made from 4 oz. to 2 lb. If larger they are too heavy, so that it will be difficult to make them keep above water without a cork float, which must be tied to the neck of the case; but the rockets will not drive so well with as without floats. Cases for these are made in the same manner and proportion as for sky-rockets, only a little thicker of paper. When you fill those which are driven solid, put in first one ladleful of slow fire, then two of the proper charge, and on that one or two ladles of sinking charge, then the proper charge, then the sinking charge again, and so on till you have filled the case within three diameters; then drive on the composition one ladleful of clay,

through which make a small hole to the charge; then fill the case within half a diameter with corn-powder, on which turn down two or three rounds of the case in the inside; then pinch and tie the end very tight: having filled your rockets according to the above directions, dip their ends in melted rosin or sealing-wax, or else secure them well with grease. When you fire those rockets, throw in six or eight at a time; but, if you would have them all sink, or swim, at the same time, you must drive them with an equal quantity of composition, and fire them all together.

58. *To make pipes of communiction, which may be used under water.* Pipes for this purpose must be a little thicker of paper than those for land. Having rolled a sufficient number of pipes, and kept them till dry, wash them over with drying oil, and set them to dry; but when you oil them, leave about 1½ inch at each end dry, for joints: if they were oiled all over, when you come to join them the paste would not stick where the paper is greasy. After the leaders are joined, and the paste dry, oil the joints. These pipes will lie many hours under water, without receiving any damage.

59. *Horizontal wheels for the water.* First get a large wooden bowl without a handle; then have an octagon wheel made of a flat board 18 inches in diameter, so that the length of each side will be near seven inches: in all the sides cut a groove for the cases to lie in. This wheel being made, nail it on the top of the bowl; then take four 8-oz. cases, filled with a proper charge, each about six inches in length. Now, to clothe the wheel with these cases, get some whitish-brown paper, and cut it into slips four or five inches broad and seven or eight long. These slips being pasted all over on one side, take one of the cases, and roll one of the slips of paper about 1½ inch on its end, so that there will remain about 2½ inches of the paper hollow from the end of the case: this case tie on one of the sides of the wheel, near the corners of which must be holes bored, through which you put the packthread to tie the cases. Having tied on the first case at the neck and end, put a little meal-powder in the hollow paper; then paste a slip of paper on the end of another case, the head of which put into the hollow paper on the first, allowing a sufficient distance from the tail of one to the head of the other for the pasted paper to bend without tearing; the second case tie on as you did the first, and so on with the rest, except the last, which must be closed at the end, unless it is to communicate to any thing on the top of the wheel, such as fire-pumps or brilliant fires, fixed in holes cut in the wheel, and fired by the last or second case, as the fancy directs; six, eight, or any number, may be placed on the top of the wheel, provided they are not too heavy for the bowl. Before you tie on the cases, cut the upper part of all their ends, except the last, a little shelving, that the fire from one may play over the other, without being obstructed by the case. Wheel-cases have no clay driven in their ends, nor pinched, but are always left open; only the last, or those which are not to lead fire, which must be well secured.

The devices in fire-works are endless, varying with the fancy of the operator; but in the above sketch we have given all the theory, and enough of the practice to enable any person to adopt with ease whatever in the art he may chance to see practised by others.

PYRUS, the *pear-tree*, a genus of the pentagynia order, in the icosandria class of plants, and in the natural method ranking under the 36th order, pomaceæ. The calyx is quinquefid; there are five petals; the fruit is an apple, inferior, quinquelocular, and polyspermous. To this genus Linnæus has joined the apple and quince. There are 13 species; the most remarkable are:

1. The communis, or common pear-tree. Under this species are comprehended almost endless varieties. They bear their flowers and fruit upon spurs, arising from the sides of the branches from two or three years old and upwards; the same branches and spurs continuing fruitful for a great number of years. The different varieties furnish fruit for use from the beginning of July till the months of May and June next year; which, according to their times of ripening, may be divided into three classes, summer-pears, autumn-pears, and winter-pears. The summer-pears ripen in different sorts from the beginning of July until the middle or end of September, and are generally fit to eat from the tree, or at least do not keep a week or two before they rot. The autumn-pears come to their perfection in October, November, and December; some ripening nearly on the tree in October and the beginning of November, others requiring to lie some time in the fruitery, while some will keep two months; but all the winter-pears, though they attain their full growth on the tree by the end of October and in November, yet do not acquire perfection for eating till from the end of November to April and May. Those of each class have different properties; some being melting, others breaking, some mealy, and some hard and austere fit only for kitchen uses. As many of the finest sorts were first obtained from France, they are still continued in most catalogues by French names.

2. The malus, or common apple-tree. The varieties of this species are amazingly great with respect to the difference of the fruit. The botanists contend that the wilding, or crab-apple of the woods and hedges, is the original kind, and from the seeds of which the cultivated apple was first obtained. The varieties of this last no doubt are multiplied to some hundreds in different places, having been all first accidentally obtained from the seed or kernels of the fruit, and the approved sorts continued and increased by grafting upon crabs or any kind of apple-stocks; but although the number of varieties is very considerable, there are not above 40 or 50 sorts retained in the nurserymen's catalogues. These varieties arrive at full growth in successive order from July to the end of October, improve in perfection after being gathered, and several of the winter kinds in particular keep good for many months, even till the arrival of apples the next summer.

Among these various kinds of apples, some are used for the dessert, some for the kitchen, and some for cyder-making. Those used for the dessert are the following, placed as they successively ripen after one another. The white genneting, the margaret apple, the summer pearmain, the summer queening, the embroidered apple, the golden rennet, the summer white calville, the summer red calville, the silver pippin, the aromatic pippin, la reinette grise, la haute bonté, the royal russeting, Wheeler's russet, Sharp's russet, the spine apple, the golden pippin, the nonpareil, and the l'api or pomme d'api. Those for the kitchen use, in the order of their ripening, are these: the codlin, the summer marygold, the summer red pearmain, the Holland pippin, the Kentish pippin, the courpendu, Loan's pearmain, the French rennet, the French pippin, the royal russet, the monstrous rennet, the winter pearmain, the pome violette, Spencer's pippin, the stone pippin, and the oaken pippin. Those most esteemed for cyder are, the Devonshire royal wilding, the redstreak apple, the whitsour, the Herefordshire under-leaf; and the John apple, or deux annes, everlasting hanger, and gennet moyle.

The juice of apples is a menstruum for iron. A solution of iron in the juice of the apples called golden rennets, evaporated to a thick consistence, proves an elegant chalybeate, which keeps well.

The best method of preserving apples for winter use, is to let them hang upon the trees until there is danger of frost, to gather them in dry weather, and then to lay them in large heaps to sweat for a month or six weeks. They ought then to be carefully looked over, all which have the least appearance of decay taken out, the sound fruit wiped dry, and packed up in large oil-jars, which have been thoroughly scalded and dry, and then stopped close to exclude the air. If this plan is duly observed, the fruit will keep a long time sound, and their flesh remain plump; whereas, when exposed to the air, their skins will shrivel, and their pulp soften.

3. The coronaria, or sweet-scented crab of Virginia, grows 12 or 15 feet high, having angular, serrated leaves, pedunculated umbels of whitish-red, sweet-scented flowers, succeeded by small round crabs, remarkably sour and austere. There is one variety, called the evergreen Virginian crab-tree.

4. The cydonia, or quinces, of which there are three varieties.

All the varieties of the pear-tree are hardy, and will succeed in any common soil of a garden or orchard. They are propagated by grafting and budding upon any kind of pear-stocks; also occasionally upon quince-stocks, and sometimes upon white-thorn stocks; but pear-stocks are generally preferable to all others for general use. All kinds of apples are propagated in the same manner, using apple-stocks instead of pear-stocks. They will succeed in any common soil of a garden or orchard, and in any free situation, except in a low and very moist soil, in which they are apt to canker, and very soon go off. In a friable loam they are generally very successful.

PYTHIAN GAMES, in antiquity, solemn games celebrated near Delphi, in honour of Apollo, and in remembrance of his having killed the serpent Python.

These were held every two years, abou the month of Elaphebolion, which answeet to our February. The celebration of these games was attended with the Pythian song, in which was celebrated the fight of Apollo and the serpent. The victors were crowned with branches of laurel; though, at the first institution, the crown was of beech-leaves. See Game.

Q

Q, or q, the sixteenth letter of our alphabet. As a numeral it stands for 500; and with a dash over it, thus $\overline{Q}$, for 500000. Used as an abbreviature, q signifies quantity, or quantum: thus, among physicians, q. pl. is quantum placet, *i. e.* as much as you please of a thing; and q. s. quantum sufficit, *i. e.* as much as is necessary. Q. E. D. among mathematicians, is quod erat demonstrandum, *i. e.* which was to be demonstrated; and Q. E. F. quod erat faciendum, *i. e.* which was to be done. Q. D. among grammarians, is quasi dictum, *i. e.* as if it was said, or, as who should say. In the notes of the antients, Q stands for Quintus, or Quintius; Q. B. V. for quod bene vertat; Q. S. S. S. for quæ supra scripta sunt; Q. M. for Quintus Mutius, or quomodo; Quint. for Quintilius; and Quæs. for quæstor.

QUADRANGLE, in geometry, the same with a quadrilateral figure, or one consisting of four sides and four angles.

QUADRANS, the quarter or fourth part of any thing, particularly the as, or pound.

QUADRANT, in geometry, is either the quarter or fourth part of a circle, or the fourth part of its circumference; the arch of which therefore contains 90 degrees.

Quadrant also denotes a mathematical instrument, of great use in astronomy and navigation, for taking the altitudes of the sun and stars, as also taking angles in surveying, heights and distances, &c.

This instrument is variously contrived, and furnished with different apparatus, according to the various uses it is intended for; but they have all this in common, that they consist of the quarter of a circle, whose limb or arch is divided into 90°, &c. Some have a plummet suspended from the centre, and are furnished either with plain sights, or a telescope to look through.

The principal and most useful quadrants are as follows:

Quadrant, *the common, or surveying.* This instrument ABC, fig. 1. Plate Quadrants, is made of brass, or wood, &c.: the limb or arch of which BC is divided into 90°, and each of these is farther divided into as many equal parts as the space will allow, either diagonally or otherwise. To one of the radii AC, are fitted two moveable sights; and to the centre is sometimes also annexed a label, or moveable index, AD, bearing two other sights; but instead of these last sights, there is sometimes fitted a telescope. Also from the centre hangs a thread with a plummet; and on the under side or face of the instrument are fitted a ball and socket, by means of which it may be put into any position. The general use of it is for taking angles in a vertical plane, comprehended under right lines going from the centre of the instrument, one of which is horizontal, and the other is directed to some visible point. But besides the parts above described, there is often added on the face, near the centre, a kind of compartment EF, called a quadrat, or geometrical square, which is a kind of separate instrument, and is particularly useful in altimetry and longimetry, or measuring heights and distances.

This quadrant may be used in different situations; in each of them, the plane of the instrument must be set parallel to that of the eye and the objects whose angular distance is to be taken. Thus, for observing heights or depths, its plane must be disposed vertically, or perpendicular to the horizon; but to take horizontal angles or distances, its plane must be disposed parallel to the horizon.

Again, heights and distances may be taken two ways, viz. by means of the fixed sights and plummet, or by the label; as also, either by the degrees on the limb, or by the quadrat. Thus, fig. 2 shews the manner of taking an angle of elevation with this quadrant; the eye is applied at C, and the instrument turned vertically about the centre A, till the object R is seen through the sights on the radius AC; then the angle of elevation RAH, made with the horizontal line KAH, is equal to the angle BAD, made by the plumb line and the other radius of the quadrant, and the quantity of it is shewn by the degrees in the arch BD cut off by the plumb line AD.

Quadrant, *astronomical.* See Observatory.

Quadrant, *Cole's*, is a very useful instrument, invented by Mr. Benjamin Cole. It consists of six parts, viz. the staff AB, fig. 3; the quadrantal arch DE; three vanes A, B, C; and their vernier FG. The staff is a bar of wood about two feet long, an inch and a quarter broad, and of a sufficient thickness to prevent it from bending or warping. The quadrantal arch is also of wood, and is divided into degrees and third parts of degrees, to a radius of about nine inches; and to its extremities are fitted two radii, which meet in the centre of the quadrant by a pin, about which it easily moves. The sight-vane A is a thin piece of brass, near two inches in height and one broad, set perpendicularly on the end of the staff A, by means of two screws passing through its foot. In the middle of this vane is drilled a small hole, through which the coincidence or meeting of the horizon and solar spot is to be viewed. The horizontal vane B is about an inch broad, and two inches and a half high, having a slit cut through it of near an inch long, and a quarter of an inch broad; this vane is fixed in the centre-pin of the instrument, in a perpendicular position, by means of two screws passing through its foot, by which its position with respect to the sight-vane is always the same, their angle of inclination being equal to 45 degrees. The shade-vane C is composed of two brass plates. The one which serves as an arm, is about $4\frac{1}{2}$ inches long, and $\frac{3}{4}$ of an inch broad; being pinned at one end to the upper limb of the quadrant by a screw, about which it has a small motion; the other end lies in the arch, and the lower edge of the arm is directed to the middle of the centre-pin. The other plate, which is properly the vane, is about two inches long, being fixed perpendicularly to the other plate, at about half an inch distance from that end next the arch; this vane may be used either by its shade, or by the solar spot cast by a convex lens placed in it. And because the wood-work is often subject to warp or twist, therefore this vane may be rectified by means of a screw, so that the warping of the instrument may occasion no error in the observation, which is performed in the following manner: set the line G on the vernier against a degree of the upper limb of the quadrant; and turn the screw on the backside of the limb forward or backward, till the hole in the sight-vane, the centre of the glass, and the sunk spot in the horizon-vane, lie in a right line.

To find the sun's altitude by this instrument. Turn your back to the sun, holding the staff of the instrument with the right hand, so that it is in a vertical plane passing through the sun; apply one eye to the sight-vane looking through that and the horizon-vane till the horizon is seen; with the left hand slide the quadrantal arch upwards, till the solar spot or shade, cast by the shade-vane, falls directly upon the spot or slit in the horizon-vane; then will that part of the quadrantal arch which is raised above G or S (according as the observation respects either the solar spot or shade), shew the altitude of the sun at that time. But for the meridian altitude, the observation must be continued; and as the sun approaches the meridian, the sea will appear through the horizon-vane, which completes the observation; and the degrees and minutes, counted as before, will give the sun's meridian altitude; or the degrees counted from the lower limb upwards, will give the zenith distance.

Quadrant, *Collins's or Sutton's*, fig. 4, is a stereographic projection of one quarter of the sphere between the tropics, upon the plane of the ecliptic, the eye being in its north pole; and fitted to the latitude of London. The lines running from right to left, are parallels of altitude; and those crossing them are azimuths. The smaller of the two circles bounding the projection, is one quarter of the tropic of Capricorn; and the greater is a quarter of the tropic of Cancer. The two ecliptics are drawn from a point on the left edge of the quadrant, with the characters of the signs upon them; and the two horizons are drawn from the same point. The limb is divided both into degrees and time; and by having the sun's altitude, the hour of the day may here be found to a minute. The quadrantal arches next the centre contain the calendar of months; and under them, in another arch, is the sun's declination. On the projection are placed several of the most remarkable fixed stars between the tropics; and the next below the projection are the quadrant and line of shadows.

To find the time of the sun's rising or setting, his amplitude, his azimuth, hour of the day, &c. by this quadrant. Lay the thread on the day of the month, and bring the bead to the proper ecliptic, either of summer or winter, according to the season, which is called rectifying; then by moving the thread bring the bead to the horizon, in which case the thread will cut the limb in the point of the time of the sun's rising or setting before or after 6; and at the same time the bead will cut the horizon in the degrees of the sun's amplitude. Again, observing the sun's altitude with the quadrant, and supposing it found to be 45° on the 5th of May, lay the thread over the 5th of May, then bring the bead to the summer ecliptic, and carry it to the parallel of altitude 45°; in which case the thread will cut the limb at 55° 15′, and the hour will be seen among the hour-lines to be either 41 m. past 9 in the morning, or 19 m. past 2 in the afternoon. Lastly, the bead shews among the azimuths the sun's distance from the south 50° 41′.

But if the sun's altitude is less than what it is at 6 o'clock, the operation must be performed among those parallels above the upper horizon; the bead being rectified to the winter ecliptic.

Quadrant, *gunner's*, fig. 5, sometimes called the gunner's square, is used for elevating and pointing cannon, mortars, &c. and consists of two branches, either of wood or brass, between which is a quadrantal arch divided into 90°, and furnished with a thread and plummet.

The use of this instrument is very easy; for if the longer branch, or bar, is placed in the mouth of the piece, and it is elevated till the plummet cuts the degree necessary to hit a proposed object, the thing is done.

Sometimes on the sides of the longer bar, are noted the division of diameters and weights of iron balls, as also the bores of pieces.

Quadrant, *Gunter's*, so called from its inventor, Edmund Gunter, (fig. 6) besides the apparatus of other quadrants, has a stereographic projection of the sphere on the plane of the equinoctial; and also a calendar of the months, next to the divisions of the limb; by which, besides the common purposes of other quadrants, several useful questions in astronomy, &c. are easily resolved.

Use of Gunter's quadrant. 1. To find the sun's meridian altitude for any given day, or conversely the day of the year answering to any given meridian altitude. Lay the thread to the day of the month in the scale next the limb; then the degree it cuts in the limb is the sun's meridian altitude. And, contrariwise, the thread being set to the meridian altitude, it shews the day of the month.

2. To find the hour of the day. Having put the bead, which slides on the thread, to the sun's place in the ecliptic, observe the sun's altitude by the quadrant; then if the bead is laid over the same in the limb, the bead will fall upon the hour required. On the contrary, laying the bead on a given hour, having first rectified or set it to the sun's place, the degree cut by the thread on the limb gives the altitude.

Note: the bead may be rectified otherwise, by bringing the thread to the day of the month, and the bead to the hour-line of 12.

3. To find the sun's declination from his place given, and the contrary. Bring the bead to the sun's place in the ecliptic, and move the thread to the line of declination ET, so shall the bead cut the degree of declination required. On the contrary, the bead being adjusted to a given declination, and the thread moved to the ecliptic, the bead will cut the sun's place.

4. The sun's place being given, to find the right ascension, or contrariwise. Lay the thread on the sun's place in the ecliptic, and the degree it cuts on the limb is the right ascension sought. And the converse.

5. The sun's altitude being given, to find his azimuth, and contrariwise. Rectify the bead for the time, as in the second article, and observe the sun's altitude; bring the thread to the complement of that altitude; then the bead will give the azimuth sought, among the azimuth-lines.

Quadrant, *Hadley's*, (fig. 7) so called from its inventor, John Hadley, esq. is now universally used, as the best of any for nautical and other observations.

Description of Hadley's quadrant. Fig. 7, represents a quadrant, or octant, of the common construction. The following parts are those which require the particular attention of the observer:

I. BC the arc.
II. AD the index, *ab* the nonius scale.
III. E the index-glass.
IV. F the fore horizon-glass.
V. G the back horizon-glass.
VI. K the dark glasses or screens.
VII. HI the vanes or sights.
VIII. The arc BC is called the limb or quadrantal arc; the arc *cd*, lying from *o* towards the right, is called the arc of excess.

The quadrant consists of an arc BC, firmly attached to two radii, or bars, AB, AC, which are strengthened and bound together by the two braces LM.

The index D is a flat bar of brass, that turns on the centre of the octant. At the lower end of the index there is an oblong opening: to one side of this opening a vernier is fixed, to subdivide the divisions of the arc; at the bottom or end of the index there is a piece of brass, which bends under the arc, carrying a spring to make the vernier lie close to the divisions: it is also furnished with a screw to fix the index in any desired position. See Vernier.

The circular arcs on the arc of the quadrant are drawn from the centre on which the index turns: the smallest excentricity in the axis of the index would be productive of considerable errors.

The position of the index on the arc after an observation, points out the number of degrees and minutes contained in the observed angle.

Upon the index E, and near its axis, is fixed a plain speculum, or mirror of glass, quicksilvered. It is set in a brass frame, and is placed so that the face of it is perpendicular to the plane of the instrument; this mirror being fixed to the index, moves along with it, and has its direction changed by the motion thereof.

This glass is designed to receive the image of the sun, or any other object, S, and reflect it upon either of the two horizon-glasses F and G, according to the nature of the observation.

The brass frame with the glass is fixed to the index by the screw C; the other screw serves to replace it in a perpendicular position, if by any accident it has been deranged.

The index-glass is often divided into two parts, the one silvered, the other black with a small screen in front. A single black surface has indeed some advantages; but if the glasses are well selected, there is little danger to be apprehended of error from a want of parallelism; more is to be feared from the surfaces not being flat.

On the radius AB of the octant, are two small speculums F and G. The surface of the upper one is parallel to the index-glass, when the counting division of the index is at *o* on the arc; but the surface of the lower one is perpendicular to the index-glass, when the index is at 0 degrees on the arc; these mirrors receive the reflected rays from the object, and transmit them to the observer.

The horizon-glasses are not entirely quicksilvered; the upper one F, is only silvered on its lower part, or that half next the quadrant, the other half being transparent; and the back part of the frame is cut away, that nothing may impede the sight through the unsilvered part of the glass. The edge of the foil of this glass is nearly parallel to the plane of the instrument, and ought to be very sharp, and without a flaw.

The other horizon-glass G, is silvered at both ends; in the middle there is a transparent slit, through which the horizon, or other object, may be seen.

Each of these glasses is set in a brass frame, to which there is an axis; this axis passes through the wood-work, and is fitted to a lever on the under side of the quadrant; by this lever the glass may be turned a few degrees on its axis, in order to set it parallel to the index-glass. The lever has a contrivance to turn it slowly, and a button to fix it. To set the glasses perpendicular to the plane of the quadrant, there are two sunk screws, one before and one behind each glass; these screws pass through the plate on which the frame is fixed, into another plate; so that by loosening one and tightening the other of these screws, the direction of the frame with its mirror may be altered, and thus be set perpendicular to the plane of the instrument.

There are two red or dark glasses, and one green one K; they are used to prevent the bright rays of the sun, or the glare of the moon, from hurting the eye at the time of observation. They are each of them set in a brass frame, which turns on a centre; so tha they may be used separately, or together, as the brightness of the sun may require. The green glass may be used also alone, if the sun is very faint; it is also used for taking the altitude of the moon, and in ascertaining her distance from a fixed star.

When these glasses are used for the fore observation, they are fixed as at K; when used for the back observation, they are removed to N.

Each of the vanes H and I, is a perforated piece of brass, designed to direct the sight parallel to the plane of the quadrant. That which is fixed at I is used for the fore, the other for the back, observation.

The vane I has two holes: one exactly at the height of the quicksilvered edge of the horizon-glass; the other somewhat higher, to direct the sight to the middle of the transparent part of the mirror, for those objects which are bright enough to be reflected from the unsilvered part of the mirror.

Directions to hold the instrument. It is recommended to support the weight of the instrument by the right hand, and reserve the left to govern the index. Place the thumb of the right hand against the edge of the quadrant, under the swelling part of which the fore sight I stands, extending the fingers across the back of the quadrant, so as to lay hold on the opposite edge, placing the fore finger above, and the other fingers below the swelling part, or near the fore horizon-glass; thus you may support the instrument conveniently, in a vertical position, by the right hand only; by resting the thumb of the left hand against the side, or the fingers against the middle bar, you may move the index gradually either way.

In the back observation, the instrument should be supported by the left hand, and the index be governed by the right.

Of the two objects which are made to coincide by this instrument, the one is seen directly by a ray passing through, the other by a ray reflected from, the same point of the horizon-glass to the eye. This ray is called the visual ray; but when it is considered merely as a line drawn from the middle of the horizon-glass to the eye-hole of the sight vane, it is called the axis of vision.

The axis of a tube, or telescope, used to direct the sight, is also called the axis of vision.

The quadrant, if it is held as before directed, may be easily turned round between the fingers and thumb, and thus nearly on a line parallel to the axis of vision; thus the plane of the quadrant will pass through the two objects when an observation is made, a circumstance absolutely necessary, and which is more readily effected when the instrument is furnished with a telescope. Within the telescope are two parallel wires, which by turning the eye-glass tube may be brought parallel to the plane of the quadrant, so that by bringing the object to the middle between them, you are certain of having the axis of vision parallel to the plane of the quadrant.

Of the observations. There are two sorts of observations to be made with this instrument: the one is when the back of the observer is turned towards the object, and therefore called the back observation; the other when the face of the observer is turned towards the object, which is called the fore observation.

To rectify the instrument for the fore observation. Slacken the screw in the middle of the handle behind the glass F; bring the index close to the button h; hold the instrument in a vertical position, with the arch downwards; look through the right-hand hole in the vane I, and through the transparent part of the glass F, for the horizon; and if it lies in the same right line with the image of the horizon seen on the silvered part, the glass F is rightly adjusted; but if the two horizontal lines disagree, turn the screw which is at the end of the handle backward or forward, till those lines coincide; then fasten the middle screw of the handle, and the glass is rightly adjusted.

To take the sun's altitude by the fore observation, Having fixed the screens above the horizon-glass F, and suited them proportionally to the strength of the sun's rays, turn your face towards the sun, holding the instrument with your right hand, by the braces L and M, in a vertical position, with the arch downward; put your eye close to the right-hand hole in the vane I, and view the horizon through the transparent part of the horizon-glass F, at the same time moving the index D with the left hand, till the reflex solar spot coincides with the line of the horizon; then the degrees counted from that end next your body, will give the sun's altitude at that time, observing to add or subtract 16 minutes according as the upper or lower edge of the sun's reflex image is made use of.

But to get the sun's meridian altitude, which is the thing wanted for finding the latitude, the observations must be continued; and as the sun approaches the meridian, the index D must be continually moved towards B, to maintain the coincidence between the reflex solar spot and the horizon; and consequently as long as this motion can maintain the same coincidence, the observation must be continued till the sun has reached the meridian, and begins to descend, when the coincidence will require a retrograde motion of the index, or towards C; and then the observation is finished, and the degrees counted as before will give the sun's meridian altitude, or those from B will give the zenith distance; observing to add the semidiameter, or 16′, when his lower edge is brought to the horizon, or to subtract 16 when the horizon and upper edge coincide.

To take the altitude of a star by the fore observation. Through the vane H, and the transparent slit in the glass G, look directly to the star; and at the same time move the index, till the image of the horizon behind you, being reflected by the great speculum, is seen in the silvered part of G, and meets the star; then will the index shew the degrees of the star's altitude.

To rectify the instrument for the back observation. Slacken the screw in the middle of the handle, behind the glass G; turn the button h on one side, and bring the index as many degrees before 0 as are equal to double the dip of the horizon at your height above the water; hold the instrument vertical, with the arch downward; look through the hole of the vane H; and if the horizon seen through the transparent slit in the glass G, coincides with the image of the horizon seen in the silvered part of the same glass, then the glass G is in its proper position; but if not, set it by the handle, and fasten the screw as before.

To take the sun's altitude by the back observation. Put the screens as at K; and in proportion to the strength or faintness of the sun's rays, let either one or both or neither of the frames of those glasses be turned close to the face of the limb; hold the instrument in a vertical position, with the arch downward, by the braces L and M, with the left hand; turn your back to the sun, and put one eye close to the hole in the vane H, observing the horizon through the transparent slit in the horizon-glass G; with the right hand move the index D, till the reflected image of the sun is seen in the silvered part of the glass G, and in a right line with the horizon; swing your body to and fro, and if the observation is well made, the sun's image will be observed to brush the horizon, and the degrees reckoned from C, or that part of the arch farthest from your body, will give the sun's altitude at the time of observation; observing to add 16′, or the sun's semidiameter, if the sun's upper edge is used, and subtract the same for the lower edge.

The direction just given, for taking altitudes at sea, would be sufficient, but for two corrections that are necessary to be made before the altitude can be accurately determined, viz. one on account of the observer's eye being raised above the level of the sea, and the other on account of the refraction of the atmosphere, especially in small altitudes.

The following tables, therefore, shew the corrections to be made on both these accounts:

TABLE I. Dip of the horizon of the sea.			TABLE II. Refractions of the stars, &c. in altitude.					
Height of the eye.	Dip of the horizon.		Appar. altit. in deg.	Refraction.		App. alt. in deg.	refraction.	
Feet.	′	″	°	′	″	°	′	″
1	0	57	0	33	0	11	4	47
2	1	21	¼	30	35	12	4	23
3	1	39	½	28	22	15	3	30
5	2	8	1	24	29	20	2	35
10	3	1	2	18	35	25	2	2
15	3	42	3	14	36	30	1	38
20	4	16	4	11	51	35	1	21
25	4	46	5	9	54	40	1	8
30	5	14	6	8	29	45	0	57
35	5	39	7	7	20	50	0	48
40	6	2	8	6	29	60	0	33
45	6	24	9	5	48	70	0	21
50	6	44	10	5	15	80	0	10

General rules for these corrections. 1. In the fore observations, add the sum of both corrections to the observed zenith distance, for the true zenith distance; or subtract the said sum from the observed altitude, for the true one. 2. In the back observation, add the dip and subtract the refraction for altitudes; and for zenith distances do the contrary, viz. subtract the dip, and add the refraction.

Example. By a back observation, the altitude of the sun's lower edge was found by Hadley's quadrant to be 25° 12′, the eye being 30 feet above the horizon. By the tables, the dip on 30 feet is 5′ 14″, and the refraction on 25° 12′ is 2′ 1″. Hence

Appar. alt. lower limb	25°	12′	0″
Sun's semidiameter, sub.	0	16	0
Appar. alt. of centre	24	56	3
Dip of horizon, add	0	5	14
	25	1	14
Refraction, subtract	0	2	1
True alt. of centre	24	59	13

In the case of the moon, besides the two corrections above, another is to be made for her parallaxes. But for all these particulars, see the requisite tables for the Nautical Almanac; also Robertson's Navigation, vol. 2, pa. 340, &c. edit. 1780.

2. Sinical quadrant is one of some use in navigation. It consists of several concentric quadrantal arches, divided into eight equal parts, by means of radii, with parallel right lines crossing each other at right angles. Now any one of the arches, as BC, fig. 8. in the Plate, may represent a quadrant of any great circle of the sphere, but is chiefly used for the horizon or meridian. If then BC is taken for a quadrant of the horizon, either of the sides, as AB, may represent the meridian, and the other side AC will represent a parallel, or line of east and west; all the other lines parallel to AB will be also meridians; and all those parallel to AC, east and west lines, or parallels. Again, the eight species into which the arches are divided by the radii, represent the eight points of the compass in a quarter of the horizon; each containing 11° 15′. The arch BC is likewise divided into 90°, and each degree subdivided into 12′, diagonalwise. To the centre is fixed a thread, which being laid over any degree of the quadrant, serves to divide the horizon.

If the sinical quadrant is taken for a fourth part of the meridian, one side of it AB may be taken for the common radius of the meridian and equator; and then the other, AC, will be half the axis of the world. The degrees of the circumference BC will represent degrees of latitude; and the parallels to the side AB assumed from every point of latitude to the axis, AC, will be radii of the parallels of latitudes, as likewise the cosine of those latitudes.

Hence, suppose it is required to find the degrees of longitude contained in 83 of the lesser leagues in the parallel of 48°; lay the thread over 48° of latitude on the circumference, and count thence the 83 leagues on AB, beginning at A; this will terminate in H, allowing every small interval four leagues. Then tracing out the parallel HE, from the point H to the thread; the part AE of the thread shews that 125 greater or equinoctial leagues make 6° 15′; and therefore that the 83 lesser leagues AH, which make the difference of longitude of the course, and are equal to the radius of the parallel HE, make 6° 15′ of the said parallel.

When the ship sails upon an oblique course, such course, beside the north and south greater leagues, gives lesser leagues easterly and westerly, to be reduced to degrees of longitude of the equator. But these leagues being made neither on the parallel of departure, nor on that of arrival, but on all the intermediate ones, there must be found a mean proportional parallel between them. To find this, there is on the instrument a scale of cross latitudes. Suppose then it were required to find a mean parallel between the parallels of 40° and 60°; take with the compasses the middle between the 40th and 60th degree on the scale; this middle point will terminate against the 51st degree, which is the mean parallel sought.

The chief use of the sinical quadrant is, to form upon it triangles similar to those made by a ship's way with the meridians and parallels; the sides of which triangles are measured by the equal intervals between the concentric quadrants, and the lines N and S, E and W; and every 5th line and arch are made deeper than the rest. Now suppose a ship has sailed 150 leagues north-east by north, or making an angle of 33° 45′ with the north part of the meridian; here are given the course and distance sailed, by which a triangle may be formed on the instrument similar to that made by the ship's course; and hence the unknown parts of the triangle may be found. Thus, supposing the centre A to represent the place of departure, count by means of the concentric circles along the point the ship sailed on, viz. AAD, 150 leagues; then in the triangle AED, similar to that of the ship's course, find AE = difference of latitude, and DE = difference of longitude, which must be reduced according to the parallel of latitude come to.

Quadrant *of altitude* is an appendix to the artificial globe, consisting of a thin slip of brass, the length of a quarter part of one of the great circles of the globe, and graduated. At the end, where the division terminates, is a nut riveted on, and furnished with a screw, by means of which the instrument is fitted on the meridian, and moveable round upon the rivet to all points of the horizon, as represented in the figure referred to. Its use is to serve as a scale in measuring of altitudes, amplitudes, azimuths, &c.

QUADRANTAL, in Roman antiquity, a vessel every way square like a die, serving as a measure of liquids; its capacity was eighty libræ or pounds of water, which made 48 sextaries, two urnæ, or eight congii.

QUADRAT, a mathematical instrument, called also a geometrical square, and line of shadows; it is frequently an additional member on the face of the common quadrant, as also on those of Gunter's and Sutton's quadrant; but we shall describe it by itself, as being a distinct instrument.

It is made of any solid matter, as brass, wood, &c. or of any four plane rules joined together at right angles, as represented in Plate Quadrant's fig. 9, where A is the centre, from which hangs a thread with a small weight at the end, serving as a plummet. Each of the sides BE and DE is divided into a hundred equal parts, or if the sides are long enough to admit of it, into a thousand parts; C and F are two sights, fixed on the side AD. There is, moreover, an index AH, which, when there is occasion, is joined to the centre A, in such a manner that it can be moved freely round, and remain in any given situation. On this instrument are two sights K, L, perpendicular to the right line going from the centre of the instrument. The side DE is called the upright side, or the line of the direct or upright shadows; and the side BE is termed the reclining side, or the line of the versed or back shadows.

To measure an accessible height AB, fig. 10. by the quadrat, let the distance BD be measured, which suppose = 96 feet, and let the height of the observer's eye be six feet; then holding the instrument with a steady hand, or rather resting it on a support, let it be directed towards the summit A, so that it may be seen clearly through both sights; the perpendicular or plumb-line meanwhile hanging free, and touching the surface of the instrument; let now the perpendicular be supposed to cut off on the upright side KN 80 equal parts; it is evident that LKN, ACK, are similar triangles, and by prop. 4. lib. 6. of Euclid, NK : KL : : KC (*i.e.* BD) : CA; that is, 80 : 100 : : 96 : CA; therefore by the rule of three, $CA = \frac{96 \times 100}{80} = 120$ feet; and CB, the height of the observer's eye, = 6 feet, being added, the whole height BA is 126 feet.

If the observer's distance, as DE, is such that, when the instrument is directed as formerly towards the summit A, the perpendicular falls on the angle P, and the distance BE or CG is 120 feet, CA will also be 120 feet; for PG : GH : : GC : CA; but PG = GH, therefore GC = CA; that is, CA will be 120 feet, and the whole height BA = 126 feet as before.

But let the distance BF be 300 feet, and the perpendicular or plumb-line cut off 40 equal parts from the reclining side. Now, in this case, the angles QAC, QZI, are equal (29. 1. Eucl.), as are also the angles QZI, ZIS; therefore ∠ ZIS = QAC; but ZSI = QCA, as being both right: hence, in the equiangular triangles ACQ, SZI, we have (by 4. 6. Eucl.) ZS : SI : : CQ : CA; that is, 100 : 40 : : 300 : CA, or $CA = \frac{40 \times 300}{100} = 120$; and by adding six feet, the observer's height, the whole height BA will be 126 feet.

To measure any distance at land or sea by the quadrat. In this operation the index AH, fig. 9, is to be applied to the instrument, as was shown in the description; and by the help of a support, the instrument is to be placed horizontally at the point A, fig. 11. then let it be turned till the remote point F, whose distance is to be measured, is seen through the fixed sights; and bringing the index to be parallel with the other side of the instrument, observe through its sights any accessible mark B, at a distance; then carrying the instrument to the point B, let the immoveable sights be directed to the first station A, and the sights of the index to the point F. If the index cuts the right side of the square, as in K, the proportion will be (by 4. 6.) BR : RK : : BA (the distance of the stations to be measured with a chain) : AF, the distance sought. But if the index cuts the reclined side of the square in the point L, then the proportion is, LS : SB : : BA : AG, the distance sought; which accordingly may be found by the rule of three.

Quadrat, in printing, a piece of metal cast like the letters, to fill up the void spaces between words, &c. There are quadrats of different sizes, as *m* quadrats, *n* quadrats, &c. which are respectively of the dimensions of these letters.

QUADRATIC EQUATION, that wherein the unknown equality is of two dimensions, or raised to the second power. See Algebra.

QUADRATURE, in geometry, denotes the squaring, or reducing a figure to a square. Thus the finding of a square which shall contain just as much surface or area as a circle, an ellipsis, a triangle, &c. is the quadrature of a circle, ellipsis, &c.

The quadrature of curvilinear spaces, as the circle, ellipsis, parabola, &c. is a matter of much deeper speculation, making a part of the higher geometry; wherein the doctrine of fluxions is of singular use. See Fluxion.

Case I. Let ARC (Plate Quadrant, fig. 12.) be a curve of any kind, whose ordinates R*b*, CB, are perpendicular to the axis AB. Imagine a right line *b*R*g*, perpendicular to AB, to move parallel to itself from A towards B; and let the velocity thereof, or the fluxion of the absciss A*b*, in any proposed position of that line, be denoted by bd; then will bn, the rectangle under bd, and the ordinate bR, express the corresponding fluxion of the generating area AbR: which fluxion, if A$b = x$, and bR $= y$, will be $y\dot{x}$. From whence, by substituting for y or $\dot{x}$, according to the equation of the curve, and taking the fluent, the area itself AbR will become known.

But in order to render this still more plain, we shall give some examples, wherein x, y, z, and u, are all along put to denote the absciss, ordinate, curve line, and the area, respectively. Thus, if the area of a right-angled triangle is required, put the base AH (fig. 13,) $= a$, the perpendicular HM $= b$, and let AB $= x$ be any portion of the base considered as a flowing quantity; and let BR $= y$, be the ordinate, or perpendicular corresponding. Then, because of the similar triangles AHM and ABR, we shall have $a : b :: x : y = \frac{bx}{a}$. Whence, $y\dot{x}$, the fluxion of the area ABR, is, in this case, equal to $\frac{bx\dot{x}}{a}$; and consequently the fluent thereof, or the area itself, $= \frac{bx^2}{2a}$: which, therefore, when $x = a$, and BR coincides with HM, will become $\frac{ab}{2} = \frac{\text{AH} \times \text{HM}}{2} =$ the area of the whole triangle AHM; as is also demonstrable from the principles of common geometry.

Again, let the curve ARMH (fig. 14,) whose area you would find, be the common parabola; in which case, if AB $= x$, and BR $= y$, and the parameter $= a$, we shall have $y^2 = ax$, and $y = a^{\frac{1}{2}} x^{\frac{1}{2}}$: and therefore $\dot{u}\ (= y\dot{x}) = a^{\frac{1}{2}} x^{\frac{1}{2}} \dot{x}$; whence $u = \frac{2}{3} \times a^{\frac{1}{2}} x^{\frac{3}{2}} = \frac{2}{3}\ a^{\frac{1}{2}} x^{\frac{1}{2}} \times x = \frac{2}{3} yx = \frac{2}{3} \times \text{AB} \times \text{BR}$. Hence a parabola is two-thirds of a rectangle of the same base and altitude.

The same conclusion might have been found more easily in terms of y: for $x = \frac{y^2}{a}$, and $\dot{x} = \frac{2y\dot{y}}{a}$; and consequently $\dot{u}\ (= y\dot{x}) = \frac{2y^2\dot{y}}{a}$; whence $u = \frac{2y^3}{a} = \frac{2y}{3} \times \frac{y^2}{n} = \frac{2y}{3} \times x = \frac{2}{3} \times \text{AB} \times \text{BR}$, as before.

Quadrature, in astronomy, that aspect of the moon when she is 90° distant from the sun; or when she is in a middle point of her orbit, between the points of conjunction and opposition, namely, in the first and third quarters.

Quadrature-lines are two lines placed on Gunter's sector: they are marked with Q. and 5, 6, 7, 8, 9, 10: of which Q. signifies the side of the square, and the other figures the side of the polygons of 5, 6, 7, &c. sides. S, on the same instrument, stands for the semidiameter of a circle, and 90 for a line equal to 90° in circumference.

QUADRATUS, in anatomy, a name given to several muscles on account of their square figures.

QUADRIGA, in antiquity, a car or chariot drawn by four horses. On the reverse of medals we frequently see the emperor or Victory in a quadriga, holding the reins of the horses; whence these coins are, among the curious, called nummi quadrigati, and Victoriati.

QUADRILATERAL, in geometry, a figure whose perimeter consists of four right lines, making four angles; whence it is also called a quadrangular figure. The quadrilateral figures are either a parallelogram, trapezium, rectangle, square, rhombus, or rhomboides.

QUADRILLE, a game at cards, sometimes called ombre by four; which chiefly differs from ombre by three, in being played by four persons; and having all the forty cards dealt out, to each person, at ten each.

The general laws of this game are, 1. It is not permitted to deal the cards any otherwise than four by three, the dealer being at liberty to begin with which of those numbers he pleases. 2. If he who plays either sans prendre, or calling a king, names a trump of a different suit from that his game is in, or names two several suits, that which he first named must be the trump. 3. He who plays must name the trump by its proper name, as he likewise must the king he calls. 4. He who has said I pass, must not be again admitted to play, except he plays by force, upon account of his having spadille. 5. He who has asked the question, and has leave given him to play, is obliged to do it; but he must not play sans prendre except he is forced to do it. 6. He who has the four kings may call the queen of either of his kings. 7. Neither the king nor queen of the suit which is trumps must be called. 8. He who has one or several kings, may call any king he has in his hand; in such case, if he wins, he alone must make six tricks; if he wins, it is all his own; and if he loses he pays all by himself. 9. Every one ought to play in his turn, but for having done otherwise no one must be beasted. 10. He, however, whose turn it is not to play, having in his hand the king the ombre has called, and who shall trump about with either spadille, manille, or basto, or shall even play down the king that was called, to give notice of his being the friend, must not pretend to undertake the vole; nay, he must be condemned to be beasted if it appears that he did it with any fraudulent design. 11. He who has drawn a card from his game, and presented it openly in order to play it, is obliged so to do, if his retaining it may be either prejudicial to the game, or give any intimation to the friend, especially if the card is a matadore; but he who plays sans prendre, or calls his own king, is not subject to this law. 12. None ought to look upon the tricks, nor to count aloud what has been played, except when it is his turn to play, but to let every one reckon for himself. 13. He who, instead of turning up the tricks before any one of his players, shall turn up and discover his game, must be equally beasted with him whose cards he had so discovered, the one paying one half and the other the like. 14. He who renounces must be beasted as many times as he has so done, but if the cards are mixed he is to pay but one beast. 15. If the renounce prejudices the game, and the deal is not played out, every one may take up his cards, beginning at the trick where the renounce was made, and play them over again. 16. He who shews the game before the deal is out must be beasted, except he plays sans prendre. 17. None of the three matadores can be commanded down by an inferior trump. 18. If he who plays sans prendre with the matadores in his hand, demands only one of them, he must receive only that he mentioned. 19. He who, instead of sans prendre, shall demand matadores, not having them; or he who shall demand sans prendre instead of matadores; cannot compel the players to pay him what is really his due. 20. Matadores are only paid when they are in the hands of the ombre, or of the king his ally, whether all in one hand, or separately in both. 21. He who undertakes the vole and does not make it, must pay as much as he would have received had he won it. 22. He who plays and does not make three tricks is to be beasted alone, and must pay all that is to be paid; and if he makes no tricks at all, he must also pay to his two adversaries the vole, but not to his friend.

QUADRUPEDS, in zoology, a class of land animals, with hairy bodies, and four limbs or legs proceeding from the trunk of their bodies; add to this, that the females of this class are viviparous, or bring forth their young alive, and nourish them with milk from their teats.

QUADRUPLE, a sum or number multiplied by four, or taken four times.

QUAKERS. By stat. 7 and 8 W. III. c. 27, and 8 G. I. c. 6. quakers making and subscribing the declaration of fidelity mentioned in 1 W. and M. shall not be liable to the penalty against others refusing to take such oaths: and not subscribing the declaration of fidelity, &c. they are disabled to vote at the election of members of parliament.

By 7 and 8 W. III. c. 34, made perpetual by 1 G. I. c. 6, quakers, where an oath is required, are permitted to make a solemn affirmation or declaration of the truth of any fact; but they are not capable of being witnesses in any criminal cause, serving on juries, or bearing any office or place of profit under government, unless they are sworn like other protestants; but this clause does not extend to the freedom of a corporation. 1 Lord Raym. 337.

By stat. 22 G. II. c. 46. an affirmation shall be allowed in all cases (except criminal) where by any act of parliament an oath is required, though no provision is therein made for admitting a quaker to make his affirmation. See Friends.

QUALEA, a genus of the monandria monogynia class and order. The calyx is four-parted; corolla two-petalled; fruit a berry. There are two species, trees of Guiana.

QUAMDIU SE BENE GESSERIT, a clause frequently to be found in letters patent of the grant of offices, as in those to the barons of the exchequer, &c. where it intimates that they shall hold the same as long as they shall behave themselves well. It is said that these words intend what the law would imply if an office was granted during life.

QUANTUM MERUIT, in law, is an action upon the case, founded on the necessity of paying a person for doing any thing as much as he deserves.

QUARE, in law, a term affixed to the title of several writs: as, 1. Quare ejecit infra terminum, is a writ that lies for a lessee cast out of his farm before his term is expired. 2. Quare impedit, a writ that lies for a person that has purchased an advowson, against him who disturbs him in the right thereof by presenting a clerk to it when the church is vacant. This writ differs from what is called a darrein presentment, because that is brought where a person or his ancestors formerly presented; but this lies for him that is purchaser himself. Yet in both these writs, the plaintiff recovers the presentation and damages; though the title to the advowson is recovered only by a quare impedit. 3. Quare incumbravit is a writ that lies against a bishop, who, within six months after the vacancy of a benefice, confers it on his clerk, while two others are contesting the right of presentation. 4. Quare non admisit is a writ that lies where any one has recovered an advowson or presentation, and sending his clerk to be admitted, the bishop refuses to admit him; in which case the person that has the presentation may have this writ agaist the bishop. 5. Quare non permittit is a writ that lies for one who has a right to present for a turn against the proprietary. 6. Quare obstruxit, is a writ that lies for him who, having a right to pass through another's grounds, cannot enjoy the same, because the owner has fenced them up.

QUARTER, the fourth part of any thing, the fractional expression for which is $\frac{1}{4}$. Quarter, in weights, is generally used for the fourth part of a hundredweight avoirdupois, or 28lb.

Used as the name of a dry measure, quarter is the fourth part of a ton in weight, or eight bushels.

QUARTER, in heraldry, is applied to the parts or members of the first division of a coat that is quartered or divided into four quarters.

QUARTER *of a point*, in navigation, is the fourth part of the distance between two cardinal points, which is 2° 48′.

QUARTER *of a ship*, is that part of a ship's hold which lies between the steerage-room and the transom.

QUARTER-MASTERS, or *quarteers*, in a ship of war, are officers whose business it is to rummage, stow, and trim, the ship in the hold; to overlook the steward in his delivery of victuals to the cook, and in pumping or drawing out beer, or the like. They are also to keep their watch duly, in conning the ship, or any other duty.

QUARTER-SESSIONS. See SESSIONS.

QUARTERING, in gunnery, is when a piece of ordnance is so traversed that it will shoot on the same line, or on the same point of the compass, as the ship's quarter bears.

QUARTERING, in heraldry, is dividing a coat into four or more quarters, or quarterings, by parting, couping, &c. that is, by perpendicular and horizontal lines, &c.

QUARTERS, a name given at sea to the several stations where the officers and crew of a ship of war are posted in action.

The number of men appointed to manage the artillery is always in proportion to the nature of the guns, and the number and condition of the ship's crew. They are, in general, as follow, when the ship is well manned, so as to fight both sides at once occasionally:

Pounder		No. of men.
To a 42	-	15
32	-	13
24	-	11
18	-	9
12	-	7
9	-	6
6	-	5
4	-	4
3	-	3

This number, to which is often added a boy to bring powder to every gun, may be occasionally reduced, and the guns nevertheless well managed. The number of men appointed to the small arms on board his majesty's ships and sloops of war, by order of the admiralty, are:

Rate of the ship.		No. of men to the small arms.
1st	- - -	150
2d	- - -	120
3d of 80 guns	-	100
— of 70 guns	-	80
4th of 60 guns	-	70
4th	- - -	60
5th	- - -	50
6th	- - -	40
Sloops of war	-	30

The lieutenants are usually stationed to command the different batteries, and direct their efforts against the enemy. The master superintends the movements of the ship, and whatever relates to the sails. The boatswain, and a sufficient number of men, are stationed to repair the damaged rigging; and the gunner and carpenter, wherever necessary, according to their respective offices.

QUARTERS, *close*, in a ship, those places where the seamen quarter themselves, in case of boarding, for their own defence, and for clearing the decks, &c.

QUARTZ. This stone, which is very common in most mountainous countries, is sometimes crystallized, and sometimes amorphous. The primitive form of its crystals, according to Mr. Hauy, is a rhomboidal parallelopiped, the angles of whose rhombs are 94° and 86°, so that it does not differ much from a cube. The most common variety is a dodecahedron, composed of two six-sided pyramids, applied base to base, whose sides are isosceles triangles, having the angle at the vertex 40°, and each of the angles at the base 70°; the inclination of a side of one pyramid to the contiguous side of the other pyramid is 104°. There is often a six-sided prism interposed between the two pyramids, the sides of which always correspond with those of the pyramids. For a description and figure of the other varieties of quartz crystals, and for a demonstration of the law which they have followed in crystallizing, we refer the reader to Romé de Lisle and Mr. Hauy.

The texture of quartz is more or less foliated. Fracture conchoidal or splintery. Its lustre varies, and also its transparency, and in some cases it is opaque. It causes a double refraction. Specific gravity from 2.64 to 2.67, and in one variety 2.69. Its colour and appearance are exceedingly various: this has induced mineralogists to divide it into numerous varieties. The common division is into five subspecies.

1. Amethyst. Colour violet, of different degrees of intensity, sometimes greenish. Commonly found in crystals in the hollow cavities of agates. Composed, according to Rose, of 97.50 silica
0.25 alumina
0.50 oxide of iron and manganese

98.25

2. Rock crystal. Colourless, or white with different shades of grey, yellow, brown, and red. Usually crystallized in the hollows of veins. Transparency 3, 4. Composed, according to Bergman, of
93 silica
6 alumina
1 lime

100.

3. Milk and rosy red quartz. Colour usually red. Always in mass, never crystallized. Lustre greasy. Transparency 2, 3. Found in Bavaria and Finland. Supposed to contain manganese.

4. Common quartz. A constituent of many mountains. Colours exceedingly numerous, white, grey, brown, yellow, red, green of various shades. Usually amorphous; sometimes crystallized. Its transparency chiefly distinguishes it from rock crystal. See CRYSTAL.

5. Trase: usually lake-green, sometimes olive and pistachio green. Commonly in mass; rarely crystallized.

Cronstedt observes, that quartz in general, and especially its crystals, are very commonly supposed, when yet in their soft and dissolved state, to have included within them some vegetables; for instance, grass and moss. "This (says he) I cannot absolutely deny; but it deserves carefully to be examined, if that which is shown as a grass is not an asbestos, or a striated cockle; and the moss only branched varieties filled with earth, which, by their being ramose, bear a vegetable appearance. It is very common in agates, and makes them of less value than they otherwise would be. This is most generally the case with those stones which are shown as including vegetables: and for my own part, I have never been so fortunate as to meet with any others."

M. Magellan remarks, that quartz is one of the principal kinds of stone which contain metals. Some of the Hungarian veins consist entirely of it, and the gold is so minutely dispersed, that it cannot be discerned by the best microscopes before it is separated by pounding and washing. The width of the veins, some of which are half a fathom, and some still more, repay the trouble and expences, which the small quantity of gold would not otherwise counterbalance. Nature has not any where produced mountains of pure quartz; for though some rocks in Sweden are ranked among the quartzes, they are undoubtedly mixed with heterogeneous matters. Near Lauterberg upon the Hartz are veins of this stone from one to three fathoms wide, consisting of a loose sand, in which they find the copper ore in nests. In the Danish isle of Anhalt we meet with triangular quartz pebbles. There are likewise crystals of quartz having water enclosed in them; some fine pieces of this kind are to be met with in the imperial cabinet at Vienna, &c.

Rock crystals are generally found upon or among quartz, and are to be met with in all parts of the world. The greatest number are furnished to the European countries from mount Saint Gothard in Switzerland. Here large pieces, weighing from 5 to 800 pounds, were found at Grimselberg; one of 1200 pounds was found some years ago at Frisbach in the Valais; and a piece six feet long, four broad, and equally thick, was found in the island of Madagascar, a place where these natural productions are of the most extraordinary size and perfection.

When great quantities of quartz are continually agitated by the sea or river water, they are sometimes reduced to such very minute parts as to be easily carried away, suspended in the water; and there are sands of so minute a size as to measure less than the two or three hundredth part of an inch. These are called quick-sands. Immense tracts of land consist only of loose sands, particularly along the sea-shore in many parts of Europe. When sand is about as big as peas, it is called gravel; and when it is free from saline and heterogeneous particles, it is employed in making mortar, and for other economical purposes. That which is very pure serves for making flint-glass, with red calces of lead, and the proper alkaline flux; but when mixed with ferruginous-black sand, the glass assumes a greenish-black colour. "This (says M. Magellen) I have seen among the various specimens of glass made by Mr. E. Delaval, F. R. S. who produced a very fine transparent and colourless glass out of the same sand with which he had made some of that black glass, and this only by separating from it all the ferruginous mixture."

QUASSIA, a genus of the monogynia order, in the decandria class of plants, and in the natural method ranking under the 14th order, gruinales. The calyx is pentaphyllous; there are five petals; the nectarium is pentaphyllous; there are from two to five seed-cases, standing asunder, and monospermous. There are three species, the amara, simaruba, and excelsa.

1. The quassia amara grows to the height of several feet, and sends off many strong branches. The wood is of a white colour and light; the bark is thin and grey; the leaves are placed alternately on the branches, and consist of two pair of opposite pinnæ, with an odd one at the end: the flowers are all hermaphrodite, of a bright red colour, and terminate the branches in long spikes. It is a native of South America, particularly of Surinam, and also of some of the West Indian islands. The root, bark, and wood, of this tree, have all places in the materia medica. The wood is most generally used, and is said to be a tonic, stomachic, antiseptic, and febrifuge.

2. The quassia simaruba is common in all the woody lands in Jamaica. It grows to a great height and considerable thickness. The trunks of the old trees are black and a little furrowed. Those of the young trees are smooth and grey, with here and there a broad yellow spot. The inside bark of the trunk and branches is white, fibrous, and tough. It tastes slightly bitter. The wood is hard, and useful for buildings. It splits freely, and makes excellent staves for sugar-hogsheads. It has no sensible bitter taste. The branches are alternate and spreading. The leaves are numerous and alternate. The flowers are of a yellow colour, and placed on spikes beautifully branched.

The fruit is of that kind called a drupa, and is ripe towards the end of May. It is of an oval shape, is black, smooth, and shining. The pulp is fleshy and soft; the taste nauseous and sweet. The nut is flattened, and on one side winged. The kernel is small, flat, and tastes sweet. The natural number of these drupæ is five on each common receptacle; but for the most part there are only two or three. The roots are thick, and run at a small depth under the surface of the ground to a considerable distance. The bark is rough, scaly, and warted. The inside when fresh is a full yellow, but when dry paler. It has but little smell. The taste is bitter, but not very disagreeable. This is the true cortex simarubæ of the shops. The shops are supplied with this bark from Guiana; but now we may have it from our own islands at a moderate expence.

Most authors who have written on the simaruba agree, that in fluxes it restores the lost tone of the intestines, allays their spasmodic motion, promotes the secretions by urine and perspiration, removes that lowness of spirits attending dysenteries, and disposes the patient to sleep; the gripes and tenesmus are taken off, and the stools changed to their natural colour and consistence. In a moderate dose it occasions no disturbance or uneasiness; but in a large dose it produces sickness at stomach and vomiting. Negroes are less affected by it than white people. Dr. Cullen, however, says, "We can perceive nothing in this bark but that of a simple bitter; the virtues ascribed to it in dysentery have not been confirmed by my experience, or that of the practitioners in this country; and leaving what others are said to have experienced to be further examined and considered by practitioners, I can only at present say, that my account of the effect of bitters will perhaps explain the virtues ascribed to simaruba. In dysentery I have found an infusion of camomile-flowers a more useful remedy."

3. The quassia excelsa, or polygama, was named by sir Joseph Banks, Dr. Solander, and Dr. Wright. It is very common in the woodlands of Jamaica, is beautiful, tall, and stately, some being 100 feet long, and 10 feet in circumference eight feet above the ground. The trunk is straight, smooth, and tapering, sending off its branches towards the top. The outside bark is pretty smooth, of a light grey or ash-colour, from various lichens. The bark of the roots is of a yellow cast, somewhat like the cortex simaruba. The wool is of a yellow colour, tough, but not very hard. It takes a good polish, and is used as flooring. The flowers are small, of a yellowish-green colour, with a very small calyx. The male or barren tree has flowers nearly similar to the hermaphrodite, but in it there are only the rudiments of a style. The fruit is a smooth black drupa, round-shaped, and of the size of a pea. Except the pulp of the fruit, every other part of this tree has an intensely bitter taste. In taste and virtues it is nearly equal to the quassia of Surinam. The happiest effects result from the use of this medicine in obstinate remitting fevers from marsh-miasmata, in agues which had resisted the use of Jesuits' bark, and in dysenteries of long standing. It is in daily practice in dropsies from debility, either in simple infusions or tincture by itself, or joined with aromatics and chalybeates. Dr. Drummond, an eminent physician in Jamaica, prescribes it with great success in the above cases, as well as in amenorrhœa, chlorosis, dyspepsia, and in that species of pica called dirt-eating, so fatal to a number of negroes.

The bark of the quassia polygama, but especially the wood, is intensely bitter. They may both be used in various forms. In certain cases of dropsy, aromatics and preparations are joined to it, also in amenorrhœa ad chlorosis; and in worm fevers, the cabbage-bark, or other vegetable anthelmintics.

Quassia, in chemistry. Many vegetable substances have an intensely bitter taste, and on that account are employed in medicine, by brewers, &c. This is the case with the wood of the quassia amara and excelsa, the common quassia of the shops; with the roots of the gentiana lutea, common gentian; the leaves of the humulus lupulus or hop; the bark and wood of the spartium scoparium, or common broom; the flowers and leaves of the anthemis nobilis or chamomile; and many other substances. These bodies owe their bitter taste to the presence of a peculiar vegetable substance differing from every other, which may be distinguished by the name of the bitter principle.

No chemical examination of this substance has been hitherto published; nor indeed are we in possession of any method of separating it from other bodies, or of ascertaining its presence. At the same time it cannot be doubted that it possesses peculiar characters; and its action on the animal economy renders it an object of importance.

1. When water is digested over quassia for some time, it acquires an intensely bitter taste and a yellow colour, but no smell. When water thus impregnated is evaporated to dryness in a low heat, it leaves a brownish-yellow substance, which retains a certain degree of transparency. It continues ductile for some time, but at last becomes brittle. This substance we might consider as the bitter principle in a state of purity. If it contains any foreign body it must be in a very minute proportion. This substance is found to possess the following properties: 1. Its taste is intensely bitter. Colour brownish-yellow. 2. When heated, softens, and swells, and blackens; then burns away without flaming much, and leaves a small quantity of ashes. 3. Very soluble in water and in alcohol. 4. Does not alter the colour of infusion of litmus. 5. Lime water, barytes water, and strontian water, occasion no precipitate. Neither is any precipitate thrown down by silicated potass, aluminated potass, or sulphat of magnesia. 6. The alkalies occasion no change in the diluted solution of the bitter principle. 7. Oxalat of ammonia occasions no precipitate. 8. Nitrat of silver renders the solution muddy, and a very soft flaky yellow precipitate falls slowly to the bottom. 9. Neither corrosive sublimate nor nitrat of mercury occasions any precipitate. 10. Nitrat of copper, and the ammoniacal solution of copper, produce no change; but muriat of copper gives the white precipitate, which falls when this liquid salt is dropt into water. 11. Sulphat and oxymuriat of iron occasion no change. 12. Muriat of tin renders the solution muddy, but occasions no precipitate, unless the solution is concentrated; in that case a copious precipitate falls. 13. Acetat of lead occasions a very copious white precipitate. But the nitrat of lead produces no change. 14. Muriat of zinc occasions no change. 15. Nitrat of bismuth produces no change, though when the salt is dropt into pure water a copious white precipitate appears. 16. Tartar emetic produces no change; but when the muriat of antimony is used, the white precipitate ap-

pears, which always falls when this salt is dropt into pure water. 17. Muriat and arseniat of cobalt occasion no change. 18. Arseniat of potass produces no effect. 19. Tincture of nutgalls, infusion of nutgalls, gallic acid, occasion no effect.

These properties are sufficient to convince us that the bitter principle is a substance differing considerably from all the other vegetable principles. The little effect of the different reagents is remarkable. Nitrat of silver and acetat of lead are the only two bodies which throw it down. This precipitation cannot be ascribed to the presence of muriatic acid; for if muriatic acid was present, nitrat of lead would also be thrown down. Besides, the flakes introduced by nitrat of silver are too light, and indeed have no resemblance whatever to muriat of silver. The precipitate by acetat of lead is very copious. This salt is therefore the best substance for detecting the presence of the bitter principle, when we are certain that no other substance is present which throws down lead.

QUEEN, a woman who holds a crown singly. The title of queen is also given by way of courtesy to her that is married to a king, who is called by way of distinction queen-consort.

A queen-consort is inferior to the king, and is really his subject, though, as the king's wife, she has several prerogatives above other women. Though an alien, she may purchase lands in fee-simple, without either naturalization or denization. She may present to a benefice. She shall not be amerced if she is nonsuited in any action; and may not be impleaded till first petitioned. To conspire her death, or violate her chastity, is high treason. She has an antient peculiar revenue called queen-gold; besides a very large dower, with a royal court, and officers of her own. No person here must marry a queen dowager without the licence of the succeeding king, on pain of forfeiting his lands and goods; but though she marry any of the nobility, or even one under that degree, she does not lose her dignity.

QUERCUS, the *oak-tree*, a genus of the polyandria order, in the monœcia class of plants, and in the natural method ranking under the 50th order, amentaceæ. The calyx is nearly quinquefid; there is no corolla; the stamina are from five to ten in number. The female calyx is monophyllous, very entire, and scabrous. There is no corolla; the styles are from two to five; and there is an ovate seed.

There are 26 species; the most remarkable are: 1. The robur, or common English oak, from about 60 or 70 to 100 feet high, with a prodigious large trunk and spreading head. There is a variety having the leaves finely striped with white. This species grows in great abundance all over England, in woods, forest, and hedge-rows, and is supposed to continue its growth many centuries. 2. The prinus, or chesnut-leaved American oak, grows 50 or 60 feet high; having large oblong-oval smooth leaves, pointed both ways, the edges sinuated-serrated, with the sinuses uniformly round. 3. The phellos, or willow-leaved American oak, grows 40 or 50 feet high, having long, narrow, smooth, entire leaves, like those of the willow. There is a variety called the dwarf willow-leaved oak. 4. The alba, or white Virginian oak, grows 30 or 40 feet high, having a whitish bark, with long obliquely pinnatifid light-green leaves, the sinuses and angles obtuse. 5. The nigra, or black Virginian oak, grows 30 or 40 feet high, having a dark-coloured bark, large wedge-shaped slightly-trilobated leaves. 6. The rubra, or red Virginian oak, grows about 60 feet high, having a dark-greyish bark, long obtusely-sinuated leaves, with the sinuses terminated by bristly points, and sometimes red spotted veins, but generally dying in autumn to a reddish colour, remaining on the trees late in the season. 7. The esculus of Pliny, or cut-leaved Italian oak, grows about 30 feet high, having a purplish bark, oblong deeply-sinuated smooth leaves, and long slender close-sitting acorns in very large cups. 8. Ægilops, or large prickly-cupped Spanish oak, grows 70 or 80 feet high, or more, with a very large trunk, and widely spreading head, having a whitish bark, large oblong-oval deeply-serrated smooth leaves, the serratures bowed backward, and large acorns placed in singularly large prickly-cups. This is a noble species, almost equal in growth to our common English oak. 9. Cerris, or smaller prickly-cupped Spanish oak, grows 30 or 40 feet high, and has oblong lyre-shaped pinnatifid transversely-jagged leaves, downy underneath, and small acorns placed in prickly cups. 10. The ilex, or common evergreen oak, grows 40 or 50 feet high, having a smooth bark, oval and oblong undivided serrated petiolated leaves, downy and whitish underneath. The varieties are, broad-leaved, narrow-leaved, and sometimes both sorts, and other different-shaped leaves on the same tree; also sometimes with sawed and prickly leaves. 11. The gramuntia, or Montpelier holly-leaved evergreen oak, grows 40 or 50 feet high; and has oblong-oval, close-sitting, sinuated, spinous leaves, downy underneath, bearing a resemblance to the leaves of holly. 12. The suber, or cork-tree, grows 30 or 40 feet high, having a thick, rough, fungous, cleft bark, and oblong-oval, undivided, serrated leaves, downy underneath. This species furnishes that useful material cork, it being the bark of the tree; which becoming of a thick fungous nature, under which, at the same time, is formed a new bark, and the old being detached for use, the tree still lives, and the succeeding young bark becomes also of the same thick spongy nature in six or seven years, fit for barking, having likewise another fresh bark forming under it, becoming cork like the others in the like period of time: and in this manner these trees wonderfully furnish the cork for use. The tree grows in great plenty in Spain and Portugal, and from these countries we receive the cork. The Spaniards burn it, to make that kind of light black we call Spanish black, used by painters. Cups made of cork are said to be good for hectical persons to drink out of. The Egyptians made coffins of cork, which being lined with a resinous composition, preserved dead bodies uncorrupted. The Spaniards line stone walls with it, which not only renders them very warm, but corrects the moisture of the air. 13. The coccifera, scarlet, or kermes oak, grows but 14 or 15 feet high, branching all the way, and of bushy growth, with large oval, undivided, indented, spinous leaves, and producing small glandular excrescences, called kermes, or scarlet grain, used by the dyers. The small scarlet glands found in this tree are the effect of certain insects depositing their eggs betwixt the bark of the branches and leaves, causing an extravasation of the sap, and forming the excrescence or substance in question, which being dried is the kermes or scarlet pastel. 14. The Molucca, Moluccan oak, commonly called American live oak, grows about 40 feet high, having oval, spear-shaped, smooth, entire leaves, and small, oblong, eatable acorns.

All the above produce flowers annually in the spring, about April or May, of a yellowish colour, but make no ornamental appearance, and are males and females separated in the same tree, the males being in loose amentums, and the females sitting close to the buds in thick leathery hemispherical calyxes, succeeded by the fruit or acorns.

The English oak claims precedence as a timber-tree, for its prodigious height and bulk, and superior worth of its wood. Every possessor of considerable estates ought therefore to be particularly assiduous in raising woods of them; which is effected by sowing the acorns either in a nursery and the plants transplanted where they are to remain, or sown at once in the places where they are always to stand. All the sorts will prosper in any middling soil and open situation, though in a loamy soil they are generally more prosperous; however, there are but few soils in which oaks will not grow; they will even thrive tolerably in gravelly, sandy, and clayey land, as may be observed in many parts of this country of the common oak.

The oak is remarkable for its slowness of growth, bulk, and longevity. It has been remarked that the trunk has attained to the size only of fourteen inches in diameter, and some to twenty, in the space of fourscore years. As to bulk, we have an account of an oak belonging to lord Powis, growing in Broomfield-wood, near Ludlow in Shropshire, in the year 1764, the trunk of which measured 68 feet in girth, 23 in length, and which, reckoning 90 feet for the larger branches, contained in the whole 1455 feet of timber, round measure, or 29 loads and five feet, at 50 feet to a load.

In the opinion of many, the Cowthorp oak near Wetherby, in Yorkshire, is the father of the forest. Dr. Hunter, in his edition of Evelyn, has given an engraving of it. Within three feet of the surface, he says, it measures 16 yards, and close to the ground 26. In 1776, though in a ruinous condition, it was 85 feet high, and its principal limb extended 16 yards from the bole. The foliage was very thin. If this measurement was taken as the dimensions of the real stem, the size of this tree would be enormous; but, like most very large trees, its stem is short, spreading wide at the base, the roots rising above the ground like buttresses to the trunk, which is similar not to a cylinder but to the frustum of a cone. Mr. Marsham says, "I found it in 1768, at four feet, 40 feet 6 inches; at five feet, 36 feet 6 inches; and at six feet, 32 feet 1 inch." In the principal dimensions then, the size of the stem, it is exceeded by the Bentley oak, of which the same writer gives the following account: "In 1759 the oak in Holt-forest, near Bentley, was at seven feet, 34 feet. There is a large excrescence at five and six feet that would render the measure unfair. In 1778 this tree was increased half an inch in 10 years. It does not appear to be hollow, but by the trifling increase I conclude it not sound.". These dimensions, however, are exceeded by those of the Boddington oak. It grows in a piece of rich grass land, called the old orchard ground, belonging to Boddington manor-farm, lying near the turnpike-road between Cheltenham and Tewksbury, in the vale of Gloucester. The stem is remarkably collected at the root, the sides of its trunk being much more upright than those of large trees in general; and yet its circumference at the ground is about 20 paces; measuring with a two-foot rule, it is more than 18 yards. At three feet high it is 42 feet, and where smallest, *i. e.* from five to six feet high, it is 36 feet. At six feet it swells out larger, and forms an enormous head, which has been furnished with huge, and probably extensive, arms. But time and the fury of the wind have robbed it of much of its grandeur, and the greatest extent of arm in 1783 was eight yards from the stem.

In the Gentleman's Magazine for May 1794, we have an account of an oak-tree growing in Penshurst-park in Kent, together with an engraving. It is called the bear or bare oak, from being supposed to resemble that which Camden thought gave name to the county of Berkshire. The dimensions of the tree are these:

	Feet.	Inches.
Girth close to the ground	35	6
Ditto one foot from ditto	27	6
Ditto five feet from ditto	24	0
Height taken by shadow	73	0
Girth of lowest, but not largest limb	6	9

With respect to longevity, Linnæus gives account of an oak 260 years old; but we have had traditions of some in England (how far to be depended upon we know not) that have attained to more than double that age. Mr. Marsham, in a letter to Thomas Beevor, Esq. Bath Papers, vol. i. p. 79, makes some very ingenious calculations on the age of trees, and concludes from the increase of the Bentley oak, &c. that the Fortworth chesnut is 1100 years old.

Besides the grand purposes to which the timber is applied in navigation and architecture, and the bark in tanning of leather, there are other uses of less consequence, to which the different parts of this tree have been referred. The highlanders use the bark to dye their yarn of a brown colour, or, mixed with copperas, of a black colour. Oak saw-dust is also a principal ingredient in dyeing drabs, especially in fustian. The acorns are a good food to fatten swine and turkeys; and after the severe winter of the year 1709, the poor people in France were miserably constrained to eat them themselves. There are, however, acorns produced from another species of oak, which are eaten to this day in Spain and Greece, with as much pleasure as chesnuts, without the dreadful compulsion of hunger.

Quercus marina, the sea oak. See Fucus.

QUERIA, a genus of the trigynia order, in the triandria class of plants, and in the natural method ranking under the 22d order, caryophyllei. The calyx is pentaphyllous; there is no corolla; the capsule is unilocular, and trivalved, with one seed. There are three species, viz. hispanica, canadensis, and trichotoma.

QUICK, or Quickset hedge, among gardeners, denotes all live hedges, of whatsoever sort of plants they are composed, to distinguish them from dead hedges; but in a more strict sense of the word, it is restrained to those planted with the hawthorn, or cratægus oxyacantha, under which name these young plants, or sets, are sold by the nursery-gardeners, who raise them for sale. See Cratægus.

Quick-silver. See Mercury.

QUILTING, a method of sewing two pieces of silk, linen, or stuff, on each other, with wool or cotton between them; by working them all over in the form of chequer or diamond work, or in flowers. The same name is also given to the stuff so worked.

QUINCE. See Pyrus.

QUINCHAMALIA, a genus of the pentandria monogynia class and order. The calyx is inferior, five-toothed; corolla tubular, superior; anth. sessile; seed one. There is one species, a herb of Chili.

QUINCUNX, in Roman antiquity, denotes any thing that consists of five-twelfth parts of another, but particularly of the as.

Quincunx order, in gardening, a plantation of trees, disposed originally in a square, and consisting of five trees, one at each corner, and a fifth in the middle; or a quincunx is the figure of a plantation of trees, disposed in several rows, both length and breadthwise, in such a manner, that the first tree in the second row commences in the centre of the square formed by the two first trees in the first row, and the two first in the third, resembling the figure of the five at cards.

QUINDECAGON, in geometry, a plane figure with fifteen sides and 15 angles, which, if the sides are all equal, is termed a regular quindecagon, and irregular when otherwise.

The side of a regular quindecagon inscribed in a circle is equal in power to the half-difference between the side of the equilateral triangle, and the side of the pentagon inscribed in the same circle; also the difference of the perpendiculars let fall on both sides, taken together.

QUINQUINA. See Cinchona, and Pharmacy.

QUINTILE, in astronomy, an aspect of the planets when they are 72 degrees distant from one another, or a fifth part of the zodiac.

QUIRE of paper, a quantity of 24 or 25 sheets.

QUISQUALIS, a genus of the monogynia order, in the decandria class of plants, and in the natural method ranking under the 31st order, vepreculæ. The calyx is quinquefid and filiform; the petals five; the fruit is a quinque-angular plum. There is only one species, viz. Indica, a shrub of the East Indies.

QUI TAM, in law, is where an action is brought, or an information exhibited, against a person, on a penal statute, at the suit of the king and the party or informer, when the penalty for breach of the statute is directed to be divided between them; in that case, the informer prosecutes as well for the king as himself.

QUIT-CLAIM, in law, signifies a release of any action that one person has against another. It signifies also a quitting a claim or title to lands, &c.

Quit-rent, in law, a small rent that is payable by the tenants of most manors, whereby the tenant goes quit and free from all other services. Antiently this payment was called white-rent, on account that it was paid in silver coin, and to distinguish it from rent-corn.

QUOIN, or Coin, on board a ship, a wedge fastened on the deck close to the breech of the carriage of a gun, to keep it firm up to the ship's side.

QUOITS, a kind of exercise or game known among the antients under the name discus.

QUO MINUS, is a writ which issues out of the court of exchequer to the king's farmer or debtor, for debt, trespass, &c. Though this writ was formerly granted only to the king's tenants or debtors, the practice now is become general for the plaintiff to surmise, that by the wrong the defendant does him, he is the less able to satisfy his debt to the king, by which means jurisdiction is given to the court of exchequer to determine the cause. This writ is to take the body of the defendant in like manner as the capias in the common pleas, and the writ of latitat in the king's bench.

Quo-warranto, in law, a writ which lies against a person or corporation that usurps any franchise or liberty against the king; as to have a fair, market, or the like, in order to oblige the usurper to shew by what right and title he holds or claims such franchise. This writ also lies for mis-user or non-user of privileges granted. The attorney-general may exhibit a quo-warranto in the crown-office against any particular persons, or bodies politic or corporate, who use any franchise or privilege without having a legal grant or prescription for the same; and a judgment obtained upon it is final, as being a writ of right.

R.

R, the seventeenth letter of our alphabet. In the notes of the antients, R. or RO. signifies Roma; R. C. Romana civitas; R. G. C. rei gerendæ causa; R. F. E. D. recte factum et dictum; R. G. F. regis filius; R. P. res publica, or Romani principes; and R.R.R.F.F.F. res Romana ruet ferro, fame, flamma.

Used as a numeral, R antiently stood for eighty, and with a dash over it, thus R̄, for 80,000; but the Greek r, or ϱ, signified 100.

In the prescriptions of physicians, R or ℞ stands for recipe, i. e. take.

RABBETING, in carpentry, the planing or cutting of channels or grooves in boards. In ship-carpentry, it signifies the letting-in of the planks of the ship into the keel; which, in the rake and run of a ship, is hollowed away, that the planks may join the closer.

RABBIT. See LEPUS.

RACHITIS. See MEDICINE.

RACK. See ARRACK.

RACKOON. See URSUS.

RADIAL CURVES, are curves of the spiral kind, whose ordinates, if they may be so called, all terminate in the centre of the including circle, appearing like radii of that circle, whence the name.

RADIALIS, or RADIÆUS. See ANATOMY.

RADIANT. See HERALDRY.

RADIATED FLOWERS. See BOTANY.

RADIATION, the act of a body emitting or diffusing rays of light all round, as from a centre.

RADICLE. See PLANTS, *physiology of*, BOTANY, and GERMINATION.

RADIUS, in geometry, the semidiameter of a circle, or a right line drawn from the centre to the circumference. See CIRCLE, and GEOMETRY.

RADIUS. See ANATOMY.

RAFT, a sort of float, formed by an assemblage of various planks or pieces of timber fastened together side by side, so as to be conveyed more commodiously to any short distance in a harbour or road than if they were separate. The timber and plank with which merchant-ships are laden, in the different parts of the Baltic Sea, are attached together in this manner, in order to float them off to the shipping.

RAFTERS, in building, are pieces of timber, which standing by pairs on the raising-piece, meet in an angle at the top, and form the roof of a building. It is a rule in building, that no rafters should stand farther than 12 inches from one another: and as to their sizes or scantlings, it is provided by act of parliament, that principal rafters, from 12 feet six inches to 14 feet six inches long, shall be five inches broad at the top, and eight at the bottom, and six inches thick. Those from 14 feet six inches to 18 feet six inches long, to be nine inches broad at the foot, seven inches at the top, and seven inches thick; and those from 18 feet six inches, to 21 feet six inches long, to be 10 inches broad at the foot, eight at the top, and eight thick. Single rafters, eight feet in length, must have four inches and a half, and three inches three quarters, in their square. Those of nine feet long, must be five and four inches square.

Principal rafters should be nearly as thick at the bottom as the beam, and should diminish in their length one-fifth or one-sixth of their breadth; the king-posts should be as thick as the principal rafters; and their breadth according to the size of those that are intended to be let into them, the middle part being left somewhat broader than the thickness.

RAG WORT. See SENECIS.

RAGG, *rowley*, a genus of stones belonging to the siliceous class. It is of a dusky or dark-grey colour, with many small shining crystals, having a granular texture, and acquiring an ochry crust by exposure to the air. The specific gravity is 2.748. It becomes magnetic by being heated in an open fire. In a strong fire it melts without addition, but with more difficulty than basaltes. It was analysed by Dr. Withering, who found that 100 parts of it contain 47.5 of siliceous earth, 32.5 of argil, and 20 of iron.

RAJA, *ray*, a genus of fishes of the class amphibia, and of the order nantes. The generic character is, mouth situated beneath the head, transverse, beset with teeth; spiracles beneath, five on each side the neck; body in most species sub-rhomboidal.

This genus, of which there are 19 species, is distinguished by the remarkable breadth and thinness of the body, the pectoral fins appearing like a continuation of the sides themselves, being covered with the common skin. Their rays are cartilaginous, straight, and furnished with numerous swellings or knots; the teeth are very numerous, small, and placed in ranges over the lips or edges of the mouth; the eyes are furnished with a nictitating membrane or skin, which can at pleasure be drawn over them like an eyelid; and at some distance above the eyes are situated the nostrils, each appearing like a large and somewhat semilunar opening edged with a reticulated skin, and furnished internally with a great many laminated processes divided by a middle partition; they are guarded by an exterior valve: behind the eyes are also a pair of holes communicating with the mouth and gills: these latter, taken together, present a vast extent of surface: the young are contained in oblong square capsules, with lengthened corners, and are discharged at distant intervals, the young animal gradually liberating itself from its confinement, and adhering for some time by the umbilical vessels. The rays in general feed on the smaller kind of crabs, testacea, marine insects, and fishes. They are constant inhabitants of the sea, lying concealed during part of the winter among the mud or sand, from which they occasionally emerge and swim to unlimited distances.

1. Raja batis, of a rhomboid shape. The skate is one of the largest of the European rays, sometimes weighing from one to two hundred pounds, and even, according to some accounts, not less than three. Its general colour on the upper parts is a pale cinereous brown, varied with several darker or blackish undulations; the under part is white, marked with numerous, distant, black specks; in the male, the pectoral fins are beset towards their tips or edges with numerous small spines; on each side the tail, at some distance from the base, is a sharp spine; several very strong ones run down the back of the tail, and in some specimens a row of smaller ones is visible on each side. As an edible fish, the skate is considered as one of the best of its tribe, and is an established article in the European markets, being found in great plenty in the adjoining seas, where it usually frequents the shores in the manner of flat fish. It breeds in the month of March and April, and deposits its ova from May to September. We are informed by Mr. Willughby, that a skate of 200 pounds weight was sold in the fish-market at Cambridge to the cook of St. John's college in that university, and was found sufficient to dine the whole society, consisting of more than 120 persons. In October the skate is usually poor and thin, begins to improve in November, and grows gradually better till May, when it is considered as in its highest perfection.

2. Raja clavata, the thornback, grows to a very considerable size, though rarely equal in magnitude to the skate. In its general appearance it resembles that fish, but is somewhat broader in proportion, and is easily distinguished from the skate by the very strong curved spines with which its upper surface is covered: these are most conspicuous down the middle and on each side of the back, where four or six, of much larger size than the rest, are generally seen; the remaining parts being furnished with many scattered spines of smaller size, intermixed with still more minute ones, and the whole skin is of a rough or shagreen-like surface; the back is marked with an uncertain number of pale or whitish round spots, of different sizes, and which are commonly surrounded with a blackish or dark-coloured edge: these spots are said to be caused by the shedding of the spines at different intervals; along the middle of the back runs a single row of strong spines, continued to the tip of the tail; and it often happens that there are three or even five rows of spines on this part: the colour

of the skin is a brownish grey, with irregular blackish or dusky variegations; the under part is white, with a slight cast of flesh-colour; and about the middle of the body, as well as on the fins, are disposed several spines, similar to those on the upper side, but less strong: the cartilage dividing the upper and lower portions of the body, is in this species remarkably conspicuous; but since a similar appearance exists in several other species, it cannot be of much importance in the specific character.

The thornback is an inhabitant of the Mediterranean and other seas, and is in some esteem as a food, though not equal to the skate in goodness.

3. Raja chagrinea, shagreen ray. Body less broad in proportion than in most others of this division; snout long and pointed, and furnished with two rows of spines; several others are placed in a semicircle towards the eyes, of which the iris is sapphire-coloured; both sides of the tail are armed with numerous smaller ones; the whole upper surface of the animal is roughened by numerous small granules like those on the skin of some of the shark-tribe, and particularly of the great dog-shark, of the skin of which is prepared the substance known by the name of shagreen; colour above cinereous brown, beneath white. Native of the European seas.

4. Raja pastinaca, sting ray, with slender tail, generally armed with a spine. Shape subrhomboidal, but somewhat approaching to ovate, the pectoral fins being less pointed than in some of this division; snout pointed; body more convex than in the preceding rays; colour of the whole animal above yellowish-olive, with the back darkest, and approaching, in some specimens, to a blueish brown; beneath whitish; tail without fin, of considerable length, very thick at the base, and gradually tapering to the extremity, which is very slender; near the middle it is armed, on the upper part, with a very long, flattened, and very sharp-pointed bone or spine, finely serrated in a reversed direction on both sides; with this the animal is capable of inflicting very severe wounds on such as incautiously attempt to handle it; and it answers the purpose both of an offensive and defensive weapon: it is annually cast, and as it frequently happens that the new spine has arrived at a considerable size before the old one has been cast, the animal is occasionally found with two, in which state it has been sometimes erroneously considered as a distinct species. This fish is said not to grow to so large a size as many others of the genus: it is an inhabitant of the Mediterranean, Atlantic, and Indian seas, and is numbered among the edible rays. On account of the danger attending the wounds inflicted by the spine, it is usual with the fishermen to cut off the tail as soon as the fish is taken; and it is said to be illegal in France, and some other countries, to sell the animal with the tail still adhering. It is hardly necessary to observe, that the spine is perfectly void of any venomous quality, though formerly supposed to contain a most active poison; and that the effects sometimes produced by it are entirely those arising from deep puncture and laceration, which, if taking place in a tendinous part, or among the larger nerves and blood-vessels, have often proved fatal.

The general habits of the animal are similar to those of the rest of the genus, often lying flat and in ambuscade on the soft mud at the bottom of the shores which it frequents, and seizing its prey by surprise, and at other times pursuing it through the depths of the ocean.

5. Raja aquila, eagle ray. This species grows to a very great size, sometimes measuring ten, twelve, or even fifteen feet in length.

6. Raja sephen, pearled ray. Shape subrhomboid; the upper part of the body, measured from the tips of the pectoral fins, which are obtuse, forming a half-rhomb; the lower part, from the tips of the pectoral fins to the tail, forming a half-circle; snout small and slightly pointed; ventral fins rather small and rounded; tail more than twice the length of the body, gradually tapering to a fine point, furnished beneath the middle part with a shallow fin running to a considerable distance, and above with a strong and sharp spine, as in the sting ray and many others, and sometimes two spines are found instead of one; back, from between the eyes to some distance beyond the base of the tail, covered with pretty close-set tubercles or granules, three of which, in the middle of the back, are far larger than the rest, and resemble three pearls disposed in a longitudinal direction on that part: colour of the whole animal deep cinereous-brown above, and reddish white beneath: grows to a large size, sometimes measuring eleven feet from the snout to the end of the tail. Native of the Red Sea.

It is from the skin of this species, according to Cepede, that the beautiful substance called galuchat by the French is prepared; and which being coloured with blue, green, or red, according to the fancy of the artist, and afterwards polished, is so frequently used for various kinds of cases, telescope-tubes, &c. For this purpose the smaller or younger specimens are preferred; the tubercles in the more advanced or full-grown animals being too large for the uses above-mentioned.

7. Raja diabolus, demon ray, with bilobate front. This highly singular animal, in point of general shape, is allied to the eagle ray, but with a much greater extent of pectoral fins, appearing extremely broad in proportion to its length; the head, which is of moderate size, is straight or rectilinear in front, each side projecting into a vertically flattened and slightly pointed lobe or wattle, of nearly two feet in length, and giving somewhat the appearance of a pair of horns; the pectoral fins are of a subtriangular figure, curving downwards on each side, and terminating in a point; the back is very slightly elevated into a somewhat pyramidal form; and at its lower part is situated the dorsal fin, which is of a lengthened shape, and inclines backwards. This species is an inhabitant of the Mediterranean, Atlantic, and Indian seas. It is said to be chiefly observed about the Azores, where it is known by the name of mobular.

8. Raja torpedo, of a rounded shape. The torpedo has been celebrated both by antients and moderns for its wonderful faculty of causing a sudden numbness or painful sensation in the limbs of those who touch or handle it. This power the antients, unacquainted with the theory of electricity, were contented to admire, without attempting to explain; and, as is usual in similar cases, magnified it into an effect little short of what is commonly ascribed to enchantment. Thus we are told by Oppian, that the torpedo, conscious of his latent faculty, when caught by a hook, exerts it in such a manner, that, passing along the line and rod, it benumbs the astonished fisherman, and suddenly reduces him to a state of helpless stupefaction. See ELECTRICITY, and GALVANISM.

The body of the torpedo is of a somewhat circular form, perfectly smooth, slightly convex above, and marked along each side of the spine by several small pores or foramina; the colour of the upper surface is usually a pale reddish-brown, sometimes marked by five large, equidistant, circular, dusky spots with paler centres; the under surface is whitish, or flesh-coloured. The torpedo, however, is observed to vary considerably in the cast and intensity of its colours. The general length of the torpedo seems to be about eighteen inches or two feet, but it is occasionally found of far larger dimensions; specimens having been taken on our own coasts of the weight of fifty, sixty, and even eighty pounds.

The torpedo is an inhabitant of most seas, but seems to arrive at a larger size in the Mediterranean than elsewhere. It is generally taken with the trawl, but has been sometimes known to take a bait. It commonly lies in water of about forty fathoms depth, in company with others of this genus. It preys on smaller fish, and according to Mr. Pennant, a surmullet and a plaise have been found in the stomach of two of them: the surmullet, as Mr. Pennant well observes, is a fish of that swiftness, that it would be impossible for the torpedo to take it by pursuit; we must therefore suppose that it stupefies its prey by exerting its electric faculty. The torpedo often inhabits sandy places, burying itself superficially, by flinging the sand over it, by a quick flapping of all the extremities. It is in this situation that it gives its most forcible shock, which is said to throw down the astonished passenger that inadvertently treads on the animal.

The torpedo, with respect to its general anatomy, does not materially differ from the rest of the ray tribe, except in its electric or galvanic organs.

It appears that the electric organs of the torpedo constitute a pair of galvanic batteries, disposed in the form of perpendicular hexagonal columns. In the gymnotus electricus, on the contrary, the galvanic battery is disposed lengthwise on the lower part of the animal.

Spallanzani informs us, that some few minutes before the torpedo expires, the shocks which it communicates, instead of being given at distant intervals, take place in quick succession, like the pulsations of the heart: they are weak, indeed, but perfectly perceptible to the hand when laid on the fish at this juncture, and resemble very small electric shocks. In the space of seven minutes, no less than 360 of these small shocks were perceived. Spallanzani also assures us of another highly curious fact, which he had occasion to verify from his own experience, viz. that the young torpedo can not only exercise its electric faculty as soon as born, but even while it is yet a fœtus in the body of the parent animal. This fact was ascertained by Spallanzani on dissecting a torpedo in a pregnant state, and which contained in its ovarium several roundish eggs of different sizes, and also two perfectly formed fœtuses, which, when tried in the usual manner, communicated a very sensible electric shock, this was still more perceptible when the little animals were insulated by being placed on a plate of glass.

The electricity of the torpedo is altogether voluntary, and sometimes, if the animal is not irritated, it may be touched or even handled without being provoked to exert its electric influence.

9. Raja rhinobatos, of a lengthened shape. This remarkable species seems from its habit to connect in some degree the genera of raja and squalus, the body being much longer than in the preceding kinds of ray: the snout is lengthened, but not very sharp; and the body, which is moderately convex above, and flat beneath, gradually tapers from the shoulders to the tail, which is furnished above with two fins, of an oblong shape, and situated at a considerable distance from each other; the tip of the tail is also dilated into an oblong fin. The colour of the whole animal is a dull earthy-brown, paler beneath, and the skin is every where roughened by minute tubercles. This fish is said to grow to the length of about four feet, and is a native of the European seas. It is observed to be more frequent about the coasts of Naples than elsewhere.

RAJANIA, a genus of the hexandria order, in the diœcia class of plants, and in the natural method ranking under the 11th order, sarmentaceæ. The male calyx is sexpartite; there is no corolla. The female calyx as in the male, without any corolla; there are three styles; the fruit is roundish, with an oblique wing, inferior. There are seven species, climbing plants of the West Indies.

RAIL, in ornithology. See RALLUS.

RAIN. See METEOROLOGY.

RAINBOW. See OPTICS.

RAISING-PIECES, in architecture, are pieces that lie under the beams, and over the posts or puncheons.

RAISINS, grapes prepared by suffering them to remain on the vine till they are perfectly ripe, and then drying them in the sun, or by the heat of an oven. The difference between raisins dried in the sun, and those dried in ovens, is very obvious: the former are sweet and pleasant; but the latter have a latent acidity with the sweetness, that renders them much less agreeable.

The common way of drying grapes for raisins is, to tie two or three bunches of them together while yet on the vine, and dip them into a hot lixivium of wood-ashes with a little of the oil of olives in it. This disposes them to shrink and wrinkle; and after this they are left on the vine three or four days separated on sticks in an horizontal situation, and then dried in the sun at leisure, after being cut from the tree. The finest and best raisins are those called in some places Damascus and Jube raisins; which are distinguished from the others by their size and figures: these are flat and wrinkled on the surface, soft and juicy within, and near an inch long; and when fresh and growing on the bunch, are of the size and shape of a large olive.

The raisins of the sun, and jar-raisins, are all dried by the heat of the sun; and these are the sorts used in medicine.

RAKE *of a ship*, is all that part of her hull which hangs over both ends of her keel. That which is before is called the fore-rake, or rake-forward; and that part which is at the setting on of the stern-post, is called the rake-aft or afterward.

RALLUS, the *rail*, in ornithology, a genus belonging to the order of grallæ. The beak is thickest at the base, compressed, equal, acute, and somewhat sharp on the back near the point; the nostrils are oval; the feet have four toes, without any web; and the body is compressed. Mr. Latham, in his Index Ornithologicus, enumerates 24 species, besides some varieties. They are chiefly distinguished by their colour. "These birds (says Buffon) constitute a large family, and their habits are different from those of the other shore-birds which reside on sands and gravel. The rails, on the contrary, inhabit only the slimy margins of pools and rivers, especially low grounds covered with flags and other large marsh-plants. This mode of living is habitual, and common to all the species of water-rails. The land-rail frequents meadows; and from the disagreeable cry, or rather rattling in the throat, of this bird, is derived the generic name. In all the rails, the body is slender, and shrunk at the sides; the tail extremely short; the head small; the bill like that of the gallinaceous kind, though much longer, and not so thick; a portion of the leg above the knee is bare; the three fore-toes without membranes, and very long; they do not, like other birds, draw their feet under their belly in flying, but allow them to hang down; their wings are small, and very concave, and their flight is short. They seem to be more diffused than varied; and nature has produced or transported them over the most distant lands. Captain Cook found them at the Straits of Magellan, in different islands of the southern hemisphere, at Anamoka, at Tanna, and at the isle of Norfolk. In the Society Islands there are two species of rails; a little black-spotted one (pooanée), and a little red-eyed one (moiho). It appears that the two acolins of Fernandez, which he denominates water-quails, are of a species of rails peculiar to the great lake of Mexico. The colins, which might be confounded with these, are a kind of partridges." The principal species are,

1. The aquaticus, or water-rail, a bird of a long slender body, with short concave wings. It delights less in flying than running, which it does very swiftly along the edges of brooks covered with bushes; as it runs, it every now and then flirts up its tail, and in flying hangs down its legs, actions it has in common with the water-hen. Its weight is four ounces and a half. The length to the end of the tail is 12 inches; the breadth 16. The bill is slender, slightly incurvated, an inch and three quarters long; the head, hind part of the neck, the back, and coverts of the wings and tail, are black, edged with olive-brown; the throat, breast, and upper part of the belly, are ash-coloured; the sides under the wings as far as the rump, finely varied with black and white bars. The tail is very short, and consists of twelve black feathers. "Water-rails (says Buffon) are seen near the perennial fountains during the greatest part of the winter, yet like the land-rails they have their regular migrations. They pass Malta in the spring and autumn. The viscount de Querhoent saw some fifty leagues off the coasts of Portugal on the 17th of April. They were so fatigued, that they suffered themselves to be caught by the hand. Gmelin found these birds in the countries watered by the Don. Belon calls them black rails, and says they are every where known, and that the species is more numerous than the red rail or land-rail. The flesh of the water-rail is not so delicate as that of the land-rail, and has even a marshy taste, nearly like that of the gallinule. It continues the whole year in England."

2. The porzana, or gallinule, is not very frequent in Great Britain, and is said to be migratory. It inhabits the sides of small streams, concealing itself among the bushes. Its length is nine inches; its breadth fifteen; it weighs four ounces five drachms. The head is brown, spotted with black; the neck a deep olive, spotted with white; the feathers of the back are black next their shafts, then olive-coloured, and edged with white: the scapulars are olive, finely marked with two small white spots on each web; the legs of a yellowish green. "Its habits (says Buffon) wild, its instinct stupid, the porzana is unsusceptible of education, nor is even capable of being tamed. We raised one, however, which lived a whole summer on crumbs of bread and hemp-seed: when by itself, it kept constantly in a large bowl of water; but if a person entered the closet where it was shut, it ran to conceal itself in a small dark corner, without venting cries or murmurs. In the state of liberty, however, it has a sharp piercing voice, much like the scream of a young bird of prey; and though it has no propensity to society, as soon as one cries, another repeats the sound, which is thus conveyed through all the rest in the district. Like all the rails, it is so obstinately averse to rise, that the sportsman often seizes it with his hand, or fells it with a stick. If it finds a bush in its retreat, it climbs upon it, and from the top of its asylum beholds the dogs brushing along in fault: this habit is common to it and to the water-rail. It dives, swims, and even swims under water, when hard pushed."

3. The crex, crake, or corn-crek, has been supposed by some to be the same with the water-rail, and that it differs only by a change of colour at a certain season of the year: this error is owing to inattention to their characters and nature, both which differ entirely. The bill of this species is short, strong, and thick, formed exactly like that of the water-hen, and makes a generical distinction. It never frequents watery places; but is always found among corn, grass, broom, or furze. It quits the kingdom before winter; but the water-rail endures our sharpest seasons. They agree in their aversion to flight; and the legs, which are remarkably long for the size of the bird, hang down whilst they are on the wing: they trust their safety to their swiftness on foot, and seldom are sprung a second time but with great difficulty. The land-rail lays from twelve to twenty eggs, of a dull white colour, marked with a few yellow spots: notwithstanding this they are very numerous in this kingdom. Their note is very singular; and, like the quail, it is decoyed into a net by the imitation of its cry, *crek crek crek*, by rubbing hard the blade of a knife on an indented bone. Most of the names given in different languages to this

bird are evidently formed to imitate this singular cry.

They are in greatest plenty in Anglesea, where they appear about the 20th of April, supposed to pass over from Ireland, where they abound. At their first arrival, it is common to shoot seven or eight in a morning. They are found in most of the Hebrides, and the Orkneys. On their arrival they are very lean, weighing only six ounces; but before they leave this island, grow so fat as to weigh above eight. The feathers on the crown of the head and hind part of the neck are black, edged with bay-colour; the coverts of the wings of the same colour, but not spotted; the tail is short, and of a deep bay; the belly white; the legs ash-coloured.

RALLYING, in war, re-assembling or calling together troops broken and put to flight.

RAM, in zoology. See OVIS.

RAM, in astronomy. See ARIES.

RAM, *battering*, in antiquity, a military engine used to batter and beat down the walls of places besieged.

The battering ram was of two sorts; the one rude and plain, the other compound. The former seems to have been no more than a great beam which the soldiers bore on their arms and shoulders, and with one end of it by main force assailed the wall. The compound ram is thus described by Josephus: It is a vast beam, like the mast of a ship, strengthened at one end by a head of iron, something resembling that of a ram, whence it took its name. See Plate Miscel. fig. 196. This was hung by the middle with ropes to another beam which lay across two posts; and hanging thus equally balanced, it was by a great number of men drawn backwards and pushed forwards, striking the wall with its iron head.

Plutarch informs us, that Mark Anthony, in the Parthian war, made use of a ram fourscore feet long; and Vitruvius tells us, that they were sometimes 106, and sometimes 120 feet in length; and to this, perhaps, the force and strength of the engine was in a great measure owing. The ram was managed at one time by a whole century of soldiers, and they being spent, were seconded by another century, so that it played continually without any intermission.

In order to calculate the force of the battering-ram R, suppose it to be 28 inches in diameter, and 180 feet long; and consequently its solid content 750 cubic feet; which, allowing 50 pounds for each foot, will weigh 37500 pounds: and suppose its head of cast-iron, together with three iron-hoops, &c. to be 3612 pounds. Now all these weights added together, make 41112 pounds, equal the weight of the whole ram; which will require 1000 men to move it so as to cause it to strike against the point L of the wall AHIGE, each man moving a weight of 41 pounds. The quantity of motion produced by this action, when the ram moves one foot in a second, may be expressed by the number 41112; which motion or force compared with the quantity of motion in the iron ball B, shot out of the cannon C, will be found equal to it: for a cannon-ball is known to move as fast as sound for about the space of a mile; and if you multiply 36 pounds, the weight of the ball, by 1142, the number of feet which sound moves in one second, you will have the number 41112 for the quantity of motion or force, in the ball B striking at L. And if, after a few strokes given by the battering-ram, the mortar or cement is so loosened, that the piece of the wall ADDFE is at last by a stroke of the ram carried forward from F to K, and so beaten down; the same thing will be performed by a cannon-ball, after an equal number of strokes.

This shews how advantageous the invention of gunpowder is; since we are thereby enabled to give such a prodigious velocity to a small body, that it shall have as great a quantity of motion as a body immensely greater, and requiring more hands to work it: for three men will manage a cannon which shall do as much execution as the above battering-ram, wrought by 1000. The ram whose force is here calculated, is taken at a mean; being larger than some, and less than others, of those used by the antients.

RAM'S-HEAD, in a ship, is a great block belonging to the fore and main halyards. It has three shivers in it, into which the halyards are put, and in a hole at the end of it are reeved the ties.

RAMADAN, a solemn season of fasting among the Mahometans, kept in the ninth month of the Arabic year.

RAMPANT. See HERALDRY.

RAMPART, in fortification, is an elevation of earth round a place capable of resisting the cannon of an enemy; and formed into bastions, curtins, &c. See FORTIFICATION.

RAMPHASTOS, in ornithology, a genus belonging to the order of picæ. The bill is very large, and serrated outwardly. The nostrils are situated behind the base of the beak; and in most of the species the feet are toed, and placed two forwards and two backwards. The tongue is long, narrow, and feathered on the edges. Mr. Latham enumerates fifteen different species, of which the toucans are the most remarkable, and were formerly divided into four or five varieties, though Mr. Latham makes them distinct species, of which we shall only describe that called the red-beaked toucan.

This bird is about the size of a jack-daw, and of a similar shape, with a large head to support its monstrous bill. This bill, from the angles of the mouth to its point, is six inches and a half; and its breadth in the thickest part is a little more than two. Its thickness near the head is one inch and a quarter; and it is a little rounded along the top of the upper chap, the under side being round also; the whole of the bill extremely slight, and but a little thicker than parchment. The upper chap is of a bright yellow, except on each side, which is of a fine scarlet colour; as is also the lower chap, except at the base, which is purple. Between the head and the bill there is a black line of separation all round the base of the bill; in the upper part of which the nostrils are placed, and are almost covered with feathers; which has occasioned some writers to say that the toucan has no nostrils. Round the eyes on each side of the head, is a space of blueish skin, void of feathers; above which the head is black, except a white spot on each side joining to the base of the upper chap. The hinder part of the neck, the back, wings, tail, belly, and thighs, are black. The under side of the head, throat, and the beginning of the breast, are white. Between the white on the breast, and the black on the belly, is a space of red feathers, in the form of a new moon, with its horns upwards. The legs, feet, and claws, are of an ash-colour; and the toes stand like those of parrots, two before and two behind.

It is reported by travellers, that this bird, though furnished with so formidable a beak, is harmless and gentle, being so easily made tame as to sit and hatch its young in houses. It feeds chiefly upon pepper, which it devours very greedily. It builds its nest in holes of trees, which have been previously scooped out for this purpose. There is no bird secures its young better from external injury than the toucan. It has not only birds, men, and serpents, to guard against, but a numerous tribe of monkeys, still more prying, mischievous, and hungry, than all the rest. The toucan, however, scoops out its nest into the hollow of some tree, leaving only a hole large enough to go in and out at. There it sits, with its great beak, guarding the entrance; and, if the monkey ventures to offer a visit of curiosity, the toucan gives him such a welcome, that he presently thinks proper to retire, and is glad to escape with safety.

This bird is only found in the warm climates of South America, where it is in great request, both for the delicacy of its flesh, which is tender and nourishing, and for the beauty of its plumage, particularly the feathers of the breast. The skin of this part the Indians pluck off, and when dry glue to their cheeks; and this they consider as an irresistible addition to their beauty. See Plate Nat. Hist. fig. 342.

RANA, *frog*, a genus of amphibia of the order reptiles; the generic character is, body four-footed, without tail, and naked, or without any integument but the skin.

This genus may be divided into three sections, viz. 1. Frogs, commonly so called, or ranæ, with light active bodies, and which leap when disturbed. 2. Slender-limbed frogs, hylæ, calamitæ, or ranæ arboreæ, viz. such as have light bodies, very slender limbs, and toes terminating in flat, circularly expanded, tips, enabling the animals to adhere at pleasure to the surface even of the smoothest bodies. Several of this division generally reside on trees, adhering by their toes to the lower surfaces of the leaves and branches. 3. Toads, bufones, or such as have large heavy bodies, short thick limbs, and which rather crawl than leap when disturbed.

1. Rana temporaria, the common frog, is the most common of all the European species, being almost every where seen in moist situations, or wherever it can command a sufficient quantity of insects, worms, &c. on which it feeds. In colour it varies considerably, but its general tinge is olive-brown, variegated on the upper parts of the body and limbs with irregular blackish spots; those on the limbs being mostly disposed in a transverse direction: beneath each eye is a longish mark or patch, reaching to the setting on of the fore-legs, and which seems to form one of its principal specific distinctions.

It is generally in the month of March that the frog deposits its ova or spawn, consisting of a large heap or clustered mass of gelatinous transparent eggs, in each of which is imbedded the embryo, or tadpole, in the form of a round black globule. The spawn commonly lies more than a month, or sometimes five weeks, before the larvæ or tadpoles are hatched from it; and during this period each egg gradually enlarges in size, and a few days before the time of exclusion the young animals may be perceived to move about in the surrounding gluten. When first hatched, they feed on the remains of the gluten in which they were imbedded; and in the space of a few days, if narrowly examined, they will be found to be furnished, on each side the head, with a pair of ramified branchiæ or temporary organs, which again disappear after a certain space. These tadpoles are so perfectly unlike the animals in their complete state, that a person not conversant in natural history would hardly suppose them to bear any relationship to the frog; since, on a general view, they appear to consist merely of head and tail. Their motions are extremely lively, and they are often seen in such vast numbers as to blacken the whole water with their legions. They live on the leaves of duckweed and other small water-plants, as well as on various kinds of animalcules, &c. and when arrived at a larger size, they may even be heard to gnaw the edges of the leaves on which they feed, their mouths being furnished with extremely minute teeth or denticulations. The tadpole is also furnished with a small kind of tubular sphincter or sucker beneath the lower jaw, by the help of which it hangs at pleasure to the under surface of aquatic plants, &c. From this part it also occasionally hangs, when very young, by a thread of gluten, which it seems to manage in the same manner as some of the smaller slugs have been observed to practise. Its interior organs differ, if closely inspected, from those of the future frog, in many respects; the intestines in particular are always coiled into a flat spiral, in the manner of a cable in miniature.

When the tadpoles have arrived at the age of about five or six weeks, the hind legs make their appearance, gradually increasing in length and size; and, in about a fortnight afterwards, or sometimes later, are succeeded by the fore legs, which are indeed formed beneath the skin much sooner, and are occasionally protruded and again retracted by the animal through a small foramen on each side of the breast, and are not completely stretched forth till the time just mentioned. The animal now bears a kind of ambiguous appearance, partaking of the form of a frog and a lizard. The tail at this period begins to decrease, at first very gradually, and at length so rapidly as to become quite obliterated in the space of a day or two afterwards. The animal now ventures upon land, and is seen wandering about the brinks of its parent waters, and sometimes in such multitudes as to cover a space of many yards in extent. This is the phenomenon which has so frequently embarrassed the minds not only of the vulgar, but even of some superior characters in the philosophic world; who, unable to account for the legions of these animals with which the ground is occasionally covered in certain spots, at the close of summer, have been led into the popular belief of their having descended from the clouds in showers.

As soon as the frog has thus assumed its perfect form, it feeds no longer on vegetables but on animal food; supporting itself on small snails, worms, &c. and insects. For the readier obtaining its prey, the structure of its tongue is extremely well calculated, being so situated that the root is attached to the fore rather than the hind part of the mouth; and when at rest, lies backwards, as if the animal was swallowing the tip. By this means the creature is enabled to throw it out to some distance from the mouth, which is done with great celerity, and the bifid and glutinous extremity secures the prey, which is swallowed with an instantaneous motion, so quick that the eye can scarcely follow it.

The frog can hardly be said to arrive at its full size till the age of about five years, and is supposed to live at least twelve or fifteen years.

The frog is extremely tenacious of life, and, like other amphibia, will survive for a considerable space the loss of many of its organs. If confined entirely under water, it is still enabled to support its existence for several days, as appears by sir Thomas Brown's experiment, who kept a frog under water six days. On the contrary, it cannot so well dispense with the want of water, and is unable to survive too long an exposure to a dry air and a hot sun. It is, therefore, particularly careful to secure a retreat where it may enjoy the benefit of shade and a sufficient supply of moisture. It delights, however, to bask occasionally in a moderate sunshine, and is unable to support severe cold.

2. Rana esculenta, green frog. This species is the largest of the European frogs, and is found plentifully in France, Italy, Germany, and many other parts of Europe, but is a rare animal in England. In its general appearance it extremely resembles the common frog, but is of larger size, and of an olive-green colour, distinctly and strongly marked on the upper parts of the body with moderately large and somewhat rounded black spots or patches; the limbs are elegantly marked or barred transversely with bands of the same colour. The head is rather larger and sharper in proportion than that of the common frog; and the long deep-brown patch under each eye, which forms so constant and conspicuous a character in that animal, is much less distinct, and sometimes even entirely wanting. The proportion of the limbs is nearly the same as in the common frog, and the hind feet are very strongly palmated.

The green frog is a very voracious animal, and will occasionally seize on young birds of various kinds, mice, and even young ducklings which happen to stray too far from their parents, swallowing them whole like the rest of its prey. It arrives at its full growth in about four years, begins to breed at the age of five years, and lives to about sixteen.

3. Rana catesbeiana, bull-frog. This remarkable species is not uncommon in many parts of North America, where it is known by the name of the bull-frog, its voice resembling the distant lowing of that animal. It grows to a very large size, and is about 18 inches from the nose to the end of the hind feet. Its colour, on the upper parts, is a dusky olive or brownish, somewhat irregularly marked with numerous deep-brown spots; while the under parts are of a pale or whitish cast, with a tincture of yellowish green.

4. Rana ignea, fire-frog, is a native of Germany, Italy, and many other parts of Europe, but is not found in England. Its colour on the upper parts is a dull olive-brown, the skin being marked with large and small tubercles; round the edges of the mouth is placed a row of blackish streaks or perpendicular spots. The under parts both of the body and limbs are orange-coloured, spotted or variegated with irregular markings of dull blue. It is from the colour of the under surface that this species has obtained its titles of bufo igneus, fire-frog, &c.

This animal may be considered rather as an aquatic than terrestrial species, being rarely found on land, but chiefly inhabiting turbid stagnant waters, in which, in the month of June, it deposits its spawn, the ova being much larger in proportion than in most others of the genus. The tadpoles are hatched towards the end of June, and are of a pale yellowish-brown colour; and when young are often observed to hang from the surface of leaves, &c. by a glutinous thread proceeding from the small tube or sucker beneath the lower lip.

The fire-frog is a lively, active animal; leaping and swimming with equal or even superior agility to the common frog. When surprised on land, or unable to escape, it squats close to the ground, at the same time turning back its head and limbs in a singular manner; and if farther teased or irritated, evacuates from the hinder part of the thighs a kind of saponaceous frothy fluid, of no bad scent, but which in some circumstances has been found to excite a slight sensation of acrimony in the eyes and nostrils. This species is observed to breed at the age of three years, and may be supposed to live about ten; but this is not entirely ascertained. Its voice, according to Roesel, is sharper or lighter than in other frogs, less disagreeable, and in some degree resembling a kind of laugh: according to authors, however, it rather resembles the tone of a bell, or the note of a cuckoo; for which reason the animal has been called rana bombina. The male only is vocal.

5. Rana piscis, larva, or tadpole. This animal is a native of South America, and seems to be more particularly found in Surinam than in other parts. In its general form it very much resembles the rana temporaria, or common European frog; and is, when living, of a yellowish olive-colour, spotted and variegated on the body and limbs with rufous or yellowish brown; the principal mark of distinction from others of the genus being the somewhat oblique longitudinal stripes on the hind legs: the fore feet have only four toes, and are unwebbed; but the hind feet have five, and are very deeply palmated to the very ends or tips of the toes; and near the thumb or shortest toe is an oblong callus, resembling an additional or spurious toe.

The tadpole of this frog, from its very large size, the strong and muscular appearance of the tail, and the ambiguous aspect which it exhibits in the latter part of its progress toward its complete or ultimate form, has long continued to constitute the paradox of European naturalists; who, however strong and well-grounded their suspicions might be relative to its real nature, and the mistake of most describers, were yet obliged, in some measure, to acquiesce in the general testimony of those who had seen it in its native waters, and who declared it to be at length transmuted, not into a frog, but a fish! and it was even added by some, that it afterwards reverted to its tadpole form again!! That it is really no other than a frog in its larva or tadpole state, will be evident to every one who considers its structure; and more especially, if it is collated with the tadpole even of some European frogs. Like our European tadpoles, this animal, according to the more or less advanced state in which it is found, is furnished either with all the four legs, or with only the two hinder ones: it also sometimes happens that in the largest-sized of these tadpoles, exceeding perhaps the length of six or eight inches, the hind legs alone appear; while in those of far smaller size both the fore and hind legs are equally conspicuous.

It will readily appear that the larva of this frog is larger in proportion to the complete animal than in any other species hitherto discovered. It may also be not improper to observe, that perhaps all the specimens of these very large tadpoles occurring in museums, may not be those of the rana paradoxa in particular, but of some other American, African, or Asiatic frogs, as the R. ocellata, marina, &c. See Frog-fish, Vol. I. p. 780.

Hylæ, or frogs with rather slender bodies, long limbs, and the tips of the toes flat, orbicular, and dilated.

6. Rana zebra, zebra-frog, appears to be by far the largest of all the hylæ, or slender-bodied frogs, and is, according to Seba, a native of Carolina and Virginia. Its colour is an elegant pale rufous-brown, beautifully marked on the back and limbs, and even to the ends of the toes, with transverse chesnut-coloured bands, which on the limbs are double and much more numerous than on the back; the fore feet are tetradactylous, and the hind pentadactylous; the head is large in proportion, the eyes protuberant, and the mouth wide. It measures about five inches.

7. Rana arborea, tree-frog. In the beauty of its colours, as well as in the elegance of its form and the agility of its movements, the tree-frog exceeds every other European species. It is a native of France, Germany, Italy, and many other European regions, but is not found in the British islands. Its principal residence, during the summer months, is on the upper parts of trees, where it wanders among the foliage in quest of insects, which it catches with extreme celerity, stealing softly toward its prey in the manner of a cat towards a mouse, and when at the proper distance, seizing it with a sudden spring, frequently of more than a foot in height. It often suspends itself to the under parts of the leaves, thus continuing concealed beneath their shade. Its size is smaller than any other European frog, except the fire-frog. Its colour on the upper parts is green, more or less bright in different individuals; the abdomen is whitish, and marked by numerous granules; the under surface of the limbs is reddish, and the body marked on each side by a longitudinal blackish or violet-coloured streak. The body is smooth above, and moderately short above; the hind legs are very long and slender; the fore feet have four and the hind feet five toes, all of which terminate in rounded, flat, and dilated tips, the under surface of which, being soft and glutinous, enables the animal to hang with perfect security from the leaves of trees, &c. The skin of the abdomen is also admirably calculated by nature for this peculiar power of adhesion, being covered with small glandular granules in such a manner as to fasten closely even to the most polished surface; and the animal can adhere at pleasure to that of glass, in whatever position or inclination it is placed, by merely pressing itself against it.

Though the tree-frog inhabits the woods during the summer months, yet on the approach of winter it retires to the waters, and there submerging itself in the soft mud, or concealing itself beneath the banks, remains in a state of torpidity, and again emerges in the spring, at which period it deposits its spawn in the waters, like the rest of this genus. During their residence among the trees, they are observed to be particularly noisy on the approach of rain; so that they may be considered, in some measure, as a kind of living barometers; more especially the males, which, if kept in glasses, and supplied with proper food, will afford an infallible presage of the changes of weather.

Toads. 8. Rana bufo, common toad. Of all the European toads, this seems to be the most universally known; at least, in its complete or perfect form. It is found in gardens, woods, and fields; and frequently makes its way into cellars, or any obscure recesses in which it may occasionally conceal itself, and where it may find a supply of food, or a security from too great a degree of cold. In the early part of spring, like others of this genus, it retires to the waters, where it continues during the breeding-season, and deposits its ova or spawn in the form of double necklace-like chains or strings of beautifully transparent gluten, and of the length of three or four feet.

The toad is an animal too well known to require any very particular description of its form. It may be necessary to observe that it is always covered by tubercles, or elevations on the skin, of larger or smaller size in different individuals; and that the general colour of the animal is an obscure brown above, much paler and irregularly spotted beneath.

The toad arrives at a considerable age; its general term of life being supposed to extend to 15 or even 20 years: and Mr. Pennant, in his British Zoology, gives us a curious account, communicated by a Mr. Arscott of Tehott in Devonshire, of a toad's having lived, in a kind of domestic state, for the space of more than 40 years, and of having been in a great degree tamed, or reclaimed from its natural shyness or desire of concealment; since it would always regularly come out of its hole at the approach of its master, &c. in order to be fed. It grew to a very large size, and was considered as so singular a curiosity, that even ladies, laying aside their usual aversion and prejudices, requested to see the favourite toad. It was, therefore, often brought to table, and fed with various insects, which it seized with great celerity, and without seeming to be embarrassed by the presence of company. This extraordinary animal generally resided in a hole beneath the steps of the house-door, fronting the garden; and might probably have survived many years longer, had it not been severely wounded by a raven, which seized it before it could take refuge in its hole; and notwithstanding it was liberated from its captor, it never again enjoyed its usual health, though it continued to live above a year after the accident happened.

With respect to the supposed venomous qualities of the toad, from the experiments of Laurenti, it appears that small lizards, on biting the common toad, were for some time disordered and paralytic, and even appeared to be dead, but in a few hours were completely recovered.

It is also observed, that dogs, on seizing a toad, and carrying it for some little time in their mouth, will appear to be affected with a very slight swelling of the lips, accompanied by an increased evacuation of saliva; the mere effect of the slightly acrimonious fluid which the toad on irritation exudes from its skin, and which seems, in this country at least, to produce no dangerous symptoms in such animals as happen to taste or swallow it. The limpid fluid also, which this animal discharges when disturbed, is a mere watry liquor, perfectly free from any acrimonious or noxious qualities, and appearing to be no other than the contents of a peculiar reservoir, common to this tribe, destined for some purpose in the economy of the animals which does not yet appear to be clearly understood. The common toad may therefore be pronounced innoxious, or perfectly free from any poisonous properties, at least with respect to any of the larger animals; and the innumerable tales recited by the older writers of its supposed venom, appear to be either gross exaggerations, or else to have related to the effects of some other species mistaken for the common toad; it being certain that some of this genus exude from their skin a highly acrimonious fluid.

It might seem unpardonable to conclude the history of this animal without mentioning the very extraordinary circumstance of its having been occasionally discovered enclosed or imbedded, without any visible outlet, or even any passage for air, in the substance of wood, and even in that of stone or blocks of marble.

On this subject a curious experiment was made by Mons. Herrissant of the French academy, in consequence of an assertion, that in the year 1771, on pulling down a wall at a seat belonging to the duke of Orleans, and which had been built 40 years, a living toad had been found in it; its hind feet being confined or imbedded in the mortar. M. Herrissant therefore, in the presence of the academy, inclosed three toads in as many boxes, which were immediately covered with a thick coat of plaister or mortar, and kept in the apartments of the academy. On opening these boxes eighteen months afterwards, two of the toads were found still living: these were immediately re-inclosed; but on being again opened some months after, were found dead. These experiments are perhaps not very conclusive; and only appear to prove what was before well known, viz. that the toad, like many other amphibia, can support a long abstinence, and requires but a small quantity of air: but in the accounts generally given of toads discovered in stones, wood, &c. the animals are said to have been completely impacted or imbedded, and without any space for air.

9. Rana viridis. The green toad is a native of Germany and some other parts of Europe, and seems to have been first described by Valisneri, and afterwards by Laurenti, who informs us that it inhabits the cavities of walls about Vienna, and is distinguished by its greenish and confluent spots on the upper parts, disposed on a pale or whitish ground, and scattered over with tubercles. Each of the green spots or patches is also bounded by a blackish margin, and the whole pattern has a somewhat rudely geographical or map-like appearance. The odour of this species is very strong; resembling that of the common black or garden nightshade, but much more powerful, so as to fill a whole room. The female is of a browner cast than the male. In winter this species retires under ground, and, like others of the genus, frequents the waters at the breeding season.

10. Rana dubia, or musica. Of this animal a specimen is preserved in the British Museum, under the title of rana musica: its size is that of a common toad, but the shape of the body differs, seeming gradually to decrease from the shoulders to the hind legs, somewhat in the manner of the hylæ or tree-frogs. Its colour, so far as can be determined from the specimen long preserved in spirit of wine, appears to have been a moderately deep-brown above, and pale or whitish beneath, slightly marbled or variegated with brown. The whole upper surface is beset with distinct oval pustules or tubercles.

Whether this is the species intended by Linnæus, under the name of rana musica, may perhaps be questioned. In the Systema Naturæ he refers to no author or figure, but informs us that the animal is a native of Surinam, and that it has a musical voice. See Plate Nat. Hist. fig. 344.

11. Rana cornuta, horned toad. Among the whole tribe of amphibia, it is, perhaps, difficult to find an animal of a more singular appearance than this, which may be regarded as of a more deformed and hideous aspect than even the pipa, or toad of Surinam. This arises not so much from the general shape of the animal, as from the extraordinary structure of the upper eyelids, which are so formed as to resemble a pair of short sharp-pointed horns; while the width of the mouth is such as to exceed that of any other species, and even to equal half the length of the body itself. The skin of the body, both above and below, is of a cinereous yellow, striped with lines of obscure greyish brown. Along the back runs a broad white band, commencing at the head, and thence decreasing gradually, so as to appear narrow over the hind parts: it is also beset with small specks like pearls. All the rest of the body is rough, with sharp spines, except the head, which is variegated with white, and the abdomen, which is of a deep rufous yellow. The legs are surrounded by a kind of bands or fillets; and the toes are marked in a similar manner, and resemble in some degree the human fingers, and are four in number on the fore legs, and five on the hind: the hind feet are also webbed. The head is very large and thick, and when the mouth is opened, exhibits a broad and thick tongue, shaped somewhat like an oyster, and fastened in front to the lower jaw, but loose behind as in frogs; it is also covered over with papillæ. The female agrees in all respects with the male, except that the mouth is still wider, and the front is variegated in a somewhat different manner. See Plate Nat. Hist. fig. 343.

Seba seems to have been misinformed as to the native country of this species, which he imagined to be Virginia; but the animal is now known to be a native of South America only.

12. Rana pipa. This also is one of those animals which, at first view, every one pronounces deformed and hideous; the general uncouthness of its shape being often aggravated by a phenomenon unexampled in the rest of the animal world, viz. the young in various stages of exclusion, proceeding from cells dispersed over the back of the parent.

The size of the pipa considerably exceeds that of the common toad: the body is of a flattish form; the head subtriangular; the mouth very wide, with the edges or corners furnished with a kind of short cutaneous and lacerated appendage on each side: in the male, however, the head is rather oval than triangular, and the parts just mentioned less distinct; the fore feet are tetradactylous, the toes long and thin, and each divided at the tip into four distinct portions or processes, each of which, if narrowly inspected with a magnifier, will be found to be again obscurely subdivided almost in a similar manner; the hind feet are five-toed, and very widely webbed; the web reaching to the very tips of the toes. The male pipa is larger than the female, measuring sometimes not less than seven inches from the nose to the end of the body; the nose in both sexes is of a somewhat truncated form, like that of a mole or hog, and the eyes extremely small; from each eye, in the female, run two rows of granules, or glandular points, to the middle of the back; the whole body is also covered with similar points or glandules, but smaller than the former: in the male a single row of granules proceeds from each eye down the back, instead of a double row as in the female: these points or granules are also larger than in the female, and gradually decrease in size as they approach the lower part of the back: the skin round the neck, in both sexes, forms a kind of loose or wrinkled collar: the abdomen of the male is of a browner tinge than that of the female, and is sometimes obscurely spotted with yellow; but the general colour, both of the male and female pipa, is a dark or blackish brown.

It was for a long time supposed that the ova of this extraordinary animal were produced in the dorsal cells, without having been first excluded in the form of spawn; but later observations have proved that a still more extraordinary process takes place; and that the spawn after exclusion is received into the open cells of the back, and there concealed till the young have arrived at maturity. The female pipa deposits her eggs or spawn at the brink of some stagnant water; and the male collects or amasses the heap of ova, and deposits them with great care on the back of the female, where, after impregnation, they are pressed into the cellules, which are at that period open for their reception, and afterwards close over them; thus retaining them till the period of their second birth; which happens in somewhat less than three months, when they emerge from the back of the parent in their complete state. During the time of their concealment, however, they undergo the usual change of the rest of this genus, being first hatched from the egg in the form of a tadpole; and gradually acquire their complete shape some time before their exclusion.

According to Fermin, the pipa is calculated by nature for producing but one brood of young; and, compared with the rest of the genus, it can by no means be considered as a very prolific animal; the number of young produced by the female which he observed, amounted to 75, and were all excluded within the space of five days.

RANCIDITY. See Oils.

RANDOM SHOT, in gunnery, is a shot made when the muzzle of a gun is raised above the horizontal line, and is not designed to shoot directly or point-blank. The utmost random of any piece is about ten times as far as the bullet will go point-blank. The bullet will go farthest when the piece is mounted to about 45° above the level range. See Gunnery, and Projectiles.

RANGE, in gunnery, the path of a bullet, or the line it describes from the mouth of the piece to the point where it lodges. If the piece is in a line parallel to the horizon, it is called the right or level range: if it is mounted to 45°, it is said to have the utmost range; all others between 00 and 45° are called the intermediate ranges.

RANGER, a sworn officer of a forest, appointed by the king's letters-patent, whose business is to walk through his charge, to drive back the deer out of the purlieus, &c. and to present all trespasses within his jurisdiction at the next forest-court.

RANGES, in a ship, two pieces of timber that go across from side to side; the one on the forecastle, a little abaft the fore-mast; and the other in the beak-head, before the wouldings of the bowsprit.

RANK, in war, is a row of soldiers placed side by side.

To double the ranks is to put two ranks into one. To close the ranks is to bring the men nearer: and to open them, is to set them farther apart.

Rank, the order or place assigned a person suitable to his quality or merit. See Precedence.

Rank *and precedence*, in the army and navy, are as follow:

Engineers' rank. Chief, as colonel; director, as lieutenant-colonel; sub-director, as major; engineer in ordinary, as captain; engineer extraordinary, as captain-lieutenant; sub-engineer, as lieutenant; practitioner engineer, as ensign.

Navy rank. Admiral, or commander-in-chief of his majesty's fleet, has the rank of a field-marshal; admirals with their flags on the main-top-mast head, rank with generals of horse and foot; vice-admirals, with lieutenant-generals; rear-admirals, as major-generals; commodores with broad pendants, as brigadier-generals; captains of post-ships, after three years from the date of their first commission, as colonels; other captains commanding post ships, as lieutenant-colonels; captains not taking post, as majors; lieutenants, as captains.

Rank between the Army, Navy, and Governors.

Army.	Navy.	Governors.
General in chief	Admiral in chief	Commander in chief of the forces in America
Generals of horse	Admiral with a flag at the main-top-mast	Captain-generals of provinces
Lieutenant-generals	Vice-admirals	Lieutenant-generals of provinces
Major-generals	Rear-admirals	Lieutenant-governors and presidents
Colonels	Post-captains of 3 years	Lieutenant-governors not commanding
Lieutenant-colonels	Post-captains	Governors of charter colonies
Majors	Captains	Deputy-governors
Captains	Lieutenants	Established by the king, 1760.

RANUNCULUS, *crowfoot*, a genus of the polygamia order, in the polyandria class of plants; and in the natural method ranking under the 26th order, multisiliquæ. The calyx is pentaphyllous; there are five petals, each with a melliferous pore on the inside of the heel; the seeds naked.

There are 59 different species of this genus; six or eight of which claim general esteem as flowery plants for ornamenting the gardens. The rest, as the common crowfoot, &c. are common weeds in the fields, waters, and pasture-ground, not having merit for garden-culture. Of the garden kinds, the principal sort is the Asiaticus or Turkey and Persian ranunculus, which comprises many hundred varieties of large, double, most beautiful flowers, of various colours: but several other species having varieties with fine double flowers, make a good appearance in a collection; though as those of each species consist only of one colour, some white, others yellow, they are inferior to the Asiatic ranunculus, which is large, and diversified a thousand ways in rich colours, in different varieties. All the garden kinds, however, in general effect a very agreeable diversity in assemblage in the flower compartments, &c. and they being all very hardy, succeed in any open beds and borders, &c.

The Asiatic species in all its varieties will succeed in any light, rich, garden earth; but the florists often prepare a particular compost for the fine varieties, consisting of good garden-mould or pasture-earth, sward and all, a fourth part of rotted cow-dung, and the like portion of sea-sand; and with this they prepare beds four feet wide, and two deep: however, in default of such compost, use beds of any good light earth of your garden; or, if necessary, it may be made light and rich with a portion of drift-sand and rotten dung, cow-dung is most commonly recommended; but they will also thrive in beds of well-wrought kitchen-garden earth, and they often prosper well in the common flower-borders.

The season for planting the roots is spring; and it may be performed any time in February, or as soon as the weather is settled.

All the varieties of the Asiatic ranunculus propagate abundantly by offsets from the root; and new varieties are gained by seed. The juice of many species of ranunculus is so acrid as to raise blisters on the skin, and yet the roots may be eaten with safety when boiled.

RAPE. See Brassica.

Rape, in law, is where a man has carnal knowledge of a woman by force, and against her will; by 18 Eliz. c. 7, if any person shall unlawfully and carnally know and abuse any woman-child under the age of ten years, whether with her consent or against it, he shall be punished as for a rape. And it is not a sufficient excuse in the ravisher, to prove that she is a common strumpet; for she is still under the protection of the law, and may not be forced. Nor is the offence of a rape mitigated by shewing that the woman at last yielded to the violence, if such her consent was forced by fear of death or duress; nor is it any excuse that she consented after the fact. 1 Haw. 108.

The civilians make another kind of rape, called rape of subordination or seduction; which is seducing a maid either to uncleanness or marriage, and that by gentle means, provided there is a considerable disparity in the age and circumstances of the parties.

Rape is also a name given to a division of a county, and sometimes means the same as a hundred, and at other times signifies a division consisting of several hundreds; thus Sussex is divided into six rapes, every one of which, besides its hundreds, has a castle, a river, and a forest, belonging to it. The like parts in other counties are called tithings, lathes, or wapentakes.

RAPHANUS, *radish*, a genus of the siliquosa order, in the tetradynamia class of plants; and in the natural method ranking under the 39th order, siliquosæ. The calyx is close: the siliqua torose, or swelling out in knots, subarticulated, and round. There are two melliferous glandules between the shorter stamina and the pistil, and two between the longer stamina and the calyx. There are six species; the sativus, or common garden-radish, is best known, and of this there are several varieties. They are annual plants, which being sown in the spring, attain perfection in two or three months, and shoot up soon after into stalk for flower and seed, which, ripening in autumn, the whole plant, root and top, perishes; so that a fresh supply must be raised annually from seed in the spring, performing the sowings at several different times, from about Christmas until May, in order to continue a regular succession of young tender radishes throughout the season, allowing only a fortnight or three weeks interval between the sowings; for one crop will not continue good longer than that space of time, before they will either run to seed, or become tough, sticky, and too hot to eat.

RAPHIDIA, a genus of insects of the order neuroptera. The generic character is, mouth with two teeth; head depressed, horny; feelers four; stemmata three; wings deflex; antennæ the length of thorax, which is cylindric, and elongated in front; tail of the female furnished with a recurved lax bristle. This genus contains but few species, the most remarkable of which is the raphidia ophiopsis of Linnæus; a smallish fly, with rather large transparent wings, and a narrow thorax, stretching forwards in a remarkable manner. It is found on trees, &c. in summer, but is rather a rare insect: the pupa, according to Linnæus, resembles the complete insect, but is destitute of wings.

Raphidia cornuta is a large species, equal in size to one of the larger dragon-flies, and is distinguished by its very long hornlike jaws, which extend far beyond the thorax, and are terminated by a bifid tip: the wings are large, reticulated, and semitransparent. It is a native of North America.

Raphidia mantispa is a small species, but little superior is size to the R. ophiopsis, and is a native of some of the warmer parts of Europe. It has the habit of the genus mantis, and it is even doubtful whether it should not more properly be referred to that genus.

RAREFACTION, in physics, the act whereby a body is brought to possess more room, or appear under a larger bulk, without the accession of any new matter. This is commonly the effect of caloric, as has long been universally allowed. In many cases, however, philosophers have attributed it to the action of a repulsive principle. However, from the many discoveries concerning the nature and properties of the electric fluid and caloric, there is the greatest reason to believe that this repulsive principle is no other than caloric or fire.

RASANT, or Razant, in fortification. Rasant flank, or line, is that part of the curtin or flank whence the shot exploded rase, or glance along, the surface of the opposite bastion.

RASH, in medicine, an eruption upon the skin, thrown out in fevers or surfeits. See Medicine.

RAT. See Mus.

RATAFIA, a spirituous liquor, prepared from the kernels, &c. of several kinds of fruit, particularly of cherries and apricots. Ratafia of cherries is prepared by bruising the cherries, and putting them into a vessel wherein brandy has been long kept; then adding to them the kernels of cherries, with strawberries, sugar, cinnamon, white pepper, nutmegs, cloves; and to twenty pounds of cherries, ten quarts of brandy. The vessel is left open ten or twelve days, and then stopped close for two months before it is tapped. Ratafia of apricots is prepared two ways, viz. either by boiling the apricots in white wine, adding to the liquor an equal quantity of brandy with sugar, cinnamon, mace, and the kernels of apricots; infusing the whole for eight or ten days, then straining the liquor, and putting it up for use: or else by infusing the apricots cut in pieces in brandy, for a day or two, passing it through a straining bag, and then putting in the usual ingredients.

RATCH, or Rash, in clock-work, a sort of wheel having twelve fangs, which serve to lift up the detents every hour, and make the clock strike. See Clock-work.

RATCHETS, in a watch, are the small teeth at the bottom of the fusee, or barrel, which stops it in winding up.

RATES, in the navy, the orders or classes into which the ships of war are divided, according to their force and magnitude. The regulation which limits the rates of men of war to the smallest number possible, seems to have been dictated by considerations of political economy, or of the simplicity of the service in the royal dock-yards. The British fleet is accordingly distributed into six rates, exclusive of the inferior vessels that usually attend on naval armaments; as sloops of war, armed ships, bomb-ketches, fire-ships and cutters, or schooners commanded by lieutenants. Ships of the first rate mount 100 cannon, having 42-pounders on the lower deck, 24-pounders on the middle deck, 12-pounders on the upper deck, and 9-pounders on the quarter-deck and forecastle. They are manned with 850 men, including their officers, seamen, marines, and servants.

In general, the ships of every rate, besides the captains, have the master, the boatswain, the gunner, the chaplain, the purser, the surgeon, and the carpenter; all of whom, except the captain, have their mates or assistants, in which are comprehended the sail-maker, the master at arms, the armourer, the captain's clerk, the gunsmith, &c. The number of other officers is always in proportion to the rate of the ship. Thus a first-rate has six lieutenants, six master's mates, twenty-four midshipmen, and five surgeon's mates, who are considered as gentlemen: besides the following petty officers; quarter-masters and their mates, fourteen; boatswain's mates and yeomen, eight; gunner's mates and assistants, six; quarter-gunners, twenty-five; carpenter's mates, two, besides fourteen assistants; with one steward, and steward's mate to the purser.

If the dimensions of all ships of the same rate were equal, it would be the simplest and most perspicuous method to collect them into one point of view in a table: but as there is no invariable rule for the general dimensions, we must content ourselves with but a few remarks on ships of each rate, so as to give a general idea of the difference between them.

The Victory, one of the last-built of our first-rates, and ever memorable for being commanded by lord Nelson in the glorious battle of Trafalgar, is 222 feet 6 inches in length, from the head to the stern; the length of her keel, 151 feet 3 inches; that of her gun-deck, or lower deck, 186 feet; her extreme breadth is 51 feet 10 inches; her depth in the hold, 21 feet 6 inches; her burthen 2162 tons; and her poop reaches 6 feet before the mizen-mast.

Ships of the second rate carry 90 guns upon three decks, of which those on the lower battery are 32-pounders; those on the middle, 18-pounders; on the upper deck, 12-pounders; and those on the quarter-deck, 6-pounders, which usually amount to four or six. Their complement of men is 750, in which there are 6 lieutenants, four master's-mates, 24 midshipmen, and four surgeon's-mates, 14 quarter-masters and their mates, eight boatswain's mates and yeomen, six gunner's mates and yeomen, with 22 quarter-gunners, two carpenter's-mates with 10 assistants, and one steward and steward's mate.

Ships of the third rate carry from 64 to 80 cannon, which are 31, 18, and 9-pounders. The 80-gun ships, however, begin to grow out of repute, and to give way to those of 74, 70, &c. which have only two whole batteries; whereas the former have three, with 28 guns planted on each, the cannon of their upper deck being the same as those on the quarter-deck and forecastle of the latter, which are 9-pounders. The complement in a 74 is 650, and in a 64, 500 men; having, in peace, four lieutenants, but in war, five; and when an admiral is aboard, six. They have three master's-mates, 16 midshipmen, three surgeon's-mates, 10 quarter-masters and their mates, six boatswain's-mates and yeomen, four gunner's-mates and yeomen, with 18 quarter-gunners, one carpenter's-mate with eight assistants, and one steward and steward's-mate under the purser.

Ships of the fourth rate mount from 60 to 50 guns, upon two decks, and the quarter-deck. The lower tier is composed of 24-pounders, the upper tier of 12-pounders, and the cannon on the quarter-deck and forecastle are 6-pounders. The complement of a 50-gun ship is 350 men, in which there are three lieutenants, two master's-mates, 10 midshipmen, two surgeon's-mates, eight quarter-masters and their mates, four boatswain's mates and yeomen, one gunner's-mate and one yeoman, with 12 quarter-gunner's, one carpenter's-mate and six assistants, and a steward and steward's-mate.

Vessels of war under the fourth rate, and above the rate of sloops, are usually comprehended under the general name of frigates, and never appear in the line of battle. They are divided into the fifth and sixth rates; the former mounting from 50 to 32 guns, and the latter from 28 to 20. The largest of the fifth rate have two decks of cannon, the lower battery being of 18-pounders, and that of the upper-deck of 9-pounders; but those of 36 and 32 guns have one complete deck of guns, mounting 12-pounders, besides the quarter-deck and forecastle, which carry 6-pounders. The complement of a ship of 44 guns is 280 men; and that of a frigate of 36 guns, 240 men. The first has three, and the second two lieutenants; and both have two master's-mates, six midshipmen, two surgeon's-mates, six quarter-masters and their mates, two boatswain's-mates and one yeoman, one gunner's mate and one yeoman, with 10 or 11 quarter-gunners, and one purser's steward.

Frigates of the 6th rate carry 9-pounders, those of 28 guns having 3-pounders on their quarter-deck, with 200 men for their complement; and those of 24, 160 men: the former have two lieutenants, the latter one; and both have two master's-mates, four midshipmen, one surgeon's-mate, four quarter-masters and their mates, one boatswain's-mate and one yeoman, one gunner's-mate and one yeoman, with six or seven quarter-gunners, and one purser's-steward.

The sloops of war carry from 18 to 8 cannon: the largest have six-pounders; and the smallest, viz. those of 8 or 10 guns, four-pounders. Their officers are generally the same as in the 6th rates, with little variation; and their complements of men are from 120 to 60, in proportion to their force or magnitude. Bomb-vessels are on the same establishment as sloops; but fire-ships and hospital-ships are on that of fifth rates.

Nothing more evidently manifests the great improvement of the marine art, and the degree of perfection to which it has arrived in Britain, than the facility of managing our first rates; which were formerly esteemed incapable of government, unless in the most favourable weather of the summer. Ships of the second rate, and those of the third, which have three decks, carry their sails remarkably well, and labour very little at sea. They are excellent in a general action, or in cannonading a fortress. Those of the third rate, which have two tiers, are fit for the line of battle, to lead the convoys and squadrons of ships of war in action, and in general to suit the different exigencies of the naval service. The fourth-rates may be employed on the same occasions as the third-rates, and may be also destined amongst the foreign colonies, or on expeditions of great distance; since these vessels are usually excellent for keeping and sustaining the sea. Vessels of the fifth rate are too weak to suffer the shock of a line of battle; but they may be destined to lead the convoys of merchant-ships, to protect the commerce in the colonies, to cruize in different stations, to accompany squadrons, or be sent express with necessary intelligence and orders. The same may be observed of the sixth-rates. The frigates, which mount from 28 to 38 guns upon one deck, with the quarter-deck, are extremely proper for cruizing against privateers, or for short expeditions, being light, long, and usually excellent sailers.

RATEEN, in commerce, a thick woollen stuff, quilled, woven on a loom with four treadles, like serges, and other stuffs, that have the whale or quilling. There are some rateens dressed and prepared like cloths; others left simply in the hair, and others where the hair or knap is frized.

RATIO, in arithmetic and geometry, is that relation of homogeneous things which determines the quantity of one from the quantity of another, without the intervention of a third.

Two numbers, lines, or quantities, A and

B, being proposed, their relation one to another may be considered under one of these two heads: 1. How much A exceeds B, or B exceeds A; and this is found by taking A from B or B from A, and is called arithmetical reason, or ratio. 2. Or how many times, and parts of a time, A contains B, or B contains A; and this is called geometric reason or ratio; (or, as Euclid defines it, it is the mutual habitude, or respect, of two magnitudes of the same kind, according to quantity; that is, as to how often the one contains, or is contained in, the other;) and is found by dividing A by B, or B by A; and here note, that that quantity which is referred to another quantity, is called the antecedent of the ratio; and that to which the other is referred, is called the consequent of the ratio; as, in the ratio of A to B, A is the antecedent, and B the consequent. Therefore any quantity, as antecedent, divided by any quanity as a consequent, gives the ratio of that antecedent to the consequent.

Thus the ratio of A to B is $\frac{A}{B}$, but the ratio of B to A is $\frac{B}{A}$; and, in numbers, the ratio of 12 to 4 is $\frac{12}{4} = 3$, or triple; but the ratio of 4 to 12 is $\frac{4}{12} = \frac{1}{3}$, or subtriple.

The quantities thus compared must be of the same kind; that is, such which, by multiplication, may be made to exceed one the other; or as these quantities are said to have a ratio between them, which, being multiplied, may be made to exceed one another. Thus a line, how short soever, may be multiplied, that is, produced so long as, to exceed in length any given right line, and consequently these may be compared together, and the ratio expressed; but as a line can never, by any multiplication whatever, be made to have breadth, that is, to be made equal to a superficies, how small soever; these can therefore never be compared together, and consequently have no ratio or respect one to another, according to quantity: that is, as to how often the one contains, or is contained in, the other. See PROPORTION.

RATION, a certain allowance which is given in bread, &c. or forage, when troops are on service, for an officer or soldier.

Complete ration of the small species.

Flour, or bread -	$1\frac{1}{2}$ lbs.
Beef - - -	1
or pork - - - -	$\frac{1}{2}$
Peas - - - -	$\frac{1}{4}$ pint
Butter, or cheese -	1 oz.
Rice - - - - -	1 oz.

When the small species are not issued, $1\frac{1}{2}$ lbs. of flour or bread, with $1\frac{1}{2}$ lbs. of beef, or 10 oz. of pork, forms a complete ration; or 3 lbs. of beef, or 2 lbs. of cheese, or half a pound of rice, forms a complete ration.

The deductions to be taken for provisions from the pay of officers, non-commissioned officers, or men, are the same for all ranks, and in all corps, under the like circumstances of service, when serving out of Great Britain, on stations where provisions are supplied by the public; also, when embarked in transports or other vessels, (except when serving as marines;) also when prisoners of war are maintained at the expence of Great Britain; also when in general hospitals, whether at home or abroad, a deduction of sixpence per day.

A deduction of threepence halfpenny from the pay of every non-commissioned officer and private in Jamaica, in New South Wales, or Gibraltar. Non-commissioned officers and soldiers serving as marines shall not be liable to any deduction from their full pay on account of provisions.

Ration for a horse on home service in 1796, 14 lbs. of hay, 10 lbs. of oats, 4 lbs. of straw, for which a stoppage is made of sixpence.

The French use the same term, viz. *ration de foin*, a ration of hay; *double ration*, double ration; *demi-ration*, a half-ration.

RATIONAL is applied to integral, fractional, and mixt numbers; thus we say, rational fraction, rational integer, and rational mixt number.

Rational is applied to the true horizon, in opposition to the sensible or apparent one.

RATIONALE, a solution, or account of the principles of some opinion, action, hypothesis, phænomenon, or the like.

RATLINES, or, as the seamen call them, RATLINS, those lines which make the ladder-steps to get up the shrouds and futtocks, hence called the ratlins of the shrouds.

RATTLE-SNAKE. See CROTALUS.

RAVELIN, in fortification, was antiently a flat bastion, placed in the middle of a curtin; but now a detached work composed only of two faces, which make a saliant angle, without any flanks, and raised before the curtin on the counterscarp of the place. A ravelin is a triangular work, resembling the point of a bastion with the flanks cut off. See FORTIFICATION.

Its use before a curtin is, to cover the opposite flanks of the two next bastions. It is used also to cover a bridge, or a gate, and is always placed without the moat. There are also double ravelins that serve to cover each other; they are said to be double when they are joined by a curtin.

RAVEN. See CORVUS.

RAUWOLFIA, a genus of the pentandria monogynia class of plants, the corolla of which consists of a single funnel-fashioned petal, with a large limb, divided into five lanceolated segments; the fruit is a succulent berry, with two seeds. There are four species, trees of South America.

RAY, a beam of light emitted from a radiant or luminous body. See OPTICS.

RAYS OF LIGHT, *colour and heat of*. Dr. Herschel had been employed in making observations on the sun by means of telescopes. To prevent the inconvenience arising from the heat, he used coloured glasses; but these glasses, when they were deep enough coloured to intercept the light, very soon cracked and broke in pieces. This circumstance induced him to examine the heating power of the different coloured rays. He made each of them in its turn fall upon the bulb of a thermometer, near which two other thermometers were placed to serve as a standard. The number of degrees which the thermometer exposed to the coloured ray rose above the other two thermometers, indicated the heating power of that ray. He found that the most refrangible rays have the least heating power; and that the heating power gradually increases as the refrangibility diminishes. The violet ray therefore has the smallest heating power, and the red ray the greatest. Dr. Herschel found that the heating power of the violet, green, and red rays, are to each other as the following numbers:

Violet = 16
Green = 22.4
Red = 55

It struck Dr. Herschel as remarkable, that the illuminating power and the heating power of the rays follow such different laws. The first exists in greatest perfection in the middle of the spectrum, and diminishes as we approach either extremity; but the second increases constantly from the violet end, and is greatest at the red end. This led him to suspect that perhaps the heating power does not stop at the end of the visible spectrum, but is continued beyond it. He placed the thermometer completely beyond the boundary of the red ray, but still in the line of the spectrum; and it rose still higher than it had done when exposed to the red ray. On shifting the thermometer still farther, it continued to rise; and the rise did not reach its maximum till the thermometer was half an inch beyond the utmost extremity of the red ray. When shifted still farther, it sunk a little; but the power of heating was sensible at the distance of $1\frac{1}{2}$ inch from the red ray.

These important experiments have been lately repeated and fully confirmed by sir Henry Englefield, in the presence of some very good judges. The apparatus was very different from that of Dr. Herschel, and contrived on purpose to obviate certain objections which had been made to the conclusions drawn by that illustrious philosopher. The bulbs of the thermometers used were mostly blackened. The following table exhibits the result obtained in one of these experiments:

Thermometer in the blue ray rose in	-	3′	from 55°	to 56°
green		3	54	58
yellow		3	56	62
full red		$2\frac{1}{2}$	56	72
confines of red		$2\frac{1}{2}$	58	$73\frac{3}{4}$
beyond the visible light		$2\frac{1}{2}$	61	79

The thermometer with its bulb blackened, rose much more when placed in the same circumstances, than the thermometer whose bulb was either naked or whitened with paint. This will be apparent from the following table:

		Time.	from	To
Red ray - -	Black therm.	3′	58°	61°
	White therm.		55	58
Dark - - -	Black therm.	3	59	64
	White therm.		58	$58\frac{1}{4}$
Confines of red	Black therm.	3	59	71
	White therm.		$57\frac{1}{2}$	$60\frac{1}{2}$

Both Dr. Herschel and sir Henry Englefield take notice of a faint blush of red of a semi-oval form, visible when the rays beyond the red end of the spectrum were collected by a lens.

From these experiments it seems to follow, that there are rays emitted from the sun, which produce heat, but have not the power of illuminating; and that these are the rays which produce the greatest quantity of heat. Consequently caloric is emitted from the sun

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in rays, and the rays of caloric are not the same with the rays of light.

On examining the other extremity of the spectrum, Dr. Herschel ascertained that no rays of caloric can be traced beyond the violet ray. He had found, however, as Senebier had done before him, that all the coloured rays of the spectrum have the power of heating: it may be questioned therefore whether there are any rays which do not warm. The coloured rays must either have the property of exciting heat as rays of light, or they must derive that property from a mixture of rays of caloric. If the first of these suppositions was true, light ought to excite heat in all cases; but it has been long known to philosophers that the light of the moon does not produce the least sensible heat, even when concentrated so strongly as to surpass, in point of illumination, the brightest candles or lamps, and yet these produce a very sensible heat. Here then are rays of light which do not produce heat; rays, too, composed of all the seven prismatic coloured rays. We must conclude, from this well-known fact, that rays of light do not excite heat; and consequently that the coloured rays from the sun and combustible bodies, since they excite heat, must consist of a mixture of rays of light and rays of caloric. That this is the case was demonstrated long ago by Dr. Hooke, and afterwards by Scheele, who separated the two species from each other by a very simple method. If a glass mirror is held before a fire, it reflects the rays of light, but not the rays of caloric; a metallic mirror, on the other hand, reflects both. The glass mirror becomes hot; the metallic mirror does not alter its temperature. If a plate of glass is suddenly interposed between a glowing fire and the face, it intercepts completely the warming power of the fire, without causing any sensible diminution of its brilliancy; consequently it intercepts the rays of caloric, but allows the rays of light to pass. If the glass is allowed to remain in its station till its temperature has reached its maximum, in that situation it ceases to intercept the rays of caloric, but allows them to pass as freely as the rays of light. This curious fact, which shews us that glass only intercepts the rays of caloric till it is saturated with them, was discovered long ago by Dr. Robison, professor of natural philosophy in the university of Edinburgh. These facts are sufficient to convince us that the rays of light and of caloric are different, and that the coloured rays derive their heating power from the rays of caloric which they contain. Thus it appears that solar light is composed of three sets of rays, the colorific, the calorific, and the deoxidizing.

The rays of caloric are refracted by transparent bodies just as the rays of light. We see, too, that, like the rays of light, they differ in their refrangibility; that some of them are as refrangible as the violet rays, but that the greater number of them are less refrangible than the red rays. Whether they are transmitted through all transparent bodies has not been ascertained; neither has the difference of their refraction in different mediums been examined. We are certain, however, that they are transmitted and refracted by all transparent bodies which have been employed as burning-glasses. Dr. Herschel has also proved, by experiment, that it is not only the caloric emitted by the sun which is refrangible, but likewise the rays emitted by common fires, by candles, by hot iron, and even by hot water.

The rays of caloric are reflected by polished surfaces in the same manner as the rays of light. This was lately proved by Herschel; but it had been demonstrated long before by Scheele, who had even ascertained that the angle of their reflection is equal to the angle of their incidence. Mr. Pictet also had made a set of very ingenious experiments on this subject, about the year 1790, which led to the same conclusion. He placed two concave mirrors of tin, of nine inches focus, at the distance of twelve feet two inches from one another. In the focus of one of them he placed a ball of iron two inches in diameter, heated so as not to be visible in the dark; in the other was placed the bulb of a thermometer. In six minutes the thermometer rose 22°. A lighted candle, which was substituted for the ball of iron, produced nearly the same effect. In this case both light and heat appeared to act. In order to separate them, he interposed between the two mirrors a plate of clear glass. The thermometer sunk in nine minutes 14°; and when the glass was again removed, it rose in seven minutes about 12°; yet the light which fell on the thermometer did not seem at all diminished by the glass. Mr. Pictet therefore concluded, that the caloric had been reflected by the mirror, and that it had been the cause of the rise of the thermometer. In another experiment, a glass matrass was substituted for the iron ball, nearly of the same diameter with it, and containing 2044 grains of boiling water. Two minutes after a thick screen of silk, which had been interposed between the two mirrors, was removed, the thermometer rose from 47° to $50\frac{1}{2}$, and descended again the moment the matrass was removed from the focus.

The mirrors of tin were now placed at the distance of 90 inches from each other; the matrass with the boiling water in one of the foci, and a very sensible air-thermometer in the other, every degree of which was equal to about $\frac{1}{11}$ of a degree of Fahrenheit. Exactly in the middle space between the two mirrors there was placed a very thin common glass mirror, suspended in such a manner that either side could be turned towards the matrass. When the polished side of this mirror was turned to the matrass, the thermometer rose only 0.5°; but when the side covered with tin foil, and which had been blackened with ink and smoke, was turned towards the matrass, the thermometer rose to 3.5°. In another experiment, when the polished side of the mirror was turned to the matrass, the thermometer rose 3°, when the other side 9.2°. On rubbing off the tin foil, and repeating the experiment, the thermometer rose 18°. On substituting for the glass mirror a piece of thin white pasteboard of the same dimensions with it, the thermometer rose 10°.

As the rays of light and of caloric emitted by the sun accompany each other, it cannot be doubted that they move with the same velocity. The rays of caloric, therefore, move at the rate of almost 200,000 miles in a second. This is confirmed by an experiment of Mr. Pictet. He placed two concave mirrors at the distance of 69 feet from each other; the one of tin as before, the other of plaister gilt, and 18 inches in diameter. Into the focus of this last mirror he put an air-thermometer, and a hot bullet of iron into that of the other. A few inches from the face of the tin mirror there was placed a thick screen, which was removed as soon as the bullet reached the focus. The thermometer rose the instant the screen was removed, without any perceptible interval; consequently the time which caloric takes in moving 69 feet is too minute to be measured. We see at once that this must be the case when we recollect that caloric moves at the rate of 200,000 miles in a second.

The velocity of caloric being equal to that of light, its particles must be equally minute. Therefore neither the addition of caloric nor its abstraction can sensibly affect the weight of bodies. As this follows necessarily as a consequence from Dr. Herschel's experiments, was it possible to prove by experiment that caloric affects the weight of bodies, the theory founded on Dr. Herschel's discoveries would be overturned: but such deductions have been drawn from the experiments of De Luc, Fordyce, Morveau, and Chaussier. According to these philosophers, bodies become absolutely lighter by being heated. The experiment of Fordyce, which seems to have been made with the greatest care, was conducted in the following manner:

He took a glass globe three inches in diameter, with a short neck, and weighing 451 grains; poured into it 1700 grains of water from the New River, London, and then sealed it hermetically. The whole weighed $2150\frac{11}{12}$ grains at the temperature of 32°. It was put for twenty minutes into a freezing mixture of snow and salt till some of it was frozen; it was then, after being wiped first with a dry linen cloth, next with clean washed dry leather, immediately weighed, and found to be $\frac{1}{60}$ of a grain heavier than before. This was repeated exactly in the same manner five different times; at each, more of the water was frozen, and more weight gained. When the whole water was frozen, it was $\frac{3}{16}$ths of a grain heavier than it had been when fluid. A thermometer applied to the globe stood at 10°. When allowed to remain till the thermometer rose to 32°, it weighed $\frac{2}{16}$ths of a grain more than it did at the same temperature when fluid. It will be seen afterwards, that ice contains less caloric than water of the same temperature with it. The balance used was nice enough to mark $\frac{1}{1600}$th part of a grain.

This subject had attracted the attention of Lavoisier, a philosopher distinguished by the uncommon accuracy of his researches. His experiments, which were published in the Memoirs of the French Academy for 1783, led him to conclude that the weight of bodies is not altered by heating or cooling them, and consequently that caloric produces no sensible change on the weight of bodies. Count Rumford's experiments on the same subject, which were made about the year 1797, are perfectly decisive. He repeated the experiment of Dr. Fordyce with the most scrupulous caution; and by a number of the most ingenious contrivances, demonstrated, that neither the addition nor the abstraction of caloric makes any sensible alteration in the weight of bodies.

Caloric not only possesses the velocity of light, but agrees with it also in another property no less peculiar. Its particles are never found cohering together in masses; and whenever they are forcibly accumulated, they fly off in all directions, and separate from each other with inconceivable rapidity. This property necessarily supposes the existence of a mutual repulsion between the particles of caloric.

Thus it appears that caloric and light resemble each other in a great number of properties. Both are emitted from the sun in rays, with the velocity of 200,000 miles in a second; both of them are refracted by transparent bodies, and reflected by polished surfaces; both of them consist of particles which mutually repel each other, and which produce no sensible effect upon the weight of other bodies. They differ, however, in this particular; light produces in us the sensation of vision; caloric, on the contrary, the sensation of heat.

Upon the whole, we are authorized by the above statement of facts, to conclude, that the solar light is composed of three distinct substances, in some measure separable by the prism on account of the difference of their refrangibility. The calorific rays are the least refrangible, the deoxidizing rays are most refrangible, and the colorific rays possess a mean degree of refrangibility. Hence the rays in the middle of the spectrum have the greatest illuminating power, those beyond the red end the greatest heating power, and those beyond the violet end the greatest deoxidizing power: and the heating power on the one hand, and the deoxidizing power on the other, gradually increase as we approach that end of the spectrum where the maximum of each is concentrated. These different bodies resemble each other in so many particulars, that the same reasoning respecting refrangibility, reflexibility, &c may be applied to all; but they produce different effects upon those bodies on which they act. Little progress has yet been made in the investigation of these effects; but we may look forward to this subject as likely to correct many vague and unmeaning opinions which are at present in repute among philosophers.

RAZOR-BILL. See Alka.

REACH, in the sea language, signifies the distance between any two points of land, lying nearly in a right line.

RE-ACTION, in physiology, the resistance made by all bodies to the action or impulse of others, that endeavour to change its state whether of motion or rest. See Motion.

REALGAR, a mineral found in Sicily and various parts of Germany. It is either massive or crystallized. The primitive form of the crystal is an octahedron with scalene triangles, and it commonly appears in 4, 6, 8, 10, or 12 sided prisms, terminated by four-sided summits. Colour red. Streak yellowish-red. Specific gravity 3.338. It is electric per se, and becomes negatively electric by friction. Before the blowpipe it melts easily, burns with a blue flame, and soon evaporates. It is also the old name for a sulphuret of arsenic, found native in different parts of Europe. It has a scarlet colour, and is often crystallized in transparent prisms. Its specific gravity is 3.2. It is composed of 80 parts of arsenic, and 20 of sulphur, and it is sometimes used as a part.

REAR, a term frequently used in composition, to denote something behind, or backwards, in respect of another, in opposition to van: thus, in a military sense, it is used for the hind part of an army, in opposition to the front, for the rear-guard, rear half-files, rear-line, rear-rank, and rear-admiral.

RE-ATTACHMENT, a second attachment of him that was formerly attached and dismissed the court without day, as by the not coming of the justices, or some such casualty.

REAUMURIA, a genus of the class and order polyandria pentagynia. The calyx is six-leaved; petals five; caps. one-celled, five-valved, many-seeded. There is one species, an annual of Egypt.

REBATE, or Rebatement, in commerce, a term much used at Amsterdam, for an abatement in the price of several commodities, when the buyer, instead of taking time, advances ready money.

REBELLION, taking up arms traitorously against the king, be it by natural subjects, or by others once subdued. See Riot.

REBUTTER, is the answer of the defendant to the plaintiff's sur-rejoinder.

RECAPITULATION, in oratory, &c. is a summary, or a concise and transient enumeration, of the principal things insisted on in the preceding discourse, whereby the force of the whole is collected into one view.

RECAPTION. Where one has deprived another of his property, the owner may lawfully claim and retake it wherever he happens to find it, so that it shall be not in a riotous manner, or attended with any breach of the peace.

RECEIPTS, are acknowledgments in writing of having received a sum of money or other value. A receipt is either a voucher for an obligation discharged or one incurred Receipts for money above 40*s.* must be on stamps: but on the back of a bill of exchange or promissory note which is already stamped, is good without a farther duty. Writing a receipt on a stamp of greater value than the law requires, incurs no penalty, and the receipt is good; but if on a stamp of a lower value, or on unstamped paper, then a receipt is no discharge, and incurs a penalty. See Stamp.

RECEIVER, in pneumatics, a glass vessel for containing the thing on which an experiment in the air-pump is to be made. See Pneumatics.

Receiver, in chemistry, a vessel of earth, glass, &c. for receiving any distilled liquor.

Receiver. Receiving stolen goods, knowing them to be stolen, is a high misdemeanour at the common law; and by several statutes is made felony and transportation; and in some particular instances, felony without benefit of clergy.

Receiver also signifies an officer, of which there are several kinds, denominated from the particular matters they receive, the places where, or the persons from whom, &c. 1. Receiver of the fines is an officer appointed to receive the money of such persons as compound with the king, upon original writs sued out of chancery. 2. Receiver-general of the duchy of Lancaster is an officer belonging to the duchy-court, who collects all the revenues, fines, forfeitures, and assessments, within that duchy. 3. Receiver-general of the public revenue, is an officer appointed in every county, to receive the taxes granted by parliament, and remit the money to the treasury.

RECIPE, in medicine, a prescription or remedy, to be taken by a patient; so called because always beginning with the word recipe, *i. e.* take; which is generally denoted by the abbreviature ℞.

RECIPIANGLE, or Recipient angle, a mathematical instrument, serving to measure re-entering and saliant angles, especially in fortification.

It usually consists of two arms, or rulers, AC, and BC (Plate Miscel. fig. 197) riveted together at C, and capable of being opened and closed, like a sector. To take an angle with it, they lay the centre of a protractor over the joint C, and apply its diameter to one of the rulers; then the degrees cut by the edge of the other ruler, shew the quantity of the angle.

There are other forms of this instrument: that represented fig. 198, has a graduated circle, by which the angles may be readily measured by its index; and fig. 199, is another kind composed of four equal rulers of brass, riveted together by their ends, so as to form a parallelogram; and on one of the rulers is fixed a graduated semicircle, which measures the opposite angle of the parallelogram, by means of one of the rulers produced so as to serve instead of an index.

RECIPROCAL terms, among logicians, are those which have the same signification; and consequently are convertible, or may be used for each other.

Reciprocal figures, in geometry, those which have the antecedents and consequents of the same ratio, in both figures. Thus, (Plate Miscel. fig. 200,) $A:B::C:D$: or $12:4::9:3$; that is, as much as the side A, in the first rectangle, is longer than B, so much deeper is the side C, in the second rectangle, than the side D in the first; and, consequently, the greater length of the one is compensated by the greater breadth or depth of the other; for as the side A is $\frac{1}{4}$ longer than C, so B is $\frac{1}{4}$ longer than D, and the rectangles of course equal; that is, $A + D = B \times C$, or $12 \times 3 = 4 \times 9 = 36$.

This is the foundation of that capital theorem, viz. that the rectangle of the extremes is always equal to that of the means; and, consequently, the reason of the rule of three.

Hence it follows, that if any two triangles, parallelograms, prisms, parallelopipeds, pyramids, cones, or cylinders, have their bases and altitudes reciprocally proportional, those two figures or solids are equal to each other; and, vice versa, if they are equal, then their bases and altitudes are reciprocally proportional. See Triangle, Parallelogram, &c.

Reciprocal proportion, in arithmetic, is when, in four numbers, the fourth is less than the second, by so much as the third is greater than the first; and vice versa.

This is the foundation of the inverse, or indirect, rule of three: thus, $4:10::8:5$.

It is applied also to quantities which, being multiplied together, produce unity. Thus $\frac{1}{x}$ and x, y and $\frac{1}{y}$, are reciprocal quantities, beause $\frac{1}{x} \times x = \frac{x}{x} = 1$, and $\frac{1}{y} \times y = \frac{y}{y} = 1$.

RECITATIVO, or Recitative, in mu-ic, a kind of singing, that differs but little ro.n ordinary pronunciation, such as that in which the several parts of the liturgy are re-earsed in cathedrals; or that in which the ctors commonly deliver themselves on the heatre at the opera, when they are to express ome action or passion, to relate some event, r reveal some design. Notwithstanding this ort of composition is noted in true time, the erformer is at liberty to alter the bars of neasure, and make some long and others hort, as his subject requires; hence the horough-bass to the recitative is usually laced below the other, to the end that he, who is to accompany the voice, may rather bserve and follow the singer, than the person hat beats the time.

RECKONING, or a Ship's Reckon-ng, in navigation, is that account by which t any time it may be known where the ship , and on what course or courses she is to teer in order to gain her port; and that ac-ount taken from the log-board is called the ead-reckoning. See Navigation.

RECLINER, or Reclining dial. See Dialling.

RECOGNISANCE, is an obligation of ecord, which a man enters into before some ourt of record, or magistrate duly autho-zed, with condition to some particular act; s to appear at the assizes or quarter-sessions, o keep the peace, &c.

RECOIL, or Rebound, the starting back-ard of a fire-arm, after an explosion. Mer-nnus tells us, that a cannon 12 feet in length, eighing 6400 lb. gives a ball of 24 lb. an uni-orm velocity of 640 feet per second. Putting, herefore, $W = 6400$, $w = 24$, $V = 640$, and $= $ the velocity with which the cannon re-oils; we shall have (because the momenta of he cannon and ball are equal) $Wv = wV$: and $v = \frac{wV}{W} = \frac{24 \times 64}{6400} = 2, 4$; that is, it ould recoil at the rate of $2\frac{4}{10}$ feet per second, free to move.

RECORD. An act committed to writing any of the king's courts, during the term herein it is written, is alterable, being no ecord; but that term once ended, and the act ly enrolled, it is a record, and of that redit which admits of no alteration or proof o the contrary.

RECORDARE facias, a writ directed to e sheriff, to remove a cause out of an in-rior court, into the king's-bench or common-eas.

RECORDER, a person whom the mayor nd other magistrates of a city or corporation sociate to them, for their better direction in atters of justice, and proceedings in law; n which account this person is generally a ounsellor, or other person well skilled in the w. The recorder of London is chosen by e lord-mayor and aldermen; and, as he is ld to be the mouth of the city, he delivers e judgment of the courts, and records and rtifies the city customs.

RECOVERY, in law, is obtaining any ing by judgment or trial at law.

A recovery resembles a fine so far as being action real or fictitious, and in that lands are recovered against the tenant of the freehold, and an absolute fee-simple is vested in the recoverer; but it is carried on through every stage of proceeding, instead of being compromised like a fine. See Fine.

This invention we owe to the ingenuity of the ecclesiastics, to evade the statute of mortmain, which prohibited them from purchasing or receiving, under pretence of a free gift, any lands or tenements whatsoever; and as judgment was given for religious houses, they were presumed to have recovered the lands by sentence of law, on a supposed prior title, and were held not to come within the statute. The convenience of those recoveries was soon discovered, and made use of by lay persons as a common mode of transferring lands; but the want of moderation on the part of the ecclesiastics, in their frequent recourse to feigned recoveries, was such as to call for parliamentary interference, and gave rise to the act in the reign of Edward the First, called the statute of Westminster; which enacts, that in all cases where ecclesiastical persons recovered lands by default, a jury should try the right; and if the demandants were found to have no title, the land should be forfeited to the lord of the fee, according to the statute of mortmain.

This act threw the recoveries into disuse, till they were resumed as a mode of evading the strictness of the statute de donis conditionalibus, which lays a general restraint on alienation. The people made many attempts to procure a repeal of this statute, but in vain; but as the inconveniences were manifest, the judges always endeavoured to contrive means of evading it; and it was decided in a case in the reign of Edward IV. that a common recovery suffered by a tenant intail, should operate as an effectual bar to his estate tail, and to all remainders and reversions depending thereon; by which means tenants in tail are now enabled to dispose of their estates, or convert them into estates in fee-simple; and it may be suffered of all things, whereof a writ of covenant may be brought for the purpose of levying a fine. There are three persons required to form a recovery; the demandant, tenant, and vouchee. The demandant is he who brings the writ of entry; the tenant is he against whom the writ is brought; and the vouchee is he whom the tenant vouches and calls to warranty; but this may be better understood by supposing John Jacobs to be tenant of the freehold, and desirous of suffering a recovery to cut off all entails and reversions, and to convey the estate in fee-simple to James Jenkins. Jenkins sues out a writ of precipe quod reddat, as in the case of a fine, and charges that the defendant has no title, but came into possession after Hugh Hunt had turned the plaintiff out of it. The proceedings are made up on the recovery-roll, in which the writ and complaint of the demandant are recited; the tenant then appears and calls upon one Charles Browning, who is supposed at the original purchase to have warranted the title to the tenant, and who is denominated the vouchee: the vouchee then appears, is impleaded, and defends the the title. Jenkins, the demandant, craves leave to imparl, which is granted; the plaintiff then returns into court, but the vouchee disappears and makes default; judgment is of course given for Jenkins, and Jacobs is to recover the value of the land from Charles Browning, as he lost them through his default. But on enquiry, it is always found that Browning (who is merely an officer of the court, and denominated the common vouchee, from being always vouched), has no lands, so that Jacobs, now called the recovree, has but a nominal recompence; and the plaintiff, who is now recoverer, has the lands vested in him by judgment of the court, and seisin delivered by the sheriff.

A recovery is sometimes with double or treble voucher, or even more if necessary. And, indeed, a double voucher is the most common, by first conveying an estate to any third person, against whom the writ is issued, he then vouches the tenant in tail who vouches over the common vouchee; for if the recovery is had immediately against the tenant in tail, it bars only such estate in the premises of which he is then actually seized; but if the recovery is had against a third person, and the tenant in tail is the first vouchee, it bars every latent right and interest which he may have in the lands recovered. If an infant suffers a recovery in person, he may reverse it, but then the writ of error must be brought during his minority. Sometimes, though but seldom, the court permits the infant to appear by guardian, where the recovery is of manifest advantage to the infant; and when this has been allowed by the judges, the infant cannot set it aside; but if it is to the prejudice of the infant, he has a remedy by action against the guardian. This appears from several cases. If the infant appears by attorney, he may reverse the recovery after he is of age, because it may be here discovered by trial whether the warrant of attorney was made by him while an infant. A married woman joining with her husband in suffering a recovery, will bar her remainder; because as she is examined privately as to her consent, it takes away the presumption in law that it is done by the compulsion of her husband.

All persons have power to suffer a recovery except the king (for if he does, he must either be tenant or vouchee, and in both cases the plaintiff must count against him, which the law does not allow), infants, persons non compos, and women who are possessed of dower; who are prohibited by the statute of 11 Henry VII. c. 20, which enacts that a recovery suffered by any woman of lands settled on her by her husband, or settled on her husband and her by any of his ancestors, shall be void.

The effect of common recoveries may appear to be an absolute bar not only of all estates tail, but of remainders and reversions expectant on the determination of such estates. So that a tenant in tail may convey lands in tail to the recoverer, free and discharged of all conditions and appointments in tail, and of all remainders and reversions. But as is before mentioned, a woman possessed of dower is prevented by the statute; and by the statute of 11 Eliz. c. 8, no tenant for life of any sort can suffer a recovery, so as to bind them in remainder or reversion. For which reason, if there is a tenant for life with remainder in tail, and other remainders over, and the tenant for life is desirous to suffer a valid recovery, either he or the tenant to the precipe must vouch the remainder-man in tail. It is an essential part of a recovery, that the tenant to the precipe should be actually seised of the freehold; but by 14 Geo. II. though the legal freehold should be vested in lessees, yet those who are intitled to the next freehold estate in remainder or reversion may make a good tenant to the precipe; and though the deed or fine which creates such tenant should be subsequent to the judgment of recovery, if it is in the same term, the recovery is valid; and that though the recovery itself does not appear to be entered, or not regularly entered on record: yet the deed to make a tenant to the precipe and declare the uses of the recovery, with twenty years possession, shall be sufficient evidence of the recovery. If a recovery is levied without any good consideration or the uses declared, they only enure to the use of him who levies them; and if there is a consideration, yet as the most usual fine, sur cognizance de droit comme ces, &c. conveys an absolute estate without limitations, these conveyances could not be made to answer the purposes of family settlements (wherein a variety of uses and designations is often necessary), unless their force and effect were made subject to the direction of more complicated deeds. These deeds, if made previous to the judgment, are called deeds to lead the uses; if subsequent, to declare them.

RECTANGLE, in geometry, the same with a right-angled parallelogram.

RECTANGLED, Rectangular, or Right-angled, appellations given to figures and solids which have one or more right angles: thus a triangle with one right angle, is termed a rectangled triangle; also parallelograms with right angles, squares, cubes, &c. are rectangular. Solids, as cones, cylinders, &c. are also said to be rectangular with respect to their situation, when their axes are perpendicular to the plane of the horizon.

RECTIFICATION, in geometry, is the finding a right line, equal in length to a curve. See the article Curve.

The rectification of curves is a branch of the higher geometry, where the use of the inverse method of fluxions is very conspicuous.

Case I. Let ACG, (Plate Miscel. fig. 201) be any kind of curve, whose ordinates are parallel to themselves, and perpendicular to the axis AQ. Then if the fluxion of the absciss AM is denoted by M*m*, or by C*n* (equal and parallel to M*m*), and *n*S, equal and parallel to C*r*, is the representation of the corresponding fluxion of the ordinate MC; then will the diagonal CS, touching the curve in C, be the line which the generating point *p* would describe, was its motion to become uniform at C; which line, therefore, truly expresses the fluxion of the space AC, gone over. See the article Fluxions.

Hence, putting AM $= x$, CM $= y$, and AC $= z$; we have $\dot{z} =$ CS $= \sqrt{Cn^2 + Sn^2} = \sqrt{\dot{x}^2 + \dot{y}^2}$; from which, and the equation of the curve, the value of z may be determined. Thus, let the curve proposed be a parabola of any kind, the general equation for which is $x = \frac{y^n}{a^{n-1}}$; and hence $\dot{x} = \frac{ny^{n-1}\dot{y}}{a^{n-1}}$, and therefore $\dot{z}\ (= \sqrt{\dot{y}^2 + \dot{x}^2}) = \sqrt{\dot{y}^2 + \frac{n^2y^{2n-2}\dot{y}^2}{a^{2n-2}}}$

$$= \dot{y} \times \left(1 + \frac{n^2y^{2n-2}}{a^{2n-2}}\right)^{\frac{1}{2}};$$ the fluent of which, universally expressed in an infinite series, is

$$y + \frac{n^2y^{2n-1}}{2n-1 \times 2a^{2n-2}} - \frac{n^4y^{4n-3}}{4n-3 \times 8a^{4n-4}} + \frac{n^6y^{6n-5}}{6n-5 \times 16a^{6n-6}} \text{ \&c.} = z.$$

Case II. Let all the ordinates of the proposed curve ARM, fig. 202, be referred to a centre C: then, putting the tangent RP (intercepted by the perpendicular CP) $= t$, the arch, BN, of a circle, described about the centre C, $= x$; and the radius CN (or CB) $= a$; we have $\dot{z} : \dot{y} :: y$ (CR) $: t$ (RP); and, consequently, $\dot{z} = \frac{\dot{y}y}{t}$: from whence the value of z may be found, if the relation of y and t is given. But, in other cases, it will be better to work from the following equation, viz. $\dot{z} = \sqrt{\dot{y}^2 + \frac{y^2\dot{x}^2}{a^2}}$, which is thus derived; let the right line CR be conceived to revolve about the centre C; then, since the celerity of the generating point R, in a direction perpendicular to CR, is to ($\dot{x}$) the celerity of the point N, as CR (y) to CN (a), it will therefore be truly represented by $\frac{y\dot{x}}{a}$; which being to ($\dot{y}$) the celerity in the direction of CR produced, as CB (s) : RP (t), it follows that $\frac{y^2\dot{x}^2}{a^2} : \dot{y}^2 :: s^2 : t^2$; whence, by composition, $\frac{y^2\dot{x}^2}{a^2} + \dot{y}^2 : \dot{y}^2 :: s^2 + t^2\ (y^2) : t^2$; therefore $\frac{y^2\dot{x}^2}{a^2} + \dot{y}^2 = \frac{y^2\dot{y}^2}{t^2}$, and consequently $\sqrt{\frac{y^2\dot{x}^2}{a^2} + \dot{y}^2}\ (= \frac{y\dot{y}}{t}) = \dot{z}$. Q. E. D.

Rectification, in chemistry, the repetition of a distillation or sublimation several times, in order to render the substance purer, finer, and freer from aqueous or earthy parts. See Distillation.

RECTILINEAR, in geometry, right-lined; thus figures whose perimeter consists of right lines, are said to be rectilinear.

RECTO, in law, a writ of right, which is of so high a nature, that whereas other writs in real actions are only to recover the possession of the land or tenements in question, which have been lost by our ancestors or ourselves; this aims to recover both the seisin which some of our ancestors or we had, and also the property of the hiring whereof the ancestor died not seised as of fee; and whereby are pleaded and tried both their rights together, viz. as well of possession as of property; so that if a man ever loses his cause upon this writ, either by judgment, or assize he is without remedy. Pract. Lib. 5.

Recto de advocatione ecclesiæ, a writ of right, lying where a man has a right of advowson, and the parson of the church dying, a stranger presents his clerk to the church; and he not having brought his action of quare impedit, nor darrein presentment, within six months, but suffered the stranger to usurp upon him.

Recto de dote, a writ of right of dower, which lies for a woman who has received part of her dower, and purposes to demand the remainder in the same town, against the heir, or his guardian if he is a ward.

Recto de dote unde nihil habet, a writ of right which lies in a case, where the husband having divers lands or tenements, has assured no dower to his wife, and she thereby is driven to sue for her thirds, against the heir or his guardian.

Recto quando dominus remisit, a writ of right, which lies in cases, where lands or tenements in the seigniory of any lord are in demand by a writ of right.

RECTOR, a term applied to several persons whose offices are very different; as, 1. The rector of a parish is a clergyman that has the charge and cure of a parish, and possesses all the tythes, &c. 2. The same name is also given to the chief elective officer in several foreign universities, particularly in that of Paris. 3. Rector is also used in several convents for the superior officer who governs the house; and the jesuits give this name to the superiors of such of their houses as are either seminaries or colleges.

RECTORY, a parish church, parsonage, or spiritual living, with all its rights, tythes, and glebes.

RECTUM, in anatomy, the third and last of the large intestines. See Anatomy.

RECURVIROSTRA, in ornithology, a genus belonging to the order of grallæ. The bill is long, subulated, bent back, sharp and flexible at the point. The feet are webbed, and furnished with three toes forwards, and a short one behind. Mr. Latham notes of this genus three species, viz. the avosetta, or the one commonly known, the Americana, and the alba. This last, it is probable, has some affinity to the Americana. The recurvirostra avosetta is about the size of a lapwing in body, but has very long legs. The substance of the bill is soft, and almost membranous at its tip; it is thin, weak, slender, compressed horizontally, and incapable of defence or effort. These birds are variegated with black and white, and during the winter are frequent on the eastern shores of Great Britain. They visit also the Severn, and sometimes the pools of Shropshire. They feed on worms and insects, which they scoop out of the sand with their bills. They lay two eggs, white, with a greenish hue, and large spots of black, about the size of a pigeon's. They are found also in various parts of the continent of Europe, in Russia, Denmark, and Sweden, but they are not numerous. They are also found in Siberia, but oftener about the salt lakes of the Tartarian desert, and about the Caspian sea; likewise on the coasts of Picardy in France, in April and November, and at Orleans, but rarely. In breeding-time they are very plentiful on the coasts of Bas Poictou. They do not appear to wander further south in Europe than Italy. Whether from timidity or address, the avoset shuns snares, and is not easily taken. The American avoset is rather larger and longer than the last. The bill is similar, and its colour black; the forehead is dusky white; the head, neck, and upper part of the breast, are of a deep cream-colour; the lower parts of the neck behind white; the back is black, and the under parts from the breast pure white; the wings are partly black, partly white, and partly ash-coloured. These birds inhabit North America; and were found by Dampier in Sharks-bay, on the coast of New Holland. See Plate Nat. Hist. fig. 345.

The recurvirostra, or scolopax alba, is about 14 inches and a quarter long, its colour white, the inferior coverts of its wings duskish, its bill orange, its legs brown. Edwards remarks that the bill of this bird is bent upwards, as in the avoset: its bill black at the tip, and orange the rest of its length; all the plumage is white, except a tint of yellowish on the great quills of the wing and of the tail. Edwards supposes that the whiteness is produced by the cold climate of Hudsons-bay, from which he received it, and that they resume their brown feathers during the summer. It appears that several species of this bird have spread further into America, and have even reached the southern provinces.

A bird of this kind, Mr. Latham says, was sent from Hudsons-bay, and from the figure, has every appearance of an avoset. In Edwards's plate, however, the toes appear cloven to the bottom; a circumstance seeming to overturn the supposition, and only to be authenticated when other specimens shall have come under the eye of the well-informed naturalist.

RECUSANT, a person who refuses to go to church, and worship God after the manner of the church of England, as by law established; to which is annexed the penalty of 20*l.* a month for nonconformity. 23 Eliz. c. 1.

RED, in dyeing, is one of the five simple or mother colours. See DYEING.

RED-LEAD. See LEAD, *oxide of.*

RED-BOOK of the exchequer, an antient record or manuscript volume, in the keeping of the king's remembrancer, containing divers miscellaneous treatises relating to the times before the Conquest.

REDDENDUM, in our law, is used substantively for the clause in a lease wherein the rent is reserved to the lessor. The proper place for it is next after the limitation of estate.

REDEMPTION, in law, a faculty or right of re-entering upon lands, &c. that have been sold and assigned, upon reimbursing the purchase-money with legal costs. Bargains wherein the faculty, or, as some call it, the equity, of redemption is reserved, are only a kind of pignorative contracts. A certain time is limited within which the faculty of redemption shall be exercised, and beyond which it shall not extend.

REDENS, REDANS, or REDANT, in fortification, a kind of work indented in form of the teeth of a saw, with saliant and re-entering angles, to the end that one part may flank or defend another. It is called saw-work, and indented work. Redens are frequently used in the fortifying of walls, where it is not necessary to be at the expence of building bastions; as when they stand on the side of a river, a marsh, the sea, &c.

REDOUBT, or REDOUTE, in fortification, a small square fort, without any defence but in front, used in trenches, lines of circumvallation, contravallation, and approach, as also for the lodgings of corps de garde, and to defend passages. In marshy grounds, redoubts are frequently made of stone-works, for the security of the neighbourhood; their face consists of from 10 to 15 fathoms, the ditch round them from 8 to 9 feet broad and deep, and their parapets have the same thickness.

REDUCT, or REDUIT, a military term signifying an advantageous piece of ground, entrenched and separated from the rest of the place, camp, &c. for an army, garrison, &c. to retire to in case of a surprize.

REDUCTION, that rule by which numbers of different denominations are brought into one denomination. See ARITHMETIC.

REDUCTION *of a figure, design, or draught,* is the making a copy of it either larger or smaller than the original, still preserving the form and proportion. The great use of the proportional compasses is the reduction of figures, &c. whence they are called compasses of reduction.

There are various methods of reducing figures, &c. The most easy is by means of the pentagraph, or parallelogram; but this has its defects. See PENTAGRAPH.

The best and most usual methods of reduction are as follows: 1. To reduce a figure, as ABCDE (Plate Miscel. fig. 203) into a less compass. About the middle of the figure, as z, pitch on a point, and from this point draw lines to its several angles A, B, C, &c. then drawing the line *ab* parallel to AB, *bc* parallel to BC, &c. you will have the figure *abcde* similar to ABCDE.

If the figure *abcde* had been required to be enlarged, there needed nothing but to produce the lines from the point beyond the angles, as zD, zC, &c. and to draw lines, viz. DC, CB, &c. parallel to the sides *dc*, *cb*, &c.

2. To reduce a figure by the angle of proportion, suppose the figure ABCDE, (fig. 204) required to be diminished in the proportion of the line AB to *ab*, (fig. 205). Draw the indefinite line GH, (fig. 206) and from G to H set off the line AB. On G describe the arch HI. Set off the line *ab* as a chord on HI, and draw GI. Then with the angle IGH, you have all the measures of the figure to be drawn. Thus, to lay down the point *c*, take the interval BC, and upon the point G, describe the arch KL. Also on the point G, describe MN; and upon A, with the distance MN, describe an arch cutting the preceding one in *c*, which will determine the side *bc*. And after the same manner are the other sides and angles to be described. The same process will also serve to enlarge the figure.

3. To reduce a figure by a scale. Measure all the sides of the figure, as ABCDE, fig. 204, by a scale, and lay down the same measures respectively from a smallerscale in the proportion required.

4. To reduce a map, design, or figure, by squares. Divide the original into little squares; and divide a fresh paper of the dimensions required into the same number of squares, which are to be larger or less than the former, as the map is to be enlarged or diminished. This done, in every square of the second figure draw what you find in its correspondent one in the first.

REDUCTION, in metallurgy, is the bringing back metalline substances which have been changed into scoriæ or oxides, into their natural and original state of metals again. See CHEMISTRY.

REDUCTION, in surgery, denotes an operation by which a dislocated, luxated, or fractured bone, is restored to its former state or place.

REDUNDANT HYPERBOLA, is a curve of the higher kind, thus called because it exceeds the conic section of that name, in the number of its hyperbolical legs; being a triple hyperbola with six hyperbolical legs.

REDUPLICATION, in logic, a kind of condition expressed in a proposition indicating or assigning the manner in which the predicate is attributed to the subject. Hence reduplicative propositions are such wherein the subject is repeated with some circumstance or condition, thus: Men, as men, are rational; Kings, as kings, are subject to none but God.

REED. See ARUNDO.

REEF, a term in navigation. When there is a great gale of wind, they commonly roll up part of the sail below, that by this means it may become the narrower, and not draw so much wind; which contracting or taking up the sail they call a reef, or reefing the sail; so also when a top-mast is sprung, as they call it, that is, when it is cracked, or almost broken in the cap, they cut off the lower piece that was nearly broken off, and setting the other part, now much shorter, in the step again, they call it a reefed top-mast.

REEL, in the manufactories. There are various kinds of reels, some very simple, others very complex. Of the former kinds those most in use are: 1. A little reel held in the hand, consisting of three pieces of wood, the biggest and longest whereof (which does not exceed a foot and a half in length, and a quarter of an inch in diameter) is traversed by two other pieces disposed different ways. 2. The common reel, or windlass, which turns upon a pivot, and has four flights traversed by long pins or sticks, whereon the skain to be reeled is put, and which are drawn closer or opened wider according to the skain. A representation of the common reel may be seen in Plate Miscel. fig. 207, where A is the bench or seat of the reel, B the two uprights; C the arms of the reel, its arbor turning, and hitching its little lantern of four notches in the teeth of the wheel; D two wheels, the upper one of which moves the lower by means of a pinion; E a hammer, the handle whereof is lowered by a peg at the bottom of the lower wheel; F a cord which is rolled round the axle of the lower wheels, and supports a weight which stops after a certain number of turns, to regulate the work-woman.

REELING, in the manufactories, the winding of thread, silk, cotton, or the like, into a skain, or upon a bottom, to prevent its entangling. It is also used for the charging or discharging of bobbins or quills, to use them in the manufacture of different stuffs, as thread, silks, cotton, &c.

RE-ENTRY, in law, signifies the resuming or retaking that possession which any one had lately foregone; as where a person makes a lease of lands to another, the lessor thereby quits the possession, and the lessee covenants that upon non-payment of the rent reserved, the lessor may lawfully re-enter.

REEVING, in the sea language, the putting a rope through a block; hence to pull a rope out of a block, is called unreeving.

REFINING, in general, is the art of purifying a thing; including not only the assaying or refining of metals, but likewise the depuration or clarification of liquors. Gold and silver may be refined by several methods, which are all founded on the essential properties of these metals, and acquire different names according to their kinds. Thus, for instance, gold having the property which no other metal, not even silver, has, of resisting the action of sulphur, of antimony, of nitrous acid, of marine acid, may be purified by these agents from all other metallic substances, and consequently may be refined. These operations are distinguished by proper names, as purification of gold by antimony, parting, concentrated parting, dry parting. In a similar manner, as silver has the property, which the imperfect metals have not, of resisting the action of nitre, it may be refined by this salt; but the term refining is chiefly applied to the purification of gold and silver by lead in the cupel. This is performed by the destruction, vitrification, and scorification, of all the extraneous and destructible metallic substances with which they are allayed.

As none but the perfect metals can resist the combined action of air and fire, without losing their inflammable principle and being changed into earthy or vitreous matters, incapable of remaining any longer united with substances in a metallic state, there is then a possibility of purifying gold and silver from all allay of imperfect metals merely by the action of fire and air, only by keeping them fused till all the allay is destroyed; but this purification would be very expensive, from the great consumption of fuel, and would be exceedingly tedious. Silver allayed with copper has been exposed longer than 60 hours to a glass-house fire without being perfectly refined; the reason of which is, that when a small quantity only of imperfect metal remains united with gold or silver, it is covered and protected from the action of the air, which is necessary for the combustion of the imperfect metals, as of all combustible matters.

This refining of gold and silver merely by the action of fire, which was the only method antiently known, was very long, difficult, expensive, and imperfect; but a much shorter and more advantageous method has been discovered. This method consists in adding to the allayed gold and silver a certain quantity of lead, and exposing afterwards this mixture to the action of the fire. Lead is one of the metals which loses most quickly and easily a sufficient quantity of its inflammable principle to cease to be in a metallic state; but, at the same time, this metal has the remarkable property of retaining, notwithstanding the action of the fire, enough of this same inflammable principle to be very easily melted into a vitrified and powerfully vitrifying matter, called litharge.

The lead then which is to be added to the gold and silver to be refined, or which happens naturally to be mixed with these metals, produces in their refining the following advantages: 1. By increasing the proportion of imperfect metals, it prevents them from being so well covered and protected by the perfect metals. 2. By uniting with these imperfect metals, it communicates to them a property it has of losing very easily a great part of its inflammable principle. 3. By its vitrifying and fusing property which it exercises with all its force upon the calcined and naturally refractory parts of the other metals, it facilitates and accelerates the fusion, the scorification, and the separation, of these metals. These are the advantages procured by lead in the refining of gold and silver.

The lead, which in this operation is scorified, and scorifies along with it the imperfect metals, separates from the metallic mass, with which it is then incapable of remaining united. It floats upon the surface of the melted mass, because, by losing part of its phlogiston, it loses also part of its specific gravity, and lastly it vitrifies.

These vitrified and melted matters accumulating more and more upon the surface of the metal while the operation advances, would protect this surface from the contact of air which is so absolutely necessary for the scorification of the rest, and would thus stop the progress of the operation, which could never be finished if a method had not been contrived for their removal. This removal of the vitrified matter is procured either by the nature of the vessel in which the melted matter is contained, and which being porous, absorbs and imbibes the scorified matter as fast as it is formed; or by a channel cut in the edge of the vessel, through which the matter flows out.

The vessel in which the refining is performed is flat and shallow, that the matter which it contains may present to the air the greatest surface possible. This form resembles that of a cup, and hence it has been called cupel. The furnace ought to be vaulted, that the heat may be applied upon the surface of the metal during the whole time of the operation. Upon this surface a crust of dark-coloured pellicle is continually forming. In the instant when all the imperfect metal is destroyed, and consequently the scorification ceases, the surface of the perfect metals is seen, and appears clean and brilliant. This forms a kind of fulguration or coruscation: by this mark the metal is known to be refined. If the operation is so conducted that the metal sustains only the precise degree of heat necessary to keep it fused before it is perfectly refined, we may observe that it fixes or becomes solid all at once in the very instant of the coruscation; because a greater heat is required to keep silver or gold in fusion when they are pure than when allayed with lead.

The operation of refining may be performed in small or in large quantities upon the same principles, but only with some differences in the management. As the refining of small quantities of perfect metals is performed in the same manner as these metals are assayed, the assay being only a very accurate refining, we refer to the article Assaying.

REFLECTION *of the rays of light*, in catoptrics, is their return, after approaching so near the surfaces of bodies, as to be repelled, or driven backwards. See Optics.

Reflector, a mirror or looking-glass. For the laws of reflexion see Optics; and for the method of silvering or foliating glass to make it reflect, see Foliating *of looking-glasses*. Vol. I. p. 758.

REFRACTION *of the rays of light*. See Optics.

Refraction, in astronomy, is an inflection of the rays of light proceeding from the heavenly bodies, in passing through the atmosphere, by which their apparent altitudes are increased. See Astronomy, Vol. I. page 171.

Refraction *in island crystal*. There is a double refraction in this substance, contrary ways, by which not only oblique rays are divided into two, and refracted into opposite parts, but even perpendicular rays are one-half refracted.

REFRANGIBILITY *of light*, the disposition of rays to be refracted. See Optics.

REGALIA, in law, the rights and prerogatives of a king; which, according to civilians, are six, viz. 1, the power of judicature; 2, the power of life and death; 3, the power of peace and war; 4, a right to such goods as have no owner, as waifs, estrays, &c. 5, assessments; and, 6, the coinage of money.

Regalia is also used for the apparatus of a coronation, as the crown, the sceptre with the cross, that with the dove, St. Edward's staff, the globe, and the orb with the cross, four several swords, &c.

REGARDANT, in heraldry, signifies looking behind; and is used for a lion, or other beast, with his face turned towards his tail. See Heraldry.

REGENT, one who governs a kingdom during the minority or absence of the king. In France, the queen-mother has the regency of the kingdom during the minority of the king, under the title of queen-regent.

Regent also signifies a professor of arts and sciences in a college, who has a set of pupils under his care; but here regent is generally restrained to the lower classes, as regent of rhetoric, regent of logic, &c. those of philosophy are rather called professors. The foreign universities are generally composed of doctors, professors, and regents.

REGIMEN, the regulation of diet, and in a more general sense, of all the non-naturals, with a view to preserve or restore health. See Materia Medica, article *Dietetics*.

Regimen, in grammar, that part of syntax or construction which regulates the dependancy of words, and the alterations which one occasions in another.

REGIMENT, a term applied to any body of troops: which, if cavalry, consists of one or more squadrons, commanded by a colonel; and, if infantry, of one or more battalions, each commanded in the same manner. The squadrons in cavalry regiments are divided, sometimes into six, and sometimes into nine troops. The battalions of British infantry are generally divided into ten companies, two of which are called the flanks; one on the right consisting of grenadiers, and another on the left formed of light troops. There is not, however, any established rule on this head; as both cavalry and infantry regiments differ according to the exigencies of service in time of war, or the principles of economy in time of peace. We are humbly of opinion, that every regiment of foot should consist of 2400 men, making three battalions of 800 each. The German regiments frequently consist of 2000 men; and the regiment of Picardy in the old French service had 6000. The French have made a distinction between the commanding officer of a regiment of cavalry, and the commanding officer of a regiment of infantry: the former was stiled mestre de camp; the latter colonel, as with us.

According to the establishment of the present French army, the term of regiment is confined to the cavalry and artillery, and the name of half-brigade is given to the infantry; so that chef de brigade, chief of brigade, corresponds with our colonel of a regiment of infantry. The denomination of colonel is still retained in the French cavalry.

With respect to the derivation of the word, it appears that the best etymology is from the French word régie, management, which comes from the Latin regere, to govern. Hence a regiment is said to be governed by a colonel. M. Beneton, a celebrated French etymologist, differs from this explanation. He traces it from the French régime, which signifies system, regimen, administration, and which is again derived from the Latin regimen, bearing the same import. In a physical acceptation of the term, régime (unde regimen) is used to express any body that is composed of several others. But this is mere conjecture on his part.

REGISTER, a public book, in which are entered and recorded memoirs, acts, and minutes, to be had recourse to occasionally, for knowing and proving matters of fact.

Of these there are several kinds; as, 1. Registers of deeds in Yorkshire and Middlesex, in which are registered all deeds, conveyances, wills, &c. that affect any lands or tenements in those counties, which are otherwise void against any subsequent purchasers, or mortgagees, &c. but this does not extend to any copyhold estate, nor to leases at a rack-rent, or where they do not exceed 21 years. The registered memorials must be ingrossed on parchment, under the hand and seal of some of the grantors or grantees, attested by witnesses who are to prove the signing or sealing of them, and the execution of the deed.

But these registers which are confined to two counties, are in Scotland general, by which the laws of North Britain are rendered very easy and regular. Of these there are two kinds; the one general, fixed at Edinburgh, under the direction of the lord-register; and the other kept in the several shires, stewartries, and regalities, the clerks of which are obliged to transmit the registers of their respective courts to the general register. No man in Scotland can have a right to any estate, but it must become registered within 40 days of his becoming seised thereof, by which means all secret conveyances are cut off. 2. Parish registers, are books in which are registered the baptisms, marriages, and burials, of each parish. The dissenters of all denominations register the births of their children at Dr. Williams's library in Red Cross street, Cripplegate.

Register is also used for the clerk or keeper of a register. Of these we have several, denominated from the registers they keep; as register of the high court of delegates; register of the arches court of Canterbury; register of the court of admiralty; register of the prerogative court; register of the garter, &c.

Register ships, in commerce, are vessels which obtain a permission either from the king of Spain, or the council of the Indies, to traffic in the ports of the Spanish West Indies, which are thus called from their being registered before they set sail from Cadiz for Buenos Ayres. Each of these permissions costs 30,000 pieces of eight; and by the tenor of the cedula, or permit, they are not to exceed 300 tons: but there is such a good understanding between the merchants and the council of the Indies, that ships of 5 or 600 tuns frequently pass unnoticed; and though the quantity and quality of the merchandize on board are always expressed, yet, by means of presents, the officers both in Spain and the Indies allow them to load and unload vastly more than the permission expresses.

Register, in printing, is disposing the forms on the press, so that the lines and pages printed on one side of the sheet fall exactly on those of the other.

Register, among letter-founders, is one of the inner parts of the mould in which the printing-types are cast. Its use is to direct the joining the mould justly together again, after opening it to take out the new-cast letter.

REGLETS, or Riglets, in printing, are thin slips of wood, exactly planed to the size of the body of the letter. The smaller sorts are placed between the lines of poetry; and both those and the larger are used in filling up short pages, in forming the whites or distances between the lines of titles, and in adjusting the distances of the pages in the chase so as to form register.

REGRATOR, or Regrater, in law, formerly signified one who bought wholesale, or by the great, and sold again by retail; but the term is now used for one who buys any wares or victuals, and sells them again in the same market or fair, or within five miles round it. See Forestalling.

Regrator, is also used for one who furbishes up old moveables to make them pass for new. And masons who take off the outward surface of hewn stone, in order to whiten it, or make it look fresh again, are said to regrate.

REGULAR, denotes any thing that is agreeable to the rules of art: thus we say a regular building, verb, &c.

A regular figure in geometry is one whose sides, and consequently angles, are equal; and a regular figure with three or four sides, is commonly termed an equilateral triangle or square, as all others with more sides are called regular polygons.

All regular figures may be inscribed in a circle. A regular solid, called also a Platonic body, is that terminated on all sides by regular and equal planes, and whose solid angles are all equal.

The regular bodies are the five following: 1. The tetrahedron, which is a pyramid comprehended under four equal and equilateral triangles. 2. The hexahedron, or cube, whose surface is composed of six equal squares. 3. The octahedron, which is bounded by eight equal and equilateral triangles. 4. The dodecahedron, which is contained under twelve equal and equilateral pentagons. 5. The icosihedron, consisting of 20 equal and equilateral triangles. These five are all the regular bodies in nature. See Tetrahedron, &c.

Proportion of the five regular bodies inscribed in the same (circle from Peter Horigon. Cursus Math. vol. i. p. 779. and Barrow's Euclid, lib. xiii.):

The diameter of the sphere being 2,

The circumference of the greatest circle is - -	6.28318
Superficies of the greatest circle	3.14159
Superficies of the sphere -	12.56637
Solidity of the sphere -	4.18859
Side of the tetrahedron -	1.62299
Superficies of a tetrahedron -	4.6188
Solidity of a tetrahedron -	0.15132
Side of a cube or hexahedron -	1.1547
Superficies of the hexahedron	8.
Solidity of the hexahedron -	1.5396
Side of an octahedron - -	1.41421
Superficies of the octahedron -	6.9282
Solidity of the octahedron -	1.33333
Side of the dodecahedron -	0.71364
Superficies of the dodecahedron	10.51462
Solidity of the dodecahedron	2.78516
Side of the icosihedron -	1.05146
Superficies of the icosihedron	9.57454
Solidity of the icosihedron -	2.53615

If one of these five regular bodies was required to be cut out of the sphere of any other diameter, it will be, As the diameter of the sphere (2), is to the side of any one solid inscribed in the same (suppose the cube, 1.1547), so is the diameter of any one sphere (suppose 8), to 9.2376, the side of the cube inscribed in this latter sphere.

Let dr (Plate Miscel. fig. 208.) be the diameter of any sphere, and da $\frac{1}{3}$ of it $=ab=br$. Erect the perpendiculars ae, cf, and bg, and draw de, df, er, fr, and gr. Then will

1. re be the side of the tetrahedron.
2. df be the side of the hexahedron.
3. de be the side of the octahedron.
4. Cut de in extreme and mean proportion in h, and ch will be the side of the dodecahedron.
5. Set the diameter dr up, perpendicularly, at r; and from the centre c, to its top, draw the line cg, cutting the circle in g. Let fall the perpendicular gb, then is br the side of the icosihedron.

Regular *curves*, such as proceed gradually in the same geometrical manner with regard to their curvities. See Curve.

REGULATOR *of a watch*, the small spring belonging to the balance; serving to adjust its motions, and make it go faster or slower. See Clockwork.

REGULUS, in chemistry, an imperfect metallic substance that falls to the bottom of the crucible in the melting of ores, or impure metallic substances. The regulus is now understood to be the pure metal.

Regulus, in astronomy, a star of the first magnitude, in the constellation Leo; called also from its situation, cor leonis, or the lion's heart. See Astronomy.

REIN-DEER. See Cervus.

REJOINDER, in law, is the defendant's answer to the plaintiff's replication or reply. Thus, in the court of chancery, the defendant puts in an answer to the plaintiff's bill, which is sometimes also called an exception; the plaintiff's answer to this is called a replication, and the defendant's answer to that a rejoinder.

REJOINTING, in architecture, filling up the joints of the stones in buildings. This ought to be performed with the best mortar, as that of lime and cement; and sometimes with plaister, as in the joints of vaults.

RELATIVE TERMS, in logic, are words which imply a relation; such are master and servant, husband and wife, &c.

In grammar, relative words are those which answer to some other word foregoing, called the antecedent; such are the relative pronouns, qui, quæ, quod, &c. and in English, who, whom, which, &c. The word answering to these relatives is often understood as, I know whom you mean, for, I know (the person) whom you mean.

RELEASE, in law, is an instrument in writing, by which estates, rights, titles, entries, actions, and other things, are extinguished and discharged; and sometimes transferred, abridged, or enlarged; and in general, it signifies one person's giving up or discharging the right or action he has, or claims to have, against another, or his lands, &c.

A release may be either in fact or in law; a release in fact is where it is expressly declared, by the very words, as the act and deed of the party; and a release in law is that which acquits by way of consequence, as where a feme creditor takes the debtor to be her husband.

RELHANIA, a genus of the class and order syngenesia polygamia superflua. The calyx is imbricate, scariose; corollets of the ray many; pappus membranaceous; recept. chaffy. There are 16 species, herbs of the Cape.

RELIEF, in law, a certain sum of money which the tenant holding by knight's service, grand serjeantry, or other tenure (for which homage, or legal service, is due), and being at full age at the death of his ancestor, paid to his lord at his entrance.

RELIEVE, in a military sense, is to send off those men that are upon duty, and to bring others to take their place; thus, to relieve the guard, the trenches, &c. is to bring fresh men upon duty, and to discharge those who were upon duty before.

RELIEVO, and RELIEF, are terms applied to that mode of working in sculpture by which figures are made to project from the ground or body on which they are formed, and to which they remain attached. The same term is used, whether the figure is cut with the chisel, modelled in clay, or cut in metal or plaister.

There are three kinds of relievo:

Alto-relievo, or high relief, when the figures are so prominent from the ground, that merely a small part of them remains attached to it.

Mezzo-relievo, or half-relief, when one half of the figure rises from the ground, in such a manner that the figure appears divided by it.

Basso-relievo, or bas-relief (low relief), when the work is raised but little from the ground, as in medals, and generally in friezes and other ornamented parts of buildings.

Bas-relief is the comprehensive term by which all works in relievo are denominated indiscriminately. See SCULPTURE.

RELIEVO, or *Relief*, in painting, is the degree of boldness with which the figures seem, at a due distance, to stand out from the ground of the painting. See PAINTING.

RELIGION. Seditious words in derogation of the established religion are indictable, as tending to a breach of the peace. 1 Haw.7.

REMAINDER, in law, is an estate limited in lands, tenements, or rents, to be enjoyed after the expiration of another particular estate.

An estate in remainder is an estate limited to take effect and be enjoyed after another estate is determined. As if a man seised in fee simple grants lands to one for 20 years, and after the determination of the said term, then to another and his heirs for ever: here the former is tenant for years, remainder to the latter in fee. In the first place, an estate for years is created or carved out of the fee, and given to the former, and the residue and the remainder of it is given to the latter. Both their interests are in fact only one estate; the present term of years, and the remainder afterwards, when added together, being equal only to one estate in fee. 2 Black. c. 11.

The word remainder is no term of art, nor is it necessary to create a remainder. So that any words sufficient to shew the intent of the party, will create a remainder; because such estates take their denomination of remainder more from the natnre and manner of their existence after they are limited, than from any previous quality inherent in the word. See Fearne on Remainders.

There is this difference between a remainder and a reversion: in case of a reversion, the estate granted, after the limited time, reverts to the grantor or his heirs; but by a remainder it goes to some third person, or a stranger.

REMEMBRANCERS, antiently called clerks of the remembrance, certain officers in the exchequer, whereof three are distinguished by the names of the king's remembrancer, the lord treasurer's remembrancer, and the remembrancer of the first fruits. The king's remembrancer enters in his office all recognizances taken before the barons, for any of the king's debts, for appearances, or observing of orders; he also takes all bonds for the king's debts, &c. and makes out processes thereon. He likewise issues processes against the collectors of the customs, excise, and others, for their accounts; and informations upon penal statutes are entered and sued in his office, where all proceeding in matters upon English bills in the exchequer-chamber remain. His duty further is to make out the bills of compositions upon penal laws, to take the statement of debts; and into his office are delivered all kinds of indentures and other evidences, which concern the assuring of any lands to the crown. He every year, in crastino Animarum, reads in open court the statute for election of sheriffs; and likewise openly reads in court, the oaths of all the officers, when they are admitted.

The lord treasurer's remembrancer is charged to make out process against all sheriffs, escheators, receivers, and bailiffs, for their accounts. He also makes out writs of fieri facias, and extent for debts due to the king, either in the pipe or with the auditors; and process for all such revenue as is due to the king, on account of his tenures. He takes the account of sheriffs; and also keeps a record, by which it appears whether the sheriffs or other accountants pay their profers due at Easter and Michaelmas; and at the same time he makes a record, whereby the sheriffs or other accountants keep their prefixed days; there are likewise brought into this office all the accounts of customers, comptrollers, and accountants, in order to make entry thereof on record; also all estreats and amercements are certified here, &c.

The remembrancer of the first fruits takes all compositions and bonds for the payment of first fruits and tenths; and makes out process against such as do not pay the same.

REMIT, in commerce. To remit a sum of money, bill, or the like, is to send the sum of money, &c.

REMITTER, in law, is where one that has a right to lands, but is out of possession, has afterwards the freehold cast upon him by some subsequent defective title, and enters by virtue of that title; in this case the law remits him to his antient and more certain right, and by an equitable fiction supposes him to have gained possession in consequence and by virtue thereof; and this, because he cannot possibly obtain judgment at law, to be restored to his prior right, since he is himself the tenant of the land. 3 Black. 190.

REMORA, the *sucking-fish*. See ECHENEIS.

REMOVER, in law, is where a suit is removed or taken out of one court into another; and is the opposite of remanding a cause, or sending it back into the same court whence it was first called.

RENDER, in law, is used in levying a fine: which is either single, whereby nothing is granted or rendered back again by the cognizee to the cognizor; or double, which contains a grant or render back again of some real common, or other thing, out of the land itself to the cognizor.

RENDEZVOUS, or RENDEVOUS, a place appointed to meet in, at a certain day and hour.

RENEALMIA, in botany, a genus of the monogynia order, belonging to the monandria class of plants. The corolla is trifid; the nectarium oblong; the calyx monophyllous; the anthera sessile, opposite to the nectarium; the berry is fleshy. There is only one species, a native of Surinam.

RENT, is a certain profit issuing yearly, out of lands and tenement corporeal.

There are at common law three kinds of rents; rent service, rent charge, and rent seck, or rack rent.

Rent service is where the tenant holds his land of his lord by fealty and certain rent; or by homage, fealty, and certain rent; or by other service and certain rent; and it is called a rent service, because it has some corporal service incident to it, which at least is fealty. Rent charge is so called because the land for payment of it is charged with a distress. Rent seck, or rack rent, is where the land is granted without any clause of distress for the same. 1 Inst. 141.

The time for payment of rent, and consequently for a demand, is such a convenient time before the sun-setting of the last day, as will be sufficient to have the money counted; but if the tenant meets the lessor on the land at any time of the last day of payment, and tenders the rent, that is sufficient tender, because the money is to be paid indefinitely on that day, and therefore a tender on that day is sufficient. See DISTRESS.

RENTERING, in the manufactories, the same with fine-drawing. It consists in sewing two pieces of cloth edge to edge, without doubling them, so that the seam scarcely appears; and hence it is denominated fine-drawing. It is a French word meaning the same thing, and is derived from the Latin retrahere, or re, in, and trahere, because the seam is drawn in or covered. It is said, that in the East Indies, if a piece of fine muslin is torn, and afterwards mended by the fine-drawers, it will be impossible to discover where the rent was. In this country the dexterity of the fine-drawers is not so great as that of those in the East; but it is still such as to enable them to defraud the revenue, by sewing a head or slip of English cloth on a piece of Dutch, Spanish, or other foreign cloth; or a slip of foreign cloth on a piece of English, so as to pass the whole as of a piece, and by that means avoid the duties, penalties, &c. The trick was first discovered in France by M. Savary.

RenterING, in tapestry, is the working new warp into a piece of damaged tapestry, whether eaten by the rats or otherwise destroyed, and on this warp to restore the antient pattern or design. The warp is to be of woollen, not linen. Among the titles of the French tapestry-makers is included that of renterers.

RENVERSE', *inverted*. See HERALDRY.

REPARATIONE FACIENDA, a writ which lies in divers cases, one of which is, where three are tenants in common or joint tenants, as pro indiviso, of a mill or house which is fallen into decay, and the one being willing to repair it, the other two will not; in this case, the party willing shall have this writ against the other two. F. N. B. 127.

REPARATIONS. A tenant for life or years, may cut down timber trees to make reparations, although he is not compelled thereto; as where a house is ruinous at the time of the lease made, and the lessee suffers it to fall, he is not bound to rebuild it, and yet if he fells timber for reparations he may justify the same. Co. Litt. 54.

REPEAT, in music, a character shewing that what was last played or sung must be repeated or gone over again.

REPELLENTS, medicines supposed to have the power of sending back into the mass of the blood such morbid humours as had been secreted from it. The term is now left out of the materia medica.

REPERCUSSION, in mechanics. See REFLECTION.

REPERCUSSION, in music, a frequent repetition of the same sound.

REPERTORY, a place in which things are orderly disposed, so as to be easily found when wanted. The indexes of books are repertories, shewing where the matters sought for are treated of. Common-place books are also kinds of repertories.

REPETEND, in arithmetic, denotes that part of an infinite decimal fraction, which is continually repeated. Thus in the numbers 2.131313, the figures 13 are the repetend. These repetends chiefly arise in the reduction of vulgar fractions to decimals, as $\frac{1}{7}$ = 0.142857 142857 142857, and so on, for ever. A single repetend is that in which only one figure repeats, as $\frac{1}{3}$ =. 333 ; and a compound repetend is that in which two or more figures are repeated, as $\frac{13}{99}$ =. 131313, &c. To find the value of any repetend, or to reduce it to a vulgar fraction, "taken the given repeating figure or figures for a numerator; and for the denominator, take as many 9s as there are figures in the repetend: thus the fraction answering to 123123, &c. is $\frac{123}{999}=\frac{41}{333}$.

REPETITION, in music, denotes a reiterating or playing over again the same part of a composition, whether it is a whole strain, part of a strain, or double strain, &c. The repetition is denoted by a character called a repeat, which is varied so as to express the various circumstances of a repeat.

REPETITION, in rhetoric, a figure which gracefully and emphatically repeats either the same word, or the same sense in different words.

REPLEADER. Whenever a repleader is granted, the pleadings must begin de novo at that stage of them, whether it is the plea, replication, rejoinder, or whatever else, wherein there appears to have been the first default, or deviation from the regular course. When a repleader is awarded, it must be without costs. 3 Black. 395.

REPLETION. See MEDICINE.

REPLEVIN, is the writ called replegiare facias by him who has cattle or other goods distrained by another, for any cause, and putting in surety to the sheriff, that upon delivery of the thing distrained, he will prosecute the action against the distrainer. Co. Lit. 12.

In this writ or action, both the plaintiff and defendant are called actors; the one, that is, the plaintiff, suing for damages, and the avowant or defendant to have a return of the goods or cattle. 2 Bond, 84.

That the avowant is in the nature of a plaintiff, appears, 1st. from his being called an actor, which is a term in the civil law, and signifies plaintiff: 2dly, from his being entitled to have judgment de retorno habendo, and damages as plaintiffs; 3dly, from this, that the plaintiff might plead in abatement of the avowry, and consequently such avowry must be in the nature of an action. Carth. 112.

Replevins by writ, issue properly out of chancery, returnable into the courts of K. B. and C. B. at Westminster. In order to obtain a replevin, application must be made to the sheriff; or one of his deputies, and security given that the party replevying will pursue his action against the distrainer; for which purpose, by the antient law, he is required to put in pledges to prosecute; and that if the right is determined against him, he will return the distress again, for which purpose he is to find pledges to make return. These pledges are discretionary, and at the peril of the sheriff. 3 Black. 147.

After the goods are delivered back to the party replevying, he is then bound to bring his action of replevin against the distrainer, which may be prosecuted in the county court, be the distress of what value it may; but either party may remove it to the superior courts of king's-bench or common-pleas, the plaintiff at pleasure, and the defendant upon reasonable cause. 3 Black. 149.

If the sheriff is shewn a stranger's goods, and he takes them, an action of trespass lies against him, for otherwise he could have no remedy; for being a stranger he cannot have the writ de proprietate probanda; and was he not intitled to this remedy, it would be in the power of the sheriff to strip a man's house of all his goods. 2 Rol. Abr. 552.

If it is determined for the plaintiff, namely, that the distress was wrongfully taken, he has already got his goods back into his own possession, and shall keep them, and moreover recover damages. But if the defendant prevails by the default or nonsuit of the plaintiff, then he shall have a writ de retorno habendo, by which the goods or chattels which were distrained and then replevied, are returned again into his custody, to be sold, or otherwise disposed of, as if no replevin had been made. If the distress was for damage feasant, the distrainor may keep the goods so returned, until tender shall be made of sufficient amends. Rol. Abr. 146.

On a retorno habendo awarded, the party desiring to have the cattle or goods restored, must shew them to the sheriff, for otherwise the sheriff may not know them.

REPLICATION, in logic, the assuming or using the same term twice in the same proposition.

REPLICATION, an exception or answer of the plaintiff in a suit to the defendant's plea; and is also that which the complainant replies to the defendant's answer in chancery, &c. The replication is to contain certainty, and not to vary from the declaration, but must pursue and maintain the cause of the plaintiff's action; otherwise it will be a departure in pleading, and going to another matter. 1 Inst. 304.

REPORT, in law, is a public relation of cases judicially argued, debated, resolved, or adjudged, in any of the king's courts of justice, with the causes and reasons of the same, as delivered by the judges. Also when the court of chancery, or any other court, refers the stating of a case, or the comparing of an account, to a master in chancery, or other referee, his certificate thereon is called a report.

REPOSE, in painting, certain masses or large assemblages of light and shade, which being well conducted, prevent the confusion of objects and figures, by engaging and fixing the eye so that it cannot attend to the other parts of the painting for some time; and thus leading it to consider the several groups gradually proceeding from stage to stage.

REPRESENTATION. There is an heir by representation, where the father dies, in the life of the grandfather, leaving a son, who shall inherit the grandfather's estate before the father's brother, &c.

REPRIEVE, to suspend a prisoner from the execution and proceeding of the law at that time. Every judge who has power to order any execution, has power to reprieve.

REPRISALS. See LETTERS OF MARQUE.

REPRISE, or REPRIZE, at sea, is a merchant-ship, which, after its being taken by a corsair, privateer, or other enemy, is retaken by the opposite party.

If a vessel thus retaken has been 24 hours in the possession of the enemy, it is deemed a lawful prize; but if it is retaken within that time, it is to be restored to the proprietor, with every thing in it, upon his allowing one-third to the vessel which made the reprise. Also if the reprise has been abandoned by the enemy, either in a tempest or from any other cause, before it has been led into any port, it is to be restored to the proprietor.

REPRODUCTION, is usually understood to mean the restoration of a thing before existing, and since destroyed. It is very well known that trees and plants may be aised from slips and cuttings; and some late observations have shown, that there are some animals which have the same property. The polype (see POLYPUS) was the first inst nce we had of this; but we had scarcely time to wonder at the discovery Mr. Trembley had made, when Mr. Bonett discovered the same property in a species of water-worm. Amongst the plants which may be raised from cuttings, there are some which seem to posssess this quality in so eminent a degree, that the smallest portion of them will become a complete tree again.

It deserves inquiry, whether this reproduction will or will not take place in whatever part the worm is cut? In order to try this, Mr. Bonett entered on a course of many experiments on the water-worms which have this property. These are, at their common growth, from two to three inches long, and of a brownish colour, with a cast of reddish. From one of these worms he cut off the head and tail, taking from each extremity only a small piece of a twelfth of an inch in length; but neither of these pieces was able to reproduce what was wanting. They both perished in about 24 hours; the tail first, and afterwards the head. As to the body of the worm from which these pieces were separated, it lived as well as before, and seemed indeed to suffer nothing by the loss, the head-part being immediately used as if the head was on, boring the creature's way into the mud. There are, besides this, two other points in which the reproduction will not take place; the one of these is about the fifth or sixth ring from the head, and the other at the same distance from the tail; and in all probability the condition of the great artery in these parts is the cause of this.

What is said of the want of the reproductive power of these parts, relates only to the head and tail ends; for, as to the body, it feels very little inconvenience from the loss of what is taken off, and very speedily reproduces those parts. Where then does the principle of life reside in such worms, which, after having their heads cut off, will have not only the same motions, but even the inclinations, that they had before? And yet this difficulty is very small, compared to several others. Is this wonderful reproduction of parts only a natural consequence of the laws of motion; or is there lodged in the body of the creature a chain of minute buds or shoots, a sort of little embryos, already formed, and placed in such parts where the reproductions are to begin? Are these worms only mere machines, or are they, like more perfect animals, a sort of compound, the springs of whose motions are actuated or regulated by a sort of soul? And if they have themselves such a principle, how is it that this principle is multiplied, and is found in every separate piece? Are we to believe with Malpighi, that these sorts of worms are all heart and brain from one end to the other? This may be; but yet if we knew that it was so, we should know in reality but very little the more for knowing it: and it seems, after all, that, in cases of this kind, we are only to admire the works of the great Creator, and sit down in silence.

The nice sense of feeling in spiders has been much talked of by naturalists; but it appears that these worms have yet somewhat more surprising in them in regard to this particular. If a piece of stick, or any other substance, is brought near them, they do not stay for its touching them, but begin to leap and frisk about as soon as it comes towards them. There want, however, some further experiments to ascertain whether this is really owing to feeling or sight; for though we can discover no distinct organs of sight in these creatures, yet they seem affected by the light of the sun or a candle, and always frisk about in the same manner at the approach of either; nay, even the moonlight has some effect upon them.

A twig of willow, poplar, or many other trees, being planted in the earth, takes root, and becomes a tree, every piece of which will in the same manner produce other trees. The case is the same with these worms; they are cut to pieces, and these several pieces become perfect animals; and each of these may be again cut into a number of pieces, each of which will in the same manner produce an animal. It has been supposed by some that these worms were oviparous; but Mr. Bonett, on cutting one of them to pieces, having observed a slender substance, resembling a small filament, to move at the end of one of the pieces, separated it; and on examining it with glasses, found it to be a perfect worm, of the same form with its parent, which lived and grew larger in a vessel of water into which he put it. These small bodies are easily divided, and very readily complete themselves again, a day usually serving for the production of a head to the part that wants one; and, in general, the smaller and more slender the worms are, the sooner they complete themselves after this operation. When the bodies of the large worms are examined by the microscope, it is very easy to see the appearance of the young worms alive, and moving about within them; but it requires great precision and exactness to be certain of this; since the ramifications of the great artery have very much the appearance of young worms, and they are kept in a sort of continual motion by the systoles and diastoles of the several portions of the artery, which serve as so many hearts. It is very certain, that what we force in regard to these animals by our operations, is done also naturally every day in the brooks and ditches where they live. A curious observer will find in these places many of them without heads or tails, and some without either; as also other fragments of various kinds, all which are then in the act of completing themselves; but whether accidents have reduced them to this state, or they thus purposely throw off parts of their own body for the reproduction of more animals, it is not easy to determine. They are plainly liable to many accidents, by which they lose the several parts of their body, and must perish very early if they had not a power of reproducing what was lost; they often are broken into two pieces, by the resistance of some hard piece of mud which they enter; and they are subject to a disease, a kind of gangrene, rotting off the several parts of their bodies, and must inevitably perish by it, had they not this surprising property.

This worm was a second instance, after the polype, of the surprising power in an animal of recovering its most essential parts when lost. But nature does not seem to have limited her beneficence in this respect to these two creatures. Mr. Bonett tried the same experiments on another species of water-worm, differing from the former in being much thicker. This kind of worm, when divided in the summer season, very often shows the same property; for if it is cut into three or four pieces, the pieces will lie like dead for a long time, but afterwards will move about again; and will be found in this state of rest to have recovered a head, or a tail, or both. After recovering their parts, they move very little; and according to this gentleman's experiments, seldom live more than a month.

It should seem, that the more difficult success of this last kind of worm, after cutting, and the long time it takes to recover the lost parts, if it does recover them at all, are owing to its thickness; since we always find in that species of worms which succeeds best of all, that those which are thinnest recover their parts much sooner than the others.

The water-insects also are not the only creatures which have this power of recovering the lost parts. The earth affords us some already discovered to grow in this manner from their cuttings, and these not less deserving our admiration than those of the water: the common earth-worms are of this kind. Some of these worms have been divided into two, others into three or four, pieces; and some of these pieces, after having passed two or three months without any appearance of life or motion, have then begun to reproduce a head or tail, or both. The reproduction of the anus, after such a state of rest, is no long work; a few days do it; but it is otherwise with the head, that does not seem to perform its functions in the divided pieces till about seven months after the separation. It is to be observed, that in all these operations, both on earth and water-worms, the hinder part suffers greatly more than the fore part in the cutting; for it always twists itself about a long time, as if actuated by strong convulsions; whereas the head usually crawls away without the appearance of any great uneasiness.

The reproduction of several parts of lobsters, crabs, &c. makes also one of the great curiosities in natural history. That, in lieu of an organical part of an animal broken off, another shall rise perfectly like it, may seem inconsistent with the modern system of generation, where the animal is supposed to be wholly formed in the egg. Yet has the matter of fact been well attested by the fishermen, and even by several virtuosoes who have taken the point into examination, particularly M. de Reaumur and M. Perrault, whose skill and exactness in things of this nature will hardly be questioned. The legs of lobsters, &c. consist each of five articulations: now, when any legs happen to break by any accident, as in walking, &c. which frequently happens, the fracture is always found to be in a part near the fourth articulation; and what they thus lose is precisely reproduced some time afterwards; that is, a part of a leg shoots out, consisting of four articulations, the first of which has two claws as before, so that the loss is entirely repaired.

If a lobster's leg is broken off by design at the fourth or fifth articulation, what is thus broken off always comes again; but it is not so if the fracture is made in the first, second, or third articulation. In those cases, the reproduction is very rare if things continue as they are. But what is exceedingly surprising is, that they do not; for, upon visiting the lobster maimed in these barren and unhappy articulations, at the end of two or three days, all the other articulations are found broken off to the fourth; and it is suspected they have performed the operation on themselves, to make the reproduction of a leg certain.

The part reproduced is not only perfectly like that retrenched, but also, in a certain space of time, grows equal to it. Hence it is that we frequently see lobsters which have their two large legs unequal, and that in all proportions. This shows the smaller leg to be a new one.

A part thus reproduced being broken, there is a second reproduction. The summer, which is the only season of the year when the lobsters eat, is the most favourable time for the reproduction. It is then performed in four or five weeks; whereas it takes up eight or nine months in any other season. The small legs are sometimes reproduced, but more rarely, as well as more slowly, than the great ones; the horns do the same. The experiment is most easily tried on the common crab.

REPTILES, in natural history, an order of amphibia, the character of which is, that they breathe through the mouth; have feet, and flat naked ears, without auricles. There are five genera of reptiles, viz.

Testudo
Draco
Lacerta
Rana
Siren.

REPULSION, in physics, that property in bodies, by which, if they are placed just beyond the sphere of each other's attraction of cohesion, they mutually fly from each other.

That there is a force which opposes the approach of bodies towards each other, and which tends to separate them farther from each other, is obvious from the slightest view of the phenomena of nature. When we present the north pole of a magnet A to the same pole of another magnet B, suspended on a pivot, and at liberty to move, the magnet B recedes as the other approaches; and by following it with A at a proper distance, it may be made to turn round on its pivot with considerable velocity. In this case there is evidently some force which opposes the approach of the north poles of A and B, and which causes the moveable magnet to retire before the other. There is then a repulsion between the two magnets, a repulsion which increases with the power of the magnets; and this power has been made so great, by a proper combination of magnets, that all the force of a strong man is insufficient to make the two north poles touch each other. The same repulsion is equally obvious on electrical bodies; and indeed it is by means of it alone that the quantity of electricity is measured by philosophers. If two cork balls are suspended from a body with silk threads, so as to touch each other; if we charge the body with electricity, the cork balls separate from each other, and stand at a distance proportional to the quantity of electricity with which the body is charged; the balls of course repel each other. See ELECTRICITY.

But it is not in electric and magnetic bodies only that repulsion is perceived. Newton has shewn that it exists also between two pieces of glass. He found that when a convex lens is put upon a flat glass, it remains at the distance of the $\frac{1}{137}$th part of an inch, and a very considerable pressure is required to diminish this distance; nor does any force which can be applied bring them into actual mathematical contact; a force may indeed be applied sufficient to break the glasses in pieces; but it may be demonstrated that it does not diminish their distance much beyond the $\frac{1}{1000}$th part of an inch. There is, therefore, a force of repulsion which prevents the two glasses from touching each other.

That the particles of air repel each other is evident; for a considerable force is required to keep them as near each other as we find them at the surface of the earth; and when this force is removed, they separate from each other, that is to say, the air expands. Nor is it known how far this expansion extends. Air has been artificially expanded to 3000 times its usual bulk, and doubtless at great heights in the atmosphere its expansion is still much greater than that. On the other hand, air may be forcibly condensed, that is to say, its particles may be made to approach nearer each other; but a considerable force is required to produce this effect; and this force increases nearly as the density: if it is removed, the particles again separate, and the air assumes its former bulk. What are the limits of this condensation is not known; but air has been forcibly compressed to 1000th part of its natural bulk. Thus we see that the particles of air may be made to approach 16 times nearer each other. The elasticity of air, or the effort which it makes when compressed to resume its former bulk, is evidently the consequence of a repulsive force which its particles exert. All gaseous fluids possess the same repulsive force, and are indebted to it for their elasticity.

The particles of solid elastic bodies likewise repel each other; for they also, when forcibly compressed, resume their former size, and of course their particles repel each other. It has been demonstrated by philosophers, that all liquids are capable of a certain degree of compression, and that when the compressing force is removed they resume their former bulk; consequently the particles of these bodies also repel each other.

All bodies then possess a repulsive force, which exerts itself either at sensible distances or at insensible distances; of course the repulsions may be divided into two classes.

The only sensible repulsions with which we are acquainted, take place at small distances. They may be reduced to two kinds, namely, electricity and magnetism. It has been ascertained, that bodies possessed of the same kind of electricity repel each other; and likewise the same magnetic poles of bodies repel each other; while, on the other hand, differently electrified bodies, and the different poles of magnetic bodies, attract each other. Repulsion increases, as far as has been ascertained, inversely as the square of the distance; consequently, at the point of contact it is infinite.

Insensible repulsion is most conspicuous in elastic fluids, as air and the gases; but it is exhibited also by elastic bodies in general. In these, if a judgment can be formed from the experiments on air, the repulsion increases nearly at the rate of $\frac{1}{a^3}$.

Insensible repulsion may either be a force inherent in the particles of bodies, or it may belong exclusively to some particular body combined with these particles. The first of these hypotheses seems to have been adopted by Newton.

Other philosophers have supposed that repulsion is not a property inherent in all matter, but confined to a peculiar substance which has been generally considered as caloric. According to this hypothesis, there are two kinds of matter, one whose particles attract, another whose particles repel. Let us call the first cohesive matter, and the other caloric; and let us suppose also, what must be the case, that cohesive matter and caloric attract each other with a certain force, in certain circumstances. This will explain the expansive power of caloric, which combining with the particles of other cohesive matter, destroys the cohesion of those particles, and acts upon the body as a repulsive force; and this appears at least to explain the repulsion which exists in elastic, and, perhaps, other fluids.

Before we quit this subject, it will be worth while to shew, by an example, that the repulsion between the particles of caloric often acts as a real chemical force, and that it affords a key to explain several phenomena which at first sight appear nearly contradictory. Why do bodies require different temperatures in order to unite? and why does the presence of caloric in many cases favour, or rather produce, union, while it prevents or destroys it in others?

Some substances, phosphorus for instance, combine with oxygen at the common temperature of the atmosphere; others, as carbon, require a higher temperature; and others, as hydrogen and azotic gas, do not combine, except at a very high temperature. To what are these differences owing?

It is evident, that whatever diminishes the cohesion which exists between the particles of any body, must tend to facilitate their chemical union with the particles of other bodies. This is the reason that bodies combine more easily when held in solution by water, or when they have been previously reduced to a fine powder. Now caloric possesses the property of diminishing cohesion: and one reason why some bodies require a high temperature to cause them to combine is, that at a low temperature the attraction of cohesion is in them superior to that of affinity; accordingly, it becomes necessary to weaken that attraction by caloric till it becomes inferior to that of affinity. The quantity of caloric necessary for this purpose must vary according to the strength of the cohesion and of the affinity; it must be inversely as the affinity, and directly as the cohesion. Wherefore, if we knew precisely the force of the cohesion between the particles of any body, and of the affinity between the particles of that body and of any other, we could easily reduce the temperature necessary to calculation.

That caloric or temperature acts in this manner, cannot be doubted, if we consider that other methods of diminishing the attraction of cohesion may be substituted for it with success. A large lump of charcoal, for instance, will not unite with oxygen at so low a temperature as the same charcoal will do when reduced to a very fine powder; and charcoal will combine with oxygen at a still lower temperature, if it is reduced to its integrant particles, by precipitating it from alcohol, as Dr. Priestley did by passing the alcohol through red-hot copper. And to shew that there is nothing in the nature of oxygen and carbon which renders a high temperature necessary for their union, if they are presented to each other in different circumstances, they combine at the common temperature of the atmosphere; for if nitric acid, at the temperature of 6°, is poured upon charcoal-powder, well dried in a close crucible, the charcoal takes fire, owing to its combining with the oxygen of the acid. And in some other situations, carbon is so completely divided that it is capable of combining with the oxygen of the atmosphere, or, which is the same thing, of catching fire at the common temperature: this seems to be the case with it in those pyrophori that are formed by distilling to dryness several of the neutral salts which contain acetous acid. These observations are sufficient to shew, that caloric is in many cases necessary in order to diminish the attraction of cohesion.

But there is a difficulty still remaining. How comes it that certain bodies will combine with oxygen without the assistance of any foreign heat, provided the combination is once begun, though a quantity of caloric is necessary to begin the combination; and that other bodies require to be surrounded by a great quantity of caloric during the whole time of their combining with oxygen? Alcohol, for instance, if once kindled, burns till it is quite consumed; and this is the case with oils also, provided they are furnished with a wick.

We should err very much, were we to suppose that a high temperature is not as necessary to these substances during the whole of their combustion as at the commencement of it: for Mr. Monge found, on making the trial, that a candle would not burn after the temperature of the air around it was reduced below a certain point.

All substances which continue to burn after being once kindled are volatile, and they burn the easier in proportion to that volatility. The application of a certain quantity of caloric to alcohol volatilizes part of it, that is, diminishes the attraction of its cohesion, so much that it combines with oxygen. The oxygen which enters into this combination gives out as much heat as volatilizes another portion of the alcohol, which combines with oxygen in its turn, more heat is given out; and thus the process goes on. Oils and tallow exhibit the very same phenomena; only as they are less volatile, it is necessary to assist the process by means of the capillary attraction of the wick, which confines the action of the caloric evolved to a small quantity of oil, and thus enables it to produce the proper effect. In short, then, every substance which is capable of continuing to burn after being once kindled is volatile, or capable of being converted into vapour by the degree of heat at first applied. The reason that a live coal will not burn when suspended insulated in the air, is not, as Dr. Hutton supposed, because its light is dissipated, but because the coal cannot be converted into vapour by the degree of heat which it contains, and because the cohesion of its particles is too great to allow it to combine with oxygen without some such change. There are some coals, however, which contain such a quantity of bitumen, that they will burn even in the situation supposed by Dr. Hutton, and continue to burn, provided they are furnished with any thing to act as a wick. It is needless to add, that bitumen, like oil, is easily converted into vapour.

But this explanation, instead of removing our difficulties, has only served to increase them: for if caloric only acts by diminishing the attraction of cohesion, and converting these substances into vapour, why do not all elastic fluids combine at once without any additional caloric? why do not oxygen and hydrogen, when mixed together in the state of gas, unite at once and form water? and why do not oxygen and azote, which are constantly in contact in the atmosphere, unite also and form nitrous gas? Surely it cannot be the attraction of cohesion that prevents this union. And if it is ascribed to their being already combined with caloric, how comes it that an additional dose of one of the ingredients of a compound decomposes it? Surely, as Mr. Monge has observed, this is contrary to all the other operations in chemistry.

That the particles of fluids are not destitute of an attraction for each other, is evident rom numberless facts. The particles of water draw one another after them in cases of capillary attraction; which is probably owing to the attraction of cohesion. It is owing to the attraction of cohesion, too, that small quantities of water form themselves into spheres; nor is this attraction so weak as not to be perceptible. If a small plate of glass is laid upon a globule of mercury, the globule, notwithstanding the pressure, continues to preserve its round figure. If the plate is gradually charged with weights one after another, the mercury becomes thinner and thinner, and extends itself in the form of a plate; but as soon as the weights are removed, it recovers its globular figure again, and pushes up the glass before it. Here we see the attraction of cohesion, not only superior to gravitation, but actually overcoming an external force. And if the workman, after charging his plate of glass with weights, when he is forming mirrors, happens to remove these weights, the mercury which had been forced from under the glass, and was going to separate, is drawn back to its place, and the glass again pushed up. Nor is the attraction of cohesion confined to solids and liquids; it cannot be doubted, that it exists also in gases; at least it is evident, that there subsists an attraction between gases of a different kind; for although oxygen and azotic gas are of different gravities, and ought therefore to occupy different parts of the atmosphere, we find them always mixed together; and this can only be ascribed to an attraction.

It seems evident, in the first place, that the affinity between the bases of the gases under consideration and oxygen, is greater than their affinity for that dose of caloric which produces their elastic form; for when they are combined with oxygen, the same dose will not separate them again. Let us take hydrogen for an instance. The affinity of hydrogen is greater for oxygen than for the caloric which gives it its gaseous form; but the oxygen is also combined with caloric, and there exists an attraction of cohesion between the particles of the hydrogen gas and oxygen gas; the same attraction subsists between those of oxygen gas and hydrogen gas. Now the sum of all these affinities (namely, the affinity between hydrogen and caloric, the affinity between oxygen and caloric, the cohesion of the particles of the hydrogen, and the cohesion of the particles of oxygen) is greater than the affinity between the hydrogen and oxygen; and therefore no decomposition can take place. Let the affinity between

Oxygen and caloric be	-	50
Hydrogen and caloric	-	50
Cohesion of oxygen for hydrogen		4
Cohesion of hydrogen	- -	2
Sum of quiescent affinities	-	106
The affinity of oxygen and hydrogen		105

The quiescent affinities being greater than the divellent affinities, no decomposition can take place.

Let now a quantity of caloric be added to the oxygen and hydrogen gas, it has the property of expanding them, and of course of diminishing their cohesion; while its affinity for them is so small, that it may be neglected. Let us suppose that it diminishes the cohesion of the oxygen 1, and of the hydrogen also 1, their cohesion will now be 3 and 1; and the quiescent affinities being only 104, while the divellent are 105, decomposition would of course take place, and a quantity of caloric would thus be set at liberty to produce the same effects upon the neighbouring particles.

Thus, then, caloric acts only by diminishing cohesion; and the reason that it is required so much in gaseous substances, and in those combinations into which oxygen enters, is the strong affinity of oxygen and the other bases of the gases for caloric; for owing to the repulsion which exists between the particles of that subtile substance, an effect is produced by adding large doses of it, contrary to what happens in other cases. The more of it is accumulated, the stronger is the repulsion between its particles, and therefore the more powerful is its tendency to fly off: and as this tendency is opposed by its affinity for the body and the cohesion of its particles, it must diminish both these attractions.

REPUTATION, or Fame. The security of reputation, or good name, from the arts of detraction and slander, is a right to which every man is intitled, by reason and natural justice; since, without this, it is impossible to have the perfect enjoyment of any other advantage or right. 1 Black. 134.

Reputation is properly under the protection of the law, as all persons have an interest in their good name, and scandal and defamation are injurious to it; though defamatory words are not actionable, otherwise than as they are a damage to the estate of the person injured. Wood's Inst. 37.

REQUESTS, *Court of*, an antient court of equity, instituted about the nineteenth year of Henry VII. See Court.

In the fortieth and forty-first years of queen Elizabeth, it was adjudged, upon solemn argument, in the court of common pleas, that the court of request was then no court of equity.

RESCRIPT, an answer delivered by an emperor, or a pope, when consulted by particular persons, on some difficult question, or point of law, to serve as a decision thereof.

RESCUE, or Rescous, is the taking away and setting at liberty against law, any distress taken for rent, or services, or damage feasant; but the more general notion of rescous is, the forcibly freeing another from an arrest or some legal commitment; which being a high offence, subjects the offender not only to an action at the suit of the party injured, but likewise to fine and imprisonment at the suit of the king. Co. Lit. 160.

If goods are distrained without cause, or contrary to law, the owner may make rescue; but if they are once impounded, or even though taken without any cause, the owner may not break the pound and take them out, for then they are in custody of the law. 1 Black. 12. See Distress.

RESEARCH, in music, is a kind of prelude or voluntary played on the organ, &c. wherein the performer seems to search or look out for the strains and touches of harmony, which he is to use in the regular piece to be played afterwards.

RESEDA, *dyer's-weed, yellow-weed, weld*, or *wild-wood*, a genus of the order of trigynia, in the dodecandria class of plants; and in the natural method ranking under the 54th order, miscellaneæ. The calyx is monophyllous and partite; the petals laciniated; the capsule unilocular, and opening at the mouth. There are 13 species; of which the most remarkable is the luteola, or common dyer's weed, growing naturally in waste places in many parts of Britain. The young leaves are often undulated; the stalk is a yard high, or more, terminated with a long naked spike of yellowish-green flowers: the plant is cultivated and much used for dyeing silk and wool of a yellow colour. The great recommendation of the plant is, that it will grow with very little trouble, without dung, and on the very worst soils. For this reason it is commonly sown with, or immediately after, barley or oats, without any additional care except drawing a bush over it to harrow it in. The reaping of the corn does it little or no hurt, as it grows but little the first year; and the next summer it is pulled and dried like flax. Much care and nicety, however, is requisite, so as not to injure either the seed or stalk; or, which sometimes happens, damaging both, by letting it stand too long, or pulling it too green. To avoid these inconveniences, a better method of culture has been devised. This new method is, to plough and harrow the ground very fine, without dung, as equally as possible; and then sowing about a gallon of seed, which is very small, upon an acre, some time in the month of August. In about two months it will be high enough to hoe, which must be carefully done, and the plants left about six inches asunder. In March it is to be hoed again, and this labour is to be repeated a third time in May. About the close of June, when the flower is in full vigour, and the stalk is become of a greenish yellow, it should be pulled; a sufficient quantity of stems being left growing for seed till September.

RESERVE, *body of*, or *corps de reserve*, in military affairs, the third or last line of an army, drawn up for battle; so called because they are reserved to sustain the rest, as occasion requires; and not to engage, but in case of necessity.

RESIDENCE, is the continuance of a parson or vicar on his benefice. By statute 43d Geo. III. chap. 84, it is enacted that the statute 13th Eliz. c. 20, and its continuing statutes, are repealed; and that the penalties for non-residence under the act 21st Hen. VIII. are repealed; and that every spiritual person possessed of any archdeaconry, or other dignity, benefice, curacy, or chapelry, who shall, without exemption, or sufficient cause, as is specified in the acts of the 21st, 25th, and 28th Hen. VIII., absent himself from his benefice for more than three months in the year (unless he resides at some place where he has other dignity or benefice), and less than six, shall pay one-third of the annual value (deducting all out-goings, except curate's pay); when eight months, two-thirds; and when the whole year, three-fourths. The penalty, with costs, to go to the informer; but the penalty for non-residence cannot be recovered, if the parson has resided a whole year without absence before the action is brought.

Besides the exemptions contained in the above-mentioned act, the following persons are exempt: clerk, or deputy clerk, of the king's closet; chaplain of the house of commons; chaplain-general of the forces; brigade-chaplain on foreign service; chaplains of ships of the dock-yards, of garrisons, or of the corps of artillery, during the time of attending such offices; chaplain to any British factory, or in the household of any British minister, abroad; chancellor, or vicar-general, or in his absence, the surrogate, or official, in an ecclesiastical court; minor canon, vicar, choral, or other officer, in any cathedral or collegiate church; deans, subdeans, priests, or readers, in the king's private chapels; chaplain of the military asylum, of the hospitals of Chelsea, Greenwich, Haslar, and Plymouth, while attending their duty; preacher or reader at the inns of court or the rolls; the bursar, dean, vice-president, public tutor, or chaplain, or such other public officers, in the universities, or at Eton, or Winchester, or schoolmaster or usher in the same, or at Westminster; and persons entitled by the last of the above-mentioned statutes to the privilege of non-residence, till after forty years of age, shall not be entitled to it after thirty. The bishops may, if they think fit, grant licences for non-residence in certain cases, the fee for which shall not be more than ten shillings, independant of stamp-duty; and if the bishop refuses to grant the licence, the party who thinks himself aggrieved may appeal to the archbishop, on giving security for paying the expences of the appeal: the reasons for granting the licences shall be transmitted to the archbishop, for his examination and allowance; and during the vacancy of any see, the vicar-general may grant them, and they shall not be void on the death or removal of the granter, unless revoked by his successor.

A person, although he may reside on the living, is yet liable to the penalties of non-residence, if he resides in any other house than that appointed for his residence, except by such licence from the diocesan as has been stated, or while the tenant to whom the house of residence has been let continues in possession.

RESIDUAL FIGURE, in geometry, the figure remaining after subtracting a lesser from a greater.

Residual Root, in algebra, a root composed of two parts or members, connected together by the sign —.

Thus $x-y$ is a residual root, so called because its value is no more than the difference between its parts x and y.

RESIGNATION, in the canon law, the surrendering a benefice into the hands of the collator, or bishop.

RESIGNEE, in law, the person to whom a thing is resigned.

RESIN, in natural history, a viscid juice oozing either spontaneously, or by incision, from several trees, as the pine, fir, &c.

Resins. It is at present the opinion of chemists, that resins stand in the same relation to the volatile oils that wax does to the fixed. Wax is considered as a fixed oil saturated with oxygen; resins as volatile oils saturated with the same principle.

The resins are very numerous; and on account of the various purposes to which they are applied, and the peculiarity of their properties, constitute one of the most important genera of vegetable substances. Till lately they have been very much overlooked by chemists, who satisfied themselves with gleaning doubtful information from artists and manufacturers. Many erroneous opinions concerning them have of course been admitted into every system of chemistry. The subject has lately engaged the attention of Mr. Hatchett, whose consummate skill and happy talent for observation peculiarly fitted him for the task.

Resins often exude spontaneously from trees; they often flow from artificial wounds; and not uncommonly are combined at first with volatile oil, from which they are separated by distillation. The reader can be at no loss to form a notion of what is meant by resin, when he is informed that common rosin furnishes a very perfect example of a resin, and that it is from this substance that the whole genus derived their name: for rosin is very frequently denominated resin.

Resins may be distinguished by the following properties:

They are solid substances, naturally brittle; have a certain degree of transparency, and a colour most commonly inclining to yellow. Their taste is more or less acrid, and hot like that of volatile oils; but they have no smell unless they happen to contain some foreign body. They are all heavier than water. Their specific gravity varies from 1.0180 to 1.2289. They are all non-conductors of electricity; and when excited by friction, their electricity is negative.

When exposed to heat, they melt; and if the heat is increased, they take fire; and burn with a strong yellow flame, emitting at the same time a vast quantity of smoke.

They are all insoluble in water, whether cold or hot; but when they are melted along with water, or mixed with volatile oil and then distilled with water, they seem to unite with a portion of that liquid; for they become opaque, and lose much of their brittleness. This at least is the case with common rosin. They are all, with a few exceptions, soluble in alcohol, especially when assisted by heat. The solution is usually transparent; and when the alcohol is evaporated, the resin is obtained unaltered in its properties. When the solution is mixed with water, it becomes milky, and the resin falls in the state of a white powder. They are soluble also in sulphuric ether. Many of them are soluble in several of the fixed oils, especially in the drying oils. The greater number are soluble in the volatile oils; at least in oil of turpentine, the one commonly employed.

Hitherto it has been affirmed by all chemists, both antient and modern, that the alkalies do not exert action on the resins. Fourcroy, for instance, in his last work, affirms this in the most positive manner; but the experiments of Mr. Hatchett have demonstrated this opinion to be completely erroneous. He reduced a quantity of common rosin to powder, and gradually added it to a boiling lixivium of carbonat of potass; a perfect solution was obtained of a clear yellow colour, which continued permanent after long exposure to the air. The experiment succeeded equally with carbonat of soda, and with solutions of pure potass or soda. Every other resin tried was dissolved as well as rosin. Mr Hatchett's discovery must lead to very important consequences. The well-known fact, that the soap-makers in this country constantly mix rosin with their soap; that it owes its yellow colour, its odour, and its easy solubility in water, to this addition; ought to have led chemists to have suspected the solubility of resins in alkalies. No such consequence, however, was drawn from this notorious fact.

It has been supposed also that the acids are incapable of acting upon the resins. Fourcroy is equally positive with regard to this; and Gren speaks of it in such a manner, that every reader must conclude that he had tried the effect of nitric acid upon resins. Yet Mr. Hatchett has ascertained this opinion likewise to be erroneous, at least as far as nitric acid is concerned. He found that resins are thrown down from their solutions in alkalies in the state of a curdy precipitate; but when nitric acid is added in excess, the whole of the precipitate is redissolved in a boiling heat. This remarkable fact, which did not hold when sulphuric or muriatic acids were used, led him to try whether the resins were soluble in nitric acid. He poured nitric acid, of the specific gravity 1.38, on powdered rosin in a tubulated retort; and by repeated distillation formed a complete solution of a brownish yellow colour. The solution took place much sooner in an open matrass than in close vessels. The solution continues permanent, though left exposed to the air. It becomes turbid when water is added; but when the mixture is boiled, the whole is redissolved. When Mr. Hatchett collected the precipitate thrown down by water by filtration, he found that it still possessed the properties of resin. The resin is thrown down from nitric acid by potass, soda, and ammonia; but an excess of these alkalies redissolves the precipitate, and forms brownish orange-coloured liquids. When Mr. Hatchett dissolved resin in boiling nitric acid, the solution was attended with a copious discharge of nitrous gas; and when the powdered resin was thrown into cold nitric acid, a considerable effervescence soon took place, and a porous mass was formed, commonly of a deep orange-colour.

When resins are subjected to destructive distillation, we obtain, according to Gren, carbureted hydrogen and carbonic acid gas, a very small portion of acidulous water, and much empyreumatic oil. The charcoal is light and brilliant, and contains no alkali.

When volatile oils are exposed for some time to the action of the atmosphere, they acquire consistency, and assume the properties of resins. During this change they absorb a quantity of oxygen from the air. Westrum put 30 grains of oil of turpentine into 40 cubic inches of oxymuriatic acid gas. Heat was evolved; the oil gradually evaporated, and assumed the form of yellow resin. Mr. Proust observed, that when volatile oil is exposed to the air, it is partly converted into a resin, and partly into a crystallized acid; usually the benzoic or the camphoric. Hence we see that the oil is converted into two distinct substances. During this change oxygen is absorbed; and Fourcroy has observed that a portion of water is also formed. It is probable, from these facts, that resin is volatile oil deprived of a portion of its hydrogen, and combined with oxygen.

Hermstadt affirms, that to know whether any vegetable substance contains resin, we have only to pour some sulphuric ether upon it in powder, and expose the infusion to the light. If any resin is present, the ether will assume a brown colour.

Having now described the general properties of resinous bodies, it will be proper to take a more particular view of those of them which are of the most importance, that we may ascertain how far each possesses the general characters of resins, and by what peculiarities it is distinguished from the rest. The most distinguished of the resins are the following:

1. *Rosin.* This substance is obtained from different species of fir; as the pinus abies, sylvestris, larix, balsamea. It is well known that a resinous juice exudes from the pinus sylvestris, or common Scotch fir, which hardens into tears. The same exudation appears in the pinus abies, or spruce fir. These tears constitute the substance called thus, or common frankincense. When a portion of bark is stripped off these trees, a liquid juice flows out, which gradually hardens. This juice has obtained different names according to the plant from which it comes. The pinus sylvestris yields common turpentine; the larix, Venice turpentine; the balsamea, balsam of Canada, &c. All these juices, which are commonly distinguished by the name of turpentine, are composed of two ingredients; namely, oil of turpentine, and rosin. When the turpentine is distilled, the oil comes over, and the rosin remains behind. When the distillation is continued to dryness, the residuum is known by the name of common rosin, or colophonium; but when water is mixed with it while yet fluid, and incorporated by violent agitation, the mass is called yellow rosin. During winter the wounds made in the fir-trees become incrusted with a white brittle substance called barras or galipot, consisting of rosin united to a small portion of oil. The yellow rosin made by melting and agitating this substance in water, is preferred for most purposes; because it is more ductile, owing probably to its still containing some oil. The properties of rosin are those which have been detailed in the former part of this article. Its uses are numerous and well known.

2. *Mastich.* This resin is obtained from the pistacea lentiscus; a tree which grows in the Levant, particularly in the island of Chios. When transverse incisions are made into this tree, a fluid exudes, which soon concretes into yellowish semitransparent brittle grains. In this state it is sold under the name of mastich. It softens when kept in the mouth, but imparts very little taste. This has induced surgeons to employ it to fill up the cavities of carious teeth, which it does tolerably well. When heated, it melts, and exhales a fragrant odour. It contains a little volatile oil. It dissolves readily in fixed oils and in alcohol; but is too fusible and opaque to answer as a varnish. Mr. Hatchett found it soluble in alkalies and nitric acid with the phenomena described in the former part of this article. Its specific gravity is 1.074.

3. *Sandarach.* This resin is obtained from the juniperus communis, or common juniper. It exudes spontaneously, and is usually in the state of small round tears of a brown colour, and semitransparent, not unlike mastich, but rather more transparent and brittle. Besides the resinous part, it contains a peculiar principle. Mr. Hatchett found the resin of juniper soluble in alkalies and nitric acid. Its specific gravity is 1.092.

4. *Elemi.* This resin is obtained from the amyris elemifera; a tree which grows in Canada and Spanish America. Incisions are made in the bark during dry weather, and the resinous juice which exudes is left to harden in the sun. It comes to this country in long roundish cakes wrapped in flag-leaves. It is of a pale yellow colour, semitransparent; at first softish, but it hardens by keeping. Its smell is at first strong and fragrant, but it gradually diminishes. When distilled, it yields a portion of volatile oil. The residuum is a pure resin. Its specific gravity is 1.018.

5. *Tacamahac.* This resin is obtained from the fagara octandra, and likewise it is supposed from the populus balsamifera. It comes from America in large oblong masses wrapt in flag-leaves. It is of a light-brown colour, very brittle, and easily melted when heated. Mr. Hatchett found it soluble in alkalies and nitric acid with the usual phenomena. Its specific gravity is 1.046.

6. *Animé.* This resin is obtained from the hymenæa courbaril or locust tree, which is a native of North America. Animé resembles copal very much in its appearance; but is readily soluble in alcohol, which copal is not: this readily distinguishes them. It is said to be very frequently employed in the making of varnishes. Its specific gravity, according to Brisson, is 1.028.

7. *Ladanum,* or *labdanum.* This resin is obtained from the cystus creticus, a shrub which grows in Syria and the Grecian islands. See LABDANUM.

8. *Opobalsamum,* or *balm of Gilead.* This resin is obtained from the amyris Gi-

leadensis, a tree which grows in Arabia, especially near Mecca. It is so much valued by the Turks that it is seldom or never imported into Europe. We are of course ignorant of its composition. It is said to be at first turbid and white; and of a strong aromatic smell, and bitter, acrid, astringent taste; but by keeping, it becomes limpid and thin, and its colour changes first to green, then to yellow, and at last it assumes the colour of honey.

9. *Copaiva*, or *balsam of copaiva*. This resin is obtained from the copaifera officinalis; a tree which grows in South America, and some of the West Indian islands. The resinous juice exudes from incisions made in the trunk of the tree. The juice thus obtained is transparent, of a yellowish colour, an agreeable smell, a pungent taste, at first of the consistence of oil, but it gradually becomes as thick as honey. It is a combination of volatile oil and resin; the oil is easily obtained by distillation with water. It is employed in medicine.

10. *Dragon's blood*. This resin is obtained from different plants, as the calamus rotang, dracæna draco, and pterocarpus draco. It comes both from the East Indies and Spanish America; and it cannot be doubted that different vegetable substances have been confounded under the same name, the red colour having been formerly considered as sufficient to constitute dragon's blood. The substance of that name described by French writers has an astringent taste, and is partly soluble in water. This seems to be the dragon's blood of America, in which Proust detected abundance of tan. The dragon's blood which comes to this country from the East Indies is tasteless, and insoluble in water; but it dissolves in alcohol, which it tinges of a fine crimson. It dissolves also in fixed oils, tinging them red. It is in small masses wrapt in leaves. Colour dark red. Powder crimson. Brittle. Fracture glassy. Opaque. Melts when heated, and readily burns. These properties prove it to be a resin. We must, then, distinguish two distinct substances hitherto confounded under the same name. According to Brisson, the specific gravity of dragon's blood (probably the species which contains tan) is 1.204.

11. *Guaiac*. This resin is obtained from the guaiacum officinale, a treee which is a native of the West Indies. The resin exudes spontaneously, and is driven out melted by heating one end of the wood in billets previously bored longitudinally; the melted resin runs out at the extremity farthest from the fire. Guaiac is of a green colour, has some transparency, and is brittle. Its fracture is vitreous. When heated, it melts. It has no smell, and scarcely any taste. Alcohol dissolves it; but water has no effect upon it. When thrown on burning coals, it diffuses a fragrant odour. When swallowed in powder, it causes a burning sensation in the throat.

12. *Botany Bay resin*. This resin is said to be the produce of the acarois resinifera; a tree which grows abundantly in New Holland, especially near Botany Bay. Specimens of it were brought to London about the year 1799, where it was tried as a medicine. Some account was given of it in governor Philips's Voyage, and in White's Journal of a Voyage to New South Wales; but it is to professor Lichtenstein that we are indebted for an account of its chemical properties. The resin exudes spontaneously from the trunk of the singular tree which yields it, especially if the bark is wounded. It is at first fluid, but becomes gradually solid when dried in the sun. According to governor Philips, it is collected usually in the soil which surrounds the tree, having doubtless run down spontaneously to the ground. It consists of pieces of various sizes, of a yellow colour unless when covered with a greenish-grey crust. It is firm, yet brittle; and when pounded, does not stick to the mortar nor cake. In the mouth it is easily reduced to powder without sticking to the teeth. It communicates merely a slight sweetish astringent taste. When moderately heated, it melts; on hot coals it burns to a coal, emitting a white smoke which has a fragrant odour something like storax. When thrown into the fire, it increases the flame like pitch. It communicates to water the flavour of storax, but is insoluble in that liquid. When digested in alcohol, two-thirds dissolve: the remaining third consists of one part of extractive matter, soluble in water, and having an astringent taste; and two parts of woody fibre and other impurities, perfectly tasteless and insoluble. The solution has a brown colour, and exhibits the appearance and the smell of a solution of benzoin. Water throws it down unaltered. When distilled, the products were water, an empyreumatic oil, and charcoal; but it gives no traces of any acid, alkali, or salt, even when distilled with water.

Twelve parts were boiled in a solution of pure soda in water. Two parts of the resin were dissolved; the remaining ten parts were floating on the solution, cohering together in clots. No crystals were obtained by evaporating part of the solution; and when sulphuric acid was dropt into another portion, resin separated unaltered. When mixed with twice its weight of nitric acid, the resin swims unaltered on the surface; but when heat is applied, a considerable effervescence takes place. The digestion was continued till the effervescence stopped, and the resin swam on the surface of the liquid, collected together in clots. It was then separated by filtration. It had lost $\frac{1}{12}$th of its weight. The resin thus treated had acquired a bitterish taste, was not so easily melted as before, and alcohol was capable of dissolving only one-half of it. The solution was brown, tasted like bitter almonds; and when mixed with water, let fall a yellow resinous precipitate of a very bitter taste. The insoluble portion mixed with water, but formed a turbid liquid, which passed through the filtre. The nitric acid solution separated from the resin by filtration, was transparent; its colour was yellow; its taste bitter; and it tinged substances dipped into it of a yellow colour. By evaporation it yielded oxalic acid, and deposited a yellow earthy-like powder. This last substance was insoluble in water, and scarcely soluble in alcohol. Its taste was exquisitely bitter, like quassia. It mixed with the saliva, and readily stained the skin and paper yellow. The residuum continued bitter and yellow, but yielded no precipitate with potass and nitrat of lime. The bitter substance, into which this resin was thus converted by nitric acid, deserves particular attention. He suspects that it is capable of producing the same changes on all the resins: but this conjecture has been verified only with regard to colophonium, which he found to yield equally a yellow bitter substance.

13. The *green resin* which constitutes the colouring matter of the leaves of trees, and almost all vegetables, is insoluble in water, and soluble in alcohol. From the experiments of Proust we learn, that when treated with oxymuriatic acid it assumes the colour of a withered leaf, and acquires the resinous properties in greater perfection.

14. *Copal*. This substance, which deserves particular attention from its importance as a varnish, and which at first sight seems to belong to a distinct class from the resin, is obtained from the rhus copallinum, a tree which is a native of North America; but the best sort of copal is said to come from Spanish America. Copal is a beautiful transparent resinous-like substance, with a slight tinge of brown. When heated it melts like other resins; but it differs from them in not being soluble in alcohol, nor in oil of turpentine without peculiar management. Neither does it dissolve in the fixed oils with the same ease as the other resins. It resembles gum animé exactly in appearance; but is easily distinguished by the solubility of this last in alcohol. The specific gravity of copal varies.

RESISTANCE, or *resisting-force*, in philosophy, denotes, in general, any power which acts in an opposite direction to another, so as to destroy or diminish its effect.

There are various kinds of resistance arising from the various natures and properties of the resisting bodies, and governed by various laws; as, the resistance of solids, the resistance of fluids, the resistance of the air, &c.

Resistance *of solids*, in mechanics, is the force with which the quiescent parts of solid bodies oppose the motion of others contiguous to them.

Of these there are two kinds: The first where the resisting and the resisted parts, *i.e.* the moving and quiescent bodies, are only contiguous, and do not cohere; constituting separate bodies or masses. This resistance is what Leibnitz calls resistance of the surface, but which is more properly called friction; for the laws of which, see the article Friction.

The second case of resistance, is where the resisting and resisted parts are not only contiguous, but cohere, being parts of the same continued body or mass. This resistance was first considered by Galileo, and may properly be called renitency.

Theory of the resistance of the fibres of solid bodies. To conceive an idea of this resistance, or renitency of the parts, suppose a cylindrical body suspended vertically by one end. Here all its parts, being heavy, tend downwards, and endeavour to separate the two contiguous planes or surfaces where the body is the weakest; but all the parts of them resist this separation by the force with which they cohere, or are bound together. Here then are two opposite powers, viz. the weight of the cylinder, which tends to break it; and the force of cohesion of the parts, which resists the fracture.

If now the base of the cylinder is increased without increasing its length, it is evident that both the resistance and the weight will be increased in the same ratio as the base; and hence it appears that all cylinders of the same matter and length, whatever their bases are, have an equal resistance, when vertically suspended.

But if the length of the cylinder is increased without increasing its base, its weight is increased, while the resistance or strength continues unaltered; consequently the lengthening has the effect of weakening it, or increases its tendency to break.

Hence, to find the greatest length a cylinder of any matter may have, when it just breaks with the addition of another given weight, we need only take any cylinder of the same matter, and fasten to it the least weight that is just sufficient to break it; and then consider how much it must be lengthened, so that the weight of the part added, together with the given weight, may be just equal to that weight, and the thing is done. Thus, let l denote the first length of the cylinder, c its weight, g the given weight the lengthened cylinder is to bear, and w the least weight that breaks the cylinder l, also x the length sought; then as $l : x :: c : \frac{cx}{l} =$ the weight of the longest cylinder sought; and this, together with the given weight g, must be equal to c, together with the weight w; hence then $\frac{cx}{l} + g = c + w$; therefore $x = \frac{c + w - g}{c}$ $l =$ the whole length of the cylinder sought. If the cylinder must just break with its own weight, then is $g = 0$, and in that case $x = \frac{c + w}{c} l$ is the whole length that just breaks by its own weight. By this means Galileo found that a copper wire, and of consequence any other cylinder of copper, might be extended to 4801 fathoms of 6 feet each.

If the cylinder is fixed by one end into a wall, with the axis horizontally; the force to break it, and its resistance to fracture, will here be both different; as both the weight to cause the fracture, and the resistance of the fibres to oppose it, are combined with the effects of the lever; for the weight to cause the fracture, whether of the weight of the beam alone, or combined with an additional weight hung to it, is to be supposed collected into the centre of gravity, where it is considered as acting by a lever equal to the distance of that centre beyond the face of the wall where the cylinder or other prism is fixed; and then the product of the said whole weight and distance, will be the momentum or force to break the prism. Again, the resistance of the fibres may be supposed collected into the centre of the transverse section, and all acting there at the end of a lever equal to the vertical semidiameter of the section, the lowest point of that diameter being immoveable, and about which the whole diameter turns when the prism breaks; and hence the product of the adhesive force of the fibres, multiplied by the said semidiameter, will be the momentum of resistance, and must be equal to the former momentum when the prism just breaks.

Hence, to find the length a prism will bear, fixed so horizontally, before it breaks, either by its own weight, or by the addition of any adventitious weight; take any length of such a prism, and load it with weights till it just breaks. Then, put

$l =$ the length of this prism,
$c =$ its weight,
$w =$ the weight that breaks it,
$a =$ distance of weight w
$g =$ any given weight to be borne,
$d =$ its distance,
$x =$ the length required to break.

Then $l : x :: c : \frac{cx}{l}$ the weight of the prism x, and $\frac{cx}{l} \times \frac{1}{2} x = \frac{cx^2}{2l} =$ its momentum; also $dg =$ the momentum of the weight g; therefore $\frac{cx^2}{2l} + dg$ is the momentum of the prism x and its added weight. In like manner $\frac{1}{2}cl + aw$ is that of the former or short prism, and the weight that broke it; consequently $\frac{cx^2}{2l} + dg = \frac{1}{2}cl + aw$, and $x = \sqrt{\frac{aw + \frac{1}{2}cl - dg}{c}} \times 2l$ is the length sought, that just breaks with the weight g at the distance d. If this weight g is nothing, then $x = \sqrt{\frac{aw + \frac{1}{2}cl}{c}} \times 2l$ is the length of the prism that just breaks with its own weight.

If two prisms of the same matter, having their bases and lengths in the same proportion, are suspended horizontally; it is evident that the greater has more weight than the lesser, both on account of its length, and of its base; but it has less resistance on account of its length, considered as a longer arm of a lever, and has only more resistance on account of its base; therefore it exceeds the lesser in its momentum more than it does in its resistance, and consequently it must break more easily.

Hence appears the reason why, in making small machines and models, people are apt to be mistaken as to the resistance and strength of certain horizontal pieces, when they come to execute their designs in large, by observing the same proportions as in the small.

When the prism, fixed vertically, is just about to break, there is an equilibrium between its positive and relative weight; and consequently those two opposite powers are to each other reciprocally as the arms of the lever to which they are applied, that is, as half the diameter to half the axis of the prism. On the other hand, the resistance of a body is always equal to the greatest weight which it will just sustain in a vertical position, that is, to its absolute weight. Therefore, substituting the absolute weight for the resistance, it appears, that the absolute weight of a body, suspended horizontally, is to its relative weight, as the distance of its centre of gravity from the fixed point or axis of motion, is to the distance of the centre of gravity of its base from the same.

The discovery of this important truth, at least of an equivalent to it, and to which this is reducible, we owe to Galileo. On this system of resistance of that author, Mariotte made an ingenious remark, which gave birth to a new system. Galileo supposes that where the body breaks, all the fibres break at once; so that the body always resists with its whole absolute force, or the whole force that all its fibres have in the place where it breaks. But Mariotte, finding that all bodies, even glass itself, bend before they break, shews that fibres are to be considered as so many little bent springs, which never exert their whole force till stretched to a certain point, and never break till entirely unbent. Hence those nearest the fulcrum of the lever, or lowest point of the fracture, are stretched less than those farther off, and consequently employ a less part of their force, and break later.

This consideration only takes place in the horizontal situation of the body; in the vertical, the fibres of the base all break at once; so that the absolute weight of the body must exceed the united resistance of all its fibres; a greater weight is therefore required here than in the horizontal situation; that is, a greater weight is required to overcome their united resistance, than to overcome their several resistances one after another. See TIMBER, *strength of*.

RESISTANCE *of fluids*, is the force with which bodies, moving in fluid mediums, are impeded and retarded in their motion.

A body moving in a fluid is resisted from two causes. The first of these is the cohesion of the parts of the fluid. For a body, in its motion, separating the parts of a fluid, must overcome the force with which those parts cohere. The second is the inertia or inactivity of matter, by which a certain force is required to move the particles from their places in order to let the body pass.

The retardation from the first cause is always the same in the same space, whatever the velocity may be, the body remaining the same; that is, the resistance is as the space run through in the same time; but the velocity is also in the same ratio of the space run over in the same time; and therefore the resistance from this cause, is as the velocity itself.

The resistance from the second cause, when a body moves through the same fluid with different velocities, is as the square of the velocity. For, first, the resistance increases according to the number of particles or quantity of the fluid struck in the same time; which number must be as the space run through in that time, that is, as the velocity: but the resistance also increases in proportion to the force with which the body strikes against every part; which force is also as the velocity of the body, so as to be double with a double velocity, and triple with a triple one, &c.; therefore, on both these accounts, the resistance is as the velocity multiplied by the velocity, or as the square of the velocity. Upon the whole therefore, on account of both causes, viz. the tenacity and inertia of the fluid, the body is resisted partly as the velocity and partly as the square of the velocity.

But when the same body moves through different fluids with the same velocity, the resistance from the second cause follows the proportion of the matter to be removed in the same time, which is as the density of the fluid.

Hence therefore, if d denotes the density of the fluid,
v the velocity of the body,
and a and b constant coefficients:

then $adv^2 + bv$ will be proportional to the whole resistance to the same body, moving with different velocities, in the same direction, through fluids of different densities, but of the same tenacity.

But to take in the consideration of different tenacities of fluids; if t denotes the tenacity, or the cohesion of the parts of the fluid, then $adv^2 + btv$ will be as the said whole resistance.

Indeed the quantity of resistance from the cohesion of the parts of fluids, except in glutinous ones, is very small in respect of the other resistance; and it also increases in a much lower degree, being only as the velocity, while the other increases as the square of the velocity, and rather more. Hence then the term btv is very small in respect of the other term adv^2; and consequently the resistance is nearly as this latter term, or nearly as the square of the velocity. This rule has been employed by most authors, and is very near the truth in slow motions; but in very rapid ones, it differs considerably from the truth, as we shall perceive below; not indeed from the omission of the small term ctv, due to the cohesion, but from the want of the full counterpressure on the hinder part of the body; a vacuum, either perfect or partial, being left behind the body in its motion; and also perhaps to some compression or accumulation of the fluid against the fore part of the body.

Resistance and retardation are used indifferently for each other, as being both in the same proportion, and the same resistance always generating the same retardation. But with regard to different bodies, the same resistance frequently generates different retardations; the resistance being as the quantity of motion, and the retardation as that of the celerity.

The retardations from this resistance may be compared together, by comparing the resistance with the gravity or quantity of matter. It is demonstrated that the resistance of a cylinder, which moves in the direction of its axis, is equal to the weight of a column of the fluid, whose base is equal to that of the cylinder, and its altitude equal to the height through which a body must fall in vacuo, by the force of gravity, to acquire the velocity of the moving body. So that, if a denotes the area of the face or end of the cylinder, or other prism, v its velocity, and n the specific gravity of the fluid; then, the altitude due to the velocity v being $\frac{v^2}{4g}$, the whole resistance, or motive force m, will be $n \times d \times \frac{v^2}{4g} = \frac{anv^2}{4g}$; the quantity g being $= 16\frac{1}{12}$ feet, or the space a body falls, in vacuo, in the first second of time. And the resistance to a globe of the same diameter would be the half of this. Let a ball, for instance, of 3 inches diameter, be moved in water with a celerity of 16 feet per second of time: now from experiments on pendulums, and on falling bodies, it has been found, that this is the celerity which a body acquires in falling from the height of 4 feet; therefore the weight of a cylinder of water of 3 inches diameter, and 4 feet high, that is, a weight of about 12 lb. 4 oz., is equal to the resistance of the cylinder; and consequently the half of it, or 6 lb. 2 oz., is that of the ball.

Or, the formula $\frac{anv^2}{4g}$ gives

$$\frac{.7854 \times 9 \times 1000 \times 16 \times 16}{144 \times 4 \times 16} =$$

196 oz., or 12 lb. 4 oz., for the resistance of the cylinder, or 6 lb. 2 oz. for that of the ball, the same as before.

Let now the resistance, so discovered, be divided by the weight of the body, and the quotient will shew the ratio of the retardation to the force of gravity. So if the said ball, of 3 inches diameter, is of cast iron, it will weigh nearly 61 ounces, or $3\frac{13}{16}$ lb.; and the resistance being 6 lb. 2 oz., or 98 ounces, therefore the resistance being to the gravity as 98 to 61, the retardation, or retarding force, will be $\frac{98}{61}$, or $1\frac{3}{5}$, the force of gravity being 1. Or thus; because a the area of a great circle of the ball, is $= pd^2$, where d is the diameter, and $p = .7854$, therefore the resistance to the ball is $m = \frac{pnd^2v^2}{8g}$; and because its solid content is $w = \frac{2}{3}pd^3$, and its weight $\frac{2}{3}Npd^3$, where N denotes its specific gravity, therefore dividing the resistance or motive force m by the weight w, gives $\frac{m}{w} = \frac{3nv^2}{16Ndg} = f$ the retardation, or retarding force, that of gravity being 1; which is therefore as the square of the velocity directly, and as the diameter inversely; and this is the reason why a large ball overcomes the resistance better than a small one, of the same density.

Resistance *of Fluid Mediums to the Motion of Falling Bodies*. A body freely descending in a fluid, is accelerated by the relative gravity of the body, (that is, the difference between its own absolute gravity and that of a like bulk of the fluid,) which continually acts upon it, yet not equably, as in a vacuum: the resistance of the fluid occasions a retardation, or diminution of acceleration, which diminution increases with the velocity of the body. Hence it happens, that there is a certain velocity, which is the greatest that a body can acquire by falling; for if its velocity is such, that the resistance arising from it becomes equal to the relative weight of the body, its motion can be no longer accelerated; for the motion here continually generated by the relative gravity, will be destroyed by the resistance; or the force of resistance will be equal to the relative gravity, and the body forced to go on equably: for, after the velocity is arrived at such a degree, that the resisting force is equal to the weight that urges it, it will increase no longer, and the globe must afterward continue to descend with that velocity uniformly. A body continually comes nearer and nearer to this greatest celerity, but can never attain accurately to it. Now, N and n being the specific gravities of the globe and fluid, $N - n$ will be the relative gravity of the globe in the fluid, and therefore $w = \frac{2}{3}pd^3(N - n)$ is the weight by which it is urged downward; also $m = \frac{pnd^2v^2}{8g}$ is the resistance, as above; therefore these two must be equal when the velocity can be no farther increased, or $m = w$, that is $\frac{pnd^2v^2}{8g} = \frac{2}{3}pd^3(N - n)$, or $nv^2 = \frac{16}{3}dg$ $(N - n)$; and hence $v = \sqrt{\frac{16}{3}dg \times \frac{N - n}{n}}$ is the said uniform or greatest velocity to which the body may attain; which is evidently the greater in the subduplicate proportion of v the diameter of the ball. But v is always $= \sqrt{4gfs}$, the velocity generated by any accelerative force f in describing the space s; which being compared with the former, it gives $s = \frac{4}{3}d$, when f is $= \frac{N - n}{n}$; that is, the greatest velocity is that which is generated by the accelerating force $\frac{N - n}{n}$ in passing over the space $\frac{4}{3}d$, or $\frac{4}{3}$ of the diameter of the ball, or it is equal to the velocity generated by gravity in describing the space $\frac{N - n}{n} \times \frac{4}{3}d$. For example; if the ball is of lead, which is about $11\frac{1}{4}$ times the density of water; then $N = 11\frac{1}{4}$, $n = 1$, $N - n = \frac{N - n}{n} = 10\frac{1}{4} = \frac{41}{4}$, and $\frac{N - n}{n} \times \frac{4}{3}d = \frac{4}{3}d = 13\frac{2}{3}d$; that is, the uniform or greatest velocity of a ball of lead, descending in water, is equal to that which a heavy body acquires by falling in vacuo through a space equal to $13\frac{2}{3}$ of the diameter of the ball, which velocity is $v = 2\sqrt{\frac{4}{3}dg \times \frac{N - n}{n}} = 2\sqrt{13\frac{2}{3}dg} = 8\sqrt{13\frac{2}{3}d}$ nearly, or 8 times the root of the same space.

Hence it appears, how soon small bodies come to their greatest or uniform velocity in descending in a fluid, as water, and how very small that velocity is; which explains the reason of the slow precipitation of mud, and small particles, in water; as also why, in precipitations, the larger and gross particles descend soonest, and the lowest.

Farther, where $N = n$, or the density of the fluid is equal to that of the body, then $N - n = 0$, consequently the velocity and distance descended are each nothing, and the body will just float in any part of the fluid.

Moreover, when the body is lighter than the fluid, then N is less than n, and $N - n$ becomes a negative quantity, or the force and motion tend the contrary way, that is, the ball will ascend up towards the top of the fluid by a motive force which is as $n - N$. In this case, then, the body ascending by the action of the fluid, is moved exactly by the same laws as a heavier body falling in the fluid. Wherever the body is placed, it is sustained by the fluid, and carried up with a force equal to the difference of the weight of a quantity of the fluid of the same bulk as the body, from the weight of the body; there is therefore a force which continually acts equably upon the body; by which not only the action of gravity of the body is counteracted, so as that it is not to be considered in this case; but the body is also carried upwards by a motion equably accelerated, in the same manner as a body heavier than a fluid descends by its relative gravity: but the equability of acceleration is destroyed in the same manner by the resistance, in the ascent of a body lighter than the fluid, as it is destroyed in the descent of a body that is heavier.

For the circumstances of the correspondent velocity, space, and time, &c. of a body moving in a fluid in which it is projected with a given velocity, or descending by its own weight, &c. see Dr. Hutton's Select Exercises, prop. 29, 30, 31, and 32, page 221, &c.

Resistance *of the Air*, is the force with which the motion of bodies, particularly of projectiles, is retarded by the opposition of the air or atmosphere. See Gunnery, Projectiles, &c.

The air being a fluid, the general laws of the resistance of fluids obtain in it; subject only to some variations and irregularities from the different degrees of density in the different stations or regions of the atmosphere.

The resistance of the air is chiefly of use in military projectiles, in order to allow for the differences caused in their flight and range by it. Before the time of Mr. Robins, it was thought that this resistance to the motion of such heavy bodies as iron balls and shells, was too inconsiderable to be regarded; and that the rules and conclusions derived from the common parabolic theory, were sufficiently exact for the common practice of gunnery. But that gentleman shewed, in his New Principles of Gunnery, that, so far from being inconsiderable, it is in reality enormously great, and by no means to be rejected without incurring the grossest errors; so much so, that balls or shells which range, at the most, in the air, to the distance of two or three miles, would in a vacuum range to 20 or 30 miles, or more. To determine the quantity of this resistance, in the case of different velocities, Mr. Robins discharged musket-balls, with various degrees of known velocity, against his balistic pendulums, placed at several different distances, and so discovered by experiment the quantity of velocity lost, when passing through those distances, or spaces of air, with the several known degrees of celerity. For having thus known, the velocity lost or destroyed, in passing over a certain space, in a certain time, (which time is very nearly equal to the quotient of the space divided by the medium velocity between the greatest and least, or between the velocity at the mouth of the gun and that at the pendulum); that is, knowing the velocity v, the space s, and time t; the resisting force is thence easily known, being equal to $\frac{vb}{2gt}$ or $\frac{vvb}{2gs}$, where b denotes the weight of the ball, and V the medium velocity above-mentioned. The balls employed upon this occasion by Mr. Robins, were leaden ones, of $\frac{1}{12}$ of a pound weight, and $\frac{3}{4}$ of an inch diameter; and to the medium velocity of

1600 feet, the resistance was 11 lb.,
1065 feet, - - - - - - it was $2\frac{4}{5}$;

but by the theory of Newton, before laid down, the former of these should be only $4\frac{1}{2}$ lb., and the latter 2 lb.; so that, in the former case the real resistance is more than double of that by the theory, being increased as 9 to 22; and in the lesser velocity the increase is from 2 to $2\frac{4}{5}$, or as 5 to 7 only.

Mr. Euler has shewn, that the common doctrine of resistance answers pretty well when the motion is not very swift, but in swift motions it gives the resistance less than it ought to be, on two accounts: 1. Because in quick motions, the air does not fill up the space behind the body fast enough to press on the hinder parts, to counterbalance the weight of the atmosphere on the fore part. 2. The density of the air before the ball being increased by the quick motion, will press more strongly on the fore part, and so will resist more than lighter air in its natural state. He has shewn that Mr. Robins has restrained his rule to velocities not exceeding 1670 feet per second; whereas had he extended it to greater velocities, the result must have been erroneous; and he gives another formula himself, and deduces conclusions differing from those of Mr. Robins.

Mr. Robins having proved that, in very great changes of velocity, the resistance does not accurately follow the duplicate ratio of the velocity, lays down two positions, which he thought might be of some service in the practice of artillery, till a more complete and accurate theory of resistance, and the changes of its augmentation, may be obtained. The first of these is, that till the velocity of the projectile surpasses 1100 or 1200 feet in a second, the resistance may be esteemed to be in the duplicate ratio of the velocity; and the second is, that when the velocity exceeds 1100 or 1200 feet, then the absolute quantity of the resistance will be near 3 times as great as it should be by a comparison with the smaller velocities. Upon these principles he proceeds in approximating to the actual ranges of pieces with small angles of elevations, viz. such as do not exceed 8° or 10°, which he sets down in a table, compared with their corresponding potential ranges. But we shall see presently that these positions are both without foundation; that there is no such thing as a sudden or abrupt change in the law of resistance, from the square of the velocity to one that gives a quantity three times as much; but that the change is slow and gradual, continually from the smallest to the highest velocities; and that the increased real resistance no where rises higher than to about double of that which Newton's theory gives it.

The subject of the resistance of the air, as begun by Robins, has been prosecuted by Dr. Hutton, to a very great extent and variety, both with the whirling-machine, and with cannon-balls of all sizes, from 1lb to 6lb. weight, as well as with figures of many other different shapes, both on the fore part and hind part of them, and with planes set at all varieties of angles of inclination to the path or motion of the same; from all which he has obtained the real resistance to bodies for all velocities, from 1 up to 2000 feet per second; together with the law of the resistance to the same body for all different velocities, and for different sizes with the same velocity, and also for all angles of inclination.

RESISTANCES OF DIFFERENT BODIES.

Velocity per second.	Small hemis. flat side.	Large hemisph. flat side.	Large hemisph. round side.	Cone. vertex.	Cone. base.	Cylinder.	Whol. globe	Resistance as the power of the velocity
feet.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	
3	.028	.051	.020	.028	.064	.050	.027	
4	.048	.096	.039	.048	.109	.090	.047	
5	.072	.148	.063	.071	.162	.143	.068	
6	.103	.211	.092	.098	.225	.205	.094	
7	.141	.284	.123	.129	.298	.278	.125	
8	.184	.368	.160	.168	.382	.360	.162	
9	.233	.464	.199	.211	.478	.456	.205	
10	.287	.573	.242	.260	.587	.565	.255	
11	.349	.698	.292	.315	.712	.688	.310	2.052
12	.418	.836	.347	.376	.850	.826	.370	2.042
13	.492	.988	.409	.440	1.000	.979	.435	2.036
14	.573	1.154	.478	.512	1.166	1.145	.505	2.031
15	.661	1.336	.552	.589	1.346	1.327	.581	2.031
16	.754	1.538	.634	.673	1.546	1.526	.663	2.033
17	.853	1.757	.722	.762	1.763	1.745	.752	2.038
18	.959	1.998	.818	.858	2.002	1.986	.848	2.044
19	1.073	2.258	.922	.959	2.260	2.246	.949	2.047
20	1.196	2.542	1.033	1.069	2.540	2.528	1.057	2.051
Mean propor. Nos.	140	288	119	126	291	285	124	2.040
1	2	3	4	5	6	7	8	9

In this table are contained the resistances to several forms of bodies, when moved with several degrees of velocity, from three feet per second to twenty. The names of the bodies are at the tops of the columns, as also which end went foremost through the air; the different velocities are in the first column, and the resistances on the same line, in their several columns, in avoirdupois ounces and decimal parts. So on the first line are contained the resistances when the bodies move with a velocity of three feet in a second, viz. in the second column for the small hemisphere, of 4^3 inches diameter, its resistance .028 ounces when the flat side went foremost; in the third and fourth columns the resistances to a larger hemisphere, first with the flat side, and next the round side foremost; the diameter of this, as well as all the following figures, being $6\frac{2}{5}$ inches, and therefore the area of the great circle $= 32$ square inches, or $\frac{2}{9}$ of a square foot; then in the 5th and 6th columns are the resistances to a cone, first its vertex, and then its base foremost, the altitude of the cone being $6\frac{5}{8}$ inches, the same as the diameter of its base; in the seventh column the resistance to the end of the cylinder, and in the eighth, that against the whole globe or sphere. All the numbers shew the real weights which are equal to the resistances; and at the bottoms of the columns are placed proportional numbers, which shew the mean proportions of the resistances of all the figures to one another, with any velocity. Lastly, in the ninth column are placed the exponents of the power of the velocity which the resistances in the eighth column bear to each other, viz. which that of the ten-feet velocity bears to each of the following ones, the medium of all of them being as the 2.04 power of the velocity, that is, very little above the square or second power of the velocity, so far as the velocities in this table extend.

From this table the following inferences are easily deduced:

1. That the resistance is nearly in the same proportion as the surfaces; a small increase only taking place in the greater surfaces, and for the greater velocities. Thus, by comparing together the numbers in the second and third columns, for the bases of the two hemispheres, the areas of which bases are in the proportion of $17\frac{3}{4}$ to 32, or 5 to 9 very nearly, it appears that the numbers in those two columns, expressing the resistances, are nearly as 1 to 2 or 5 to 10, as far as the velocity of 12 feet; but after that, the resistances on the greater surface increase gradually more and more above that proportion.

2. The resistance to the same surface with different velocities, is, in these slow motions, nearly as the square of the velocity; but gradually increases more and more above that proportion as the velocity increases. This is manifest from all the columns: and the index of the power of the velocity is set down in the ninth column, for the resistances

in the eighth, the medium being 2.04; by which it appears that the resistance to the same body is, in these slow motions, as the 2.04 power of the velocity, or nearly as the square of it.

3. The round ends, and sharp ends, of solids, suffer less resistance than the flat or plane ends, of the same diameter; but the sharper end has not always the less resistance. Thus, the cylinder, and the flat ends of the hemisphere and cone, have more resistance, than the round or sharp ends of the same; but the round side of the hemisphere has less resistance than the sharper end of the cone.

4. The resistance on the base of the hemisphere, is to that on the round, or whole sphere, as $2\frac{1}{7}$ to 1, instead of 2 to 1, as the theory gives that relation. Also the experimented resistance, on each of these, is nearly $\frac{1}{4}$ more than the quantity assigned by the theory.

5. The resistance on the base of the cone, is to that on the vertex, nearly as $2\frac{3}{10}$ to 1; and in the same ratio is radius to the sine of the angle of inclination of the side of the cone to its path or axis. So that, in this instance, the resistance is directly as the sine of the angle of incidence, the transverse section being the same.

6. When the hinder parts of bodies are of different forms, the resistances are different, though the fore-parts are exactly alike and equal; owing probably to the different pressures of the air on the hinder parts. Thus, the resistance to the fore-part of the cylinder, is less than on the equal flat surface of the cone, or of the hemisphere; because the hinder part of the cylinder is more pressed or pushed by the following air than those of the other two figures; also, for the same reason, the base of the hemisphere suffers a less resistance than that of the cone, and the round side of the hemisphere less than the whole sphere.

Resistance of the fibres of solid bodies is more properly called cohesion.

RESOLUTION, in chemistry, &c. the reduction of a mixed body into its component parts, or first principles, by a proper analysis.

Resolution, in music, is when a canon or perpetual fugue is not written on a line, or in one part, but all the voices that are to follow the guide or first voice are written separately either in score, that is in separate lines, or in separate parts, with the pauses each is to observe, and in the proper tone to each.

RESPIRATION consists in drawing a certain quantity of air into the lungs, and throwing it out again alternately. Whenever this function is suspended, even for a very short time, the animal dies.

The fluid respired by animals is common atmospherical air; and it has been ascertained by experiment, that no other gaseous body with which we are acquainted, can be substituted for it. All the known gases have been tried; but they all prove fatal to the animal which is made to breathe them Gaseous bodies, as far as respiration is concerned, may be divided into two classes: 1. Unrespirable gases; 2. Respirable gases. See Air.

I. The gases belonging to the first class are of such a nature that they cannot be drawn into the lungs of an animal at all; the epiglottis closing spasmodically whenever they are applied to it. To this class belong carbonic acid, and probably all the other acid gases, as has been ascertained by the experiments of Pilatre de Rozier. Ammoniacal gas belongs to the same class; for the lungs of animals suffocated by it were found by Pilatre not to give a green colour to vegetable blues.

II. The gases belonging to the second class may be drawn into the lungs, and thrown out again, without any opposition from the respiratory organs; of course the animal is capable of respiring them. They may be divided into four subordinate classes; 1. The first set of gases occasion death immediately, but produce no visible change in the blood. They occasion the animal's death merely by depriving him of air, in the same way as he would be suffocated by being kept under water. The only gases which belong to this class are hydrogen and azotic. 2. The second set of gases occasion death immediately, but at the same time they produce certain changes in the blood, and therefore kill, not merely by depriving the animal of air, but by certain specific properties. The gases belonging to this class are carbureted hydrogen, sulphureted hydrogen, carbonic oxide, and perhaps also nitrous gas. 3. The third set of gases may be breathed for some time without destroying the animal; but death ensues at last, provided their action is long enough continued. To this class belong the nitrous oxide and oxygen gas. 4. The fourth set may be breathed any length of time without injuring the animal. Air is the only gaseous body belonging to this class.

It has been long known that an animal can only breathe a certain quantity of air for a limited time; after which it becomes the most deadly poison, and produces suffocation as effectually as the most noxious gas, or a total absence of air. It was suspected long ago, that this change is owing to the absorption of a part of the air; and Mayow made a number of very ingenious experiments in order to prove the fact. Dr. Priestley and Mr. Scheele demonstrated, that the quantity of oxygen gas in atmospheric air is diminished; and Lavoisier demonstrated, in 1776, that a quantity of carbonic acid gas, which did not previously exist in it, was found in air after it had been for some time respired. It was afterwards proved by Lavoisier, and many other philosophers, who confirmed and extended his facts, that no animal can live in air totally destitute of oxygen. Even fish, which do not sensibly respire, die very soon if the water in which they live is deprived of oxygen gas. Frogs, which can suspend their respiration at pleasure, die in about forty minutes, if the water in which they have been confined is covered over with oil. Insects and worms, as Vauquelin has proved, exhibit precisely the same phenomena. They require air as well as other animals, and die like them if they are deprived of it. They diminish the quantity of oxygen in the air in which they live, and give out, by respiration, the very same products as other animals. Worms, which are more retentive of life than most other animals, or at least not so much affected by poisonous gases, absorb every particle of the oxygen contained in the air in which they are confined, before they die. Mr. Vauquelin's experiments were made on the gryllus viridissimus, the limax flavus, and helix pomatia.

The quantity of air respired differs very much in different animals. Man and hot-blooded animals are under the necessity of breathing constantly; whereas amphibious animals have a certain power over respiration, and can suspend the function altogether for a limited time. Dr. Barclay has ascertained that these animals acquire a much greater command over their respiratory organs by habit. Fish do not breathe at all, and consume so little air, that the small portion of it held in solution by the water in which they swim is sufficient for them. It appears that the number of respirations made in a given time differs considerably in different men. Dr. Hales reckons them at 20 in a minute. A man on whom Dr. Menzies made experiments, breathed only 14 times in a minute. Mr. Davy informs us that he makes between 26 and 27 in a minute.

The quantity of air drawn in and emitted at every respiration must differ considerably with the size of the man and the capacity of his lungs. Dr. Menzies found that a man draws in at a medium 43.77 cubic inches of air at every inspiration. Dr. Goodwin has concluded, from his experiments, that, after a natural expiration, the mean quantity of air which remains in the lungs amounts to 109 cubic inches; but Menzies has endeavoured to prove that the number ought to have been 179. Mr. Davy has ascertained that his lungs, after a forced expiration, still retain 41 cubic inches of air; after a natural expiration they contain

	118 cubic inches
After a natural inspiration	135
After a forced inspiration	254
By a full forced expiration after a forced inspiration, he threw out	190 cubic inches
After a natural inspiration	78.5
After a natural expiration	67.5

Let us now endeavour to trace the changes produced by respiration. These are of two kinds, namely: 1. The changes produced upon the air respired. 2. Changes produced upon the blood exposed to this air. Each of these naturally claims our attention.

1. For our knowledge of the changes produced upon the air by respiration, we are chiefly indebted to Priestley, Cigna, Menzies, Lavoisier and Seguin, and Mr. Davy. These changes are the following: 1. Part of the air respired disappears. 2. It becomes impregnated with carbonic acid. 3. It is loaded with water in the state of vapour.

1. From the experiments of Dr. Menzies, it follows, that one-twentieth of the air inspired disappears in the lungs. This agrees pretty nearly with the experiments made with great care by Lavoisier; an account of which he was employed in drawing up when he was murdered by order of the French usurpers of that period. Neither do the experiments published lately by Mr. Davy, and which appear to have been performed with much precision, differ much from those of Dr. Menzies. According to Mr. Davy, about $\frac{1}{19}$th of the air inspired disappears during respiration.

Concerning the portion of the air which disappears, it has hitherto been the general opinion that it is the oxygen only, and that the azote remains the same after respiration as before it. These conclusions were the consequence of the experiments of Lavoisier, who announced the non-alteration of the azote of the atmosphere at a very early period of his researches. This conclusion seems to have been the consequence of the opinion which he entertained, that air is merely a mechanical mixture of the two gases, oxygen and azotic; for when he first adopted it, his apparatus was not delicate enough to measure small changes; and he does not appear to have afterwards examined the azotic residuum with much attention. Mr. Davy has rendered it probable that a portion of the azote of the air as well as its oxygen disappears during respiration.

According to Dr. Menzies, at every respiration 2.1885 cubic inches of oxygen gas are consumed. Now, 2.1885 cubic inches of that gas amount to 0.68669 grains troy. Supposing, with Hales, that a man makes 1200 respirations in an hour, the quantity of oxygen gas consumed in an hour will amount to 824.028 grains, and in 24 hours to 19776.672 grains, or 41.2104 ounces troy. This quantity exceeds that found by other chemists considerably; but the allowance of oxygen for every respiration is rather too great. Indeed, from the nature of Dr. Menzie's apparatus, it was scarcely possible to measure it accurately. According to the last experiments of Lavoisier and Seguin, a man, at an average, consumes in twenty-four hours, by respiration, 32.48437 ounces troy of oxygen gas: that is to say, that a quantity of oxygen gas, equal to that weight, disappears from the air which he respires in 24 hours. According to Mr. Davy, the average quantity of air which disappears during every respiration is 1.4 cubic inch; of which 0.2 are azote and 1.2 oxygen. This, allowing 26 respirations per minute, as was the case with Mr. Davy (the subject of the experiment), amounts in 24 hours to rather more than 38 ounces of air; or precisely to 4.68 ounces of azote, and 33.54 of oxygen. This does not differ far from the result obtained by Lavoisier, excepting in the azote, which the French chemist neglected altogether. We may consider it therefore as approximating to the truth as nearly as can be expected in the present state of the science.

2. That the air thrown out of the lungs contains carbonic acid, may be easily ascertained by blowing it through a tube into lime-water, which immediately becomes milky; and the bulk of the gas may be estimated by putting a portion of air from the lungs into a graduated jar standing over mercury, introducing a little barytic water, or pure soda, to absorb the carbonic acid, and observing the diminution of bulk in consequence of this absorption. According to Lavoisier, a man in 24 hours throws out from his lungs at an average about 15.73 ounces troy of carbonic acid. From the experiments of Mr. Davy, on the other hand, it follows, that at every expiration about 1.1 cubic inch of carbonic acid is emitted, which amounts in 24 hours to no less than 37 ounces. The difference between these two sets of experiments is enormous, and claims a more complete experimental investigation to determine, whether the proportion of this gas emitted by different individuals, or by the same individual at different times, does not differ essentially. This supposition is surely very probable, as it tallies with what we know to be the case in other excretions; and if it proves true, would throw more light upon the nature of respiration than any thing which has hitherto been ascertained. In the mean time, till farther experiments decide the point, we may consider Mr. Davy's conclusions as nearest the medium of the two, because they correspond with the earlier experiments of Lavoisier, and remove a very striking anomaly which appears when we compare Lavoisier's experiments on the respiration of the guinea-pig with those on the respiration of man. He put a guinea-pig into 708.989 grains troy of oxygen; and after the animal had breathed the gas for an hour, he took it out. He found that the oxygen

gas now amounted only to	592.253 gr.
Consequently there had disappeared -	116.736
The carbonic acid gas formed was	130.472
The guinea-pig consumed in 24 hours -	5.8368 oz.
troy of oxygen gas, and emitted	6.5236 oz.

of carbonic acid gas. Man, on the other hand, consumes in the same time 32.48437 oz. of oxygen gas, and emits only 15.73 oz. of carbonic acid gas. The oxygen gas consumed by the pig is to the carbonic acid gas emitted as 1.00 : 1.12; whereas in man it is as 1.000 : 0.484. If we could depend upon the accuracy of each of these experiments, they would prove, beyond a doubt, that the changes produced by the respiration of the pig are different, at least in degree, from those produced in man; but it is more probable that some mistake has happened in one or other of the experiments.

3. It is not so easy to determine the proportion of water emitted from the lungs mixed with the air expired, as it is that of the carbonic acid. According to the experiments of Dr. Hales, it amounts in a day to 20.4 oz.; but his method was not susceptible of great accuracy. Mr. Lavoisier, on the other hand, estimates it at 28.55 ounces; but this proportion seems rather to have been the result of calculation than of any direct measurement. It can only be considered therefore as an approximation to the truth, and most probably a very imperfect one.

III. Let us now endeavour to ascertain the changes produced on the blood by respiration. The whole of the blood is propelled from the heart to the lungs, circulates through the vessels of that organ, and during that circulation it is exposed to the influence of the air which the animal is constantly drawing into the lungs. Now certain changes are produced upon it by this action, which have been partly traced by the experiments of Priestley, Cigna, Fourcroy, Hassenfratz, Beddoes, Watt, and above all by those of Mr. Davy. These changes, as far as we are acquainted with them, are the following: 1. The blood absorbs air. 2. It acquires a florid red colour, and the chyle disappears. 3. It emits carbonic acid, and perhaps carbon. 4. It emits water, and perhaps hydrogen.

As the azote which has separated from the air during respiration is not to be found in the products of respiration, we must conclude that it has been absorbed by the blood. The experiments of Mr. Davy have rendered it exceedingly probable that the air is absorbed unaltered by the blood; that it is afterwards decomposed by that liquid; and that the portion of azote which is useless is given out again, and mixed with the air in the lungs. The following facts render this opinion probable: When hydrogen gas is respired, no part of it is absorbed or disappears, nor are any positive changes produced on the blood. But when the gaseous oxide of azote is respired, it diminishes in quantity, while at the same time carbonic acid is evolved as usual, and a quantity of azotic gas makes its appearance. Now, as this azotic gas did not exist separately in the air before respiration, it must have been produced by the decomposition of the oxide of azote; but its quantity being much less than the azote contained in the oxide of azote which had disappeared, it follows that at least a part of this last gas had been absorbed by the blood unaltered; and if a part is thus absorbed, why not the whole? In that case the azotic gas must have been separated from the blood, in consequence of the subsequent decomposition of the oxide of azote absorbed. Now, as air is composed of precisely the same ingredients with the oxide of azote; and as a portion of the azote, as well as of the oxygen, of the air respired, disappears; it is reasonable to suppose that the air is absorbed by the blood, and that the azotic gas which is developed is thrown out of the blood in consequence of the decomposition of the air absorbed. But farther, if the oxygen of the air was alone absorbed by the blood during respiration while the azote remains unaltered, oxygen gas ought to answer the same purposes as air. This gas, however, cannot be respired without occasioning death at last; and when it is respired, the proportion of oxygen which disappears in a given time is much smaller than when the air is respired. Thus when 182 cubic inches of oxygen gas were breathed by Mr. Davy for half a minute, 11.4 cubic inches of the gas disappeared, whereas 15.6 cubic inches disappear in the same time when common air is respired. This is a demonstration that the whole of air is useful in respiration, and not merely its oxygen; and if so, the air must be absorbed.

2. It has been long known that the blood which flows in the veins is of a dark-reddish purple colour, whereas the arterial blood is of a florid scarlet colour. Lower observed that the colour of venous blood was converted into that of arterial during its passage through the lungs. No chyle can be distinguished by its white colour in the blood after it has passed through the lungs. The changes, then, which take place upon the appearance of the blood, are two: 1. It acquires a florid red colour; 2. the chyle totally disappears. Lower himself knew that the change was produced by the air, and Mayow attempted to prove that it was by absorbing a part of the air. But it was not till Dr. Priestley discovered that venous blood acquires a scarlet colour when put in contact with oxygen gas, and arterial blood a dark red colour when put in contact with hydrogen gas; or, which is the same thing, that oxygen gas instantly gives venous blood the colour of arterial, and hydrogen, on the

contrary, gives arterial blood the colour of venous blood; it was not till then that philosophers began to attempt any thing like an explanation of the phenomena of respiration.

The blood is a fluid of so complex a nature that it is not easy to ascertain the changes produced in it by exposure to different gases out of the body; and even if that could be done, we have no method of proving that the effects of these gaseous bodies upon the coagulated blood are the same as they would be on the blood in its natural state, circulating in the vessels of a living animal. The facts which have been ascertained are the following:

1st. It appears from the experiments of Priestley, Girtanner, and Hassenfratz, that when venous blood is exposed to oxygen gas confined over it, the blood instantly assumes a scarlet colour, and the gas is diminished in bulk; therefore part of the gas has been absorbed. Mr. Davy indeed could not perceive any sensible diminution of the bulk of the gas.

2d. The same change of colour takes place when blood is exposed to common air; and in that case the diminution of the bulk of the air is rather more sensible.

3d. Venous blood exposed to the action of azotic gas continues unaltered in colour; neither does any perceptible diminution of the gas ensue.

4th. Venous blood exposed to the action of nitrous gas becomes of a deep purple, and about one-eighth of the gas is absorbed.

5th. Venous blood exposed to nitrous oxide becomes of a brighter purple, especially on the surface, and a considerable portion of the gas is absorbed.

6th. Venous blood exposed to carbonic acid gas becomes of a brownish-red colour, much darker than usual, and the gas is slightly diminished in bulk.

7th. Carbureted hydrogen gas gives venous blood a fine red colour, a shade darker than oxygen gas does, as was first observed by Dr. Beddoes, and at the same time a small portion of the gas is absorbed. This gas has the property of preventing, or at least greatly retarding, the putrefaction of blood, as was first observed by Mr. Watt.

8th. When arterial blood is put in contact with azotic gas, or carbonic acid gas, it gradually assumes the dark colour of venous blood, as Dr. Priestley found. The same philosopher also observed, that arterial blood acquired the colour of venous blood when placed in vacuo. Consequently this alteration of colour is owing to some change which takes place in the blood itself, independant of any external agent.

The arterial blood becomes much more rapidly and deeply dark-coloured when it is left in contact with hydrogen gas placed above it. We must suppose, therefore, that the presence of this gas accelerates and increases the change, which would have taken place upon the blood without any external agent.

9th. If arterial blood is left in contact with oxygen gas, it gradually assumes the same dark colour which it would have acquired in vacuo, or in contact with hydrogen; and after this change oxygen can no longer restore its scarlet colour. It is therefore only upon a part of the blood that the oxygen acts; and after this part has undergone the change which occasions the dark colour, the blood loses the power of being affected by oxygen.

10th. Mr. Hassenfratz poured into venous blood a quantity of oxymuriatic acid; the blood was instantly decomposed, and assumed a deep and almost black colour. When he poured common muriatic acid into blood, the colour was not altered. Now oxymuriatic acid has the property of giving out its oxygen readily; consequently the black colour was owing to the instant combination of a part of the blood with oxygen.

Such are the phenomena produced upon the blood by the different gases out of the body; but the science is not far enough advanced at present to be able to explain them in a satisfactory manner. The obvious changes produced on the blood in the lungs by respiration, are the florid red colour, and the disappearing of the chyle.

3. That carbonic acid is emitted from the lungs during expiration, has been fully ascertained; but whether it is formed in the lungs, according to the theory of Lavoisier, by the combination of the oxygen of the air with carbon emitted by the blood, or is emitted ready-formed from the blood at the same time that the air is absorbed, is not so obvious; but the latter opinion is more probable, and indeed follows from the supposition that air is absorbed without decomposition.

4. It is much more reasonable to conclude that the watery vapour which exhales from the lungs along with the air expired, has been emitted from the blood, or from the vessels of the lungs, than to suppose with Lavoisier, that it is formed in the lungs by the combination of the oxygen of the air with hydrogen emitted from the blood.

From the preceding enumeration of facts, we may conclude that the following changes are produced by respiration: The blood, as it passes through the lungs, absorbs a portion of air, and carries it along with it through the blood-vessels. During the circulation this air is gradually decomposed by the blood, its oxygen and part of its azote entering into new combinations, while at the same time a portion of azote, of carbonic acid, and water, is evolved. When the blood returns to the lungs, it absorbs a new dose of air, and at the same time lets go the azotic gas, carbonic acid gas, and watery vapour, which had been formed during the circulation. The same changes are again repeated, and the same substances emitted, every time the blood comes to the lungs.

It is probable that, during a considerable part of the day, there is a constant influx of chyle into the blood; and we are certain that lymph is constantly flowing into it. Now it appears, from the most accurate observations hitherto made, that neither chyle nor lymph contains fibrina, which forms a very conspicuous part of the blood. This fibrina is employed to supply the waste of the muscles; the most active parts of the body, and therefore, in all probability, requiring the most frequent supply. Nor can it be doubted that it is employed for other useful purposes. The quantity of fibrina in the blood, then, must be constantly diminishing, and therefore new fabrina must be constantly formed. But the only substances out of which it can be formed are the chyle and lymph, neither of which contains it. There must, therefore, be a continual decomposition of the chyle and lymph going on in the blood-vessels, and a continual new formation of fibrina. Other substances also may be formed; but we are certain that this must be formed there, because it does not exist previously. Now, one great end of respiration must undoubtedly be, to assist this decomposition of chyle, and complete formation of blood.

It follows, from the experiments of Fourcroy, that fibrina contains more azote, and less hydrogen and carbon, than any of the other ingredients of the blood, and consequently also than any of the ingredients of the chyle. In what manner the chyle, or a part of it, is converted into fibrina, it is impossible to say: we are not sufficiently acquainted with the subject to be able to explain the process. But we can see at least, that carbon and hydrogen must be abstracted from that part of the chyle which is to be converted into fibrina; and we know, that these substances are actually thrown out by respiration. We may conclude, then, that one use of the air absorbed is to abstract a quantity of carbon and hydrogen from a part of the chyle by compound affinity, in such proportions that the remainder becomes fibrina: therefore one end of respiration is to form fibrina. Doubtless the other ingredients of the blood are also new-modified, though we know too little of the subject to throw any light upon it.

But the complete formation of blood is not the only advantage gained by respiration: the temperature of all animals depends upon it. It has been long known, that those animals which do not breathe have a temperature but very little superior to the medium in which they live. This is the case with fishes and many insects. Man, on the contrary, and quadrupeds which breathe, have a temperature considerably higher than the atmosphere: that of man is 98°. Birds, who breathe in proportion a still greater quantity of air than man, have a temperature equal to 103° or 104°. It has been proved, that the temperature of all animals is proportional to the quantity of air which they breathe in a given time.

These facts are sufficient to demonstrate, that the heat of animals depends upon respiration. But it was not till Dr. Black's doctrine of latent heat became known to the world, that any explanation of the cause of the temperature of breathing animals was attempted. That illustrious philosopher, whose discoveries form the basis upon which all the scientific part of chemistry has been reared, saw at once the light which his doctrine of latent heat threw upon this part of physiology, and he applied it very early to explain the temperature of animals.

According to him, part of the latent heat of the air inspired becomes sensible; and of course the temperature of the lungs, and the blood that passes through them, must be raised: and the blood, thus heated, communicates its heat to the whole body. This opinion was ingenious, but it was liable to an unanswerable objection: for if it was true, the temperature of the body ought to be greatest in the lungs, and to diminish gradually as the distance from the lungs increases; which is not true. The theory, in consequence, was abandoned even by Dr. Black himself: at least he made no attempt to support it.

Crawford and Lavoisier, who considered all the changes operated by respiration as taking place in the lungs, accounted for the origin of animal heat almost precisely in the same manner with Dr. Black. According to them the oxygen gas of the air combines in the lungs with the hydrogen and carbon emitted by the blood. During this combination, the oxygen gives out a great quantity of caloric, with which it had been combined; and this caloric is not only sufficient to support the temperature of the body, but also to carry off the new-formed water in the state of vapour, and to raise considerably the temperature of the air inspired. According to these philosophers, then, the whole of the caloric which supports the temperature of the body is evolved in the lungs. Their theory accordingly was liable tothe same objection with Dr. Black's; but they obviated it in the following manner: Dr. Crawford found, that the specific caloric of arterial blood was 1.0300, while that of venous blood was only 0.8928. Hence he concluded, that the instant venous blood is changed into arterial blood, its specific caloric increases; consequently it requires an additional quantity of caloric to keep its temperature as high as it had been while venous blood. This addition is so great, that the whole new caloric evolved is employed; the temperature of the lungs must necessarily remain the same as that of the rest of the body. During the circulation, arterial blood is gradually converted into venous; consequently its specific caloric diminishes, and it must give out heat. This is the reason that the temperature of the extreme parts of the body does not diminish.

This explanation is certainly ingenious, but it is not quite satisfactory: for the difference in the specific caloric, granting it to be accurate, is too small to account for the great quantity of heat which must be evolved. It is evident that it must fall to the ground altogether, provided, as we have seen reason to suppose, that the carbonic acid gas and water are not formed in the lungs, but during the circulation.

Since the air enters the blood, and combines with it in the state of gas, it is evident that it will only part at first with some of its caloric; and this portion is chiefly employed in carrying off the carbonic acid gas, the azotic gas, and the water. For the reason that the carbonic acid leaves the blood at the instant that the air enters it, seems to be this: The air combines with the blood, and part of its caloric unites at the same instant to the carbonic acid, and converts it into gas: another portion converts the water into vapour. The rest of the caloric is evolved during the circulation, when the oxygen of the air combines with hydrogen and carbon, and forms water and carbonic acid gas. The quantity of caloric evolved in the lungs seems not only sufficient to carry off the carbonic acid and water, which the diminution of the specific caloric must facilitate; but it seems also to raise the temperature of the blood a little higher than it was before. For Mr. John Hunter constantly found, that the heat of the heart in animals was a degree higher than any other part of the body which he examined. Now this could scarcely happen, unless the temperature of the blood was somewhat raised during respiration.

Thus we have seen two uses which respiration seems to serve. The first is the completion of blood by the formation of fibrina; the second is the maintaining of the temperature of the body at a particular standard, notwithstanding the heat which is continually giving out to the colder surrounding bodies. But there is a third purpose, which explains why the animal is killed so suddenly when respiration is stopped. The circulation of the blood is absolutely necessary for the continuance of life. Now the blood is circulated in a great measure by the alternate contractions of the heart. It is necessary that the heart should contract regularly, otherwise the circulation could not go on. But the heart is stimulated to contract by the blood: and unless blood is made to undergo the change produced by respiration, it ceases almost instantaneously to stimulate. As the blood receives oxygen in the lungs, we may conclude that the presence of oxygen is necessary to its stimulating power.

REST, the continuance of a body in the same place, or its continual application or contiguity to the same parts of the ambient or contiguous bodies; and, therefore, is opposed to motion. See MOTION.

REST, in music, the same with pause.

RESTAURATION, in architecture, the act of repairing those parts of a building that are gone to decay, in such a manner as to give it its original strength and beauty. See ARCHITECTURE.

RESTIO, a genus of the triandria order, in the diœcia class of plants. The male calyx is an ovate spike of membranaceous scales; the corolla is proper, hexapetalous, and persistent. The female calyx and corolla are as in the male; the germen is roundish, and is sex-sulcated; there are three erect and persistent styles; the capsule is roundish, with six plaits, and is rostrated and trilocular; the seeds are oblong and cylindrical. There are twenty-eight species, all natives of the Cape, some of them resembling rushes; and used for making brooms, thatching houses, &c.

RESTITUTION, of medals. See MEDAL.

RESTORATIVE. See MEDICINE, and MATERIA MEDICA.

RETAINER, in law, a servant who does not continually dwell in the house of his master, but only attends upon special occasions.

RETAINING FEE, the first fee given to a serjeant or counsellor at law, in order to make him sure, and prevent his pleading on the contrary side.

RETARDATION, in physics, the act of diminishing the velocity of a moving body. See RESISTANCE.

RETE MIRABILE, in anatomy, a small plexus, or net-work, of vessels in the brain, surrounding the pituitary gland. See ANATOMY.

RETE MUCOSUM. See CUTIS.

RETENTION, is defined, by Mr. Locke, to be a faculty of the mind, whereby it keeps or retains those simple ideas it has once received by sensation or reflection.

RETENTION, is also used in medicine, &c. for the state of contraction in the solids or vascular parts of the body, which makes them hold fast their proper contents. In this sense retention is opposed to evacuation and excretion.

RETICULA, or RETICULE, in astronomy, a contrivance for the exact measuring the quantity of eclipses.

The reticule is a little frame, consisting of thirteen fine silken threads, equidistant from each other, and parallel, placed in the focus of object-glasses of telescopes; that is, in the place where the image of the luminary is painted in its full extent; of consequence, therefore, the diameter of the sun or moon is seen divided into twelve equal parts or digits; so that to find the quantity of the eclipse, there is nothing to do but to number the luminous and the dark parts. As a square reticule is only proper for the diameter, not for the circumference, of the luminary, it is sometimes made circular by drawing six concentric equidistant circles. This represents the phases of the eclipse perfectly.

RETINA, in anatomy, the expansion of the optic nerve on the internal surface of the eye, whereupon the images of objects being painted, are impressed, and by that means conveyed to the common sensory in the brain, where the mind views and contemplates their ideas. See OPTICS.

RETORT, in chemistry, a kind of hollow spherical vessel. See CHEMISTRY.

RETRAXIT, in law, is where a plaintiff comes in person to the court where his action is brought, and declares he will not proceed in it, in which case the action is barred for ever. A retraxit differs from a nonsuit in this, that it is always where the plaintiff or demandant is personally in court. See NONSUIT.

RETRENCHMENT, in the art of war, any kind of work raised to cover a post, and fortify it against the enemy, such as fascines loaded with earth, gabions, barrels of earths, sandbags, and generally all things that can cover the men and stop the enemy. But retrenchment is more particularly applicable to a fosse bordered with a parapet; and a post fortified thus is called post retrenched, or strong post.

Retrenchments are either general or particular: general retrenchments are new fortifications made in a place besieged, to cover the besiegers when the enemy become masters of a lodgment on the fortification, that they may be in a condition of disputing the ground inch by inch, and putting a stop to the enemy's progress in expectation of relief.

RETROGRADATION, or RETROGRESSION, the act or effect of a thing moving backwards.

The retrograde motion of the planets is an apparent motion, whereby they seem, to an observer placed on the earth, to move backwards, or contrary to the signs. See ASTRONOMY.

RETURN, returna, or retorna, in law, is used in divers senses. 1. Return of writs by sheriffs and bailiffs is a certificate made by them to the court, of what they have done in relation to the execution of the writ directed to them. This is wrote on the back of the writ by the officer, who thus sends the writ back to the court from whence it issued, in order that it may be filed. 2. Return of a commission is a certificate or answer sent to the court from whence the commission issues, concerning what has been done by the commissioners. 3. Returns, or days in bank, are certain days in each term, appointed for the return of writs, &c. Thus Hilary term has four returns, viz. in the king's bench, on the day next after the octave, or eighth day after Hilary day: on the day next after the fifteenth day from St. Hilary: on the day after the purification: and on the next after the octave of the purification. In the common pleas, in eight days of St. Hilary: from the day of St. Hilary in fifteen days: on the day after the purification: in eight days of the purification. Easter term has five returns, viz. in the king's bench, on the day next after the fifteenth day from Easter: on the day next after one month from Easter: on the day next after five weeks from Easter: and on the day next after the day following ascension-day. In the common pleas, in fifteen days from the feast of Easter: in three weeks from the feast of Easter: in one month from Easter day: in five weeks from Easter day: on the day after the ascension-day. Trinity term has four returns, viz. on the day following the second day after Trinity: on the day following the eighth day after Trinity: on the day next after the fifteenth day from Trinity: on the day next after three weeks from Trinity. In the common pleas, on the day after Trinity: in eight days of Trinity: in fifteen days from Trinity: in three weeks from Trinity. Michaelmas term has six returns, viz. on the day next after three weeks from St. Michael: on the day next after one month of St. Michael: on the day following the second day after All-souls: on the day next after the second day after St. Martin: on the day following the octave of St. Martin: on the day next after 15 days of St. Martin. In the common pleas, in three weeks from St. Michael: in one month from St. Michael: on the day after All-souls: on the day after St. Martin: on the octave of St. Martin: in fifteen days from St. Martin. It is to be observed, that, as in the king's bench, all returns are to be made on some particular day of the week in each term, care must be taken not to make the writs out of that court returnable on a non-judicial day; such as Sunday, and All-saints, in Michaelmas term, the purification in Hilary, the ascension in Easter, and Midsummer-day except it should fall on the first day of Trinity term.

RETURNO HABENDO or RETURNUM AVERIORUM, is a writ which lies for a person who has avowed a distress by him made, and proved the same to be lawfully taken, for returning to him the cattle distrained which were before replevied by the party distrained upon surety given to prosecute.

RETURNUM IRREPLEGIABILE, a writ for the final return of cattle to the owner, when found to be unjustly distrained.

RETZIA, a genus of the monogynia order, in the pentandria class of plants, and in the 29th natural order, campanaceæ. The capsule is bilocular; the corolla cylindrical, and villous without; the stigma bifid. There is one species of the Cape, frutescent.

REVE, REEVE, or GREVE, the bailiff of a franchise, or manor, thus called, especially in the west of England. Hence shire-reve, sheriff, port-greve, &c.

REVEILLE, a beat of drum about break of day, to give notice that it is time for the soldiers to arise, and that the sentries are to forbear challenging.

REVELS, entertainments of dancing, masking, acting comedies, farces, &c. antiently very frequent in the inns of court, and in noblemen's houses, but now disused. The officer who has the direction of the revels at court, is called the master of the revels.

REVENUE, PUBLIC, the yearly income appropriated to the expences of government. There are four different sources of public revenue: 1. The income derived from property vested in the public. 2. The emoluments of lucrative prerogatives annexed to the sovereignty. 3. Voluntary contributions from the people. 4. Taxes or imposts, not spontaneously given, but legally exacted. From one or other of these great sources all public revenue must arise.

The revenue of the kings of England consisted formerly of various branches which were inherited as the patrimony of the crown. Of these, the rents and profits of the demesne lands of the crown might alone have furnished a very considerable income, as there are few estates in the country which have not at some period or other since the Conquest been in the hands of the king. The custody of the lay revenues, lands, and tenements, of bishoprics during their vacancy, and of the temporalities of such abbeys as were of royal foundation, was made a productive source of revenue by some of the kings, who kept the sees a long time vacant to enjoy their income; Elizabeth kept the see of Ely vacant nineteen years for this purpose. First fruits and tenths of the livings of the clergy, were originally paid to the pope; but upon the destruction of his authority in England, were demanded by the king as his successor in clerical supremacy. The other branches of the antient revenue were, the profits of the military tenures; with the right of purveyance and pre-emption; and a claim to all property of which no other person had any legal pretension, such as treasure-trove or money-plate, or bullion found hidden in the earth; deodands, and forfeitures of lands and goods for offences; waifs, or goods stolen and thrown away by the thief in his flight; estrays, or valuable animals found wandering and the owner unknown; goods wrecked, if no proof could be made within a certain space of time who were the legal proprietors; the right to mines of silver and gold; and to certain fish, as whales and sturgeons, when either thrown on shore, or caught near the coast. These, with fines and forfeitures of various descriptions, and fees to the crown in a variety of legal matters, composed the ordinary revenue of the kings of England; but in the times of war, and on other occasions of extraordinary expence, it became necessary to have recourse to more general and efficient modes of raising money. The taxes thus occasionally collected were denominated Danegeld or Dane-money, escuage or scutage, hydage, talliage, tenths and fifteenths, and subsidies. Subsidies fell into disuse during the civil wars in the reign of Charles I. when the parliament introduced weekly and monthly assessments at a fixed sum upon each county, which were levied by a pound-rate both upon lands and personal estates. The scutages, hydage, talliage, subsidies, and periodical assessments, were all properly land-taxes, though not so generally known under that name as the more general imposition by which they have been superseded.

On the restoration of Charles II. it was deemed expedient to abolish the feudal rights and profits of wardship, marriage, livery, and purveyance: the propriety of this measure was generally acknowledged; and in order to make up the deficiency it would occasion in the king's revenue, an excise duty of fifteen pence per barrel upon all beer and ale, and a proportionable sum upon other liquors sold in the kingdom, was established. Excise duties had been introduced by the Long Parliament: about the same time also, considerable additions were made to the revenue of the customs; the post-office was established on a permanent footing, forming a new and very beneficial branch of public income; the land-tax was adopted on very nearly the plan on which it is at present assessed; and many improvements were made in other branches of the revenue. From this period the progress of the public revenue has been very rapid. The depreciation of the value of money, and the consequent advance in the price of all articles of consumption; the greater military and naval establishments which are kept up, and the accumulation of public debts for which an annual interest must be paid; have increased in an astonishing degree the sum requisite for defraying the yearly expences of government.

Sir John Sinclair, in his History of the Public Revenue, gives the following view of its amount at the commencement of each reign:

	Year.	Annual income.
William the Conqueror,	1066	£400,000
William Rufus	1087	350,000
Henry I. -	1100	300,000
Stephen -	1135	250,000
Henry II. -	1154	200,000
Richard I. -	1189	150,000
John - -	1199	100,000
Henry III. -	1214	80,000
Edward I. -	1272	150,000
Edward II. -	1307	100,000
Edward III. -	1347	154,139
Richard II. -	1377	130,000
Henry IV. -	1399	100,000
Henry V. -	1413	76,643
Henry VI. -	1422	64,976
Edward IV. -	1460	100,000
Edward V. -	1483	
Richard III. -	1483	
Henry VII. -	1485	400,000
Henry VIII. -	1509	800,000
Edward VI. -	1547	400,000
Mary -	1553	450,000
Elizabeth -	1558	500,000
James I. -	1602	600,000
Charles I. -	1625	895,819
The Commonwealth	1648	1,517,247
Charles II.		1,800,000
James II. -	1684	2,001,855
William III. -	1688	3,895,205
Queen Anne -	1706	5,691,803
George I. -	1714	6,762,643

	Year.	Annual income.
George II. -	1727	£8,522,540
George III. -	1760	8,800,000

The above statement shews a vast increase of the public revenue, particularly from the time of Charles I. but its progress since the year 1760, has been much more remarkable. In 1773 it amounted to 10,066,661*l.*; in 1780 it had advanced to 12,255,214*l.*; and in 1786 when the debts incurred by the American war had been fully provided for, it amounted to 15,096,112*l.* The increase of commerce during the peace, naturally improved such branches of the revenue as depended thereon; so that in 1791, its total produce was 16,712,000*l.* In the course of the war with the French Republic, the old taxes increased in produce, not only in consequence of an increased expenditure, which, to a certain extent, always increased the revenue, but also from an unexampled series of commercial and of general prosperity.

In former wars it was never expected, that the trade and manufactures of the country could equal their extent in peace; but at this period, various circumstances contributed to render Great Britain the emporium of Europe, and almost of the world. At home, the great increase of population, enabled the country to have in pay a greater number of seamen and soldiers than at any former period of its history, without experiencing any want of hands to carry on, to a greater extent than ever, agriculture, manufactures, and commerce. Great Britain also acquired abroad many valuable possessions of the French, the Dutch, and the Spaniards; and by the greatness of its maritime power held the complete dominion of the sea. Whilst it possessed these advantages, the continent of Europe was convulsed with war, unable to direct its attention to commercial industry, and had no market but England from which it could procure the productions of both the Indies.

It is not surprising, therefore, that under such favourable circumstances the wealth and income of the nation should increase, and consequently, that the old taxes should become more productive, which with the great number of new duties that it has been found necessary to impose, has raised the nett produce of the permanent and annual duties, composing the ordinary public revenue, to the vast sum of 35,314,158*l.* 10*s.* 4¼*d.*; in addition to which there are temporary taxes of very considerable amount, imposed for defraying part of the increased expenditure during the war, which made the total amount of the public revenue of Great Britain for the year ending 5th January 1806, as follows:

Nett produce of the

Customs -	£.7,192,889	15	11¼
Excise -	16,352,885	10	10
Stamps -	4,123,527	3	2
Land and Assessed Taxes -	6,261,778	19	4¼
Post-office -	1,237,004	19	10½
Pensions and Salaries	111,173	3	5¾
Hackney Coaches	26,454	14	10
Hawkers and Pedlars	8,444	2	9¾
Small branches of the hereditary revenue	157,373	11	10¾
War-taxes, Customs, and Excise -	8,992,377	13	8¼
Property-tax	£4,377,583	12	9½
Arrears of Income-duty, &c. -	49,403	6	9¾
Total	£.48,890,896	15	6½

In addition to the permanent and temporary taxes, constituting the public revenue, there are always certain incidental receipts applicable to the public service; such as the profits of lotteries, fees of the regulated exchequer-office, moneys repaid by public accountants, &c.

REVERBERATION, in physics, the act of a body repelling or reflecting another after its impinging on it.

REVERBERATORY, or REVERBERATING FURNACE. See FURNACE, Vol. I. p. 792, 2d column.

REVERSE *of a medal, coin,* &c. denotes the second or back side, in opposition to the head or principal figure. See MEDALS.

REVERSED, in heraldry, a thing turned backwards, or upside-down.

REVERSION, in law, is defined to be returning of lands, &c. into the possession of the donor, or his heirs. Reversion, in the law of England, has two significations; the one of which is an estate left, which continues during a particular estate in being; and the other is the returning of the land, &c. after the particular estate is ended; and it is further said to be an interest in lands, when the possession of it fails; or where the estate which was for a time parted with, returns to the grantors, or their heirs. But, according to the usual definition of a reversion, it is the residue of an estate left in the grantor, after a particular estate granted away ceases, continuing in the grantor of such an estate.

The difference between a remainder and a reversion, consists in this: that the remainder may belong to any man except the grantor; whereas the reversion returns to him who conveyed the lands, &c.

In order to render the doctrine of reversions easy, we shall give the following table; which shews the present value of one pound, to be received at the end of any number of years not exceeding forty; discounting at the rate of five, four, and three per cent. compound interest. See INTEREST.

Years.	Value at 5 per cent.	Value at 4 per cent.	Value at 3 per cent.
1	.9524	.9615	.9709
2	.9070	.9245	.9426
3	.8638	.8898	.9151
4	.8227	.8548	.8885
5	.7835	.8219	.8626
6	.7462	.7903	.8375
7	.7107	.7599	.8131
8	.6768	.7307	.7894
9	.6446	.7026	.7664
10	.6239	.6756	.7441
11	.5847	.6496	.7224
12	.5568	.6246	.7014
13	.5303	.6006	.6809
14	.5051	.5775	.6611
15	.4810	.5553	.6419
16	.4581	.5339	.6232
17	.4363	.5134	.6050
18	.4155	.4936	.5874
19	.3957	.4746	.5703
20	.3769	.4564	.5537
21	.3589	.4388	.5375
22	.3418	.4219	.5219
23	.3255	.4057	.5067
24	.3100	.3901	.4919
25	.2953	.3757	.4776
26	.2812	.3607	.4637
27	.2678	.3468	.4502
28	.2551	.3335	.4371
29	.2429	.3206	.4243
30	.2314	.3083	.4120
31	.2204	.2965	.4000
32	.2099	.2851	.3883
33	.1999	.2741	.3770
34	.1903	.2636	.3660
35	.1813	.2534	.3554
36	.1726	.2437	.3450
37	.1644	.2343	.3350
38	.1566	.2253	.3252
39	.1491	.2166	.3158
40	.1420	.2083	.3066

The use of the preceding table.—To find the present value of any sum to be received at the end of a given term of years, discounting at the rate of three, four, or five per cent. compound interest. Find by the above table the present value of one pound to be received at the end of the given term, which multiply by the number of pounds proposed (cutting off four figures from the product on account of the decimals), then the result will be the value sought. For example: the present value of 10,000*l.* to be received ten years hence, and the rate of interest five per cent. is equal to .6139 × 10,000 = 6139.0000 or 6139*l.* Again, the present value of 10.000*l.* due in ten years, the rate of interest being three per cent. is .7441 × 10,000 = 7441*l.*

REVERSION *of series,* in algebra, a kind of reversed operation of an infinite series.

REVIEW, in chancery, is used for a bill where a cause has been heard, and a decree thereon signed; but some error in law appearing upon the decree, or new matter being discovered after it was made, this bill is given for a fresh examination into the merits of the cause.

REVIEW, in war, is the appearance of an army, or part of an army, in order of battle, and their being viewed by the general, that he may know the condition of the troops.

REVIEW, is also the name of one kind of periodical publications, now too much prostituted (under the shelter of anonymous criticism) to the purposes of the malice of rival authors, and the petty artifice of interested booksellers.

REVISE, among printers, a second or third proof of a sheet to be printed; taken off in order to be compared with the last proof, to see whether all the mistakes marked in it are actually corrected.

REVIVOR, *bill of,* in chancery, is a bill for reviving a cause, where either of the parties dies after the bill and answer, and before the cause is heard; or if heard, before the decree is inrolled: in which case this bill must be brought, praying that the former proceeding may stand revived, and be put upon the same footing as at the time of the abatement.

REVOCATION, in law, signifies the recalling, or annulling and making void, some power, grant, deed, &c. made before.

RHACHITIS. See MEDICINE.

RHAMNUS, the *buckthorn*, a genus of the monogynia order, in the pentandria class of plants; and in the natural method ranking under the forty-third order, dumosæ. The calyx is tubulous, with five minute scales surrounding the stamina; there is no corolla; the fruit is a berry. There are forty-two species; of which the most remarkable are, 1. The catharticus, or common purging buckthorn, growing naturally in some parts of Britain. This grows to the height of 12 or 14 feet, with many irregular branches at the extremities. The leaves are oval-lanceolate, finely serrated on the edges, their nerves converging together. The flowers grow in clusters, one in each footstalk, white, and in this species divided into four segments; the fruit is a round black herry, containing four seeds. The juice of the berries is a strong purgative, and is made use of for making the common syrup of buckthorn kept in the shops. The bark is emetic; the juice of the unripe berries with alum dyes yellow; the ripe ones a fine green; the bark dyes yellow. The green colour yielded by the berries, called by the French verdevissie, is much esteemed by miniature-painters. Of this species there are two varieties, viz. the dwarf buckthorn, a shrub of about a yard high, of a greenish colour, but of little show; and the long-leaved dwarf buckthorn, which is a larger shrub, with leaves somewhat larger, but in other respects very similar to the dwarf buckthorn. 2. The lotus has the leaves, prickles, flowers, and fruit, of the zizyphus or jubeb; only with this difference: that the fruit is here round, smaller, and more luscious, and at the same time the branches, like those of the paliurus, are neither so much jointed nor crooked. The fruit is in great repute, and tastes somewhat like gingerbread. The Arabs call it aneb enta el seedra, or the jubeb of the seedra: of which Olavus Celsius had so high an opinion, that he has described it as the dudaim of the Scriptures. This species is very common in the Jereede and other parts of Bombay; and has been supposed by some to be the same plant with that celebrated by Homer for its enchanting property; though the latter is more generally supposed to have been a species of diospyros. It is proper, however, to distinguish between both these shrubs and a herb often mentioned by the ancients under the name of lotus. They are also different from the Egyptian lotus described by Herodotus; for which see NYMPHÆA. 3. The frangula, or berry-bearing alder, is a deciduous shrub, a native of England and most of the northern parts of Europe, and affords several varieties. 4. The alpine, rough-leaved frangula, or berry-bearing alder, is also a deciduous shrub, and native of the Alps. It differs in no respect from the common sort, except that it has no thorns, and that it will grow to be rather taller, with tough, large, and double laciniated leaves. The smooth-leaved alpine frangula is a variety of this species, with smooth leaves and of a lower growth. 5. The paliurus, or thorn of Christ, is a deciduous shrub or tree, a native of Palestine, Spain, Portugal, and Italy. It will grow to nearly the height of 14 feet, and is armed with sharp thorns, two of which are situated at each joint, one is about half an inch long, straight, and upright; the other is scarcely half that length, and bent backward; and between them is the bud for next year's shoot. "This plant (says Hanbury) is undoubtedly the sort of which the crown of thorns for our Blessed Saviour was composed." 6. The common alaternus is an evergreen tree, and native of the south of Europe. There are several varieties of this species; the most remarkable of which are the broad-leaved and the jagged-leaved alaternus, which have all been confounded with the phillyrea. 7. The insectorius, or narrow-leaved buckthorn, is an evergreen shrub or tree, and native of Spain. It grows to the height of ten or twelve feet, and sends forth several branches from the bottom to the top. They are covered with a blackish or dark-coloured bark, and each of them is terminated by a long sharp thorn. The fruit continues on the trees all winter, making a beautiful appearance among the narrow clustered leaves at that season. 8. The oleoides, or olive-leaved buck horn, is an evergreen shrub, and native of Spain, and grows to the height of eight or ten feet. It sends forth numerous branches, each of which is terminated by a long sharp spine. The flowers are small, of a whitish-green colour, and are succeeded by round black berries.

RHAPIS, a genus of the monogynia order, in the hexandria class of plants; and in the natural method ranking under the first order, palmæ. The calyx is a monophyllous trifid spatha; the corolla monopetalous and trifid. There are 2 species, viz. 1. Flabelliformis, or ground-ratan, a native of China; 2. Arundinacea, simple-leaved rhapis, a native of Carolina.

RHEA *Americana*, the American ostrich, in size is very little inferior to the common one; the bill is sloped not unlike that of a goose, being flat on the top and rounded at the end; the eyes are black, and the lids furnished with hairs; the head is rounded, and covered with downy feathers; the neck is two feet eight inches long, and feathered also; from the tip of one wing to that of the other extended, the length is eight feet; but from the want of continuity of the webs of the feathers, and their laxity of texture, the bird is unable to raise itself from the ground; it is, however, capable of greatly assisting itself by their motion in running, which it does very swiftly; the legs are stout, bare of feathers above the knees, and furnished with three toes, all placed forwards, each having a straight and stout claw as in the cassowary; on the heel is a callous knob, serving in place of a back toe; the general colour of the plumage is dull grey mixed with white, inclining to the latter on the under parts; the tail is very short, and not conspicuous, being entirely covered with long loose and floating feathers, having its origin from the lower part of the back and rump, and entirely covering it; the bill and legs are brown.

In respect to manners, it is said to be a general feeder, but more fond of flies, which it catches with great dexterity, and will also, like the common ostrich, swallow bits of iron and any other trash offered to it. In common with the ostrich of the Old World, it lays a number of eggs, from forty to sixty, in the sand, each of them holding a quart; but it differs from that bird in many particulars, especially in wanting the callosity of the sternum, and spars on the wing. With these last the common ostrich is known to defend itself; in defect of them, the bird here treated of uses the feet with such address, as to become at once a furious and dangerous antagonist. The female calls its young ones together with a kind of whistling note somewhat similar to that of a man; when young it is very tame, frequently following the first creature it meets with. The flesh of this bird is said to be very unpalatable. It is found in various parts of South America, from Patagonia to Guiana, and is known by the name of choique.

RHEEDIA, a genus of the monogynia order, in the polyandria class of plants; and in the natural method ranking with those of which the order is doubtful. The corolla is tetrapetalous; there is no calyx; and the fruit is a trispermous berry. There is one species, a tree.

RHETORIC, in the most extensive sense of the word, denotes the art of composition, or that which enables us to apply language or speech to the best possible advantage. According to etymology, which often affords the most satisfactory explanation of words, it signifies the art of pouring forth a stream of sentiment, and communicating with fluency our feelings and thoughts to others. It is derived from the Greek ῥέω, to speak; and this again from ῥέω, to flow, or run like a river. Homer speaking of the eloquence of Nestor, says

Του καὶ ἀπὸ γλώσσης μέλιτος γλυκίων ῥέεν αὐδή.

Iliad I. line 49.

"And out of his mouth flowed an harangue sweeter than honey."

Taken in this point of view, rhetoric will comprehend all polite literature, poetry perhaps excepted, the belles-lettres of the French, the pathetic and pleasant of every kind; compositions whose aim and end is not so much to inform or satisfy the understanding, as to move, incline, and persuade, by addressing the imagination, the affections, and, in some measure, sensation itself.

There cannot be a better rule for composition, or one more plain and practical, than what is laid down by Cicero: "We are first to consider what is to be said; secondly, how; thirdly, in what words; and, lastly, how it is to be ornamented." We will venture to add, as a supplement even to Cicero, how far it ought to be ornamented.

The matter of any composition does not, properly speaking, fall under the cognizance of rhetoric, any farther than that there is an intimate connection between the subject and the style; and that the sentiments, whatever they are, naturally form, and raise or lower, swell or contract, the diction; on which we shall have occasion to make some observations when we speak of style.

But the second point in Cicero's rule, arrangement or order, is the most important, beyond all comparison, in every species of composition. It is in this, principally, that the mind of the author is seen; the process of his thoughts; the connection of his ideas with one another, and with his main design.

In every composition it is required that there should be some plan or object; just as in every thing we do or say, there is some purpose or intention. All written compositions may be divided into discourse or reasoning, poetry, and history, including both narration and description. In all, unity of design is indispensable. In discourse or reasoning, the object is to prove and impress on the mind some truth or series of truths. Here the bond of connection is cause and effect: the reason why such and such a thing must be so and so, and cannot be, or reasonably be supposed to be, otherwise. We believe certain things, it is true, on authority, or the testimony of others; but then it must be observed we judge of evidence by reason.

In respect to unity of design, there is a very near resemblance between epic poetry and history. The unity of design and action required in both differs not in kind but in degree. In epic or narrative poetry, the connection among the events related or described is more close and sensible. The narration is not carried on through such a length of time; and the actors hasten to some remarkable period which satisfies the curiosity of the reader. This difference between the epic poem and history, depends on that particular situation of the imagination and the passions which is supposed in the former. The imagination of both writer and reader is more enlivened, and the passions more inflamed, than in history, civil, political, or literary, biography, or any species of narration that confines itself to strict truth and reality. The same unity of design that runs through the epopeia, must also run through dramatic compositions, whether comic or tragic. Even in an ode, though the poet may be hurried from his plan for a time, or perhaps (as is sometimes the case, even with Horace) drop it altogether, there must appear some aim or design at least in the outset.

The connecting principle among the several events or circumstances which form the subject of a poem, may be very different according to the different designs of the poet. The Metamorphoses of Ovid is a work that embraces every fabulous transformation produced by the power of the gods. Thus, his plan is formed upon the connecting principle of resemblance. The subject of poetry forms a distinct article in the present work; but as unity of design is a principle common to all kinds of composition, it saves repetition to glance at poetical as well as rhetorical or prosaic composition, as far as this universal principle in all works of art is concerned.

As there may be different connecting principles in poetical, so also there may be in historical composition; and in every species of this composition, as in that, there must be some connecting principle, some bond of union among the different parts. Even in an epistle communicating or requiring information, there is a unity of design. In grave and serious letters, the subject is naturally and almost necessarily one; and even in the most light and familiar epistles there is this unity; that while they relate to a thousand particulars indifferent to all the world besides, they all of them relate to the situation, circumstances, and feelings, either of the writer, or the friend to whom the letter is addressed. Here the design is both interesting and closely attended to, in the eye of the parties concerned, even in proportion as the composition appears both uninteresting and desultory to others. In memoirs and anecdotes too, though apparently a mere collection of materials for building an edifice, there is an unity of design, in as much as they relate to some one person, or class of persons, some distinct time or period, or some place or country. Thus we have Memoirs of Frederic the Great of Prussia, Curious Collections relating to the State of Society in the middle Ages, and Anecdotes of the Court and Empire of Russia. In biography, the unity of design is manifest. That there is an unity of design in natural history, consisting chiefly in classification as well as description, needs no illustration.

But the grand province of history, and what is generally understood by the term, is,

History civil and political. The state, progress, or vicissitudes of society, in any particular period or country, in government, science, art, manners, and general civilization. The annalist, in his collections, or rather selections, (for it would be as absurd, as it is impossible, to record every thing) is guided by the connection of contiguity in time or place; the philosophical, the true, and legitimate historian, by that of cause and effect. "He traces the series of actions, according to their natural order, remounts to their secret springs and principles, and delineates their most remote consequences. He chooses for his subject a certain portion of that great chain of events which compose the history of mankind. Each link in this chain he endeavours to touch in his narration. Sometimes unavoidable ignorance renders all his attempts fruitless; sometimes he supplies by conjecture what is wanting in knowledge; and always he is sensible that the more unbroken the chain is, which he presents to his readers, the more perfect is his production. He sees that the knowledge of causes is not only the most satisfactory, (this relation or connection being the strongest of all); but also the most instructive: hence it is by this knowledge alone, that we are enabled to controul events and govern the future." Hume's Essays. Association of Ideas.

The matter of a composition being prepared, and the general design formed, the next thing to be considered is

The order of arrangement of the parts of a composition. And first of all, on this head, it may be observed that the authors of written compositions, usually, as is very natural and proper, set out with an *introduction*, whether in the form of a preface, or address to the reader, separate from the body of the work, or in the beginning of the work itself, without any distinction or separation. If the composition is addressed to the ear, the orator bespeaks the candid attention of his hearers by removing any prejudices they may be supposed to have conceived, and shewing the interest and importance of the subject of his discourse. He considers well what is the state or tone of mind of his hearers. To this he addresses himself in the first place; and endeavours to carry them along with him from one step or stage to another, till through a train of reasoning he arrives at the conclusion. There is a familiar illustration of the nature and use of an introduction or exordium to be met with every day in our house of commons; where the speakers often assure the house, when it begins to grow late, or when, from any other cause, it betrays symptoms of impatience or inattention, that "they will not trespass on their time for more than a very few minutes." In like manner the writer of a discourse or essay bespeaks the candid attention of his readers, by giving some general account of the nature of his design. If it is a question in history or philosophy, that is, concerning either matter of fact, or relations of ideas, he follows up his introduction immediately with a *statement* and history of the controversy. In some instances this statement and history are the only introduction; and, indeed, if the question is universally and highly interesting, there is no other introduction necessary: there can be none better. It is not only in doctrinal or didactic subjects that some introduction is required, but also even in most poetical, especially the epic, and historical compositions. The poet announces and gives an outline of his subject and design at the outset of his work, in order to interest his reader in its farther developement. He awakens curiosity by some of the most striking events in his narrative. Thus Homer tells you at once that he sings of the wrath of Achilles:

"That wrath which hurl'd to Pluto's dreary reign,
The souls of mighty chiefs, untimely slain."

Thus, in the Odyssey, he interests us in his design by a glimpse of the character of Ulysses, and his adventures after the reduction of Troy. Thus Virgil, having introduced himself to the reader, by letting him know who he was, in the first seven lines of the Æneid gives a summary view of the hardships, sufferings, and designs of Æneas. He introduces him first near the period when his designs were accomplished; designs that could not fail to interest every Roman; and afterwards shews, as in perspective, the more distant events, circumstances, and causes, that led to their formation, and crowned them with success. Thus Milton interests the Christian reader by letting him know in the outset of Paradise Lost, that he sings

"Of man's first disobedience, and the fruit
Of that forbidden tree whose mortal taste
Brought death into the world, and all our woe,
With loss of Eden, till one greater man
Restore us, and regain the blissful seat."

Thus, also, Virgil announces his different designs in the exordiums of his different books of Georgics; and thus also Thomson, in his Seasons.

In dramatic pieces there is no annunciation of a design, because suspense is kept up till the catastrophe. In tragedy, the design is, however, partly announced by the very name or names of the illustrious heroes or princes to whom it relates; and in comedy, the design is in some measure frequently expressed in the title; as in Love for Love; the Busybody; the Taming of the Shrew; the Careless Husband: the Jealous Wife; the School for Scandal, &c. &c.

With regard to that most extensive and important branch of composition, civil and political history, here too an introduction or annunciation of the design is as natural as in the epopeia; and it may be added, it is precisely of the same kind. The general effect or impression, the most striking event, truth, inference, or moral, that remains uppermost in the mind, after reviewing any series of events, and which serves as a bond of union among the occurrences and transactions which the historian involves in the stream of his narrative, impels him, it is supposed, to communicate his views, sentiments, and emotions, to others. It is natural therefore, and as it is natural it is expected, that the historian, in most cases, should introduce his work by glancing at the importance and the nature of his main design or object. Thus Livy, in his much admired and truly admirable preface, expresses his design of inquiring into the cause by which the Roman empire was extended over the world, and reached to such a pitch of greatness that it seemed to totter under its own weight. The design was noble and grand, and the annunciation of it could not but draw attention. Thus Sallust chooses for a subject the Catilinarian conspiracy, because it was "in the highest degree memorable on account of the singularity, and the danger involved in the enormous crime." Thus also he writes an account of the Jugurthine war: "first, because it was great and terrible, and the success various; and, secondly, because a check was then given, for the first time, to the insolence of the nobility." In both cases he makes an apology for retiring from political life, and employing himself in the composition of history.

2. In didactic discourse, the speaker or writer, after an introduction, *states* the truth which he proposes to prove or illustrate, and also the chief propositions or points, by the establishment of which he forms his conclusion. This serves to keep up the attention of the hearer or reader to the main object, and the connection or dependance of this on the intermediate or subordinate propositions; but the heads must not be too many, for otherwise they would run into the embarrasment of multiplicity, and in fact cease to be heads.

3. As to the disposition of arguments, or order of placing them, it is generally thought the best economy to place the weaker (if they are not rather to be omitted altogether) in the middle; and such as are stronger, in order to excite attention and draw esteem, partly in the beginning, and, as what is heard or read last commonly dwells longest on the mind, partly at the end. But if there are only two arguments, the rule is to place the stronger first, and then the weaker; and after that to resume and insist principally on the former.

4. In matters that admit of doubt or disputation, it is proper, after proving your own position, to refute the arguments urged by gainsayers or adversaries.

Lastly, comes the conclusion of the discourse or treatise, or whatever it is called; which consists of two parts; a recapitulation of the principal arguments or circumstances, and an address to the passions.

In oratory too, it is observed by rhetoricians, besides the parts just mentioned, there is room for

Digression, transition, and amplification. Where a subject is of itself but unentertaining and dry, the mind is relieved and restored to the exertion of its powers by amusing digression; which, however, it is evident, should neither be too frequent nor too long, except, indeed, when the cause is very bad, and almost hopeless; for, in this case, it is good economy to divert attention as much as possible from too nice a scrutiny into the subject.

Transitions are defined to be "forms in speech by which orators tell their hearers in a few words both what they have said already, and what they next design to say." When a discourse consists of a considerable number of parts, and especially when these are of considerable length, transitions are necessary; but sometimes, in passing from one thing to another, a very general hint is sufficient.

By amplification the orater enlarges and expatiates on a subject in such a manner as to represent it in the fullest and most comprehensive view, and so that it may strike the mind in the most forcible manner, and influence the passions. He ascends from things particular to things general, or descends from things general to things particular, and an enumeration of instances; he connects his position with a concurrence of various causes, and on the other hand, with a variety of effects; he places things in the light of contrast; he amplifies facts from the circumstances of time, place, manner, and the like.

As to the order of historical composition, the general effect or impression of the whole of the materials, which serves as a bond of union among the events which the historian weaves into his narrative, serves him also as a clue by which he winds back and unfolds the concatenation of circumstances which produced the grand event, or effect or effects, that first interested and induced him to transmit the whole to posterity. Every legitimate history, as well as epic poem, springs from some important truth or moral, as from its root; and shoots forth into various branches, twigs, leaves, and flowers, until, in due time, it reproduces, in a manner, that fruit which gave it birth; until by some issue or catastrophe, it impresses on the mind the doctrine, truth, or moral, which forms its principal object; and as the epic poet, after briefly announcing the subject that fires his soul, does not fly directly and rapidly to the end he has in view, but on the contrary, keeps long on the wing, and aims in his flight to warm the mind and to gratify its vast desires by frequent views of the grandeur, magnificence, and beauty of nature; so the historian diversifies his narrative by incidents, circumstances, and episodes; various scenes are opened, various actors introduced, with various characters and manners.

As the historian is guided by his taste and judgment in the selection of his materials, so according to the measure of his taste and judgment he assigns them their place. To the order in which an infinite variety of materials may be best arranged under the eye that contemplates them, the rules or resources of rhetoric scarcely extend. If nothing more, yet certainly nothing better, can be said on the subject of order in general, than what has been said near two thousand years ago by Horace, and is still in every mouth:

Sumite materiam, vestris qui scribitis, æquam
Viribus; et versate diu quid ferre recusent,
Quid valeant humeri, cui lecta potenter erit res,
Nec facundia deseret hunc, nec lucidus ordo.

De Arte Poetica, line 38—41.

"O ye writers! make choice of a subject suited to your powers; and ponder long on what your shoulders are able or not able to bear. Where there is a good choice, neither eloquence nor method will ever be wanting."

This is in truth the quintessence of rhetoric. There is, however, as Horace immediately observes, room for taste or judgment, in the preferring of one order or arrangement of particulars to another. "The efficacy and grace of method consists in knowing when to say any thing, whether on the present, or whether, though pertinent enough to the present, it may not with advantage be reserved to some future occasion." The same just and accomplished critic says elsewhere, more generally,

Scribendi rectè, sapere est principium et fons.

De Arte Poetica, l. 299.

"The principle and spring of fine writing is good sense."

As good sense will prescribe just order in composition, so also it will suggest just and suitable sentiments.

Style. A style should correspond to the tone of mind of the author, and the tone and temper he wishes to communicate to others. The connection between the tone of mind and the diction is described by the same Roman poet, whose great master was Aristotle, in so just and connected a manner, that we shall content ourselves on the present point with quoting a small part of Horace, and referring our readers to the poet himself. "Every subject should have a style appropriate to itself. A comic subject does not admit of the pomp of a tragic strain; nor the bloody supper of Thyestes bear to be told in the simple numbers of comedy. Sometimes, however, comedy raises her voice; and Chremes roused to anger and rage, gives vent to his sentiments in a high strain of indignation. Tragedians, on the contrary, lower their style to express their grief. It is natural for men to laugh with those that laugh, and weep with those that weep; the human countenance to vary with the sympathetic emotions of joy or sorrow. If you would have me shed tears, you must first shed them yourself. Plaintive words are most correspondent with a dejected look. Threats come well from a person in anger, mirth and pleasantry from a facetious temper, and grave remonstrances from a severe character." See De Arte Poetica, line 90—118.

Though these observations are made here with a reference to poetical, it is manifest that the spirit of them (namely, that language should be suited to the nature of the subject) is applicable to all composition; to common prose, to oratorical prose, to philosophical or didactic prose, and to historical prose; on each of which it is proposed to make a few observations.

But we premise a few remarks on the qualities that should prevail in style in general. They may be reduced to these: 1, purity; 2, perspicuity; 3, vigour; 4, harmony; 5, dignity; 6, beauty.

Purity consists in the choice of such words and phraseology as are agreeable to the most general and approved usuage of the language in which we write. The offences against purity are accordingly reduced to two, barbarisms and solecisms; the former of which respects single words, the latter their construction in sentences. The words and phrases that occur in writings, though in many respects estimable, are not all of them pure, but only such as are agreeable to the usage of the most distinguished writers; writers whose works descend from one generation and one age to another, without losing aught of their original interest and beauty. Thus, our English translation of the Bible is written in a pure style; so are the Spectators and other writings of Mr. Addison, and the letters and prefaces of Mr. Pope. To purity of style it is necessary not only that it is formed according to the rules of philosophical or universal grammar, but according to the particular genius or idiom of the language in which we write. Thus, though "I see a voice" is allowable in Greek, and occurs in the twelfth verse of the first chapter of the Revelations, it would not be allowed in any original composition in English. Hence as it depends on the purity of a style whether a composition shall not become soon unintelligible and die away, or penetrate to posterity, and be transmitted to future ages, this, of all the good qualities of style, may be considered as the most important. In the present day, in our country, there seems to be a wanton introduction not only of phrases degraded by common and trivial use, but of what may be called vulgar slang (if slang is not indeed an example itself of the abuse here noted), into the debates in parliament, and consequently newspapers, pamphlets, and a deluge of ephemeral histories. What reader of the next century will understand, "it is a hoax; meeting my idea; making up my mind; blinking the question," &c. &c.? Even Mr. Hume, and other writers of note, especially among his countrymen the Scots, trespass greatly against purity, when they admit into their English style not only Scotticisms, against which they are now pretty generally on their guard, but so many Latin idioms and Gallicisms. As to Latinity, this too has been used even immoderately by our great lxicog rapher Dr. Johnson.

Perspicuity, like purity, consists partly in single words, and partly in their construction. As to single words, their force and propriety are to be judged of from the usage of the most generally approved writers at the period of our writing. For through length of time, words lose their original signification, and assume a new one, which then becomes their proper sense. Thus the word knave antiently signified a servant. In an old English version of the New Testament we find, "Paul, the knave of Jesus Christ." The proper and precise meaning of words, nearly synonimous, is to be distinguished with accuracy. For example: mercy and pity are sometimes confounded; though mercy is, properly speaking, exercised towards an offender, and pity towards one in distress. But though the meaning of all the words in a sentence, considered by themselves, may be very obvious, yet the sense of the whole may be obscured by a disorderly arrangement, of which a very apt and curious example is given by Quinctilian. "A certain man ordered in his will that his heir should erect for him a statue holding a spear made of gold" A question here of great consequence to the heir arose from the ambiguity of the expression; as it admitted of doubt whether the words, "made of gold," were to be applied to the statue, or to the spear. Care, therefore, must be taken to dispose both the words and parts of a sentence in such a manner as best agrees with their mutual connection and dependance on each other.

Vigour, or energy of style, depends chiefly on brevity and a judicious use of tropes and figures. Brevity consists in the use of general propositions and general terms, which comprehend a great number of particulars, the enumeration of which weakens a style, as in the material world bodies are weakened by dilatation. The use of figurative language, or tropes and figures, is, perhaps, still more connected with dignity and beauty of style; but we embrace the first occasion of making some remarks on its nature.

The antient rhetoricians, who were fond of multiplying distinctions to great excess, distinguished a trope from a figure; understanding by a trope a change in the usual meaning of words, and by a figure a change or deviation from the usual mode of constructing them in sentences; but they are generally confounded by the most accurate and purest writers. Both these kinds of changes, however, may be comprehended, even according to etymology, under the word trope, which in Greek signifies a turn. As no language contains a sufficient number of proper words to express all the different conceptions of our minds, tropes were introduced to supply the deficiency; to express the various ideas that occurred from different associations and analogies which sprung up in the mind on viewing things in different lights, and comparing them with one another; required this aid to language. Among the principal tropes are metaphor, allegory, metonymy, irony, hyperbole, climax, inversion, antithesis, interrogation, exclamation, apostrophe, and prosopopeia or personification.

A *metaphor* is a comparison or simile, without any words implying comparison, and commonly reduced to a single word. To say of a man that he is like a fox or a lion, is a simile; that he is a fox or a lion, a metaphor. A metaphor taken from a simile which ascribes life and action to things inanimate, and lengthened out into many, or even several circumstances, is an *allegory*. In metaphors and allegories, care should be taken that the same image or kind of trope is carried throughout the whole. A mixture of metaphors is one of the most common, as well as greatest, deformities in composition, though by a very little attention it might certainly be very easily avoided. An instance of this, amounting even to what we call a bull, occurs in Mr. Hume, though on the whole a correct writer: "The farther we mount up into antiquity, the more do we find mankind plunged into idolatry." Nat. Hist. Religion, section I. On the other hand, a minute attention to resemblances sometimes leads a writer into studiedand far-fetched conceits; than which, to a true taste, delighting only in what is great, and, consequently simple, there can be nothing more disgusting.

A *metonymy* is a trope which changes the names of things that are naturally though not essentially united, as the cause for the effect, or the effect for the cause, &c. Thus, Mars is put for war, Ceres for corn, and Bacchus for wine:

Implentur veteris Bacchi pinguisque farinæ.
Virg.

Thus, in common discourse, it is usual to say, "this is such a person's hand, I know his hand," that is his writing.

Irony is a trope in which one thing is said, and the contrary intended. The subjects of irony are all manner of vices and follies, which are sometimes exposed in this way more effectually than by the most serious reasoning. In irony, the author assumes the air of believing as others do; but by a developement of the ground of belief, of the pro and the con, brings out the truth, and leaves the reader or hearer himself to draw the conclusion. We listen to the still voice of our own reason and conscience, and secretly condemn our own tenets or our own conduct, when pride and passion might raise a mist that might shade us from the light that should emanate from others. This figure of speech was used so much by Socrates, that he got the appellation of Eiron or Droll. The most perfect specimen of irony in the English language is Swift's Directions to Servants.

Hyperbole, which exceeds the bounds of strict truth, and represents things as either greater or less than they really are, is the boldest of all tropes. The representation, however, is made in such a manner as not to impose on the hearer. It has always a very considerable effect, even when most extravagant; as it shews, at least, the opinion entertained by the speaker on any subject, in a very strong light; it is a natural expression of enlivened emotion. We meet with hyperboles even in the Scripture: "I bear you record," says St. Paul in his Epistle to the Galatians, chap. iv. "that if it had been possible ye would have plucked out your own eyes and given them to me;" and the Evangelist John concludes his Gospel in these words. "There are also many things that Jesus did, which if they should be written every one, I suppose that even the world itself could not contain the books that should be written."

Climax is a compound sentence in which the different parts or clauses are closely connected, and rise gradually in importance above one another. We have an admirable example of this trope in that passage of sacred writ, where it is said of the joys of Heaven, "that eye hath not seen, nor ear heard, neither hath it entered into the heart of man to conceive." We hear more things than we see; but the imagination can form to itself an infinitude of things that do not fall under the cognizance of any of our senses. The following is also an excellent exemplification of the climax: "Whom God did predestinate, them he also called; and whom he called, them he also justified; and whom he justified, them he also glorified." Rom. viii. 30. But there may be a climax of periods as well as of sentences. Here also we are furnished with the most apt and splendid examples by the Scriptures. "For scarcely for a righteous man will one die, yet, peradventure, for a good man, some would even dare to die; but God commendeth his love towards us, in that while we were yet sinners, Christ died for us." Rom. v. 7, 8. The contrary of a climax is the bathos, as some have called it after Pope, or the sinking in composition, otherwise called an anticlimax; from which miserable deformity and disgrace, authors might be saved by a small exertion of attention and common sense:

"And thou, Dalhousie, thou great god of war,
Lieutenant-colonel to the earl of Mar."
Blackmore.

Yet this was not burlesque; it was intended for a serious and heroic poem. In some instances it would appear as if writers were at pains to study the art of sinking. Mr. Lane Macgregor Buchannan meaning to do great honour, and to extol the isle of Skye, says, that "some of the vassals (of the great families there) are colonels, majors, captains, and lieutenants." Macgregor Buchannan's Defence of the Highlanders, page 86.

Dr. Swift observed the just order in composition when he makes one tell the ladies who entertained him in a tavern,

> "Had ye been cunning stagers,
> Yourselves might have been treated
> By captains and by majors."

But it is not only in writers of the very lowest class that we find the anticlimax. We have an example of this in Dr. Reid, where he says "the emotion raised by grand objects is awful, solemn, and serious." The order of these epithets should just have been inverted.

Inversion is a figure in speech in which the usual arrangement of words in a sentence, or of sentences in a compound sentence or period, is inverted. For an example of the first kind, see Nisus in the Æneid, exclaiming,

> "Me, me: adsum qui feci; in me convertite ferrum."
>
> Æn. lib. ix.

> "Me, me: here I am who have done the deed; on me turn your steel."

Under extreme agitation the usual process both of thought and speech is interrupted. The language of passion is broken and incoherent. The impassioned mind rushes directly to the principal figure or object; from the action to the agent; from the attribute to the substance. Of the second kind, where the mind, though unruffled and discomposed, and thinking in a regular train, is animated to great conceptions, we have an instance in the first sentence of the Paradise Lost.

Antithesis is the illustration of one thing by another, and is, we presume, universally understood. If an explanation or illustration of it by an example is wanted, the reader is referred to the three last verses of the fourth chapter of St. Paul's Second Epistle to the Corinthians. There cannot be a happier example, and the book referred to is in every hand. Neither is it necessary to explain *interrogation* or *exclamation*. The meaning of these figures is obvious from the very names to every one, and examples occur at every turn in all kinds of composition and discourse, written or spoken.

In an *apostrophe*, the speaker breaks off from the series of his discourse, and addresses himself to some particular person, present or absent, living or dead, or even to inanimate objects. A fine example of apostrophe occurs in the second book of Paradise Lost, line 681—7:

> "Whence, and what art thou, execrable shape?"

And a still finer in the fourth book, line 720—35:

> "Thus at their shady lodge arrived, both stood,
> Both turn'd, and under open sky ador'd
> The God that made both sky, and earth, and heaven,
> Which they beheld; the moon's resplendent globe,
> And starry pole: 'Thou also mad'st the night,
> Maker omnipotent, and thou the day," &c.

See also the much admired apostrophe of Æneas to his departed father Anchises:

> "Heu! genitorem, omnis curæ casûsque levamen,
> Amitto Anchisem; hic me, pater optime, fessum
> Deseris, heu!"
>
> Æneid, lib. iii. line 710.

"Here, alas! I lose my father Anchises, the soother of all my cares, my relief in every misfortune. Here, O thou best of parents! you left me overcome with fatigue," &c.

Prosopopeia, or personification, either introduces an absent person as speaking, or one who is dead as if he was alive and present, or speech is attributed to some inanimate being. The sublimest example of the prosopopeia that ever was, or can possibly be exhibited, is found in the book of Job. Job, on a review of his own actions, appeals from the criticisms of men to the judgment of God. "Then the Lord answered Job out of the whirlwind and said," &c. as in the Book of Job, chap. xxxviii—xli. 7.

There is not any figure better adapted to the purposes of the higher species of eloquence, that is, the pathetic and sublime, than the prosopopeia, by which the poet or orator may call all nature to his aid; but if it was introduced in any other than a highly impassioned strain, it would lose its effect, and even appear ridiculous. In all things the speaker is to consider well for what he has prepared the hearer.

Did our limits admit, most of our readers, and among these the most cultivated and intelligent, would excuse us from following the antient rhetoricians, and those who tread in their footsteps, through all the tropes and figures to which the subtle genius of Greece, wielding the most copious and pliant language that ever was known amongst men, has given a kind of nominal existence: synecdoche, antonomasia, litotes, euphemismus, catachresis, metalepsis, asyndeton, pleonasmus, polysyndeton, antanaclasis, ploce, epizeuxis, &c. &c. &c.

On looking over this long catalogue of words, of so little practical use, we are almost inclined to say with Butler,—

> "For all a rhetorician's rules
> But teach him how to name his tools."

All tropes and figures rise naturally out of a well stored and brilliant imagination, an earnestness to establish the truth, and the diffusive influence of the passions. The poet, the orator, animated himself, extends animation, life, and action to every object that comes in his way. To return now to vigour or energy of style.

How much this is promoted by figurative language will appear from this, that in proportion as the mind labours with any vivid emotion or conception it is prone to give it a substantial form, to clothe it in metaphorical language. Now, a lively trope conveys not only a livelier, but often a juster idea of an object, than can be communicated by proper words in the most copious periphrasis. Thus, when Virgil calls the two Scipios two thunderbolts of war, he exhibits a more lively image of the rapid force and success of their arms, than could have been given in plain words. The next-mentioned great quality of style, was

Harmony. As in music we require sound, uniformity, variety, and proportion, so we also require them, not only in compositions addressed to the ear, but also in written compositions; for the reader conceives of what he reads as if it was spoken by himself or by others. His ear, in some measure, runs over the page as well as his eye. Numbers are not confined to poetry: there is a rythmus, though of a more slow and sober kind, in prose. Here too we require sonorousness, uniformity, and variety of cadence. For these purposes there must be an intermixture of long and short words, and long and short sentences. As to the modulation of the voice in speaking, as well as of pronunciation, looks, and gesture, these belong to elocution, of which we have many professors. The sum and substance of elocution is, to speak from feeling.—Si vis me flere, &c.

The harmony of style is very much promoted by the use and invention of compound words, which any one is at liberty to contrive at pleasure, if he adheres to the analogy of language. As an example of all this, we produce a beautiful passage, which is a rural and domestic scene in Thomson's Seasons:

> ———— "In the pond
> The finely-chequered duck before her train
> Rows garrulous. The stately-sailing swan
> Gives out his snowy plumage to the gale,
> And arching proud his neck, with oary feet
> Bears forward fierce, and guards his osier-isle
> Protective of his young. The turkey nigh,
> Loud-threatening reddens; while the peacock spreads
> His every-coloured glory to the sun,
> And swims in radiant majesty along."
>
> Spring, line 773—32.

Nothing can be more harmonious.

Sublimity of style consists in language suitable to sublime emotions. Nay, the more plain and simple the images appear, the greater the surprise, wonder, and astonishment. It sometimes darts forth with rapidity and vehemence, and sometimes reposes on the tranquillity of general views, exhibited in general terms.

As an instance of the power of simplicity in every species of composition that aims at the sublime and beautiful, we may contrast the style and manner of Michael Angelo and Zuccero in painting. Michael Angelo painted his figures naked; Frederico Zuccero, who painted the cupola of Florence, peopled it with a multitude of both sexes, extremely well dressed in the fashion of the times. The style of Michael Angelo was sublime and beautiful; that of Zuccero little, and in process of time ridiculous.

Instances of the sublime are so abundant in poetry both sacred and profane, and in oratory, at least by that of the antients, that we leave the task of illustration on these two heads to our readers; but description and narration too, in prose, also admit of the sublime; and here it will be found to consist chiefly in the selection of the grandest objects and most striking circumstances, figurative language, brevity, and, what is very closely connected with brevity, the use of general terms. For example: Dr. J. Heylyn, speaking of John the Baptist, says "prophecy, vision, and miracle concurred to render his birth illustrious, and draw attention, and raise expectation with regard to a person so signally the care of heaven. Soon after his birth he was carried into the wilderness to escape (as antient writers relate), the slaughter which Herod made of the Jewish children. Thus the desart became the school in which he learnt temperance. Want taught him abstinence, till, grace and reason gaining strength, he embraced that mortification with a deliberate choice, in which he had been engaged for the preservation of his life." Heylyn's Theolog. Lectures, vol. 1, p. 13.

Another example of the sublime in narration. "It is true, king Ferdinand had laid some foundation for the future greatness of Spain; for whilst his perpetual negotiations and intrigues formed him many able statesmen and ministers, his long and successful wars in the kingdom of Grenada, and in Italy, had introduced such excellent order and discipline into his armies, and particularly amongst his infantry, that either in suffering hardships, or in battle, the world could not shew its equal. These were the arms which, at Pavia and on the Elbe, crowned so great a work of fortune with the highest pitch of glory; and afterwards in the Low Countries, supported for a while its declining greatness." Political Works of Fletcher of Saltown, page 133.

Beauty of style may be said in general to consist of an union of purity, perspicuity, a moderate use of tropes, and in harmony. In the energetic or pathetic, and the sublime, the mind being in a state of emotion and agitation, is naturally hurried into figurative language. In the contemplation or description of those objects which give birth to emotions of beauty, we are calm and collected, and are not, as in the pathetic and sublime, constrained to make use of tropes and figures; yet it is in this calm state only that we are at leisure to make use of some of the finest and most expressive tropes and figures, as antitheses, allegories, similes, and metaphors, if carried beyond a single word. How much this figurative language contributes to the beauty of style and composition is exemplified by judge Blackstone in the following: "Benevolences extorted from the subject, the arbitrary imprisonments for refusal, the exertion of martial law in time of peace, and other domestic grievances clouded the morning of that misguided prince's (Charles I.) reign, which, though its noon began a little to brighten, at last went down in blood, and left the whole kingdom in darkness." Blackstone's Commentaries.

Of the metaphors which ascribe life and action to inanimate beings, we have an example in a metaphorical description of the steam engine. "The steam engine, approaching to the nature of a perpetuum mobile, or rather an animal, incapable of lassitude as of sensation, produces coals, moves machines, works metals, and is certainly the noblest drudge that was ever employed by the hand of art. Thus we put a hook in the nose of the leviathan (Job xli.); thus we play with him as with a child, and take him for a servant for ever; thus we subdue nature, and derive aid and comfort from the elements of earthquakes." Anal. Review, Retrospect of the Active World, Feb. 1797. The metaphor being aptly kept up, givs beauty to the two first sentences here; the last rises into a style somewhat higher.

Having thus treated briefly of the principal qualities of style in general, we come now to speak of the varieties of style most proper for the different kinds of prosaic composition, which may be divided into four: the familiar or colloquial, the rhetorical, the philosophical, and the historical.

The *familiar* or *colloquial* style, is that of common but genteel and polished conversation, of letters, meaning epistles, and of written dialogue, comical or serious. The style of conversation should be simple and plain: no elaborate sentences; no affectation of wit or eloquence; scarcely any great attention to grammatical accuracy: at least that attention should never be visible. To repeat what has been said ungrammatically, for the purpose of correcting himself, as is sometimes done, is most miserably pedantic. The greatest powers of conversation are shewn in following the turn and tone of conversation, in an ingenious and pleasing manner, not in leading it. It is easy to pour forth a shew of knowledge, if one is allowed to lead the conversation; not so easy to illustrate any topic extempore. The former shews only reading, the latter learning. There are a kind of babblers, familiarly called cocks of the conversation, who, having furnished and loaded their memories at home in set conversations or literary meetings, however denominated, say their lessons to an auditory, admiring, if stupid, disgusted, if intelligent. This great metropolis abounds in illustrations of this position. In letters greater care and preparation is both allowable and required. Of epistolary writing we have some excellent models in the correspondence of Swift, Pope, Arbuthnot, Gay, and other wits of their time; but none, either in England or France, for ease, elegance, and energy of style, are to be at all compared with the epistles of Cicero, Brutus, and other Romans of high rank and cultivated genius. As to written dialogue, the style of this seems to hold a middle place between the familiar or colloquial, and the rhetorical, which may be divided into three kinds; the style proper for short and popular essays, that for a popular assembly, the senate or bar, and that for the pulpit. The subjects of the first-mentioned species of writing, are moral, critical, or entertaining; the thoughts must be condensed and close, and every thing to be said, said briefly, because the whole work itself is but short, and supposed to be read at some moment of leisure. The style should be plain and simple, that every one may understand it; yet so elegant that no one may be disgusted with it. The best model of essays, in every respect, is Mr. Addison's papers in the Spectator, Guardian, and Freeholder.

The style of eloquence proper for a public oration, admits of every possible variation or inflection, according to the tone and temper of the auditory, to what they can bear, or may be brought to bear, and enter into or sympathize with, familiar, easy and in a humorous strain, or serious, solemn, rapid, impassioned, and vehement. This rule holds in some degree in speeches addressed to juries and to our house of commons. In the house of peers, the supreme judges in civil cases, and that branch of the legislature which moderates and checks any effervescence that may appear in the resolutions of the more popular branch, the eloquence of the orator should be, as it indeed is, more guarded, chastened, and sober.

We have instances of the most pathetic and sublime eloquence among savage tribes. Witness the celebrated address of Logan, an Indian chief, to lord Dunmore, governor of Virginia. The Greek and Roman orators united the bold and unconfined tone of the rudest, with the knowledge and art of the most refined nations. The circumstances of climate, and form of government, in which there were but few laws, and the appeal in many, nay, most cases, made to equity, account, in some measure at least, for the difference between antient and modern oratory. But the more an English orator can elevate his tone, and by a rapid stream of passion throw his audience into a kind of dream, or temporary belief of every thing that is said, the nearer he arrives at the summit of excellence.

The eloquence of the pulpit is altogether of a serious, solemn, pathetic, and sublime cast. Here no rhetorical artifices are either admissible or necessary; the preacher must speak the truth, and nothing but the truth; and the truths predicated are so interesting and important, so sublime and awful, that they are not to be heightened by any exaggerations of fancy. The language of scripture too, is infinitely more energetic and impressive than that of any human composition. The preacher has only to speak from believing, and to convince his audience that he really believes what he says, by the simplicity, purity, and heavenly-mindedness of his character and conduct. This is the charm that gave efficacy to the preaching of the apostles and Christian fathers, and success to the missionaries from Rome in modern times. Order in every discourse is indispensable; and this will arise out of the subject, treated in a rational and sensible manner. Never was any English divine more esteemed and admired, either as a preacher or a man, than Dr. Heylyn, a prebendary of Westminster, above quoted. In what did his oratory consist? "The principal rule of his eloquence, (says the writer of a preface to his posthumous works) was to carry his real thoughts to the pulpit, and to preach as if he was speaking to his congregation; while his action, and every look and gesture was adapted to the nature and variations of his subject."

Philosophical or didactic style. In pure mathematics, and experimental philosophy illustrated by mathematics, nothing more is requisite or proper than purity and perspicuity. But moral philosophy, which is a mixture of facts and principles, as natural philosophy is of facts and mathematics, admits of great eloquence, and should be made as entertaining as possible.

Historical style. History may be divided into three heads. 1. Natural history. 2. Anecdotes, memoirs, annals, and books of voyages and travels, all of them containing, at least, materials for history. 3. Civil history, or the condition, actions, vicissitudes, and improvements of men united in society under different forms of governments. To each of these there is a style in some measure appropriate, though in all the style should vary with the variations of the subject. In natural history, purity or propriety, and perspicuity of style is sufficient; nothing more is required. But descriptions of natural appearances also admit of elegance, and even sublimity, as well as accuracy; of which Buffon furnishes a pleasing example. It is a pity that so charming a writer should indulge so much in the propensity of his countrymen to mere theory. His obtrusion of theory, often whimsical and extravagant, is, indeed, so offensive to a sober inquirer into the productions of nature, that a strict and severe philosopher is rather better pleased with the plainness of Pliny, and of Linnæus, whose views of both plants and animals are at once so accurate and so extensive. As to anecdotes, annals, memoirs, voyages and travels, as there is no other design in such writing than to treasure up any thing interesting that comes in his way, no other qualities of style are requisite than exactness and perspicuity, though here too the style naturally rises or falls with the objects described, and facts which are recorded. In voyages and travels it rises sometimes into the dignity and sublimity of epic poetry; when, under the arctic circle, on the borders of the Frozen Ocean, nature languishes, vegetation ceases, the elements alone appear, and the "earth is contemplated only as forming a part of the solar system." Signore Giuseppo Acerbi's Travels to the North Cape.—When, at the stupendous falls of the Clyde, "doubling a tuft of wood, you are struck at once with the awful scene which suddenly bursts upon your sight, your organs of perception are hurried along, and partake of the turbulence of the roaring waters. The powers of recollection remain suspended by this sudden shock, and it is not till after a considerable time that you are enabled to contemplate the sublime horrors of this awful scene." Newte's Tour in England and Scotland.

On viewing the same scene, the reverend Mr. Hall also raises his tone. "After seeing the smoke ascending for more than a mile as I advanced, I first heard and then saw the Clyde roaring and raging as if provoked at resistance. The question started in my mind, is nature then so bustling and noisy in her operations, so tumultuous, rapid and impetuous?" Tour in Scotland, by an unusual Route, with a Trip to the Orkneys and Hebrides.

Civil history. This being addressed to the whole world, to every country and every age, to philosophers, legislators, kings and princes, the general style, air or tone, should be that of dignity; but it should not be always elevated. It should vary with the particular subject which is treated, which may be done without descending to meanness.

The historian, Robertson, whose greatest excellence, and a great excellence it is, consists in the close and beautiful order in which he deduces events from the causes that gave them birth, is, perhaps, not sufficiently various in his style. He never sits with you in a garden chair, or by the fireside; he never descends from his pulpit.

It is to be observed, however, that some designs admit of greater variety of style than others. The Abbé St. Real, who has given so fine a specimen of the concise and rapid style, in his History of the Conspiracy of Venice, had not an opportunity, and could not with propriety vary either his matter or his manner, so much as Mr. Hume in his History of England, with occasional Sketches of the principal States of Europe for seven hundred Years. Neither Thucydides nor Sallust, confined by their designs to particular events and a very short period of time, could expatiate at leisure on a variety of subjects like Herodotus, who records the common transactions of the Greeks and Barbarians for a long period of time; the scenes of whose narrative is extended over a considerable part of the three grand divisions of the antient world, and to a period of two centuries. Thucydides writes the history of a single war, and the scene of the events is confined generally to the narrow spot of Greece. The histories of Sallust are still more circumscribed in respect of both action and space. The curiosity of the reader being strongly excited by the contemplation of one great event, and approaching catastrophe, the dignified conciseness of Thucydides and Sallust, forms the greatest beauty. The arrangement of Thucydides, who divides his work into summers and winters, is very faulty; but his style for his subject and design is admirable; yet it must be admitted that the style proper for different plans or designs in history, admits of modification from the different geniuses of different historians. The retreat of the ten thousand Greeks was a single event, and embraced but a small portion of time; yet the easy, graceful, and sweetly-flowing narrative of Xenophon, the Athenian bee, is also admirable in its kind, though different from the charming simplicity and melody of Herodotus, the energy of Thucydides, the brevity of Sallust, the majesty of Livy, and his happy imitators among the moderns, Mariana and Buchannan, and the elegant purity and precision of Julius Cæsar. In a word, though there are certain general qualities of style suited to a general subject, that style is agreeably tinctured, not deformed by a diversity of genius.

Non una quidem
Nec diversa tamen qualis decet esse sororum.

Now, to conclude, by recapitulating what has been now said on the present article. As speech is the power, so rhetoric is the art of communicating our sentiments in the fullest and most impressive manner. As the ends for which we communicate our sentiments are various, the form, style, or manner of discourse, spoken or written, is different also; corresponding with the emotions to be expressed and excited, whether of surprise, complacency, admiration, wonder, astonishment, sympathy, ridicule, honour, or shame. The first and cardinal point in every composition, is to be master of the subject; to have a clear conception of all that we wish to say. "Out of the fulness of the heart the mouth speaketh." As the analogies of language were formed before the rules of grammar, so literary works were composed before the canons of criticism and rules of rhetoric. These rules are of more use in preventing the false glare of turgidity, fustian, bombast, and conceit, than of avail to inspire the most excellent qualities of speaking or writing. An attention to these rules will obviate blemishes. A well-informed understanding, with a lively imagination and a feeling heart, are the grand sources of excellent composition; a taste for which may be farther improved by a constant perusal of the best models, in the same manner that the constant contemplation of the best pictures forms insensibly a just and nice taste for painting; but it should never be forgotten that the highest excellences of style are never attained where the fire of imagination is smothered by an anxious fear of offending against any rules; and that the absence of faults and blemishes is dearly bought by the absence of elegance and every beauty.

RHEUM, a thin serous humour, occasionally oozing out of the glands about the mouth and throat.

RHEUM, *rhubarb*, a genus of the monogynia order, in the enneandria class of plants, and in the natural method ranking under the 12th order, holoraceæ. There is no calyx; the corolla is sexfid and persistent; and there is one triquetrous seed. There are seven species. The most noted are:

1. The rhaponticum, or common rhubarb, has a large, thick, fleshy, branching, deep-striking root, yellowish within; crowned by very large, roundish, heart-shaped, smooth leaves, on thick, slightly-furrowed, foot-stalks; and an upright strong stem, two or three feet high, terminated by thick close spikes of white flowers. It grows in Thrace and Scythia, but has been long in the English gardens. Its root affords a gentle purge. It is, however, of inferior quality to some of the following sorts; but its young stalks in spring being cut and peeled, are used for tarts.

2. The palmatum (see Plate Nat. Hist. fig. 346.), palmated-leaved true Chinese rhubarb, has a thick fleshy root, yellow within; crowned with very large palmated leaves, being deeply divided into acuminated segments, expanded like an open hand; upright stems, five or six feet high or more, terminated by large spikes of flowers. This is now proved to be the true foreign rhubarb, the purgative quality of which is well known.

3. The compactum, or Tartarian rhubarb, has a large, fleshy, branched root, yellow within; crowned by very large, heart-shaped somewhat lobated, sharply indented, smooth leaves, and an upright large stem, five or six feet high, branching above; having all the branches terminated by nodding panicles of white flowers. This has been supposed to be the true rhubarb; which, however, though of superior quality to some sorts, is accounted inferior to the rheum palmatum.

4. The undulatum, undulated or waved-leaved Chinese rhubarb, has a thick, branchy, deep-striking root, yellow within; crowned with large, oblong, undulate, somewhat hairy leaves, having equal foot-stalks, and an upright firm stem, four feet high, terminated by long loose spikes of white flowers.

5. The ribes, or currant rhubarb of Mount Libanus, has a thick fleshy root, very broad leaves, full of granulated protuberances, and with equal foot-stalks and upright firm stems, three or four feet high, terminated by spikes of flowers, succeeded by berry-like seeds, being surrounded by a purple pulp. All these plants are perennial in root, and the

leaves and stalks are annual. The roots being thick, fleshy, generally divided, strike deep into the ground; of a brownish colour without and yellow within; the leaves rise in the spring, generally come up in a large head folded together, gradually expanding themselves, having thick foot-stalks; and grow from one to two feet high, or more, in length and breadth, spreading all round: amidst them rise the flower-stems, attaining their full height in June, when they flower, and are succeeded by large triangular seeds, ripening in August. Some plants of each sort merit culture in gardens for variety; they will effect a singularity with their luxuriant foliage, spikes, and flowers; and, as medical plants, they demand culture both for private and public use.

They are generally propagated by seeds sown in autumn soon after they are ripe, or early in the spring, in any open bed of light deep earth. Scatter the seeds thinly, either by broad-cast all over the surface, and raked well in, or in shallow drills a foot and a half distance, covering them near an inch deep. The plants will rise in the spring, but not flower till the second or third year: when they are come up two or three inches high, thin them to eight or ten inches, and clear out all weeds; though those designed always to stand should afterwards be hoed out to a foot and a half or two feet distance; observing if any are required for the pleasure-ground, &c. for variety, they should be transplanted where they are to remain in autumn, when their leaves decay, or early in spring, before they shoot: the others remaining where sown must have the ground kept clean between them; and in autumn, when the leaves and stalks decay, cut them down, and slightly dig the ground between the rows of plants, repeating the same work every year. The roots remaining, they increase in size annually; and in the second or third year many of them will shoot up stalks, flower, and perfect seeds; and in three or four years the roots will be arrived to a large size, though older roots are generally preferable for medical use.

Two sorts of rhubarb are met with in the shops. The first is imported from Turkey and Russia, in roundish pieces freed from the bark, with a hole through the middle of each: they are externally of a yellowish colour, and on cutting appear variegated with lively reddish streaks. The other, which is less esteemed, comes immediately from the East Indies, in longish pieces, harder, heavier, and more compact than the foregoing. The first sort, unless kept very dry, is apt to grow mouldy and worm-eaten; the second is less subject to these inconveniences. Some of the more industrious artists are said to fill up the worm-holes with certain mixtures, and to colour the outside of the damaged pieces with powder of the finer sorts of rhubarb, and sometimes with cheaper materials: this is often so nicely done as effectually to impose upon the buyer, unless he very carefully examines each piece. The marks of good rhubarb are, that it is firm and solid, but not flinty; that it is easily pulverable, and appears when powdered of a fine bright yellow colour; that, upon being chewed, it imparts to the spittle a saffron tinge, without proving slimy or mucilaginous in the mouth. Its taste is subacrid, bitterish, and somewhat astringent; the smell lightly aromatic.

Rhubarb is a mild cathartic, which operates without violence or irritation, and may be given with safety even to pregnant women and children. Besides its purgative quality, it is celebrated for an astringent one, by which it strengthens the tone of the stomach and intestines, and proves useful in diarrhœas and disorders proceeding from a laxity of the fibres. Rhubarb in substance operates more powerfully as a cathartic than any of the preparations of it. Watery tinctures purge more than the spirituous ones; whilst the latter contain in greater perfection the aromatic, astringent, and corroborating virtues of the rhubarb. The dose, when intended as a purgative, is from a scruple to a drachm or more.

The Turkey rhubarb is, among us, universally preferred to the East India sort, though this last is for some purposes at least equal to the other; it is manifestly more astringent, but has somewhat less of an aromatic flavour. Tinctures drawn from both with rectified spirit have nearly the same taste: on distilling off the menstruum, the extract left from the tincture of the East India rhubarb proved considerably the strongest.

The method of curing the true rhubarb is as follows: Take the roots up when the stalks are withering or dying away, clean from the earth with a dry brush, cut them in small pieces of about four or five inches in breadth, and about two in depth, taking away all the bark, and make a hole in the middle, and string them on packthread, keeping every piece apart; and every morning, if the weather is clear and fine, place them in the open part of the garden on stages erected by fixing small posts about six feet high in the ground, and six feet asunder, into which fix horizontal pegs, about a foot apart, beginning at the top; and the rhubarb being strung crosswise on small poles, place them on these pegs; so that, if it should rain, you could easily remove each pole with the suspended pieces into any covered place. Never suffer them to be out at night, as the damps at this season would be apt to mould them.

RHEUMATISM. See Medicine.

RHEXIA, a genus of the monogynia order, in the octandria class of plants, and in the natural method ranking with those of the 17th order calycanthemæ. The calyx is quadrifid with four petals inserted into it; the antheræ are declining; the capsule is quadrilocular, within the belly of the calyx. There are 13 species, annuals and shrubs of America.

RHINANTHUS, a genus of the angiospermia order, in the didynamia class of plants, and in the natural method ranking under the 40th order, personatæ. The calyx is quadrifid, and ventricose; the capsule bilocular, obtuse, and compressed. There are eight species, among which is the yellow rattle, a weed well known.

RHINOCEROS, a genus of quadrupeds of the order belluæ: the generic character is, horn solid, perennial, conical, seated on the nose.

1. Rhinoceros unicornis, single-horned rhinoceros. The rhinoceros is the largest of land animals, the elephant alone excepted. It is of a highly uncouth and awkward form. The back, instead of rising, as in the elephant, sinks in considerably: the head is moderately large and long; the upper lip protrudes or hangs over the lower in the form of a lengthened tip; and, being extremely pliable, answers the end of a small proboscis, and is useful to the animal in catching hold of the shoots of vegetables, &c. and delivering them into the mouth. On the nose is situated a very strong, slightly curved, sharp-pointed horn, which, in the full-grown animal, is sometimes three feet in length, and eighteen inches in circumference at the base. The mouth has four cutting-teeth, which are placed at each corner of each jaw; there are also six grinders in each jaw, of which the first is remote from the cutting-teeth. (In strict propriety it may be doubted whether the four teeth first mentioned should be called by the title of cutting-teeth.) The ears are moderately large, upright, and pointed; the eyes small; the skin naked, rough, and tuberculated, or marked with very numerous, large, callous granulations; it is destitute of hair, except a few straggling and very coarse bristles on some parts of the head, &c. About the neck the skin is disposed into several large plaits or folds; another fold of the same kind passes from the shoulders to the fore legs, and another from the hind part of the back to the thighs; the tail is slender, flattened at the end, and covered on the sides with very stiff and thick black hairs; the belly is somewhat pendulous, or shaped like that of a hog; the legs very short, strong, and thick; the feet marked into three large hoofs, all standing forwards. The general height of the rhinoceros is about eight feet; but it is said that some have been seen in Sumatra and Java which nearly equalled the size of the elephant, though they appeared lower on account of the sinking back, the pendulous abdomen, and short legs.

The rhinoceros is a native of several parts of India, as well as of the islands of Java, Sumatra, &c. This animal falls far short of the elephant in sagacity and docility. It is, however, of a quiet and inoffensive disposition, but very furious and dangerous when provoked or attacked: he is said to run with great swiftness, and, from his strength and impenetrable covering, is capable of rushing with resistless violence through woods and obstacles of every kind; the trees bending like twigs while he passes between them. In general habits and manner of feeding, the rhinoceros resembles the elephant, residing in cool sequestered spots, near waters, and in shady woods: it delights in rolling occasionally in the mud, in the manner of a hog. Its skin is so hard as to be impenetrable by any common weapons, except on the belly: it is even said, that, in order to shoot a full-grown rhinoceros of advanced age, it is necessary to make use of iron bullets; those of lead having been known to be flattened against the skin.

The bones of the rhinoceros, like those of the elephant, are often found in a fossil state in various parts of the world; and in the year 1772, an entire rhinoceros was found buried in the banks of a Siberian river, in the antient frozen soil, with the skin, tendons, and some of the flesh, in the highest state of preservation. It was discovered in the sandy banks of the river Witim, which falls into the Lena, below Jakutsk, in north lat. 64.

2. Rhinoceros bicornis, the two-horned

rhinoceros, is found in various parts of Africa, and seems to have been the kind which was known to the antient Romans, and by them exhibited in their public shows and combats of animals. In size it equals the common or single-horned species; and its habits and manner of feeding are the same; but it differs greatly in the appearance of its skin, which, instead of the vast and regularly marked armour-like folds of the former, has merely a very slight wrinkle across the shoulders, and on the hinder parts with a few fainter wrinkles on the sides, so that, in comparison with the common rhinoceros, it appears almost smooth; the skin, however, is rough or tuberculated, especially in the larger specimens; but what constitutes the specific or principal distinction is, that the nose is furnished with two horns, one of which is smaller than the other, and situated above it, or higher up on the front. These horns are said to be loose when the animal is in a quiet state, but to become firm and immoveable when it is enraged. This observation is confirmed by Dr. Sparman, who observed, in a specimen which he shot in Africa, that they were fixed to the nose by a strong apparatus of muscles and tendons, so as to allow the animal the power of giving them a steady fixture on proper occasions. This, indeed, is treated by Mr. Bruce, the celebrated Abyssinian traveller, as an absurd idea; but, on inspecting the horns and skin on which they are seated, it does not appear that they are firmly attached to, or connected with, the bone of the cranium. See Plate Nat. Hist. fig. 347.

Mr. Bruce's description of the manner of feeding, as well as of some other particulars relative to the two-horned rhinoceros, seems highly worthy of notice. He informs us, that, "besides the trees capable of most resistance, there are, in the vast forests within the rains, trees of a softer consistence, and of a very succulent quality, which seem to be destined for his principal food. For the purpose of gaining the highest branches of these, his upper lip is capable of being lengthened out so as to increase his power of laying hold with this in the same manner as the elephant does with his trunk. With this lip, and the assistance of his tongue, he pulls down the upper branches which have most leaves, and these he devours first; having stripped the tree of its branches, he does not, therefore, abandon it; but, placing his snout as low in the trunk as he finds his horns will enter, he rips up the body of the tree, and reduces it to thin pieces like so many laths; and when he has thus prepared it, he embraces as much of it as he can in his monstrous jaws, and twists it round with as much ease as an ox would do a root of celery, or any such pot-herb or garden-stuff.

"When pursued, and in fear, he possesses an astonishing degree of swiftness, considering his size, the apparent unwieldiness of his body, his great weight before, and the shortness of his legs. He is long, and has a kind of trot, which, after a few minutes, increases in a great proportion, and takes in a great distance; but this is to be understood with a degree of moderation. It is not true, that in a plain he beats the horse in swiftness. I have passed him with ease, and seen many worse mounted do the same, and though it is certainly true that a horse can very seldom come up with him, this is owing to his cunning but not his swiftness.

"The eyes of the rhinoceros are very small, and he seldom turns his head, and therefore sees nothing but what is before him. To this he owes his death, and never escapes if there is so much plain as to enable the horse to get before him. His pride and fury, then, make him lay aside all thoughts of escaping, but by victory over his enemy. He stands for a moment at bay, then, at a start, runs straight forward at the horse like the wild boar, whom, in his manner of action, he very much resembles. The horse easily avoids him by turning short aside; and this is the fatal instant: the naked man, with the sword, drops from behind the principal horseman, and, unseen by the rhinoceros, who is seeking his enemy, the horse, he gives him a stroke across the tendon of the heel, which renders him incapable of further flight or resistance.

"In speaking of the great quantity of food necessary to support this enormous mass, we must likewise consider the vast quantity of water which he needs. No country but that of the Shangalla, which he possesses, deluged with six months' rain, and full of large and deep basons, made in the living rock, and shaded by dark woods from evaporation, or watered by large and deep rivers, which never fall low or to a state of dryness, can supply the vast draughts of this monstrous creature. But it is not for drinking alone that he frequents wet and marshy places: large, fierce, and strong, as he is, he must submit to prepare himself against the weakest of all adversaries. The great consumption he constantly makes of food and water necessarily confine him to certain limited spaces; for it is not every place that can maintain him; he cannot emigrate, or seek his defence among the sands of Atbara."

The adversary just mentioned is a fly (probably of the genus œstrus), which attacks the rhinoceros, as well as the camel and many other animals, and would, according to Mr. Bruce, as easily subdue him, but for the stratagem which he practises of rolling himself in the mud by night, by which means he clothes himself in a kind of case, which defends him from his adversary the following day. The pleasure that he receives from thus rolling in the mud, and the darkness of the night, deprive him of his usual vigilance and attention. The hunters steal secretly upon him, and while lying on the ground wound him with their javelins, mostly in the belly, where the wound is mortal.

RHINOMACER, a genus of insects of the order coleoptera. The generic character is, antennæ setaceous, seated on the snout; feelers four, growing thicker towards the end, the last joint truncate. There are three species: the curculioides, that inhabits Italy; the attelaboides, that inhabits Sweden; and the cæruleus, found in Calabria.

RHIZOBALUS, a genus of the tetragynia order, in the polyandria class of plants, and in the natural method ranking under the 23d order, trihilatæ. The calyx is monophyllous, fleshy, and downy; the corolla consists of five petals, which are round, concave, fleshy, and much larger than the calyx; the stamina are very numerous, filiform, and longer than the corolla; the styli are four, filiform, and of the length of the stamina; the pericarpium has four drupæ, kidney-shaped, compressed, with a fleshy substance inside, and in the middle a flat large nut, containing a kidney-shaped kernel. Of this there are two species: the most remarkable is the pekia. The nut is sold in the shops as American nuts: they are flat, tuberculated, and kidney-shaped, containing a kernel of the same shape, which is sweet and agreeable.

RHIZOPHORA, the *mangrove* or *mangle*, a genus of the monogynia order, in the dodecandria class of plants, and in the natural method ranking under the 12th order, holoraceæ. The calyx is quadripartite, the corolla four-parted; there is one seed, very long, and carnous at the base. There are six species.

These plants are natives of the East and West Indies, and often grow 40 or 50 feet high. They grow only in water and on the banks of rivers, where the tide flows up twice a day. They preserve the verdure of their leaves throughout the year. From the lowest branches issue long roots, which hang down to the water, and penetrate into the earth. In this position they resemble so many arcades, from five to ten feet high, which serve to support the body of the tree, and even to advance it daily into the bed of the water. These arcades are so closely intertwisted one with another, that they form a kind of natural and transparent terrace, raised with such solidity over the water, that one might walk upon them, was it not that the branches are too much incumbered with leaves. The most natural way of propagating these trees is to suffer the several slender small filaments which issue from the main branches to take root in the earth. The most common method, however, is that of laying the small lower branches in baskets of mould or earth till they have taken root.

The description just given pertains chiefly to a particular species of mangrove, R. mangle, termed by the West Indians black mangles, on account of the brown dusky colour of the wood. The bark is very brown, smooth, pliant when green, and generally used in the West India islands for tanning of leather. Below this bark lies a cuticle or skin, which is lighter, thinner, and more tender. The wood is nearly of the same colour as the bark; hard, pliant, and very heavy. It is frequently used for fuel; the fires which are made of this wood being both clearer, more ardent and durable, than those made of any other materials whatever. The wood is almost incorruptible, never splinters, is easily worked, and was it not for its enormous weight, would be commodiously employed in almost all kinds of work, as it possesses every property of good timber. To the roots and branches of mangroves that are immersed in the water, oysters frequently attach themselves; so that wherever this curious plant is found growing on the sea-shore, oyster-fishing is very easy; as in such cases these shell-fish may be literally said to be gathered upon trees.

The red mangle or mangrove, a variety of the above, grows on the sea-shore, and at the mouth of large rivers; but does not advance, like the former, into the water. It generally rises to the height of 20 or 30 feet, with crooked knotty branches, which proceed from all parts of the trunk. The bark is slender, of a brown colour, and, when young, is smooth, and adheres very closely to the wood; but when old, appears quite cracked, and is easily detached from it. Under this bark is a skin as thick as parchment, red, and adhering closely to the wood, from which it cannot be detached till the tree is felled and dry. The wood is hard, compact, heavy, of a deep red, with a very fine grain. The pith or heart of the wood being cut into small pieces, and boiled in water, imparts a very beautiful red to the liquid, which communicates the same colour to wool and linen. The great weight and hardness of the wood prevent it from being generally used. From the fruit of this tree, which, when ripe, is of a violet-colour, and resembles some grapes in taste, is prepared an agreeable liquor, much esteemed by the inhabitants of the Caribbee islands.

White mangle; another variety, so termed from the colour of its wood, grows, like the two former, upon the banks of rivers, but is seldom found near the sea. The bark is grey; the wood, as we have said, white, and when green, supple; but dries as soon as cut down, and becomes very light and brittle. This species is generally called rope-mangrove, from the use to which the bark is applied by the inhabitants of the West Indies. This bark, which, from the great abundance of sap, is easily detached when green from the wood, is beaten or bruised betwixt two stones, until the hard and woody part is totally separated from that which is soft and tender. This last, which is the true cortical substance, is twisted into ropes of all sizes, which are exceedingly strong, and not apt to rot in the water.

RHODIOLA, *rose-wort*, a genus of the octandria order, in the diœcia class of plants, and in the natural method ranking under the 13th order, succulentæ. The male calyx is quadripartite, the corolla tetrapetalous. The female calyx is quadripartite, and there is no corolla; the nectaria are four; the pistils four; and there are four polyspermous capsules. There are two species, the rosea and the biternata; the first grows naturally in the clefts of the rocks and rugged mountains of Wales, Yorkshire, and Westmorland. It has a very thick fleshy root, which when cut or bruised sends out an odour like roses. It has thick succulent stalks, like those of orpine, about nine inches long, with thick succulent leaves indented at the top. The stalk is terminated by a cluster of yellowish herbaceous flowers, which have an agreeable scent, but are of short continuance. The second sort is a native of Cochin China. Both species are easily propagated by parting their roots, and require a shady situation and dry undunged soil. The fragrance of the first species, however, is greatly diminished by cultivation.

RHODODENDRUM, *dwarf rose-bay*, a genus of the monogynia order, in the decandria class of plants, and in the natural method ranking under the 18th order, bicornes. The calyx is quinquepartite; the corolla funnel-shaped; the stamina declining; the capsule quinquelocular. There are nine species; the most remarkable of which are,

1. The hirsutum, with naked hairy leaves, grows naturally on the Alps and several mountains of Italy. It is a low shrub, which seldom rises two feet high, sending out many ligneous branches covered with a light-brown bark, and oval spear-shaped leaves, sitting pretty close to the branches. They are entire, having a great number of fine iron-coloured hairs on their edges and underside. The flowers are produced in bunches at the end of the branches in May, having one funnel-shaped petal cut into five obtuse segments, and of a pale-red colour.

2. The ferrugineum, with smooth leaves, hairy on their under side, is a native of the Alps and Apennines. It rises with a shrubby stalk near three feet high, sending out many irregular branches covered with a purplish bark, and smooth spear-shaped entire leaves, whose borders are reflexed backward; the upper side is of a light lucid green, their under side of an iron-colour. The flowers are produced at the ends of the branches, are funnel-shaped, cut into five segments, and of a pale rose-colour. These plants are propagated by seeds; but being natives of barren rocky soils and cold situations, they do not thrive in gardens, and for want of their usual covering of snow in the winter, are often killed by frost in this country.

3. The chamæcistus, or ciliated-leaved dwarf rose-bay, is a low deciduous shrub, native of mount Baldus, and near Saltzburg, in Germany. It grows to the height of about a yard; the branches are numerous, produced irregularly, and covered with a purplish bark. The leaves are oval, spear-shaped, small, and in the under surface of the colour of iron. The flowers are produced at the end of the branches in bunches, are of a wheel-shaped figure, pretty large, of a fine crimson colour, and handsome appearance. They appear in June.

4. The dauricum, or Daurian dwarf rose-bay, is a low deciduous shrub, and native of Dauria. Its branches are numerous, and covered with a brownish bark. The flowers are wheel-shaped, large, and of a beautiful rose-colour: they appear in May, and are succeeded by oval capsules full of seeds, which in England do not always ripen.

5. The maximum, or American mountain laurel, is an evergreen shrub, and native of Virginia, where it grows naturally on the highest mountains, and on the edges of cliffs, precipices, &c. where it reaches the size of a moderate tree, though with us it seldom rises higher than six feet. The flowers continue by succession sometimes more than two months, and are succeeded by oval capsules full of seeds.

6. The ponticum, or pontic dwarf rose-bay, is an evergreen shrub, native of the East, and of most shady places near Gibraltar. It grows to the height of four or five feet. The leaves are spear-shaped, glossy on both sides, acute, and placed on short foot-stalks on the branches: the flowers, which are produced in clusters, are bell-shaped, and of a fine purple colour. They appear in July, and are succeeded by oval capsules containing seeds, which in England seldom attain to maturity.

In Siberia, a species of this plant is used with great success in gouty and rheumatic affections; and the inhabitants of Siberia call this shrub chei or tea, from their drinking in common a weak infusion of it, as we do the Chinese plant of that name. This practice shows that the plant, used in small quantities, must be innocent.

RHODORA, a genus of the decandria monogynia class and order. The calyx is five-toothed; petals three, unequal; stamina declined; capsules five-celled. There is one species, a shrub of Newfoundland.

RHOPALA, or RUPALA, a genus of the monogynia order, in the tetrandria class of plants, and in the natural method ranking with those that are doubtful. There is no calyx; the petals are four, oblong, obtuse, and narrowing at the base; the stamina are four, inserted in the corolla, and have large antheræ; the seed-vessel unilocular, and contains one seed. There are only two species. The montana is a shrubby plant growing in Guiana, and remarkable for the great number of branches sent off from its trunk in every direction, and for the fetid smell of the wood and bark of this plant. The other is a native of Cayenne.

RHOMBOIDES. See GEOMETRY.

RHOMBUS. See GEOMETRY.

RHUBARB. See RHEUM, and PHARMACY.

RHUMB, in navigation, a vertical circle of any given place, or the intersection of such a circle with the horizon; in which last sense rhumb is the same with a point of the compass.

RHUMB-LINE, is also used for the line which a ship describes when sailing in the same collateral point of the compass, or oblique to the meridians. See NAVIGATION.

RHUS, *sumach*, a genus of the trigynia order, in the pentandria class of plants, and in the natural method ranking under the 43d order, dumosæ. The calyx is quinquepartite; the petals five; the berry monospermous. There are 34 species, of which the most remarkable are,

1. The coriaria, or elm-leaved sumach, grows naturally in Italy, Spain, Turkey, Syria, and Palestine. The branches of this tree are used instead of oak-bark for tanning of leather; and it is said that the Turkey leather is all tanned with this shrub. It has a ligneous stalk, which divides at bottom into many irregular branches, rising to the height of eight or ten feet; the bark is hairy, of a herbaceous brown colour; the leaves are winged, composed of seven or eight pair of lobes, terminated by an odd one, bluntly sawed on their edges, hairy on their under side, of a yellowish-green colour, and placed alternately on the branches; the flowers grow in loose panicles on the end of the branches, which are of a whitish herbaceous colour, each panicle being composed of several spikes of flowers sitting close to the footstalks. The leaves and seeds of this sort are used in medicine, and are esteemed very restringent and styptic.

2. The typhinum, Virginian sumach, or vinegar-plant, grows naturally in almost every part of North America. This has a woody stem, with many irregular branches, which are generally crooked and deformed. The young branches are covered with a soft velvet-like down, resembling greatly that of a young stag's horn, both in colour and texture, whence the common people have given it the appellation of stag's horn; the leaves are winged, composed of six or seven pair of ob-

long heart-shaped lobes. The flowers are produced in close tufts at the end of the branches, and are succeeded by seeds, inclosed in purple woolly succulent covers; so that the bunches are of a beautiful purple colour in autumn; and the leaves, before they fall in autumn, change to a purplish colour at first, and before they fall to a feuillemort. It has got the name of the vinegar-plant from the double reason of the young germen of its fruit, when fermented, producing either new or adding to the strength of old weak vinegar, whilst its ripe berries afford an agreeable acid, which might supply the place when necessary of the citric acid. The powerful astringency of this plant in all its parts recommends it as useful in several of the arts. As for example, the ripe berries boiled with alum make a good dye for hats. The plant in all its parts may be used as a succedaneum for oak-bark in tanning, especially the white glove-leather. It will likewise answer to prepare a dye for black, green, and yellow colours; and with martial vitriol it makes a good ink. The milky juice that flows from incisions made in the trunk or branches, makes, when dried, the basis of a varnish little inferior to the Chinese. Bees are remarkably fond of its flowers; and it affords more honey than any of the flowering shrubs. The natives of America use the dried leaves as tobacco.

3. The glabrum, with winged leaves, grows naturally in many parts of North America: this is commonly called by the gardeners New England sumach. The stem of this is stronger and rises higher than that of the former; the branches spread more horizontally; the flowers are disposed in loose panicles, which are of an herbaceous colour.

4. The elegans, with sawed winged leaves, grows naturally in Carolina: the seeds of this were brought thence by the late Mr. Catesby. This is by the gardeners called the scarlet Carolina sumach: it rises commonly to the height of seven or eight feet, dividing into many irregular branches, which are smooth, of a purple colour, and pounced over with a greyish powder, as are also the footstalks of the leaves. The leaves are composed of seven or eight pair of lobes terminated by an odd one. The upper sides of the lobes are of a dark green, and their under hoary but smooth. The flowers are produced at the end of the branches in very close panicles, which are large, and of a bright-red colour.

5. The copallinum, or narrow-leaved sumach, grows naturally in most parts of North America, where it is known by the title of beach sumach, probably from the place where it grows. This is of humbler growth than either of the former, seldom rising more than four or five feet high in Britain, dividing into many spreading branches, which are smooth, of a light brown colour, with winged leaves, composed of four or five pair of narrow lobes, terminated by an odd one; they are of a light green on both sides. The flowers are produced in loose panicles at the end of the branches, of a yellowish herbaceous colour.

These are hardy plants, and will thrive in the open air here. The first and fourth sorts are not quite so hardy as the others, so must have a better situation, otherwise their branches will be injured by severe frost in the winter.

6. Besides these, Linnæus has included in this genus the toxicodendron, or poison-tree, under the name of rhus vernix, or poison-ash. This grows naturally in Virginia, Pennsylvania, New England, Carolina, and Japan, rising with a strong woody stalk to the height of twenty feet and upwards; though in this country it is seldom seen above twelve, by reason of the plant's being extremely tender. The bark is brown, inclining to grey; the leaves winged, and composed of three or four pair of lobes, terminated by an odd one. The lobes vary greatly in their shape, but for the most part they are oval and spear-shaped. The footstalks become of a bright purple towards the latter part of summer, and in autumn all the leaves are of a beautiful purple before they fall off.

All the species of sumach abound with an acrid milky juice, which is reckoned poisonous; but this property is most remarkable in the vernix.

The natives are said to distinguish this tree in the dark by its extreme coldness to the touch. The juice of some kinds of sumach, when exposed to the heat of the sun, becomes so thick and clammy, that it is used for bird-lime, and the inspissated juice of the poison-ash is said to be the fine varnish of Japan. A cataplasm made with the fresh juice of the poison-ash, applied to the feet, is said by Hughes, in his Natural History of Barbadoes, to kill the vermin called by the West Indians chigers. The resin called gum copal is from the rhus copallinum. See Copal.

RHYME. See Poetry.

RHYTHMICAL, in music, an epithet applied to the property or quality, in the antient melopœia and modern melody, by which the cadences, accents, and quantities, are regulated and determined.

RIAL, or Ryal. See Coin.

Rial, or Royal, is also the name of a piece of gold, antiently current among us for ten shillings.

RIBBAND, or Ribbon, a narrow sort of silk, chiefly used for head-ornaments, badges of chivalry, &c.

RIBES, the *currant* and *gooseberry-bush*, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 36th order, pomaceæ. There are five petals, and stamina inserted into the calyx; the style is bifid; the berry polyspermous, inferior. The currant and the gooseberry were long considered each as a separate genus; ribes the currant, and grossularia the gooseberry; but they are now joined together, the grossularia being made a species of ribes; all the currant kinds having inermous or thornless branches, and racemous clusters of flowers and fruit; and the gooseberry having spinous branches, and flowers and fruit for the most part singly.

There are ten species of the currant-tree, two of which, and their varieties, merit culture for their fruit: all are inermous or unarmed, having no thorns on the branches.

1. The rubrum, grows naturally in woods and the hedges in most parts of Europe, and comprises all sorts of red and white currants; as common small red currant, large-bunched red currant, Champaigne pale-red currant, common small white currant, large white Dutch currant, yellow blotched-leaved currant, silver-striped-leaved, gold-striped-leaved, gooseberry-leaved. All these sorts are varieties of one species, ribes rubrum, or common red currant; it being the parent from which all the others were first obtained from the seed, and improved by culture.

2. The nigrum, or black-currant tree. The fruit of this species being of a strong flavour, and somewhat physical relish, is not generally liked: it, however, is accounted very wholesome. There is also made of it a syrup of high estimation for sore throats and quinsies. There is a variety called the Pennsylvanian black currant, having smaller shoots, and leaves not strong-scented, and small fruit but of little value.

Of the gooseberry, there are seven species. The most remarkable are,

1. The grossularia, or rough hairy gooseberry bush. It consists of many varieties, of different sizes and colours.

2. The reclinatum, or reclinated broad-leaved gooseberry bush.

3. The oxyacanthoides, or oxyacantha-leaved gooseberry, with largish trilobate hawthorn leaves.

4. The uva crispa, or smooth gooseberry.

5. The cynosbati, or prickly-fruited gooseberry-bush, has a shrubby stem and branches, armed with spines, mostly at the axillas, and prickly fruit in clusters.

RIBS. See Anatomy.

RICCIA, a genus of the natural order of algæ, belonging to the cryptogamia class of plants. There is no calyx, but a vesicular cavity within the substance of the leaf. There is no corolla; the antheræ are cylindrical and sessile, placed on the germen, which is turbinated; the stile is filiform, perforating the anthera; and the seed-case is spherical, crowned with the withered antheræ; the seeds are hemispherical and pedicellated. There are five species.

RICHARDIA, a genus of the monogynia order, in the hexandria class of plants, and in the natural method ranking under the 47th order, stellatæ. The calyx is sexpartite; the corolla monopetalous and subcylindrical; and there are three seeds. There is one species, a herb of Vera Cruz.

RICHERIA, a genus of the class and order diœcia pentandria. The capsule is cortical, six-valved, three-celled; seeds solitary; stile trifid. There is one species, a tree of the West Indies.

RICINUS, or Palma Christi, a genus of the monadelphia order, in the monœcia class of plants, and in the natural method ranking under the 38th order, tricoccæ. The male calyx is quinquepartite; there is no corolla; the stamina numerous. The female calyx is tripartite; there is no corolla, but three bifid styles, with a trilocular capsule, and a single seed. There are six species, of which the most remarkable is the communis, or common palma Christi. This tree is of speedy growth, as in one year it arrives at its full height, which seldom exceeds twenty feet. The trunk is subligneous; the pith is large; the leaves broad and palmated; the flower-spike is simple, and thickly set with yellow blossoms in the shape of a cone; the capsules are triangular and prickly, containing three smooth grey mottled seeds. When the bunches begin to turn black, they are gathered, dried in the sun, and the seeds picked out. They are afterwards put up for use as wanted, or for exportation.

Castor oil is obtained either by expression or by decoction. The first method is practised in England; the latter in Jamaica. It is common first to parch the nuts or seeds in an iron pot over the fire; but this gives the oil an empyreumatic taste, smell, and colour; and it is best prepared in the following manner: A large iron pot or boiler is first prepared, and half-filled with water. The nuts are then beaten in parcels in deep wooden mortars, and after a quantity is beaten, it is thrown into the iron vessel. The fire is then lighted, and the liquor is gently boiled for two hours, and kept constantly stirred. About this time the oil begins to separate, and swims on the top, mixed with a white froth, and is skimmed off till no more rises. The skimmings are heated in a small iron pot, and strained through a cloth. When cold, it is put up in jars or bottles for use.

Castor oil, thus made, is clear and well flavoured, and if put into proper bottles will keep sweet for years. The expressed castor oil soon turns rancid, because the mucilaginous and acrid parts of the nut are squeezed out with the oil. On this account the preference is given to well-prepared oil by decoction. An English gallon of the seeds yield about two pounds of oil, which is a great proportion.

Before the disturbances in America, the planters imported train oil for lamps and other purposes about sugar-works. It is now found that the castor oil can be procured as cheap as the fish oil of America. It burns clearer, and has not any offensive smell. This oil, too, is fit for all the purposes of the painter, or for the apothecary in ointments and plasters. As a medicine, it purges without stimulus, and is so mild as to be given to infants soon after birth. All oils are noxious to insects, but the castor oil kills and expels them. It is generally given as a purge after using the cabbage-bark some days.

The ricinus Americanus grows as tall as a little tree, and is so beautiful that Miller says it deserves a place in every curious garden, and he planted it himself at Chelsea. It expands into many branches; the leaves are sometimes two feet in diameter, and the stem as large as a middle-sized broom-staff: towards the top of the branch it has a cluster of flowers, somewhat resembling a bunch of grapes; the flowers are small and staminous, but on the body of the plant grow bunches of rough triangular husks, each containing three speckled seeds, generally somewhat less than horse-beans; the shell is brittle, and contains white kernels of a sweet, oily, and nauseous taste. From this kernel the oil is extracted; and if the medicine should become officinal, the seeds may be imported at a reasonable rate, as the plant grows wild and in great plenty in all the British and French American islands.

Of the ricinus communis, there are a great many varieties; all of them fine majestic plants, annual, or at most biennial, in this country; but in their native soil they are said to be perennial both in root and stem. They are propagated by seeds sown on a hotbed, and require the same treatment as other tender exotics.

RICKETS. See INFANCY.

RICOTIA, a genus of the siliquosa order, in the tetradynamia class of plants, and in the natural method ranking under the 39th order, siliquosæ. The siliqua is unilocular, oblong, and compressed, with plain valvules. There is one species.

RIDE, in the sea language, is a term variously applied: thus, a ship is said to ride, when her anchors hold her fast, so that she does not drive by the force either of the wind or tide. A ship is said to ride across, when she rides with her fore and main yards hoisted up to the hounds, and both yards and arms topped alike. She is said to ride well, when she is built so as not to overbeat herself in a head-sea, the waves over raking her from stem to stern. To ride athwart, is to ride with her side to the tide. To ride betwixt wind and tide, is to ride so that the wind has equal force over her one way, and the tide the contrary way. If the wind has more power over the ship than the tide, she is said to ride wind-road, or to ride a great wind.

RIDEAU, in fortification, is a small elevation of earth, extending lengthwise on a plain, and serving to cover a camp, or to give an advantage to a post. Rideaus are also convenient for those who would besiege a place, and serve to secure the workmen in their approaches to the foot of a fortress.

RIDERS, in a ship, are large timbers, both in the hold and aloft, bolted on to other timbers to strengthen them, when the ship is discovered to be too slightly built.

RIDING-CLERK, one of the six clerks in chancery, who, in his turn, annually keeps the controlment-books of all grants that pass the great seal that year.

RIENS ARREAR, in law, is a plea used in an action of debt, for arrearages of accounts, by which the defendant alleges, that there is nothing in arrear.

RIFLE, a fire-arm which has the inside of its barrel cut with from three to nine or ten spiral grooves, so as to make it resemble a female screw, varying from a common screw only in this, that its grooves or rifles are less deflected, and approach more to a right line; it being now usual for the grooves with which the best rifled barrels are cut, to take about one whole turn in a length of thirty inches. The number of these grooves differs according to the size of the barrel and fancy of the workman; and their depth and width are not regulated by any invariable rule.

Rifles are said to have been known as far back as the middle of the sixteenth century. See Plate Rifle, &c. fig. 1, which represents a cast taken of the inside of a rifle-barrel thirty inches long and $\frac{6}{10}$ of an inch in diameter, and in which the grooves take one turn in the whole length. It will of course be observed, that the ribs in the drawing represent the grooves in the rifle. The method of loading them is as follows:

When the proper quantity of powder (one drachm avoirdupois) is put down at the muzzle, and a piece of calico or linen is gently rammed down over it as a wad, a circular piece of strong calico is greased on one side, and laid on the mouth of the piece with the greased side downwards; and a bullet of the same size as the bore of the piece before the grooves were cut, being placed upon it, is then forced gently down the barrel with it; by which means, the calico incloses the lower half of the bullet: and by its interposition between the bullet and the grooves, prevents the lead from being cut by them, and by means of the grease slides down, without its being necessary to use any violent efforts, which would destroy the circular shape of the bullet.

In order to understand the cause of the superiority of a rifle-barrel gun over one with a smooth barrel, it will be necessary to refer to Mr. Robins's discovery of the cause of the irregularities which occur in the flight of projectiles from smooth barrels, which we shall give in his own words, Tracts on Gunnery, p. 196, &c.

"Almost every projectile, besides the forces we have hitherto considered, namely, its gravitation, and that resistance of the air which directly opposes its motion, is affected by a third force which acts obliquely to its motion, and in a variable direction; and which consequently deflects the projectile from its regular track, and from the vertical plane in which it began to move; impelling it sometimes to one side, and sometimes to the other, occasioning thereby very great inequalities in the repeated ranges of the same piece, though each time loaded and pointed in the same manner; and this force operating thus irregularly, I conceive to be the principal source of all that uncertainty and confusion in the art of gunnery, which hath hitherto been usually ascribed to the difference of powder. The reality of this force, and the cause which produces it, will, I hope, appear from the following considerations.

"It will easily be granted, I suppose, that no bullet can be discharged from the pieces generally in use, without rubbing against their sides, and thereby acquiring a whirling motion as well as a progressive one. And as this whirl will, in one part of its revolution, conspire in some degree with the progressive motion, and in another part be equally opposed to it, the resistance of the air on the fore part of the bullet will be hereby affected, and will be increased in that part where the whirling motion conspires with the progressive, and diminished where it is opposed to it. And by this means the whole effort of the resistance, instead of being in a direction opposite to the direction of the body, will become oblique thereto, and will produce those effects already mentioned. If it were possible to predict the position of the axis round which the bullet should whirl, and if that axis were unchangeable during the whole flight of the bullet, then the aberration of the bullet by this oblique force would be in a given direction, and the incurvation produced thereby would regularly extend the same way, from one end of its track to the other. For instance: if the axis of the whirl were perpendicular to the horizon, then the deflection would be to the right or left; if that axis were horizontal, and perpendicular to the direction of the bullet, then the deflection would be upwards or downwards. But as the first position of this axis is uncertain, and as it may perpetually shift in the course of the bullet's flight, the deviation of the bullet is not necessarily in one certain direction, nor tending to the same side in one part of its track that it does in another; but it more usually is continually changing the tendency of its deflection, as the axis, round which it whirls, must frequently shift its position to the progressive motion by many inevitable accidents."

To prove the truth of his theory, Mr. Robins made the following experiments, before several members of the Royal Society:

"The first experiment, exhibited on this occasion, was to evince, that the whirling motion of a ball, combining with its progressive motion, would produce such an oblique resistance and deflective power, as is herein mentioned. For this purpose, a wooden ball, 4½ inches diameter, was suspended by a double string about eight or nine feet long. Now by turning round the ball, and twisting the double string, the ball, when left to itself, would have a revolving motion given it from the untwisting of the string again. And if, when the string was twisted, the ball was drawn a considerable distance from the perpendicular, and there let go; it would at first, before it had acquired its revolving motion, vibrate steadily enough in the same vertical plane in which it first began to move; but when, by the untwisting of the string, it had acquired a sufficient degree of its whirling motion, it constantly deflected on the right or left of its first track, and sometimes proceeded so far, as to have its direction at right angles to that in which it began its motion; and this deviation was not produced by the action of the string itself, but appeared to be entirely owing to the resistance being greater on the one part of the leading surface of the globe than on the other. For the deviation continued when the string was totally untwisted, and even during the time that the string, by the motion the globe had received, was twisting the contrary way. And it was always easy to predict, before the ball was let go, which way it would deflect, only by considering on which side the whirl would be combined with the progressive motion, for on that side always the deflecting power acted; as the resistance was greater here, than on the side where the whirl and progressive motion were opposed to each other.

"This experiment is an incontestable proof, that, if any bullet, besides its progressive motion, hath a whirl round its axis, it will be deflected in the manner here described. And as it is scarcely possible to suppose, but that every bullet, discharged from the pieces now in common use, must receive such a whirl from its friction against the sides of the piece, the proposition might perhaps be safely rested on this single experiment. But not to leave any thing doubtful in a subject liable to so much contestation, I undertook to evince, by an ocular proof, the reality of this deflection in musquet-bullets even in so short an interval as a hundred yards. And these experiments having succeeded to the general satisfaction of those who honoured me with their company, I shall here describe, as briefly as I can, the manner in which they were tried, and the conclusions resulting from them.

"As all projectiles in their flight are acted on by the power of gravity, the deflection of a bullet from its primary direction, supposes that deflection to be upwards or downwards in a vertical plane; because, in the vertical plane, the action of gravity is compounded and entangled with the deflective force. And for this reason, my experiments have been principally directed to the examination of that deflection, which carries the bullet to the right or left of the vertical plane, in which it began to move. For if it appears at any time, that the bullet has shifted from that vertical plane, in which its motion began, this will be an incontestable confirmation of what we asserted. Since no other power but that unequal resistance, which we here insist on, can occasion a body in motion to deviate from the vertical plane, in which it has once moved.

"Now by means of screens of exceedingly thin paper, placed parallel to each other at proper distances, this deflection in question may be many ways investigated. For by firing bullets which shall traverse these screens, the flight of the bullet may be traced out; and it may easily appear, whether they do or do not keep invariably to one vertical plane. This examination may proceed on three different principles, which I shall here separately explain.

"For first, an exact vertical plane may be traced out upon all these screens, by which the deviation of any single bullet may be more readily investigated; only by measuring the horizontal distance of its trace from the vertical plane thus delineated, and by this means the absolute quantity of its aberration may be known.

"Or if the description of such a vertical plane should be esteemed a matter of difficulty and nicety, a second method may be followed; which is that of resting the piece in some fixed notch or socket, so that though the piece may have some little play to the right and left, yet all the lines, in which the bullet can be directed, shall intersect each other in the centre of that fixed socket; by this means, if two different shot are fired from the piece thus situated, the horizontal distances of the traces made by the two bullets on any two screens, ought to be in the same proportion to each other as the respective distances of these screens from the socket, in which the piece was laid. And if these horizontal distances differ from that proportion, then it is certain, that one of these shot at least hath deviated from a vertical plane, although the absolute quantity of that deviation cannot be hence assigned; because it cannot be known, what part of it is to be imputed to one bullet, and what to the other.

"But if the constant and invariable position of the notch or socket, in which the piece was placed, is thought too hard an hypothesis in this very nice affair; the third method, and which is the simplest of all, requires no more than, that two shot be fired through three screens, without any regard to the position of the piece each time. For, in this case, if the shots diverge from each other, and both keep to a vertical plane, then if the horizontal distances of their traces on the first screen be taken from the like horizontal distances on the second and third, the two remainders will be in the same proportion with the distances of the second and third screen from the first. And if they are not in this proportion, then it will be certain, that one of them at least hath been deflected from the vertical plane; though here, as in the last instance, the quantity of that deflection in each will not be known.

"All these three methods I have myself made use of at different times, and have ever found the success agreeable to my expectation. But what I thought the most eligible for the experiments, which I proposed to shew to the society, was a compound of the two last, and the apparatus was as follows:

"On ——, being the first day appointed for these trials, the weather was unfavourable, and the experiments on that account more confused than could have been wished, though they were far from inconclusive. But on the next Thursday two screens were set up in the large walk in the Charter-house garden; the first of them at 250 feet distance from the wall (which wall was to serve for a third screen), and the second two hundred feet from the same wall. And at fifty feet before the first screen, or at 300 feet from the wall, there was placed a large block, weighing about 200lb. weight, and having fixed into it an iron bar with the socket at its extremity, in which the piece was to be laid. The piece itself was of a common length, and was bored for an ounce ball. It was each time loaded with a ball of 17 to the pound (so that the windage was extremely small) and with a quarter of an ounce of good powder. The screens were made of the thinnest tissue-paper; and the resistance they gave to the bullet (and consequently their probability of deflecting it) was so small, that a bullet lighting one time near the extremity of one of the screens, left a fine thin fragment of it towards the edge entire, which was so very weak, that it appeared difficult to handle it without breaking. These things thus prepared, five shot were made with the piece rested in the notch described above; and the horizontal distances between the first shot, which was taken as a standard, and the four succeeding ones, both on the first and second screen, and on the wall, measured in inches, were as follows:

	1st screen	2d screen	wall
1 to 2	1,75 R	3,15 R	16,7 R
3	10, L	15,6 L	69,25 L
4	1,25 L	4,5 L	15,0 L
5	2,15 L	5,1 L	19,0 L

"Here the letters R and L denote, that the shot in question went either to the right or left of the first.

"If the position of the socket in which the piece was placed, be supposed fixed (and I presume no person then present conceived, during these trials, that it could possibly vary the tenth of an inch from its first situation), then the horizontal distances, measured above on the first and second screen, and on the wall, ought to be in the proportion of the distances of the 1st screen, the 2d screen, and the wall, from the socket. But, by only looking over these numbers, it appears, that none of them are in that proportion; the horizontal distance of the 1st and 3d (for instance) on the wall being above nine inches more than it should be by this analogy.

"If without supposing the invariable position of the socket, we examine the comparative horizontal distances according to the third method described above, we shall in this case discover divarications still more extraordinary. For by the numbers set down it appears, that the horizontal distances of the 2d and 3d shot on the two screens, and on the wall, are as under:

1st screen	2d screen	wall
11,75	18,75	85,95

"Here, if, according to the rule given above, the distance on the first screen be taken from the distances on the other two, the remainder will be 7, and 74,2; and these numbers, if each shot kept to a vertical plane, ought to be in the proportion of 1 to 5, that being the proportion of the distances of the second screen and of the wall from the first. But the last number 74,2 exceeds what it ought to be by this analogy, by 39,2; so that between them there is a deviation from the vertical plane of above 39 inches, and this too in a transit of little more than eighty yards.

"But further, to shew that these irregularities do not depend upon any accidental circumstances of the ball's fitting or not fitting the piece, there were five shot more made with the same quantity of powder as before; but with smaller bullets, which ran much looser in the piece. And the horizontal distances being measured in inches from the trace of the first bullet to each of the succeeding ones, the numbers were as follow:

	1st screen	2d screen	wall
1 to 2	15,6 R	31,1 R	94,0 R
3	6,4 L	12,75 L	23,0 L
4	4,7 R	8,5 R	15,5 R
5	12,6 R	24,0 R	63,5 R

"Here again, on the supposed fixed position of the piece, the horizontal distance on the wall, between the first and third, will be found to be above fifteen inches less than it should be, if each kept to a vertical plane. And like irregularities, though smaller, occur in every other experiment. And if they are examined according to the third method set down above, and the horizontal distances of the third and fourth, for instance, are compared, these on the first and second screen, and on the wall, appear to be thus:

1st screen	2d screen	wall
11,1	21,25	38,5

"And if the horizontal distance on the first screen is taken from the other two, the remainders will be 10,15 and 27,4; where the last of them, instead of being five times the first, as it ought to be, is 23,35 short of it. So that here there is a deviation of above 23 inches.

"From all these experiments the deflection in question seems to be incontestably evinced. But to give some farther light to this subject, I took a barrel of the same bore with that hitherto used, and bent it at about three or four inches from its muzzle to the left, the bend making an angle of 3° or 4° with the axis of the piece. This piece, thus bent, was fired with a loose ball and the same quantity of powder hitherto used, the screens of the last experiment being still continued. It was natural to expect that if this piece was pointed by the general direction of its axis, the ball would be canted to the left of that direction by the bend near its mouth. But as the bullet, in passing through that bent part, would, as I conceived, be forced to roll upon the right-hand side of the barrel; and thereby the left side of the bullet would turn up against the air, and would increase the resistance on that side; I predicted to the company then present, that if the axis on which the bullet whirled did not shift its position after it was separated from the piece, then, notwithstanding the bend of the piece to the left, the bullet itself might be expected to incurvate towards the right; and this, upon trial, did most remarkably happen. For one of the bullets fired from this bent piece, passed through the first screen about 1½ inch distant from the trace of one of the shot fired from the straight piece in the last set of experiments. On the second screen the traces of the same bullets were about three inches distant, the bullet from the crooked piece passing on both screens to the left of the other; but comparing the places of these bullets on the wall, it appeared that the bullet from the crooked piece, though it diverged from the track of the other on the two screens, had now crossed that track, and was deflected considerably to the right of it; so that it was obvious, that, though the bullet from the crooked piece might at first be canted to the left, and had diverged from the track of the other bullet, with which it was compared; yet by degrees it deviated again to the right, and a little beyond the second screen crossed that track, from which it before diverged; and on the wall was deflected fourteen inches, as I remember, on the contrary side. And this experiment is not only the most convincing proof of the reality of this deflection here contended for; but is likewise the strongest confirmation, that it is brought about in the very manner, and by the very circumstances, which we have all along described.

"To prevent this irregularity, rifled barrels are made use of; and here it happens, that, when the piece is fired, the zone of the bullet follows the sweep of the rifles; and thereby, besides its progressive motion, acquires a circular motion round the axis of the piece, which circular motion will be continued to the bullet, after its separation from the piece; by which means a bullet discharged from a rifled barrel is constantly made to whirl round an axis, which is coincident with the line of its flight. And hence it follows, that the resistance on the foremost surface of the bullet is equally distributed round the pole of its circular motion; and acts with an equal effort on every side of the line of direction; so that this resistance can produce no deviation from that line. And (which is still of more importance), if by the casual irregularity of the foremost surface of the bullet, or by any other accident, the resistance should be stronger on one side of the pole of the circular motion than on the other; yet, as the place, where this greater resistance acts, must perpetually shift its position round the line in which the bullet flies, the deflection, which this inequality would occasion, if it acted constantly with the same given tendency, is now continually rectified by the various and contrary tendencies of that disturbing force, during the course of one revolution.

"This perpetual correction of a deflective effort on the foremost surface of the bullet, in consequence of the revolution of the bullet round the line of its direction, may perhaps be exemplified, by considering what happens to a castle-top, whilst it spins upon its point. For it will be easily acknowledged, that this, without its revolving motion, could not continue for the least portion of time in that situation. And if we examine how this happens, we shall find, that, though its centre of gravity is not exactly over the point it spins on, yet that inequality cannot instantly bring it to the ground according to its natural effort; because, during one revolution, the centre of gravity preponderates on every side of the top; and thereby raises it as much in one place, as it depressed it in another. And this reasoning (supposing that the tendency of the centre of gravity of the top to descend, be analogous to the action of the unequal resistance on the foremost surface of a bullet fired from a rifled barrel) will easily explain how, notwithstanding that inequality, the bullet keeps true to its track without deflection. And what is here advanced, is farther confirmed by the general practice with regard to arrows. For it is well known to every archer, that the feathers of an arrow are placed in a spiral form, so as to make the arrow spin round its axis; without which it would be obvious to the eye, that the arrow undulated in the air, and did not keep accurately to its direction. And it is owing to the same principle, that every school-boy finds himself under the necessity of making his shuttlecock spin, before he can depend upon the truth of its flight.

"This is the general theory of the motion of bullets discharged from rifled pieces; and it is found by experiment, that their actual motions correspond very well with these speculations. For the exactness which those who are dextrous in the use of these pieces attain to, is indeed wonderful; and that at such distances, that if the bullets were fired from the common pieces, in which the customary aberration takes place, not one in twenty of them could ever be traced.

"This may suffice as to the general idea of the form and convenience of a rifled piece; and here it will be expedient to insert some experiments, by which it will appear, how well it answers the purpose I have mentioned above; I mean that of keeping the ball to its regular track, by preventing that deflection, which, as we have seen, takes place in the bullets fired from common pieces.

"And first I considered, that in consequence of the reasoning about the manner in which it produces this effect; it should follow, that the same hemisphere of the bullet which lies foremost in the piece, must continue foremost during the whole course of its flight.

"To examine this particular, I took a rifled barrel carrying a bullet of six to the pound; but instead of its leaden bullet, I used a wooden one of the same size, made of a soft springy wood, which bent itself easily into the rifles without breaking. And, firing the piece thus loaded against a wall at such a distance, as the bullet might not be shivered by the blow; I always found, that the same surface, which lay foremost in the piece, continued foremost without any sensible deflection, during the time of its flight. And this was easy to be observed, by examining the bullet; as both the marks of the rifles, and the part that impinged on the wall, were sufficiently apparent.

"Now, as these wooden bullets were but the sixteenth part of the weight of those of lead; I conclude, that if there had been any unequal resistance or defective power, its effects must have been extremely sensible upon this light body; and consequently in some of the trials I made, the surface, which came foremost from the piece, must have been turned round into another situation.

"But again, I took the same piece, and loading it now with a leaden ball, I set it nearly perpendicular, sloping it only three or four degrees from the perpendicular, in the direction of the wind; and firing it in this situation, the bullet generally continued about half a minute in the air, it rising by computation to near three quarters of a mile perpendicular height.

"In these trials I found, that the bullet commonly came to the ground to the leeward of the piece, and at such a distance from it, as nearly corresponded to its angle of inclination, and to the effort of the wind; it usually falling not nearer to the piece than a hundred, nor farther from it than a hundred and fifty yards. And this is a strong confirmation of the almost steady flight of this bullet for about a mile and a half. For were the same trial made with a common piece, I doubt not that the deviation would often amount to half a mile, and perhaps considerably more; though this experiment would be a very difficult one to examine, on account of the little chance there would be of discovering where the ball fell."

It now remains to speak of the sights, which, although they do not constitute the essential part of a rifle, as they may be used with a plain bored barrel; yet as that is seldom done, and as they are always used with a rifle, it will not be proper to omit mentioning them.

It may be strictly said, that no part of the path of the bullet when fired from a rifle or musket is in a right line, as gravity acts upon the bullet the instant it quits the mouth of the piece; and although at a short distance the effect is not very perceptible, yet it is considerably so at 100 yards; and at 200 yards, the ball would probably strike the ground before it could reach the object aimed at. To remedy this inconvenience, it is found necessary to aim exactly at such a height above the object, as the ball would have been depressed to, by the power of gravity, had it been aimed at it point-blank; so that if we suppose this depression to be a foot in a hundred yards, we must aim a foot above the object. But here another inconvenience arises; for if we aim above the object by raising the muzzle of the piece, the object is excluded from our view by the intervention of the barrel; so that we are prevented from measuring the distance with the eye, and instead of one, are liable to aim two or three feet above it.

This second difficulty is removed by depressing the breech of the gun, instead of elevating the muzzle; and the quantity of the depression is measured with great nicety, by what are called the sights.

On the upper surface of the barrel, at right angles with its axis, is fixed a piece of flat thin iron (see Plate fig. 3), about six inches from the breech, and on the centre of its top, a small square notch is filed. This is called the back sight. The front sight is nothing more than the small knob of iron or brass, which is fixed on all fowling-pieces, about half an inch from the muzzle. When aim is taken, the eye is raised over the back sight, till the front sight appears through the notch, which is then brought upon the object, and forms the right line ABCD, Plate fig. 2.

But here it is evident, that the breech of the barrel is depressed in the proportion of the height of the back sight B; that the axis of the barrel forms an inclined plane with the right line ABC; that the course of the ball, if not acted upon by gravity, would be in the line ECF; and that the ball would strike at G, considerably above the object D. But being depressed in its course by the law of gravity, it will make the curve H and descend to D.

By looking at the figure it is immediately seen, that if the object aimed at had been at J, or any point nearer than D, the ball would have passed over it; and if it had been at K, or farther than D, it would have passed under it. The height of the back sight must be regulated by experiment. The government rifles have only one fixed sight, which are intended for 200 yards; but if an enemy is seen at 100 yards, aim must be taken at the knee; if at 150, below the middle. At 250 yards, the head must be aimed at; and at 300, the sight becomes useless, as it would be necessary to aim over his head, and then the inconvenience before mentioned recurs; to prevent which, the folding or additional sights are used as in figure 3, where the sight A is calculated for 150, B for 200, and C for 300 yards; beyond which distance it becomes almost useless to fire at any object of the size of a man.

Mr. Robins, who has done more on this subject than any other person, concludes an excellent paper with predicting, that whatever state shall thoroughly comprehend the nature and advantages of rifled-barrel pieces; and having facilitated and completed their construction, shall introduce into their armies their general use, with a dexterity in the management of them; will by this means acquire a superiority, which will almost equal any thing that has been done at any time by the particular excellence of any one kind of arms; and will perhaps fall but little short of the wonderful effects, which history relates to have been formerly produced, by the first inventors of fire-arms.

RIGGING of a ship, is all her cordage and ropes, belonging to her masts, yards, &c. See Ship-building.

RIGHT, in geometry, signifies the same with straight: thus a straight line is called a right one.

Right, in law, not only denotes property, for which a writ of right lies, but also any title or claim, either by virtue of a condition, mortgage, &c. for which no action is given by law, but an entry only.

By stat. 1 Will. and Mar. cap. ii. the following particulars relating to the ill conduct of king James II. were declared to be illegal, and contrary to the antient rights and liberties of the people, viz. his exercising a power of dispensing with, and suspending of, laws; his levying money without consent of parliament; violating the freedom of elections; causing partial and corrupt jurors to be returned on trials, excessive bail to be taken, and excessive fines to be imposed, as well as cruel punishments to be inflicted, &c.

RIM, in a watch, or clock, the edge or border of the circumference or circular part of a wheel.

RING, in navigation and astronomy, a brass instrument, made in the form of a ring, and serving to take altitudes of the sun. See Plate Miscel. fig. 209.

At C is a small hole, in the direction CD, which is perpendicular to CE; this hole is precisely 45° from A, and CE is parallel to the vertical diameter AB. From C, as a centre, they describe a quadrant of a circle CED; which being nicely divided into 90°, they mark upon the internal surface of the ring the places where rays, drawn from C to these degrees, cut the said surface.

To use this ring, they hold it up by the swivel, and turn the side with the hole C towards the sun; and then the sun-beams passing through the hole, make a luminous spot among the degrees, whereby the altitude is found. Some prefer the ring to the astrolabe, by reason its divisions are larger; however, it is far from being exact enough to be much depended on in astronomical observations, which are better made by quadrants. See Astrolabe, and Quadrant.

RIOT, in law. When three persons or more shall assemble themselves together, with an intent mutually to assist one another, against any who shall oppose them in the execution of some enterprise of a private nature, with force or violence, against the peace, or to the manifest terror of the people, whether the act intended was of itself lawful or unlawful: if they only meet for such a purpose or intent, though they shall after depart of their own accord without doing any thing, this is an unlawful assembly. 1 Haw. 155.

If after their first meeting, they shall move forwards towards the execution of any such act, whether they put their intended purpose into execution or not; this according to the general opinion is a riot. Id.

By 34 Ed. Ire. c. 1, it is enacted, that if a justice find persons riotously assembled, he alone has not only power to arrest the offenders, and bind them to their good behaviour, or imprison them if they do not offer good bail: but he may also authorize others to arrest them, by a bare verbal command, without other warrant; and by force thereof, the persons so commanded, may pursue and arrest the offenders in his absence as well as presence. It is also said, that after any riot is over, any one justice may send his warrant to arrest any person who was concerned in it, and that he may send him to gaol till he shall find sureties for his good behaviour. 1 Haw. 160.

The punishment of unlawful assemblies, if to the number of twelve, may be capital, according to the circumstances which attend them: but from the number of three to eleven, is by fine and imprisonment only. The same is the case by riots and routs by the common law, to which the pillory in very enormous cases has been sometimes superadded. 4 Black. c. 11.

By stat. 1 Geo. I. cap. 5, if any persons to the number of twelve or more, unlawfully and riotously assembled, continue together for an hour, after being required, by a justice of the peace, or other magistrate, to disperse, they shall be deemed guilty of felony without benefit of clergy. However, prosecutions upon this statute must be begun within one year after the offence is committed.

RITE, among divines, denotes the particular manner of celebrating divine service, in a particular country.

RITTERA, a genus of the class and order polyandria monogynia. The calyx is four-leaved; petal one; legume one-celled, two-valved. There are five species, trees of the West Indies.

RITUAL, a book directing the order and manner to be observed in celebrating religious ceremonies, and performing divine service, in a particular church, diocese, order, or the like.

RIVERS. With any person who has carefully observed the course of rivers, and traced them to their sources, there can be little doubt that they are formed by the confluence of springs, or of the little streams or rivulets that issue from them; with perhaps the exception of those rivers which proceed from lakes, where the reservoir is ready-formed, and generally by the same means.

In the beginning of the present century, the philosophical world was agitated by a debate concerning the origin of those waters which are necessary for the supply of rivers, &c. One party contended strongly for the existence of a large mass of water within the bowels of the earth, which supplied not only the rivers but the ocean itself; at the head of these we may place the ingenious but fanciful Burnet. The French philosophers, on the contrary, asserted, that the waters of the ocean were conveyed back by some subterraneous passages to the land, and being filtrated in their passage, returned again to the sea in the course of the rivers; but this opinion appears contrary to all the known principle of hydrostatics.

In opposition to these hypotheses, our illustrious countryman Halley contended that the process of evaporation, and the immense deposition of water in consequence of it, were fully adequate to the whole supply. If, indeed, we consider the immense quantity of water which is continually carried up into the atmosphere by evaporation (see EVAPORATION), and consider that this is a process which is continually going on, not only from the ocean but from the rivers themselves, and from the whole surface of the earth, we shall see but little reason to doubt of Dr. Halley's hypothesis; but may reasonably conclude, that this kind of circulation is carried on through all nature; and that the sea receives back again through the channel of the rivers, that water which it parts with to the atmosphere.

All rivers have their source either in mountains, or elevated lakes; and it is in their descent from these, that they acquire that velocity which maintains their future current. At first their course is generally rapid and headlong; but it is retarded in its journey by the continual friction against its banks, by the many obstacles it meets to divert its stream, and by the plane's generally becoming more level as it approaches towards the sea.

Rivers, as every body has seen, are always broadest at the mouth, and narrower towards their source. But what is less known, and probably more deserving curiosity, is, that they run in a more direct channel as they immediately leave their sources; and that their sinuosities and turnings become more numerous as they proceed. It is a certain sign among the savages of North America, that they are near the sea, when they find the rivers winding, and every now and then changing their direction. And this is even now become an indication to the Europeans themselves, in their journeys through those trackless forests. As those sinuosities, therefore, increase as the river approaches the sea, it is not to be wondered at, that they sometimes divide, and thus disembogue by different channels. The Danube disembogues into the Euxine by seven mouths; the Nile, by the same number; and the Wolga, by seventy.

The largest rivers of Europe are, first, the Wolga, which is about six hundred and fifty leagues in length, extending from Rescnow to Astrachan. It is remarkable of this river, that it abounds with water during the summer months of May and June; but all the rest of the year is so shallow as scarcely to cover its bottom, or allow a passage for loaded vessels that trade up its stream. The next in order is the Danube. The course of this is about four hundred and fifty leagues, from the mountains of Switzerland to the Black Sea. The Don, or Tanais, which is four hundred leagues from the source of that branch of it called the Softna, to its mouth in the Euxine Sea. In one part of its course it approaches near the Wolga; and Peter the Great had actually begun a canal, by which he intended joining those two rivers; but this he did not live to finish. The Nieper, or Borysthenes, which rises in the middle of Muscovy, and runs the course of three hundred and fifty leagues, to empty itself into the Black Sea. The Old Cossacks inhabit the banks and islands of this river; and frequently cross the Black Sea, to plunder the maritime places on the coasts of Turkey. The Dwina, which takes its rise in a province of the same name in Russia, that runs a course of three hundred leagues, and disembogues into the White Sea, a little below Archangel.

The largest rivers of Asia are, the Hoanho, in China, which is eight hundred and fifty leagues in length, computed from its source at Raja Ribron, to its mouth in the Gulph of Changi. The Jenisca of Tartary, about eight hundred leagues in length, from the lake Selinga to the Icy Sea. This river is, by some, supposed to supply most of that great quantity of drift-wood which is seen floating in the seas, near the Arctic circle. The Oby, of five hundred leagues, running from the lake of Kila into the Northern Sea. The Amour, in Eastern Tartary, whose course is about five hundred and seventy-five leagues, from its source to its entrance into the sea of Kamtschatka. The Kiam, in China, five hundred and fifty leagues in length. The Ganges, one of the most noted rivers in the world, and about as long as the former. It rises in the mountains which separate India from Tartary; and running through the dominions of the Great Mogul, discharges itself by several mouths into the bay of Bengal. It is not only esteemed by the Indians for the depth and pureness of its stream, but for a supposed sanctity which they believe to be in its waters. It is visited annually by several hundred thousand pilgrims, who pay their devotions to the river as to a god; for savage simplicity is always known to mistake the blessings of the Deity for the Deity himself. They carry their dying friends, from distant countries, to expire on its banks, and to be buried in its stream. The water is lowest in April or May; but the rains beginning to fall soon after, the flat country is overflowed for several miles, till about the end of September; the waters then begin to retire, leaving a prolific sediment behind, that enriches the soil, and, in a few days time, gives a luxuriance to vegetation, beyond what can be conceived by an European. Next to this may be reckoned the still more celebrated river Euphrates. This rises from two sources, northward of the city Erzerum, in Turcomania; and unites about three days journey below the same, whence, after performing a course of five hundred leagues, it falls into the Gulph of Persia, fifty miles below the city of Bassora in Arabia. The river Indus is extended, from its source to its discharge into the Arabian sea, four hundred leagues.

The largest rivers of Africa are: the Senegal, which runs a course of not less than eleven hundred leagues, comprehending the Niger, which some have supposed to fall into it. Later accounts, however, seem to affirm that the Niger is lost in the sands, about three hundred miles up from the western coasts of Africa. Be this as it may, the Senegal is well known to be navigable for more than three hundred leagues up the country; and how much higher it may reach is not yet discovered, as the dreadful fatality of the inland parts of Africa not only deters curiosity, but even avarice, which is a much stronger passion. The celebrated river Nile is said to be nine hundred and seventy leagues, from its source among the mountains of the Moon, in Upper Ethiopia, to its opening into the Mediterranean Sea. Upon its arrival in the kingdom of Upper Egypt, it runs through a rocky channel, which some late travellers have mistaken for its cataracts. In the beginning of its course, it receives many lesser rivers into it; and Pliny was mistaken, in saying that it received none. In the beginning also of its course, it has many windings; but, for above three hundred leagues from the sea, runs in a direct line. Its annual overflowings arise from a very obvious cause, which is almost universal with the great rivers that take their source near the Line. The rainy season, which is periodical in those climates, floods the rivers; and as this always happens in our summer, so the Nile is at that time overflown. From these inundations the inhabitants of Egypt derive happiness and plenty; and, when the river does not arrive at its accustomed height, they prepare for an indifferent harvest. It begins to overflow about the 17th of June; it generally continues to augment for forty days, and decrease in about as many more. The time of increase and decrease, however, is much more inconsiderable now than it was among the antients. Herodotus informs us, that it was a hundred days rising, and as many falling; which shews that the inundation was much greater at that time than at present. M. Buffon has ascribed the present diminution, as well to the lessening of the mountains of the Moon, by their substance having so long been washed down with the stream, as to the rising of the earth in Egypt, that has for so many ages received this extraneous supply. But we do not find, by the buildings that have remained since the times of the antients, that the earth is much raised since then. Besides the Nile in Africa, we may reckon Zara, and the Coanza, from the greatness of whose openings into the sea, and the rapidity of whose streams, we form an estimate of the great distance whence they come. Their courses, however, are spent in watering deserts and savage countries, whose poverty or fierceness have kept strangers away.

But of all parts of the world, America, as it exhibits the most lofty mountains, so also it supplies the largest rivers. The principal of these is the great river Amazons, which, from its source in the lake of Lauricocha, to its discharge into the Western Ocean, performs a course of more than twelve hundred leagues. The breadth and depth of this river is answerable to its vast length; and, where its width is most contracted, its depth is augmented in proportion. So great is the body of its waters, that other rivers, though before the objects of admiration, are lost in its bosom. It proceeds after their junction, with its usual appearance, without any visible change in its breadth or rapidity; and, if we may so express it, remains great without ostentation. In some places it displays its whole magnificence, dividing into several large branches, and encompassing a multitude of islands; and at length, discharging itself into the ocean, by a channel of an hundred and fifty miles broad. Another river, that may almost rival the former, is the St. Lawrence, in Canada, which rising in the lake Assiniboils, passes from one lake to another, from Christinaux to Alempigo; and thence to lake Superior; thence to the lake Hurons; to lake Erie; to lake Ontario; and, at last, after a course of nine hundred leagues, pours their collected waters into the Atlantic Ocean. The river Mississippi is more than seven hundred leagues in length, beginning at its source near the lake Assiniboils, and ending at its opening into the Gulph of Mexico. The river Plata runs a length of more than eight hundred leagues from its source in the river Parana, to its mouth. The river Oroonoko is seven hundred and fifty leagues in length, from its source near Pasto, to its discharge into the Atlantic ocean.

Such is the amazing length of the greatest rivers; and even in some of these, the most remote sources very probably yet continue unknown. In fact, if we consider the number of rivers which they receive, and the little acquaintance we have with the regions through which they run, it is not to be wondered at that geographers are divided concerning the sources of most of them. As among a number of roots by which nourishment is conveyed to a stately tree, it is difficult to determine precisely that by which the tree is chiefly supplied; so among the many branches of a great river, it is equally difficult to tell which is the original. Hence it may easily happen, that a similar branch is taken for the capital stream; and its runnings are pursued and delineated, in prejudice of some other branch that better deserved the name and the description. In this manner, in Europe, the Danube is known to receive thirty lesser rivers; the Wolga thirty-two or thirty-three. In Asia, the Hohanno receives thirty-five; the Jenisca above sixty; the Oby as many; the Amour about forty; the Nanquin receives thirty rivers; the Ganges twenty; and the Euphrates about eleven. In Africa, the Senegal receives more than twenty rivers; the Nile receives not one for five hundred leagues upwards, and then only twelve or thirteen. In America, the river Amazons receives above sixty, and those very considerable; the river St. Lawrence about forty, counting those which fall into its lakes; the Mississippi receives forty; and the river Plata above fifty.

The inundations of the Ganges and the Nile have been already mentioned, and it might be added, that almost all great rivers have their periodical inundations from similar causes. The author already quoted observes, that, "besides these annually periodical inundations, there are many rivers that overflow at much shorter intervals. Thus most of those in Peru and Chili have scarce any motion by night; but upon the appearance of the morning sun they assume their former rapidity; this proceeds from the mountain snows, which, melting with the heat, encrease the stream, and continue to drive on the current while the sun continues to dissolve them."

There are some rivers which are said to lose themselves in chasms under the earth, and to flow for several miles in secret and undiscovered channels. On this circumstance is founded one of the most beautiful fables of antiquity, relative to the fountain of Arethusa, in Sicily. The same thing is affirmed of the Rhine, and even of the river Mole, in Surrey, which, from this circumstance derives its name. With respect to the two latter rivers, however, some doubts are entertained of the fact.

On this subject there is a memoir of the academy of sciences lately published, by the abbé Guettard. "It is very surprising (he observes) if we reflect on it, that a river in its course, which is very often very extensive, should not meet with spongious soils to swallow up its waters, or gulphs in which they are lost; nevertheless, as there has been hitherto known but a small number of rivers whose waters thus disappear, this phenomenon has been accounted very extraordinary, both by the ancients and moderns. Mr. Guettard next describes what he has observed in several rivers of Normandy, which are lost and afterwards appear again; these are five in number, viz. the Rille, the Ithon, the Aure, the river of Sap-Audré, and the Drôme. The three first disappear gradually, and then come in sight again; the fourth loses itself entirely by degrees, but afterwards re-appears; the fifth loses some of its water in its course, and ends by precipitating itself into a cavity, whence it is never seen to rise again.

What seems to occasion the loss of the Rille, the Ithon, and the Aure, is the nature of the soil through which they pass. M. Guettard has observed that it is in general porous, and composed of a thick sand, the grains of which are not well compacted together; it sinks suddenly down by its own weight in some places, and there forms great holes; and when the water overflows the meadows, it frequently makes many cavities in several parts of them. If we therefore suppose inequalities in the channels of these rivers, and that there are certain places in which the water stagnates longer than in others, it must there dilute the ground, if we may use that expression; and having carried away the parts which united the grains of sand together, those grains will become afterwards no other than a kind of sieve, through which the waters will filtrate themselves, provided nevertheless that they find a passage under ground through which they may run. This conjecture appears to be so well founded, that each of these three rivers loses itself nearly in the same manner, that is, through cavities which the people of the country call betoirs, and which swallow up more or less according to their largeness. M. Guettard, who has carefully examined them, remarks, that these betoirs are holes in the form of a tunnel, whose diameter and aperture is at least two feet, and sometimes exceeds eleven; and whose depth varies in like manner from one and two feet, to five, six, and even twenty. The Rille during the summer season loses almost all its water in the space of two short leagues; the Ithon does very near the same. But M. Guettard observes something curious concerning this river, that formerly it was not lost, but kept its course without any interruption, as appears by the history of the country; very likely the mud, which had been collected together in several parts of its channel, might have occasioned the waters remaining in others, and have caused many betoirs. This is the more likely, as the mud having been collected together in the bed of the river Aure, it appears that, in consequence, the cavities were greatly encreased, which makes it lose itself much sooner than formerly. Besides, possibly an earthquake happening in the country might have caused several subterraneous canals through which the water of the Ithon has forced its way. In effect, it appears, that a soil's being porous is not sufficient to cause the loss of a river; for if it was, then to do so it would occasion many fens round about, nor would it renew its course after having disappeared a certain time; it must besides, find ways under ground through which it may take its course. M. Guettard seems also mcuh inclined to believe, that there are, in these parts, subterraneous cavities through which the waters may flow; and in consequence of this he reports a number of facts, all tending to prove the truth of it, or at least to prove that there must be hollow quarries serving for strainers to these waters. Upon which occasion he goes into a discussion of this question: Are there any subterraneous rivers, and is the prepossession of some persons in favour of this particular well founded? He makes it appear by several instances which he quotes, and by many reasons which he alleges, that there are at least very great presumptions in favour of this opinion. We are too apt not to look beyond the exterior of things: we feel resistance upon the surface of the earth; when we go deep, we often find it compact. It is therefore hard for us to imagine that it can contain subterraneous cavities sufficient to form channels for hidden rivers, or for any considerable body of water; in a word, that it can contain vast caverns; and yet every thing seems to indicate the contrary. A fact that is observed in the betoirs of the rivers concerning which we have spoken, and particularly of the Rille, proves in some measure that there are considerable lakes of waters in the mountains which limit its course: this fact is, that in winter the greatest part of their betoirs become springs, which supply anew the river's channel with as much water as they had absorbed from it during the summer. Now from whence can that water come, unless from the reservoirs or lakes that are inclosed in the mountains, which being lower than the river in summer, absorb its water, and being higher in winter by the rain they receive, send it back again in their turn?

M. Guettard strengthens this conjecture by several instances that render it very probable: he remarks at the same time, that this alternate effect of the betoirs swallowing up the water and restoring it again, causes perhaps an invincible obstacle to the restraining of the water within the channel of the river. It has indeed been several times attempted to stop those cavities; but the water returns with such violence in winter, that it generally carries away the materials with which they were stopped.

The river of Sap-André is lost in part, as we have before said, in the same manner as the Ithon and the Rille; but there is something more remarkable in it than in those rivers; to wit, that at the extremity of its course, where there is no perceptible cavity, it is ingulphed, but without any fall; the water passes between the pebbles, and it is impossible to force a stick into that place any further than into the betoirs of which we have spoken. What makes this river take that subterraneous direction, is an impediment which its stream meets with in that place; it is there stopped by a rising ground six or seven feet high, whose bottom it has very likely undermined, to gain a free passage, not having been able to make its way over it. At some distance it appears again; but in winter, as there is a greater quantity of water, it passes over that eminence, and keeps an uninterrupted course.

Lastly, the Drôme, after having lost some of its water in its course, vanishes entirely near the pit of Soucy; in that place it meets with a sort of subterraneous cavity near 25 feet wide, and more than 15 deep, where the river is in a manner stopped, and into which it enters, though without any perceptible motion, and never appears again.

M. Guettard finishes this memoir with some observations upon the Ierre. This river is lost in the same manner as the Rille; and though it is very near Paris, this singularity is unknown to almost every body; was it not for the account of M. l'Abbé le Bœuf, M. Guettard would have been also ignorant of it. And as he thinks the chief object of a naturalist's observation ought to be the public good, he examines the means which might be employed to restrain the water of the Ierre. The same object has made him add a description of the manner how the Rhone is lost, or rather how its course is disturbed; for it is now very certain that it does not lose itself, but that its channel is extremely confined, in the place where it was pretended that it lost itself, by two mountains, between whose feet it runs. M. Guettard makes it appear that it might not be impossible to widen that place, and give a sufficient channel to the river; which would render it navigable, and be of vast utility to all the country.

The many advantages which accrue to a country from an abundance of rivers, especially large navigable ones, are too obvious to require any particular detail; but the disadvantages and calamities occasioned by them are frequently no less obvious and fatal. Whole tracts of country are sometimes overflowed on a sudden, and every thing swept away at once; or if the deluge proceeds not such a length, yet by the quantity of stagnating water which is left, marshes are produced, which bring on diseases in the neighbouring parts. It becomes therefore an object well worthy the public attention, how to secure the banks of rivers, or to form their channels in such a manner that the superfluous water may be carried off into the ocean without producing the mischievous effects abovementioned. In a treatise on rivers and canals published in the Phil. Trans. vol. 69. by Mr. Mann, he treats this subject at great length. Having laid down a number of theorems concerning the descent of the water in rivers, he points out a method of determining whether the motion of a river in any particular place is derived from the inclination of the bottom of its channel, or merely from the pressure of the upper parts of the water upon the lower. "For this purpose," says he, "a pole must be thrust down to the bottom, and held perpendicularly to the current of the water, with its upper end above the surface; if the water swells and rises immediately against the pole, it shows that its flowing is by virtue of a preceding declivity; if, on the contrary, the water stops for some moments before it begins to rise against the pole, it is a proof that it flows by means of the compression of the upper waters upon the lower."

The best and most simple method of measuring the velocity of the current of a river, according to our author, is as follows: "Take a cylindrical piece of dry light wood, and of a length something less than the depth of the water in the river; round one end of it let there be suspended as many small weights as may be necessary to keep up the cylinder in a perpendicular situation in the water, and in such a manner that the other end of it may just appear above the surface of the water. Fix to the centre of that end which appears above water a small and straight rod precisely in the direction of the cylinder's axis; to the end that, when the instrument is suspended in the water, the deviations of the rod from a perpendicularity to the surface of it may indicate which end of the cylinder advances the fastest, whereby may be discovered the different velocities of the water at different depths; for if the rod inclines forwards according to the direction of the current, it is a proof that the surface of the water has the greatest velocity; but if it inclines back, it shows that the swiftest current is at the bottom; if it remains perpendicular, it is a sign that the velocities at the surface and bottom are equal.

"This instrument being placed in the current of a river or canal receives all the percussions of the water throughout the whole depth, and will have an equal velocity with that of the whole current from the surface to the bottom at the place where it is put in; and by that means may be found, both with ease and exactness, the mean velocity of that part of the river for any determinate distance and time.

"But to obtain the mean velocity of the whole section of the river, the instruments must be put successively both in the middle and towards the sides, because the velocities at those places are often very different from each other. Having by this means found the difference of time required for the currents to run over an equal space, or the different distances run over in equal times; the mean proportional of all these trials, which is found by dividing the common sum of them all by the number of trials, will be the mean velocity of the river or canal.

"If it is required to find the velocity of the current only at the surface, or at the middle, or at the bottom, a sphere of wood, of such a weight as will remain suspended in equilibrium with the water at the surface or depth which we want to measure, will be better for the purpose than a cylinder, because it is only affected by the water of that part of the current where it remains suspended.

It is a very easy guide both to the cylinder and the globe in that part which we want to measure, by means of two threads, or small cords, which two persons must hold and direct, one on each side of the river; taking care at the same time neither to retard nor accelerate the motion of the instrument."

Our author next proceeds to deduce from his theory the best methods of removing the defects and inconveniencies which must necessarily happen to rivers and canals in a series of years. From his theory he draws the following conclusion: that the deeper the waters are in their bed in proportion to its breadth, the more their motion is accelerated; so that their velocity increases in an inverse ratio of the breadth of the bed, and also of the greatness of the section; whence are deduced the two following universal practical rules: 1st. To augment the velocity of water in a river or canal, without augmenting the declivity of the bed, we must increase the depth and diminish the breadth of its bed. 2dly. But to diminish the velocity of water in a river or canal, we must, on the contrary, increase the breadth and diminish the depth of its bed.

The above proposition is perfectly conformable to observation and experience: for it is constantly seen, that the current is the swiftest where the waters are deepest and the breadth of the bed the least, and that they flow slowest where their depth is the least and the breadth of the bed the greatest. "The velocity of the waters" says M. de Buffon, "augments in the same proportion as the section of the channel through which they pass diminishes, the force of impulsion from the back waters being supposed always the same. Nothing," continues he, "produces so great a diminution in the swiftness of a current as its growing shallow; and on the contrary, the increase of the volume of water augments its velocity more than any other cause whatever." The celebrated Wolfe in his hydraulics assures us, that "it is a constant and universal practice, for accelerating the current of waters, to deepen the bed, and at the same time to render it narrower."

When the velocity which a river has acquired by the elevation of its springs and the impulse of the back water, is at last totally destroyed by the different causes of resistance becoming exactly equal to, or greater than, the first, the bed and current at the same time being horizontal, nothing else remains to propagate the motion, except the sole perpendicular compression of the upper waters upon the lower, which is always in a direct ratio of their depth. But this necessary resource, this remaining cause of motion in rivers, augments in proportion as all the others diminish, and as the want of it increases; for as the waters of rivers in extensive plains lose the acceleration of motion acquired in their descent from their springs, their quantity accumulates in the same bed by the junction of several streams together, and their depth increases in consequence. This junction and successive accumulation of many streams in the same bed, which we see universally in a greater or lesser degree in all rivers throughout the known world, and which is so absolutely necessary to the motion of their waters, can only be attributed, says Signor Guglielmini, to the infinite wisdom of the supreme Author of Nature.

The velocities of flowing waters is very far from being in proportion to the quantity of declivity in their bed. If it was a river whose declivity is uniform and double to that of another, it ought only to run with double the swiftness when compared to it; but in effect it is found to have a much greater, and its rapidity, instead of being only double, will be triple, quadruple, and sometimes even more; for its velocity depends much more on the quantity and depth of the water, and on the compression of the upper waters on the lower, than on the declivity of the bed. Consequently, whenever the bed of a river or canal is to be dug, the declivity must not be distributed equally throughout the whole length; but, to give a swifter current to the water, the declivity must be much greater in the beginning of its course than towards the end where it disembogues itself, and where the declivity must be almost insensible, as we see is the case in all natural rivers; for when they approach near the sea, their declivity is little or nothing; yet they flow with a rapidity which is so much greater, as they contain a greater volume of water; so that in great rivers, although a large extent of their bed next the sea should be absolutely horizontal, and without any declivity at all, yet their waters do not cease to flow, and to flow even with great rapidity, both from the impulsion of the back-waters, and from the compression of the upper waters upon the lower in the same section.

Whoever is well acquainted with the principles of the higher geometry, will easily perceive that it would be no difficult matter so to dig the bed of a canal or river, that the velocity of the current should be every where equal. It would be only giving it in the form of a curve along which a moving body should recede from a given point, and describe spaces every where proportional to the times, allowance being made for the quantity of effect of the compression of the upper waters upon the lower. This curve is what is called the horizontal isochronic, being the flattest of an infinity of others which would equally answer the problem where fluids were not concerned.

All obstacles whatever in the bed of a river or canal, such as rocks, trunks of trees, banks of sand and mud, &c. must necessarily hinder proportionably the free running off of the water; for it is evident, that the waters so far back from these obstacles, until the horizontal level of the bottom of the bed becomes higher than the top of the obstacles, must be entirely kept up and hindered from running off in proportion. Now as the waters must continue to come down from their sources, if their free running off is hindered by any obstacles whatever, their relative height back from them must necessarily be increased until their elevation, combined with the velocity of their current proceeding from it, is arrived to such a pitch at the point where the obstacles exist, as to counterbalance the quantity of opposition or impediment proceeding thence, which frequently does not happen until all the lower parts of the country round about are laid under water.

Now it is certain from all experience, that the beds of rivers and canals in general are subject to some or others of the obstacles above-mentioned. If rocks or trees do not bar their channels, at least the quantity of sand, earth, and mud, which their streams never fail to bring down, particularly in floods, and which are unequally deposited according to the various windings and degrees of swiftness in the current, must unavoidably, in course of time, fill up, in part, different places in the channel, and hinder the free running off of the back-waters. This is certainly the case, more or less, in all rivers, and in all canals of long standing, as is notorious to all those well acquainted with them. Hence, if these accidents are not carefully and with a constant attention prevented, inundations occur which sometimes lay waste whole districts, and ruin the finest tracts of ground, by covering them with sand; hence rivers become unnavigable, and canals useless for the purposes for which they were constructed. Canals, in particular, as their waters for the most part remain stagnant in them, are still more liable than rivers to have their beds fill up by the subsiding of mud, and that especially for some distance above their sluices; insomuch, that if continual care is not taken to prevent it, or remedy it as often as it happens, they will soon become incapable of receiving and passing the same vessels as formerly. Nay, the very sluices themselves, if the floors of their bottoms are not of a depth conformable to the bed of the canal, will produce the same accidents as those we have been speaking of; for if they are placed too low, they will be continually filling up with sand or mud; if too high, they have the same effect as banks or bars in the bed of a river, that is, they hinder all the back-waters under their level from running off, and soon fill up the bed to that height by the subsiding of mud. This effect is much accelerated by the shutting of the lower sluices, which makes a great volume of water flow back to those next above them, till the whole is filled and become stagnant. Now it is evident, that this state of things must contribute far more to the subsidency of mud, and all other matters brought down by the waters in canals, than can be the case in rivers whose currents constantly flow.

The waters of all rivers and canals are from time to time muddy; their streams, particularly during rains and floods, carry along with them earth and other substances which subside in those places where their currents are the least, by which their beds are continually raised; so that the successive increase of inundations in rivers, and of unfitness for navigation in canals, when they are neglected and left to themselves, is a natural and necessary consequence of the state of things, which no intelligent person can be at a loss to account for; and yet whole countries remain in this habitual state of negligence, to their very great detriment.

Having thus shown the principal accidents which rivers and canals are liable to, with the causes of them, our author proceeds to point out the most efficacious methods of preventing them, or at least of diminishing their effects. They flow immediately from the principles laid down in his essay, and do not need many words to make them completely understood. A work of this kind, he observes, if it is properly conducted, must be begun at the lower end of the river or canal: that is, at that end where their waters are discharged into the sea, or where they fall into some other greater river or canal, whence their waters are carried off without further hindrance. If it is a river whose bed, by being filled up with sand, mud, or other obstacles, and by being otherwise become irregular in its course, is often subject to its inundations, and incapable of internal navigation, the point, from which the work must be begun and directed throughout all the rest of the channel, is from the lowest water-mark of spring-tides on the shore at the mouth of the river, or even something below it, if it can be done; though this part will soon fill up again by the sand, mud, &c. which the tides cease not to roll in.

If it is a canal whose bed is to be dug anew, or one already made, which is to be cleaned and deepened from the sea-shore or some large river back into the country, and where no declivity is to be lost, as is the case in all flat countries; the work must be begun, and the depth of the whole channel directed, from the lower water-mark of spring-tides, if the mouth is to the sea, or from such a depth in the channel of the river, if the canal falls into one, that there may be such a communication of water from the canal to the river, in all situations of the current, as may let boats freely pass from one to the other. This, of course, must also direct the depth of the floor of the last sluice towards the mouth of the canal, be it to the sea or into a river. If the bottom or floor of a sluice already constructed is too low, it will soon fill up with sand or mud, and hinder the gates from opening, unless it is continually cleaned out: if, on the contrary, this floor is too high, and in a canal whose natural declivity is too little for the free current of the water, as is generally the case in Holland and Flanders, all depth of the bed of the canal below the horizontal level of the bottom of the sluice will serve to no manner of purpose, either for navigation, or for carrying off the back-waters, but will soon fill up with mud, in spite of all means used to the contrary, except that of digging it continually anew to no manner of purpose.

Setting off from this determinate point, at the mouth of a river, or at the bottom of the last sluice upon a canal, which are to be cleaned and deepened; the work must be carried on, in consequence uniformly throughout their whole course backwards into the country as far as is found necessary for the purposes intended. This is to be done after the following manner:

1st. One must dig up and carry away all irregularities in the bottom and sides of the bed, such as banks of sand and mud, rocks, stumps or trunks of trees, and whatever else may cause an obstacle to the regular motion of the water, and to the free passage of vessels upon it.

2dly. If the declivity of the bed should be still too little to give a sufficient current to carry off the water as often and as fast as is necessary, the whole bed itself must be regularly deepened, and what is dug out from the bottom must be laid upon the sides, to render it narrower in proportion to its depth.

3dly. Wherever the banks are too low to contain the stream in all its situations, they must be sufficiently raised; which may be conveniently done with what is dug out from the bed; and the whole being covered with green turf will render these banks firm and solid against the corrosion of the water. It is proper at all times to lay upon the banks what is dug from the bed, by which they are continually strengthened against the force of the current.

4thly. It is often necessary to diminish the windings and sinuosities in the channel as much as possible, by making new cuts whereby its course may approach towards a right line. This is a great resource in flat countries subject to inundations; because thereby all the declivity of a great extent of the river, through its turns and windings, may be thrown into a small space by cutting a new channel in a straight line; as may generally be done without obstacle in such countries as we are speaking of, and hereby the velocity of the current will be very greatly augmented, and the back-waters carried off to a surprising degree.

5thly. Wherever there is a confluence of rivers or canals, the angle of their junction must be made as acute as possible, or else the worst of consequences will arise from the corrosion of their respective streams; what they carry off from the sides will be thrown into irregular banks in the bottom of the bed. This acute angle of the junction may always be procured by taking the direction at some distance from the point of confluence.

6thly. Wherever the sides or banks of a river are liable to a more particular corrosion, either from the confluence of streams, or from irremediable windings and turns in the channel, they must be secured against it as much as possible by weirs: for this corrosion not only destroys the banks, and alters by degrees the course of the river, but also fills up the bed, and produces all the bad effects we have spoken of above.

7thly. But the principal and greatest attention in digging the beds of rivers and canals must be had to the quantity and form of their declivity. This must be done uniformly throughout their whole extent, or so much of it as is necessary for the purposes in hand, according to the principles laid down. Conformable thereto, the depths of their beds, and of the floors of their sluices, at the mouths where they discharge their waters, being fixed, the depth of the rest of the beds, and the quantity of declivity, must be regulated in consequence thereof, so as to increase regularly the quantity of the declivity in equal spaces the further we recede from their mouths, and proceed towards their sources or to the part where the regular current is to take place.

If the depth and volume of water in a river or canal is considerable, it will suffice, in the part next the mouth, to allow one foot perpendicular of declivity through six, eight, or even, according to Deschales, ten thousand feet in horizontal extent; at most it must not be above one in six or seven thousand. Hence the quantity of declivity in equal spaces must slowly and gradually increase as far as the current is to be made fit for navigation; but in such a manner, as that at this upper end there may not be above one foot of perpendicular declivity in four thousand feet of horizontal extent. If it is made greater than that in a regular bed containing a considerable volume of water, the current will be so strong as to be found very unfit for the purposes of navigation.

Mr. Mann calls the centre of the current, or more properly, line of greatest current, that line which passes through all the sections of a river, in the point where the velocity of the current is the greatest of all. If the current of a river is regular, and in a right line, its centre or line of greatest velocity will be precisely in the centre of the sections; but on the contrary, if the bed is irregular and full of turns and windings, the centre, or line of greatest current, will likewise be irregular, and often change its distance and direction with regard to the centres of the sections through which the waters flow, approaching successively, and more or less, to all parts of the bed, but always in proportion and conformably to the irregularities in the bed itself.

This deviation of the line of greatest current from the centres of the sections through which it passes, is a cause of many and great changes in the beds of rivers, such as the following:

1st. In a straight and regular bed, the greatest corrosion of the current will be in the middle of the bottom of the bed; because it is that part which is nearest to the line of greatest current, and at the same time which is most acted upon by the perpendicular compression of the water. In this case, whatever matters are carried off from the bottom will be thrown, by the force of the current, equally toward the two sides, where the velocity of the steam is the least in the whole section.

2dly. If the bed is irregular and winding, the line of greatest current will be thrown towards one side of the river, where its greatest force will be exerted in proportion to the local causes which turn it aside: in short turns of a river there will be a gyration, or turning round of the stream, from its beating against the outer side of the angle; this part will be corroded away, and the bottom near it excavated to a great depth. The matters so carried off will be thrown against the opposite bank of the river where the current is the least, and produce a new ground called an alluvion.

3dly. Inequalities at the bottom of a river retain and diminish the velocity of the water, and sometimes may be so great as to make them reflow; all these effects contribute to the subsiding of sand, earth, and other matters, which cease not to augment the volume of the obstacles themselves, and produce shallows and banks in the channel. These in time, and by a continuance of the causes, may become islands, and so produce great and permanent changes and irregularities in the beds of rivers.

4thly. The percussions of the centre of the current against the sides of the bed are so much the greater as they are made under a greater angle of incidence; whence it follows, that the force of percussion, and the quantity of corrosion and detriment done to the banks and weirs of rivers, and to the walls of buildings which are exposed to that percussion, are always in a direct compound proportion of the angle of incidence, of the greatness and depth of the section together, and of the quantity of velocity of the current.

5thly. It may happen in time, that the excavation of the bottom, and the corrosion of the sides, will have so changed the form of the bed as to bring the force of percussion into equilibrium with the velocity and direction of the current; in that case, all further corrosion and excavation of the bed ceases.

6thly. This gives the reason why when one river falls into another almost in a perpendicular direction, and makes with it too great an angle of incidence, this direction is changed in time, by corrosions and alluvions, into an angle much more acute, till the whole comes into equilibrium.

7thly. So great and such continued irregularities, from local causes, may happen in the motion of a river as will entirely change its antient bed, corrode through the banks where they are exposed to the greatest violence of percussion of the stream, and open new beds in grounds lower than the old one is become.

8thly. Hereupon the state of the old bed will entirely depend on the quantity of water, and on the velocity and direction of the current in the new one; for immediately after this division of the waters into two beds is made, the velocity of the current in the old one will be diminished in proportion to its less depth. In consequence, the waters will precipitate more of their mud, &c. in equal spaces than they did before; which will more and more raise up the bottom, sometimes even till it becomes equal with the surface of the stream. In this case, all the water of the river will pass into the new bed, and the old one will remain entirely dry. It is well known that this has happened to the Rhine near Leyden, and to many other rivers.

9thly. Hence the cause of the formation of the new branches and mouth, by which great rivers discharge their waters into the sea.

But in proportion as a river, that has none of these obstacles in its bed, approaches towards its mouth, we see the velocity of its current augment, at the same time that the declivity of the bed diminishes. It is for this reason that inundations are more frequent and considerable, and do more damage in the interior parts of a country, than towards the mouths of most rivers.

In the Po, for example, the height of the banks made to keep in the waters, diminishes as the river approaches to the sea. At Ferrara, they are twenty feet high: whereas, nearer the sea, they do not exceed ten or twelve feet, although the channel of the river is not larger in the one place than in the other.

The mouths of rivers, by which they discharge their waters into the sea, are liable to great variations, which produce many changes in them.

1st. The velocity and direction of the current at these mouths are in a continual variation, caused by the tides, which alternately retard and accelerate the stream.

2dly. During the flowing of the tide, the current of the river is first stopped, then turned into a direction entirely contrary throughout a considerable extent: if we may believe M. de Buffon, there are rivers in which the effect of the tides is sensible at 150 or 200 leagues from the sea.

3dly. This state of things is a cause of a a great quantity of sand, mud, &c. being precipitated and accumulated in the channel near the mouth. This continually raises and widens the bed, and at last changes it entirely into a new place, or at least opens new mouths to discharge the waters at. The Rhine, the Danube, the Wolga, the Indus, the Ganges, the Nile, the Mississippi, and many other rivers, are instances of this.

4thly. All these effects are less sensible at the mouths of little rivers, as their currents oppose no sensible obstacle to the flowing of the tides; so that the ebb carries off again what the flow had brought in.

Whenever the course of a river throughout a considerable extent of country, approaches towards a right line, its current will have a very great rapidity; and the velocity wherewith it runs diminishing the effect of its natural gravitation, the middle of the current will rise up, and the surface of the river will form a convex curve of sufficient elevation to be perceived by the eye; the highest point of this curve is always directly above the line of greatest current in the stream.

On the contrary, when rivers approach near enough to their mouths for a sensible effect to be produced in them by the flowing of the tides; and also, when in other parts of their course they meet with obstacles at the sides of their channel; in both these cases the surface of the water at the sides of the current is higher than in the middle, even though the stream should be rapid. In this situation of things, the surface of the river forms a concave curve, the lowest point of which, or that of inflection, is directly over the line of greatest current. The reason of this is, that there are in this case two different and opposite currents in the river; that by which the waters flow towards the sea, and preserve their motion even to a considerable distance; and that of the waters which remount, either by the flowing of the tide, or by their meeting with local obstacles, which form a counter current.

An island in the middle of a river produces the same effect as obstacles at the sides, regard being had to the difference of situation of each.

Eddies and whirlpools in rivers, in the centre of which there appears a conical or spiral cavity, and about which the water turns with great rapidity and sucks in whatever approaches it, proceed in general from the mutual percussion of these two counter currents; and the vacuity in the middle is produced by the action of the centrifugal force, by which the water endeavours to recede, in a direct ratio of its velocity, from the centre about which it moves.

If rivers persevered always nearly in the same state, the best means of diminishing the velocity of the current when it is found too great for the purposes of navigation, would be by widening the channel; but as all rivers are subject to frequent increase and diminution, and consequently to very different degrees of velocity and force in the current, this method is liable to produce very detrimental effects; for, when the waters are low, if the channel is very large in proportion, the stream will excavate a particular bed, which, according to the irregularities of the bottom, will form various turnings and windings with regard to the principal bed; and, when the waters come to increase, they will follow, to a certain degree, the directions which the bottom waters take in this particular bed, and thereby will strike against the sides of the channel, so as to destroy the banks and cause great damages.

It would be possible to prevent in part the bad effects proceeding from the current striking against the banks, by opening, at those places where it strikes, little gulphs into the land, dug in such a form and direction as that the striking current should enter and circulate therein, so as to destroy, or at least, greatly diminish its velocity. This effect would be felt for a considerable way down the river.

This same method might probably be used with success against the destruction of bridges, weirs, &c. by the violence of the stream during floods. Such gulfs being dug into the outer side of those turnings in the river which are immediately above the place to be secured from the violence of the stream, would successively diminish its velocity, its force and dangerous effects, a considerable way down the river.

RIVINA, a genus of the monogynia order, in the tetrandria class of plants. The perianthus is four-leaved, coloured, and permanent, the leaflet oblong egged and obtuse; there is no corolla, unless the calyx is considered as such. There are four or eight filaments, shorter than the calyx, approaching by pairs, permanent; the antheræ are small. The germ is large and roundish; the style very short; the stigma simple and obtuse. The berry is globular, sitting on the green reflected calyx, one-celled with an incurved point. There is one seed, lensform, and rugged. There are four species. It grows naturally in most of the islands of the West Indies. The juice of the berries of the plant will stain paper and linen of a bright red colour, and many experiments made with it to colour flowers have succeeded extremely well in the following manner; the juice of the berries was pressed out, and mixed with common water, putting it into a phial, shaking it well together for some time, till the water was thoroughly tinged; then the flowers, which were white and just fully blown, were cut off, and their stalks placed into the phial; and in one night the flowers have been finely variegated with red; the flowers on which the experiments were made, were the tuberose and the double white narcissus.

RIX-DOLLAR, a silver-coin current in different parts of Europe. See Coin.

ROACH. See Cyprinus.

ROAD, in navigation, is a place of anchorage at some distance from shore, where vessels usually moor, to wait for a wind or tide proper to carry them into harbour, or to set sail. When the bottom is firm, clear of rocks and sheltered from the wind, it is called a good road; and when there is but little land on any side, it is termed an open road. The roads in his majesty's dominions are free to all merchant vessels, belonging to his subjects and allies. Captains and masters of ships who are forced by storms, &c. to cut their cables, and leave their anchors in the roads, are obliged to fix marks or buoys, on pain of forfeiting their anchors, &c. Masters of ships coming to moor in a road, must cast anchor at such a distance, as that the cables, &c. do not mix, on pain of answering the damages; and when there are several vessels in the same road, the outermost to the sea-ward is obliged to keep a light in his lanthorn in the night-time, to apprise vessels coming in from sea.

ROASTING. See Metallurgy.

ROB, in pharmacy, the juices of fruit purified and inspissated till it is of the consistence of honey.

ROBBERY, in law is a felonious taking away of another man's goods from his person or presence against his will, putting him in fear, and of purpose to steal the same. West. Symbol. To make a robbery there must be a felonious intention; and so it ought to be laid in the indictment. 1 H. H. 532. It is immaterial of what value the thing taken is; a penny, as well as a pound thus forcibly extorted, makes a robbery. 1 Haw. 34.

If a man forces another to part with his property, for the sake of preserving his character from the imputation of having been guilty of an unnatural crime, it will amount to a robbery, even though the party was under no apprehension of personal danger. Leach's Cro. Law, 257.

If any thing is snatched suddenly from the head, hand, or person of any one, without any struggle on the part of the owner, or without any evidence of force, or violence being exerted by the thief, it does not amount to robbery. But if any thing is broken or torn in consequence of the sudden seizure, it would be evidence of such force as would constitute a robbery: as where a part of a lady's hair was torn away, by snatching a diamond pin from her head, and an ear was torn by pulling off an ear-ring; each of these cases was determined to be a robbery. Leach's Cro. Law, 264.

By 7 G. II. c. 21, if any person shall, with any offensive weapon assault, or by menaces, or in any forcible or violent manner, demand any money or goods, with a felonious intent to rob another, he shall be guilty of felony, and be transported for seven years.

If any person being out of prison, shall commit any robbery, and afterwards discover any two persons guilty of robbery, he shall have the king's pardon.

The hundred in which a robbery on the highway is committed, is liable to pay the damage when it is committed between the rising and setting of the sun, in any day, except Sunday, in case the robbers are not taken in forty days; hue and cry being made after the robber. And he who apprehends and prosecutes a robber on the highway, so as to convict him, is entitled to receive of the sheriff of the county where the robbery was committed, the sum of forty pounds, with the horse, furniture, arms, &c. upon such person's producing a proper certificate from the judge before whom the robber was convicted.

ROBERGIA, a genus of the class and order decandria pentagynia. The cal. is five-parted; pet. five; drupe with one-seeded nut and two-valved shell. There is one species a shrub of Guiana.

ROBINIA, *false acacia*, a genus of the decandria order, in the diadelphia class of plants; and in the natural method ranking under the 32d order, papilionaceæ. The calyx is quadrifid; the legumen gibbous and elongated. There are seventeen species. The most remarkable is the caragnana, the leaves of which are conjugated, and composed of a number of small folioles, of an oval figure, and ranged by pairs on one common stock. The flowers are leguminous, and are clustered on a filament. Every flower consists of a small bell-shaped petal, cut into four segments at the edge, the upper part being rather the widest. The keel is small, open, and rounded. The wings are large, oval, and a little raised. Within are ten stamina united at the base, curved towards the top; and rounded at the summit. In the midst of a sheath, formed by the filaments of the stamina, the pistil is perceivable, consisting of an oval germen, terminated by a kind of button. This germen becomes afterwards an oblong flattish curved pod, containing four or five seeds, of a size and shape irregular and unequal; yet in both respects somewhat resembling a lentil.

This tree grows naturally in the severe climates of Northern Asia, in a sandy soil mixed with black light earth. It is particularly found on the banks of great rivers, as the Oby, Jenisia, &c. It is very rarely met with in the inhabited parts of the country, because cattle are very fond of its leaves, and hogs of its roots; and it is so hardy, that the severest winters do not affect it. Gmelin found it in the neighbourhood of Tobolsk, buried under fifteen feet of snow and ice, yet had it not suffered the least damage. Its culture consists in being planted or sowed in a lightish sandy soil, which must on no account have been lately manured. It thrives best near a river, or on the edge of a brook or spring; but presently dies if planted in a marshy spot, where the water stagnates. If it is planted on a rich soil, well tilled, it will grow to the height of twenty feet, and in a very few years will be as big as a common birch tree.

In a very bad soil this tree degenerates, and becomes a mere shrub; the leaves grow hard, and their fine bright green colour is changed to a dull deep green. The Tongusian Tartars, and the inhabitants of the northern parts of Siberia are very fond of the fruit of this tree, it being almost the only sort of pulse they eat. The leaves and tender shoots of this tree make excellent fodder for several sorts of cattle. The roots being sweet and succulent, are very well adapted for fattening hogs; and the fruit is greedily eaten by all sorts of poultry. After several experiments somewhat similar to the methods used with anil and indigo, a fine blue colour was procured from its leaves. The smaller kind of this tree seems still better adapted to answer this purpose. The striking elegance of its foliage, joined to the pleasing yellow colour of its beautiful flowers, should, one would imagine, bring it into request for forming nosegays, or for speedily making an elegant hedge. Besides the qualities above recited, it possesses the uncommon advantage of growing exceedingly quick, and of being easily transplanted. There are large plantations of it now in Sweden, Norway, Lapland, and Iceland.

The robinia spinosa is a beautiful hardy shrub, and on account of its robust strong prickles, might be introduced into this country as a hedge plant, with much propriety. It resists the severest cold of the climate of St. Petersburgh, and perfects its seed there. It rises to the height of six or eight feet; does not send out suckers from the root, nor ramble so much as to be kept with difficulty within bounds. Its flowers are yellow, and the general colour of the plant a light pleasing green.

ROBINSONIA, a genus of the icosandria monogynia class and order. The cal. is five-toothed; pet. five; berry striated, two-celled; cells one-seeded; seeds villose. There is one species, a tree of Guiana.

ROCHFORTIA, a genus of the class and order pentandria digynia; the cal. is five-parted; cor. one-petalled, funnel-form, inferior; fruit two-celled, many-seeded. There are two species, shrubs of Jamaica.

ROCK-CRYSTAL. See QUARTZ.

ROCKET. See PYROTECHNY.

ROCKS are divided into five classes: namely, 1. Primitive rocks; 2. Rocks of transition; 3. Stratified, or secondary rocks; 4. Alluvial depositions; 5. Volcanic rocks.

Rocks primitive.

The rocks belonging to this class are distinguished from all others in containing no remains of organic bodies, and in being covered by the rocks of the other classes, but never themselves covering any other class of rocks. The term primitive was applied by Lehman, to whom we are indebted for the first scientific division of rocks, on the supposition that the rocks so denominated were formed before any other; and the term has been continued by Werner, because he has embraced the same hypothesis. The following table contains the different divisions of primitive rocks, arranged according to the order in which Werner thinks they were formed.

1. Granite,
2. Gneiss,
3. Micaceous shistus,
4. Argillaceous shistus,
5. Porphyry,
6. Sienite,
7. Serpentine,
8. Primitive limestone
9. Primitive trap,
10. Quartz,
11. Topasfels,
12. Kieselschiefer.

Let us take a view of each of these in order.

Granite is composed essentially of felspar, quartz, and mica, crystallized and united to each other. The size and proportion of the constituents vary exceedingly; but the felspar usually predominates, and the proportion of mica is smallest. Its texture is granular, and its hardness usually very considerable: hence it admits a fine polish, and is very beautiful and durable. Granite sometimes contains schorl accidentally mixed with it, and still more rarely garnets. Granite rocks are sometimes stratified, and sometimes not. They are very common, especially in great chains of mountains. Granite contains few ores. Those of iron and tin occur most frequently. See GRANITE and GNEISS.

Gneiss, like granite, is composed essentially of felspar, quartz, and mica; but they form plates which are laid on each other, and separated by thin layers of mica. The beds of gneiss sometimes alternate with layers of granular limestone, shistose, hornblende, and porphyry.

Micaceous shistus. This rock is composed essentially of quartz and mica, which alternate in plates. The mica is usually most abundant. It is grey or brown, and sometimes greenish. The texture of micaceous shistus is essentially shistose. Its stratification is very distinct. It very frequently contains garnets, and sometimes felspar, cyanite, granatite, and tourmalines. In mountains, beds of micaceous shistus often alternate with those of granular limestone and hornblende shistus, and sometimes with those of actinote, pyrites, galena, and other metallic bodies. Indeed almost all the metals are found in it either in beds or veins.

Argillaceous shistus. This rock is composed essentially of slate or argillaceous shistus; but it sometimes contains accidentally quartz, felspar, shorl, hornblende, and pyrites. It is always shistose; but the thickness of the layers varies considerably. The beds of this rock are often interrupted by subordinate beds of other minerals; the chief of these are chlorite-shistus, talc-shistus, zeichen-schiefer, alum-shistus. These frequently pass into argillaceous shistus. Sometimes also beds of granular limestone, hornblende, and some metallic ores, alternate with argillaceous shistus. This rock usually covers micaceous shistus.

Ores are common in this rock, but less so than in the two preceding. They are usually in veins.

Porphyry. The term porphyry is applied to all rocks consisting of a compact ground, in which distinct and separate crystals of some other substance are embedded. Werner confines it to certain primitive rocks which belong to a particular formation. These, considered relative to their ground, are divided into five species, each of which is denominated from its ground.

1. Hornstone porphyry. The hornstone is sometimes conchoidal, sometimes splintery,

and of a red or green colour. The crystals are quartz and felspar.

2. Felspar porphyry. The ground is usually red. The crystals are felspar and quartz.

3. Sienite porphyry. The ground is a mixture of felspar and hornblende. The crystals are felspar and quartz.

4. Pitchstone porphyry. The ground is red or green, sometimes brown, and even black.

5. Clay porphyry. The ground is an indurated clay, commonly reddish, which sometimes passes into splintery hornstone. The crystals are felspar and quartz; sometimes it contains hornblende, and more rarely mica.

Porphyry mountains are not stratified, and contain no beds of foreign substances. They are not rich in ores, yet frequently contain veins worth working.

Sienite. This rock is composed essentially of crystals of felspar and hornblende, immediately and intimately united. The felspar usually predominates. When the felspar is compact, the rock assumes a porphyritic structure. It sometimes contains accidentally grains of quartz and mica, but in a very small proportion. Its texture is granular, rarely shistose. Seldom stratified. Does not contain foreign beds. It sometimes contains metallic veins. It usually covers porphyry.

Serpentine. This rock is essentially simple. Sometimes it contains accidentally talc, asbestus, and steatites; and sometimes mica, garnets, and granular limestone, magnetic ironstone, arsenical pyrites, &c. Serpentine rocks are not stratified. Seldom contain beds of foreign minerals. They contain few ores, and seldom any worth working.

Primitive limestone. This rock is essentially simple: its mass is granular limestone of a greyish white colour. Sometimes it is accidentally mixed with mica, quartz, hornblende, tremolite, actinote, asbestus, talc, &c. Its texture granular, the grains have a foliated texture, and a crystallized appearance. This rock sometimes contains metallic veins; chiefly of galena, magnetic ironstone, blende, and pyrites.

Primitive traps. The word trap is Swedish, and signifies a stair. It was applied by the Swedish mineralogists to certain rocks whose strata when exposed, the one jutting out under the other, gave an appearance somewhat like a stair. The term was adopted by other nations, and was applied indiscriminately to a great variety of rocks; which yet bore a certain resemblance to each other. This generalization, however, introduced much confusion into the subject, which was first cleared up by Werner and his disciples. Under the term traps Werner comprehends certain series of rocks, distinguished chiefly by the hornblende, which they all contain. In the most antient, the hornblende is almost pure; this purity gradually diminishes, and in the most recent traps the hornblende degenerates to a kind of indurated clay. There are, then, three formations of traps; 1. Primitive traps; 2. Transition traps; 3. Secondary traps. The first only occupy our attention at present.

The primitive traps are composed almost entirely of hornblende. It is sometimes mixed with felspar, more rarely with mica and pyrites. There are four species; 1. Common hornblende; 2. Shistose hornblende; 3. Primitive grunstein; 4. Shistose grunstein.

1. Common hornblende is a simple rock. Its grains are sometimes so small that it appears compact. Sometimes it contains mica.

2. Shistose hornblende occasionally contains quartz, actinote, and pyrites.

3. Primitive grunstein is a mixture of hornblende and felspar. It is divided into different varieties, according as its texture is granular or compact. 1st. Common grunstein, in which the hornblende and felspar are intimately united. It resembles a sienite, in which the hornblende predominates. 2d. Fine grained grunstein, in which are embedded crystals of felspar. Texture at once granular and porphyritic. 3d. When the grains become very fine, the grunstein becomes porphyritic. 4th. When the mass becomes entirely homogeneous, we have the green porphyry of the antients.

4. Shistose grunstein is a rock composed of compact felspar, hornblende, and a little mica; sometimes it contains also quartz. Its texture is shistose. The hornblende and felspar occur nearly in equal proportion.

Grunstein often contains metallic veins.

Quartz. Considerable rocks occur composed entirely of quartz. Sometimes, indeed, they contain accidentally mica, felspar, tin, pyrites. The texture of these rocks is usually compact, but sometimes shistose.

Topasfels. This rock is composed of quartz, shorl, topaz, and lithomarga. The first three ingredients alternate in thin beds. Its texture is granular; its structure shistose. Very rare. It has been found only in Saxony, near Awerbach, forming a mountain called Schneckenstein. It rests upon granite, and contains no ores.

Kieselchiefer. Kieselchiefer, or siliceous shistus, often forms considerable rocks. Their texture is compact. They are often traversed by small veins of quartz. They contain no metallic substance.

Rocks of transition.

The rocks belonging to this class agree with those of the first in containing no remains of organized beings, or at least but seldom; but they have a considerable resemblance to those of the third class. Werner considers them as forming the passage between the first and third class of rocks; hence their name. The following table contains a list of the transition rocks.

1. Transition limestone,
2. Grauwacke,
3. Transition traps.

Let us take a view of each of these in order.

Transition limestone. This rock is simple. Its mass is a limestone; sometimes granular, sometimes compact, according as its age approaches to primitive or secondary limestone. Fracture is somewhat splintery. Somewhat transparent. Its colours are variously mingled; often red or black with white veins. Seldom contains foreign substances. Sometimes shells are observed in its superior strata.

Sometimes it alternates with beds of argillaceous shistus, and sometimes with beds of mandelstein, as in Derbyshire. It usually covers argillaceous shistus. Seldom rises to any considerable height. Usually stratified. Strata very thick. Often contains metallic veins.

Grauwacke. There are two species of rocks of grauwacke, common and shistose.

Common grauwacke is a sandstone composed of grains of quartz, kieselchiefer, and argillaceous shistus agglutinated by a cement of clay. The grains are sometimes very small, sometimes as large as a hazel nut.

Shistose grauwacke is a simple shistose rock, which has a strong resemblance to argillaceous shistus, but differing in its position. It forms beds which alternate with common grauwacke.

Grauwacke rocks are traversed by veins of quartz. They contain sometimes shells and reeds petrified. They contain no foreign beds. These rocks are distinctly stratified. The strata do not run parallel to those of the other rocks on which they lie. They usually cover transition limestone, and do not rise to any great height. They are rich in ores.

Transition traps. The principal base of all the rocks belonging to this formation is grunstein. This constitutes many of the primitive traps; but in the transition traps, the mixture is much more intimate, the grain is much finer, and the mass much more homogeneous, and its constituents are more or less blended together. Transition traps consist principally of two species, mandelstein and globular trap.

1. Mandelstein or amygdaloid. By this term is implied all rocks composed of a compact ground, containing imbedded in it minerals of a round or almond form, or containing cavities of that form. They are distinguished into primitive, transition, and secondary mandelsteins. Transition mandelstein consists of a ground of shistose hornblende, decomposed and resembling wacken or ferruginous clay. The cavities are sometimes empty, sometimes full, and then they contain quartz and chalcedony. The toadstone of Derbyshire is referred to this species. It contains round masses of calcareous spar.

2. Globular trap. This is a shistose grunstein, partly decomposed and reduced to the state of a fine grained wacken. It is composed of large spherical bodies, consisting of concentric layers; the central part being hardest.

Transition traps are not stratified. They form separate conical mountains, usually near those of transition limestone. They contain some metallic veins of copper, iron, tin, &c.

CLASS III.

Rocks secondary.

These rocks are distinguished by the remains of organized bodies, which they contain abundantly. They are usually stratified. The following table contains a list of these different rocks, arranged according to the supposed time of their formation.

1. Sandstone,	5. Rock salt,
2. Secondary limestone,	6. Pit coal,
3. Chalk,	7. Eisenthon,
4. Gypsum,	8. Secondary traps.

Sandstone. This rock is composed of quartz, varying in size; sometimes also grains of kieselschiefer, and very rarely of felspar. These grains are cemented together, sometimes by means of clay, sometimes of marl or lime, and sometimes of quartz. The cement varies in quantity, but never predominates. The size of the grains varies much: when large, the rock is usually called pudding stone.

This rock is very distinctly stratified. The beds of it often alternate with beds of compact limestone, pit coal, oolite, and a species of sandstone shistus fine grained, and mixed with leaves of mica, which gives it the appearance of micaceous shistus. It contains few metallic ores of value. Sometimes cobalt is found in it.

Secondary limestone. This rock is simple, and composed of compact limestone. Occasionally it contains crystals of quartz, pyrites, &c. Shells occur very frequently in it. It is very distinctly stratified. Its beds are sometimes separated by beds of shistose bituminous marl and sandstone, and by tubercles of hornstone and flint often arranged in beds. It is often traversed by metallic veins, chiefly of galena, grey copper ore, malachite, &c.

Chalk. The strata of chalk may be considered perhaps as subordinate to those of secondary limestone. They consist entirely of chalk, sometimes interrupted by thin beds of flint in tubercles. Shells often occur converted into siliceous matter, and sometimes pyrites in spherical masses. No metallic ores ever occur in them.

Gypsum. The strata of gypsum usually occur in mountains alternating with those of sandstone, limestone, marl, clay, rock salt. They often contain foreign crystals; chiefly quartz, arragonite, boracite, garnet: sometimes they contain sulphur. Few petrefactions are found in them except the bones of quadrupeds. They contain scarcely any metallic ores. See SULPHAT OF LIME.

Rock salt. The mountains which contain strata of rock salt are to be referred to a particular formation of gypsum, with which they usually alternate. They contain no ores.

Pit coal is found in two different formations. The first of these is distinguished particularly by the name of coal formation, or mountains of coal. They are usually composed of beds of, 1. Very brittle sandstone, containing often small particles of mica; 2 Another sandstone or pudding stone of very large grains: 3. Shistose clay; 4. Marl; 5. Limestone; 6. An argillaceous porphyry distinguished by the name of secondary porphyry; 7. Ferruginous clay; 8. Coal. The beds of coal vary in thickness and in number.

This formation of coal occupies countries of no great elevation. They occur chiefly at the bottom of chains, and in the intermediate valleys. The strata of coal in the north of England belong to it.

Coal is found in other situations, especially in the secondary trap formation. Those of Scotland belong to this class.

Argillaceous ironstone. The beds of this mineral usually alternate with those of indurated clay, shistose clay, marl, brandschiefer, and sandstone. They frequently contain calamine mixed with galena. The impressions of plants and marine petrefactions are often observable in them. They usually form small insulated hills, and are not very common.

Secondary traps. The mountains of secondary traps are composed of various rocks; some of which belong exclusively to this formation; others are found also in other mountains. The rocks peculiar to secondary traps are, 1. Basalt; 2. Wacken; 3. Basaltic tufa; 4. Secondary mandlestein; 5. Porphyry shistus; 6. Graustein; and, 7. Secondary grunstein.

1. Basalt, considered as the mass of a mountain, is a rock more or less compound; usually it is of a porphyritic structure, has for its ground the mineral called basalt. It contains usually grains of olivine, augite, basaltic hornblende, magnetic ironstone, and sometimes leucite, felspar, quartz, &c.; sometimes also mica, actinote, chalcedony. Sometimes it assumes the structure of mandelstein. In that case its cavities are filled with zeolite, steatites, limestone, &c.

It usually appears in large separate masses often prismatic. It is very common often forming detached mountains.

2. Wacken sometimes forms beds in the secondary traps. It is usually between clay and basalt. It neither contains olivine nor augite, but crystals of basaltic hornblende, and above all of black hexahedral mica. This last substance distinguishes wacken from basalt, which very seldom contains it.

3. Basaltic tufa results from the decomposition of certain basalts. It consists of fragments of basalt, pieces of olivine, the remains of vegetables, &c. agglutinated by a cement of clay.

4. The amygdaloids or mandelsteins of the secondary traps have for their base a clay which seems to be a decomposed grunstein, often penetrated with siliceous matter. It has a good deal of resemblance to wacken, and sometimes passes into it: at other times it assumes a more compact texture, and passes into basalt. Its cavities are sometimes empty, sometimes filled with green earth, zeolite, limestone, &c.

5. Porphyry shistus is a rock whose structure is shistose, and its texture porphyritic. Its base is klingstein, containing grains of felspar and sometimes of hornblende. It has a good deal of resemblance to basalt, and often passes into it But it is more nearly a chemical compound, being more transparent, sonorous, and hard.

6. Graustein is a rock composed of small grains of felspar and hornblende, which graduate into each other and form a mass almost homogeneous of an ash grey colour. It contains olivine and augite.

7. Secondary grunstein, like the primitive and transition, is composed of hornblende and felspar; but its grains are less perfectly crystallised, and less intimately mixed. It usually covers rocks of basalt.

Such are the rocks peculiar to the secondary traps. They have all less or more of a crystallized structure; whereas the other minerals found in secondary traps, but not peculiar to them, are mechanical depositions. Wacken and basalt form the passage from the one to the other. The mechanical depositions, sand, clay, &c. are usually lowermost; they are covered by wacken. Some of the other substances always occupy the summits.

Trap mountains contain abundance of petrefactions, but no ores except some veins and grains of iron. They are usually insulated; very seldom forming chains. The mountains of basalt and porphyry shistus are usually conical. They are hardly ever covered by other rocks. They usually cover sandstone, coal, secondary limestone, shistose clay; and veins of them are not uncommon in primitive mountains.

CLASS V.

Rocks volcanic.

This name is given to all the minerals thrown out during volcanic eruptions. The most complete account of them has been given by Dolomieu, who devoted the greatest part of his life to the study of volcanoes. Part of his division was published by him in the Journal de Physique for 1794; and an abstract of the whole has been given by Brochant from notes taken during a course of geology given by Dolomieu in 1797. Volcanic products have been divided by this celebrated geologist into five classes: 1. Minerals modified by the fire of volcanoes; 2. Substances not modified by the fire, or thrown out unaltered; 3. Substances sublimed by the fire of volcanoes; 4. Minerals altered by the sulphurous acid vapours of volcanoes; 5. Volcanic minerals altered by the action of the atmosphere.

Minerals modified by the fire. This set of minerals is subdivided into two heads. The first comprehends those minerals which, though they have been modified by fire, yet exhibit no appearance of its action. The second consists of those which retain obvious marks of the action of fire. Those of the first head have been distinguished by the name of compact lavas; those of the second by the name of porous.

Compact lavas bear so close a resemblance to certain rocks of an origin not volcanic, that it is extremely difficult to distinguish them. Some have the appearance of basalt; others of granite, porphyry, and various secondary traps. Dolomieu divides them into four species according to their base.

1. Compact lavas with an argillo-ferruginous base. Their colour is usually black. Fracture imperfectly conchoidal. Texture very compact. Sonorous. Smell argillaceous. Attract the magnetic needle. Very common in volcanic countries. Frequently contain crystals of augite, felspar, hornblende, garnet, leucite, olivine, mica. A specimen of the lava of Catania in Sicily, analysed by Dr. Kennedy, contained,

51.0 silica,
19.0 alumina,
14.5 oxide of iron,
9.5 lime,
4.0 soda,
1.0 muriatic acid,
———
99.0.

A specimen of the lava of Sta. Venere in Sicily he found to contain

55.78 silica,
17.50 alumina,
14.25 oxide of iron
10.00 lime,
4.00 soda,
1.00 muriatic acid,
———
97.5.

Compact lava with a petrosiliceous base. Colour very variable, grey, black, and white; but all become white before the blow-pipe. Fracture conchoidal. Grain fine and compact. Smell slightly argillaceous. Does not affect the magnetic needle. Contains usually grains of felspar; sometimes of hornblende, mica: Lucites are uncommon in it:

Compact lavas with a granite base. So named because they resemble granite, and contain all its constituents. The felspar usually predominates. It is in lamellar masses, seldom in crystals. This species contains crystals of hornblende, mica, augite.

Compact lavas with a leucite base. These lavas are uncommon. No current of lava has ever been observed composed entirely of them. They occur near Vesuvius. In them the leucites are so abundant and compressed, that they assume a compact appearance. They sometimes contain crystals of hornblende, augite, mica.

Compact lavas like basalt often affect a prismatic form.

Porous lavas, &c. This second head consists according to Dolomieu, of minerals having the same base with compact lavas; but these bases have undergone certain modifications, in which the action of fire has become evident. These modifications are chiefly three; swelling, vitrification, and calcination. The minerals belonging to this head may be reduced to seven species.

1. Porous lavas. The lavas on the surface of currents usually assume this form; especially the surface of the argillo-ferruginous lavas. The cavities are usually spheric in them, while in the porous lavas, formed from the other compact lavas, the cavities are commonly elongated. They are often employed as millstones and in buildings.

2. Scorias. The substances distinguished by this name have more or less resemblance to metallic scorias. To them may be referred the substance called black pouzzolano. It has been produced by scorification, though it no longer retains the characters of it.

The term pouzzolano (derived from the city Pouzzoles), has been usually applied to earthy matters ejected by volcanoes, which make an excellent mortar with lime. See PUZZOLANA. The best is found always in the antient currents; that in the modern forms bad mortar. There are three sorts of pouzzolano; the black, which is a scoria altered: the white, which is composed of pumice; and the red, which belongs to the products of calcination.

Compact glasses. Volcanic vitrifications are uncommon, especially compact glasses. They all resemble common glass. They are more or less transparent, often black, sometimes blueish or greenish, very seldom colourless. Sometimes prismatic.

Porous glasses or pumice stones. When the compact glasses are exposed to the heat of our furnaces, they emit a great number of air-bubbles, which renders them porous. Such is the origin of pumice. It has the same base as compact glass. The texture of pumice stones is fibrous; the fibres have a silky lustre. Colours various; white, brown, yellow, black. But before the blow-pipe they all melt into a white enamel. White pouzzolano is composed of the detritus of these stones. A specimen of pumice stone analysed by Klaproth, yielded

77.50 silica,
17.50 alumina,
1.75 oxide of iron,
3.00 soda of potass,

99.75.

Nearly the same result had been previously obtained by Dr. Kennedy.

Volcanic sands and ashes. The sands are composed of grains varying in size. They are usually mixed with crystals of felspar, augite, magnetic ironstone, &c. and often cover a great extent of ground. Etna has covered the country for 50 leagues round it with a bed of sand twelve feet thick. Volcanic ashes are merely very fine sand. They are so light, that during the eruptions of Etna, the wind often transports them as far as Egypt.

Agglutinated matters. These are merely sands and ashes covered and cemented together by a torrent of melted lava.

Calcined substances. All stony bodies which have undergone a kind of calcination by volcanic fires are denoted by this name. All volcanic matters often undergo this change. Their grain is rendered more harsh, and their feel more dry. The ferruginous lavas become more red, and cease to be attracted by the magnet.

Minerals not modified by the fire. These matters existed in the mountain before the commencement of volcanic fire, and are thrown out by it unaltered. The study of them is important, because they inform us of the internal structure of volcanic mountains. They usually belong to the primitive rocks. Sometimes they are fragments of rocks, and sometimes groups of crystals. They are thrown out in general at the beginning of eruptions.

Volcanoes sometimes emit torrents of muddy water. From these have originated the minerals called volcanic tufas. Their colour is various.

Substances sublimed. An immense quantity of matter is exhaled by volcanoes; partly in the state of gas or steam, partly in a visible form.

Hydrogen gas, carbonic acid, sulphurous acid, muriatic acid, nitric acid, &c. have been detected issuing from them.

The mineral substances which are sublimed from them, and which afterwards are deposited on their sides, are sulphur, which is very abundant; mineral oil, and various salts, especially muriats of ammonia, soda, copper, and iron; sulphats of alumina, soda, iron, and copper, and carbonat of soda. Metallic bodies are also found among these substances, iron, copper, antimony, arsenic, cinnabar, &c.

Substances altered by sulphurous acid vapours. The sulphur volatilized by volcanoes is often converted into an acid, which, acting upon the lavas, changes their appearance considerably. They become of a yellowish-white colour, much lighter and dryer, and are more easily pulverized. They contain an unusual proportion of silica, because the sulphurous acid has combined with the alumina, and formed a salt afterwards washed away by the rain. The same vapours often attack stony matters not volcanic.

The principal products of the action of these vapours on lavas are alum and sulphats of lime, magnesia and iron. These salts, especially the first, are collected with great advantage.

Volcanic substances altered by the action of the atmosphere. All rocks undergo greater or smaller changes when long exposed to the atmosphere; but these changes are much greater and more rapid in volcanic rocks than in others. Sometimes, however, it is very slow. Hence the age of volcanoes cannot be determined by the state of volcanic eruptions.

The argillo-ferruginous lavas become first red; the petrosiliceous become of a dirty grey. By degrees they assume an earthy appearance, and pass at last to a kind of friable clay. The scorias undergo the same changes much more rapidly. The earthy matters produced by this decomposition are afterwards washed down by the waters, and form large beds, which constitute a very fertile soil. The porous lavas are often partly filled with earth washed down by rains from decomposed lavas. Dolomieu supposed many crystals to owe their existence to the infiltrations of such waters.

Besides the real products of volcanoes, there are rocks which have been more or less altered by the action of fires not volcanic. These fires have often originated from the combustion of strata of coal. These have been called pseudo-volcanic rocks. These rocks are four in number; namely, porcelain jasper, burnt clay, earthy scorias, and a particular variety of polierschiefer.

Porcelain jasper is considered as a shistose clay, which has been calcined. Burnt clay resembles brick: It has been exposed to a weaker fire than porcelain jasper. Like that mineral it is considered as having been originally a shistose clay. Earthy scorias are light porous substances like scorias. They appear to have been melted. They are usually near burnt coal strata. A variety of polierschiefer sometimes occurs, which appears to have been a clay exposed to a moderate degree of heat, and rather dried than calcined. To these pseudo-volcanic minerals may be added the vitrified sorts, not uncommon in the highlands of Scotland. They seem to have originated from artificial fires. See GEOLOGY, MOUNTAINS, MINERALOGY, &c.

ROD, a land measure of sixteen feet and a half: the same with perch and pole.

ROD, in gauging. See GAUGING.

ROE, the spawn or seed of fish. That of male fishes is usually distinguished by the name of soft-roe, or milt, and that of the female, by hard-roe, or spawn.

So inconceivably numerous are these ovula, or small eggs, that M. Petit found 342,144 of them in a carp of eighteen inches; but Mr. Leewenhoeck found in a carp no more than 211,629. This last gentleman observes, that there are four times this number in a cod, and that a common one contains 9,344,000 eggs.

ROELLA, a genus of the monogynia order, in the pentandria class of plants; and in the natural method ranking under the twenty-ninth order, campanaceæ. The corolla is funnel-shaped, with its bottom shut up by staminiferous valvules; the stigma is bifid; the capsule bilocular, and cylindrical inferior. There are five species, shrubby plants of the Cape.

ROGUE, in law. See VAGRANT.

RHORIA, a genus of the class and order triandria monogynia: the cal. is bell-shaped, five-petalled, unequal; stigmas three, revolute; caps. There is one species, a shrub of Guiana.

ROLANDRA, a genus of the class and order syngenesia polygamia superflua. The florets are bundled in a head with scales interposed; cal. partial, two-valved, one-flowered: corollets hermaph. There is one species, a shrub of the West Indies.

ROLL, in manufactories, something wound and folded up in a cylindrical form.

Few stuffs are made up in rolls, except sattins, gawses, and crapes, which are apt to break, and take plaits not easy to be got out, if folded otherwise. Ribbons, laces, galloons, and paduas of all kinds, are also thus rolled.

A roll of tobacco is tobacco in the leaf, twisted on the mill, and wound twist over twist, about a stick or roller. A great deal of tobacco is sold in America in rolls of various weights; and it is not till its arrival in England, Spain, France, and Holland, that it is cut. A roll of parchment properly denotes the quantity of sixty skins.

The antients made all their books up in the form of rolls, and in Cicero's time the libraries consisted wholly of such rolls.

Roll, in law, signifies a schedule or parchment which may be rolled up by the hand into the form of a pipe.

In these schedules of parchment all the pleadings, memorials, and acts of court, are entered and filed by the proper officer; which being done, they become records of the court. Of these there are in the exchequer several kinds, as the great wardrobe-roll, the cofferer's-roll, the subsidy-roll, &c.

Roll is also used for a list of the names of persons of the same condition, or of those who have entered into the same engagement. Thus a court-roll of a manor, is that in which the names, rents, and services of each tenant are copied and inrolled.

Roll *muster*, that in which are entered the soldiers of every troop, company, regiment, &c.

As soon as a soldier's name is written down on the roll, it is death for him to desert.

Rolls-office, is an office in Chancery-lane, London, appointed for the custody of the rolls and records in chancery.

Rolls *of parliament*, are the manuscript registers, or rolls of the proceedings of our antient parliaments, which before the invention of printing, were all engrossed on parchment, and proclaimed openly in every county. In these rolls are also contained a great many decisions of difficult points of law, which were frequently in former times referred to the decision of that high court.

Roll, or Roller, is also a piece of wood, iron, brass, &c. of a cylindrical form, used in the construction of several machines, and in several works and manufactures.

A rolling-mill shewn in fig. 4. Plate, consists of two iron rollers AB, mounted in a strong iron frame, which consists of two distinct parts DE, both firmly fixed to the iron floor F; each part has a long mortice through it, in the bottom of which is the brass socket for the pivot of the roller A, and in the upper part is the brass of the upper roller; this last brass is fixed to a piece of iron G, fig. 5, which slides up and down in the mortice, and is prevented from raising by the end of a strong screw *a*, screwed through the upper part of the frame D; the roller is prevented from falling by its own weight, by the brass *b* in the under side of the pivot, which is attached by two screw-bolts *d d* to a collar upon the screw *a*, so that when the screws are turned by a handspike put between the teeth of the wheel H, the rollers A and B may be brought nearer together or further off, as occasion requires. I is a stout iron bar, fixed between the frames DE by a wedge *i* at each end, so that its upper surface is level with the top of the lower roller; at a small distance above this, is another bar *k*, fixed by two screws, between these are laid several blocks of iron L, so as to fill up all the space, except a small opening, through which the bar to be flatted is introduced; P is a small trough of iron plate, bored full of holes, to which, water is brought by a small pipe *p*. The upper roller is put in motion by a strong shaft R, which conveys the power from a water-wheel, steam engine, &c.; and the lower one is moved by a cog-wheel S, on the shaft R, which turns another T, on the axis of the lower roller. The machine is placed near to a furnace, where the iron bars to be rolled, are heated to a welding heat; the mill is then put in motion, and the iron bars taken out, with a pair of pinchers, and their ends put through the opening between the bars K and L, between the rollers; which as they turn round squeeze the iron flat, and to the proper thickness throughout, while other men behind the machine, convey it away. The rollers can be set nearer or further off by turning the screws *a a* as before described. The rolling-mill is principally used for making hoops for barrels, and iron plates; the water brought by the pipe *p* is to prevent the roller from being heated by the iron.

ROLLER, in surgery, a long and broad bandage, usually of linen-cloth, rolled round any part of the body, to keep it in, or dispose it to a state of health.

RONDELETIA, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking with those of which the order is doubtful. The corolla is funnel-shaped; the capsule bilocular, inferior, and polyspermous, roundish, and crowned. There are 14 species, shrubs of the West Indies.

ROOD, a quantity of land equal to forty square perches, or the fourth part of an acre.

ROOF. See Architecture.

ROOK, in ornithology. See Corvus.

ROOT. See Plants, *physiology of*.

Root, in mathematics, a quantity considered as the basis or foundation of a higher power; or one which being multiplied into itself any number of times, produces a square, cubic, biquadratic, &c. quantity; called the second, third, fourth, &c. power of the root, or quantity, so multiplied into itself; thus a is the square root of $a \times a$, or a^2; and 4 the square root of $4 \times 4 = 16$. Again, a is the cube-root of $a \times a \times a = a^3$; and 3 the cube-root of $3 \times 3 \times 3 = 27$: and so on. See Algebra.

The roots of powers are expressed by placing the radical sign $\sqrt{}$ over them, with a number denoting what kind of root they are: thus the square or second root of 16 is expressed by $\sqrt[2]{16}$, and the cube or third root of 27 by $\sqrt[3]{27}$; and, in general, the nth root of a raised to the power m, is expressed by $\sqrt[n]{a^m}$. When the root of a compound quantity is wanted, the vinculum of the radical sign must be drawn over the whole: thus the square root of $a^2 + 2ab + b^2$ is expressed by $\sqrt[2]{a^2 + 2ab + b^2}$; and it ought to be observed, that when the radical sign has no number above it, to denote what root is wanted, the square root is always meant; as $\sqrt{a^2}$, or $\sqrt{16}$, is the square root of a^2, or the square root of 16.

ROPE, hemp, hair, &c. spun into a thick yarn, and then several strings of this yarn twisted together by means of a wheel. When made very small it is called a cord, and when very thick, a cable. All the different kinds of this manufacture, from a fishing-line or whip-cord to the cable of a first-rate ship of war, go by the general name of cordage.

Ropes are made of every substance that is sufficiently fibrous, flexible, and tenacious, but chiefly of the inner barks of plants. The Chinese and other orientals even make them of the ligneous parts of several plants, such as certain bamboos and reeds, the stems of the aloes, the fibrous covering of the cocoa-nut, the filaments of the cotton pod, and the leaves of some grasses, such as the sparte (lygeum, Linn.). The aloe (agave, Linn.) and the sparte exceed all others in strength. But the barks of plants are the most productive of fibrous matter fit for this manufacture. Those of the linden tree (tilia) of the willow, the bramble, the nettle, are frequently used; but hemp and flax are the best; and of these the hemp is preferred, and employed in all cordage exceeding the size of a line, and even in many of this denomination.

Hemp is very various in its useful qualities; the best in Europe comes to us through Riga, to which port it is brought from very distant places southward. It is known by the name of riga rein (that is, clean) hemp. Its fibre is not the longest (at least in the dressed state in which we get it) but it is the finest, most flexible, and strongest. The next to this is supposed to be the Petersburgh braak hemp. Other hemps are esteemed nearly in the following order: Riga outshot, Petersburg outshot, hemp from Koningsburgh, Archangel, Sweden, Memel. Chucking is a name given to a hemp that comes from various places, long in the fibre, but coarse and harsh, and its strength is inferior to hemps which appear weaker. Its texture is such, that it does not admit splitting with the hatchel, so as to be more completely dressed: it is therefore kept in its coarse form, and used for inferior cordage. It is, however, a good and strong hemp, but will not make fine work. There are doubtless many good hemps in the southern parts of Europe; but little of them is brought to our market. Codilla, half clean, &c. are portions of the above-mentioned hemps, separated by the dressing, and may be considered as broken fibres of those hemps.

Only the first qualities are manufactured for the rigging of the royal navy and for the ships of the East India company.

ROPE-MAKING, is an art of very great importance; and there are few that better deserve the attention of the intelligent observer. Hardly any art can be carried on without the assistance of the rope-maker. Cordage makes the very sinews and muscles of a ship; and every improvement which can be made in its preparation, either in respect to strength or pliableness, must be of immense service to the mariner, and to the commerce and the defence of nations.

The aim of the rope-maker is to unite the strength of a great number of fibres. This would be done in the completest manner by laying the fibres parallel to each other, and fastening the bundle at the two ends; but this would be of very limited use, because the fibres are short, not exceeding three feet and a half at an average. They must therefore be entangled together, in such a manner, that the strength of a fibre shall not be able to draw it out from among the rest of the bundle. This is done by twisting or twining them together, which causes them mutually to compress each other. When the fibres are so disposed in a long skain, that their ends succeed each other along its length, without many of them meeting in one place; and this skain is twisted round; we may cause them to compress each other to any degree we please; and the friction on a fibre which we attempt to pull out may be more than its cohesion can overcome. It will therefore break. Consequently, if we pull at this twisted skain, we shall not separate it by drawing one parcel out from among the rest, but the whole fibres will break; and if the distribution of the fibres has been very equable, the skain will be nearly of the same strength in every part. If there is any part where many ends of fibres meet, the skain will break in that part.

We know very well that we can twist a skain of fibres so very hard, that it will break with any attempt to twist it harder. In this state all the fibres are already strained to the utmost of their strength. Such a skain of fibres can have no strength. It cannot carry a weight, because each fibre is already strained in the same manner as if loaded with as much weight as it is able to bear. What we have said of this extreme case is true in a certain extent of every degree of twist that we give the fibres. Whatever force is actually exerted by a twisted fibre, in order that it may sufficiently compress the rest to hinder them from being drawn out, must be considered as a weight hanging on that fibre, and must be deducted from its absolute strength of cohesion, before we can estimate the strength of the skain. The strength of the skain is the remainder of the absolute strength of the fibres, after we have deduced the force employed in twisting them together. From this observation may be established a fundamental principle in rope-making, that all twisting, beyond what is necessary for preventing the fibres from being drawn out without breaking, diminishes the strength of the cordage, and should be avoided when in our power.

It is necessary then to twist the fibres of hemp together, in order to make a rope; but we should make a very bad rope if we contented ourselves with twisting together a bunch of hemp sufficiently large to withstand the strains to which the rope is to be exposed. As soon as we let it go out of our hands, it would untwist itself, and be again a loose bundle of hemp; for the fibres are strained, and they are in a considerable degree elastic; they contract again, and thus untwist the rope or skain. It is necessary to contrive the twist in such a manner, that the tendency to untwist in one part may act against the same tendency in another and balance it. The process, therefore, of rope-making is more complicated.

The first part of this process is spinning of rope-yarns, that is, twisting the hemp in the first instance. This is done in various ways, and with different machinery, according to the nature of the intended cordage. We shall confine our description to the manufacture of the larger kinds, such as are used for the standing and running rigging of ships.

An alley or walk is inclosed for the purpose, about 200 fathoms long, and of a breadth suited to the extent of the manufacture. It is sometimes covered above. At the upper end of this rope-walk is set up the spinning-wheel, of a form resembling that in Plate Miscel. fig. 210. The band of this wheel goes over several rollers called whirls, turning on pivots in brass holes. The pivots at one end come through the frame, and terminate in little hooks. The wheel being turned by a winch, gives motion in one direction to all those whirls. The spinner has a bundle of dressed hemp round his waist, with the two ends meeting before him. The hemp is laid in this bundle in the same way that women spread the flax on the distaff. There is great variety in this; but the general aim is to lay the fibres in such a manner, that as long as the bundle lasts there may be an equal number of the ends at the extremity, and that a fibre may never offer itself double or in a bight. The spinner draws out a proper number of fibres, twists them with his fingers, and having got a sufficient length detached, he fixes it to the hook of a whirl. The wheel is now turned, and the skain is twisted, becoming what is called a rope-yarn, and the spinner walks backwards down the rope-walk. The part already twisted draws along with it more fibres out of the bundle. The spinner aids this with his fingers, supplying hemp in due proportion as he walks away from the wheel, and taking care that the fibres come in equally from both sides of his bundle, and that they enter always with their ends, and not by the middle, which would double them. He should also endeavour to enter every fibre at the heart of the yarn. This will cause all the fibres to mix equally in making it up, and will make the work smooth, because one end of each fibre is by this means buried among the rest, and the other end only lies outward; and this, in passing through the grasp of the spinner, who presses it tight with his thumb and palm, is also made to lie smooth. The greatest fault that can be committed in spinning is to allow a small thread to be twisted off from one side of the hemp, and then to cover this with hemp supplied from the other side; for it is evident, that the fibres of the central thread make very long spirals, and the skin of fibres which covers them must be much more oblique. This covering has but little connection with what is below it, and will easily be detached. But even while it remains, the yarn cannot be strong, for on pulling it, the middle part, which lies the straightest, must bear all the strain, while the outer fibres that are lying obliquely, are only drawn a little more parallel to the axis. This defect will always happen if the hemp is supplied in a considerable body to a yarn that is then spinning small. Into whatever part of the yarn it is made to enter, it becomes a sort of loosely connected wrapper. Such a yarn, when untwisted a little, will have the appearance of fig. 211. while a good yarn looks like fig. 212. A good spinner therefore endeavours always to supply the hemp in the form of a thin flat skain with his left hand, while his right is employed in grasping firmly the yarn that is twining off, and in holding it tight from the whirl, that it may not run into loops or kinks.

It is evident, that both the arrangement of the fibres and the degree of twisting depend on the skill and dexterity of the spinner, and that he must be instructed, not by a book, but by a master. The degree of twist depends on the rate of the wheel's motion, combined with the retrograde walk of the spinner.

We may suppose him arrived at the lower end of the walk, or as far as is necessary for the intended length of his yarn. He calls out, and another spinner immediately detaches the yarn from the hook of the whirl, gives it to another, who carries it aside to the reel; and this second spinner attaches his own hemp to the whirl-hook. In the mean time, the first spinner keeps fast hold of the end of his yarn; for the hemp, being dry, is very elastic, and if he were to let it go out of his hand, it would instantly untwist, and become little better than loose hemp. He waits, therefore, till he sees the reeler begin to turn the reel, and he goes slowly up the walk, keeping the yarn of an equal tightness all the way, till he arrives at the wheel, where he waits with his yarn in his hand till another spinner has finished his yarn. The first spinner takes it off the whirl-hook, joins it to his own, that it may follow it on the reel, and begins a new yarn.

Rope-yarns, for the greatest part of the large rigging, are from a quarter of an inch to somewhat more than a third of an inch in circumference, or of such a size that 160 fathoms weigh from $3\frac{1}{2}$ to 4 pounds when white. The different sizes of yarns are named from the number of them contained in a strand of a rope of three inches in circumference. Few are so coarse that 16 will make a strand of British cordage; 18 is not unfrequent for cable yarns, or yarns spun from harsh and coarse hemp; 25 is, we believe, the finest size which is worked up for the rigging of a ship. Much finer are indeed spun for sounding-lines, fishing-lines, and many other marine uses, and for the other demands of society. Ten good spinners will work up above 600 weight of hemp in a day; but this depends on the weather. In very dry weather the hemp is very elastic, and requires great attention to make smooth work. In the warmer climates the spinner is permitted to moisten the rag with which he grasps the yarn in his right hand for each yarn. No work can be done in an open spinning-walk in rainy weather, because the yarns would not take on the tar, if immediately tarred, and would rot if kept on the reel for a long time.

The second part of the process is the conversion of the yarns into what may with propriety be called a rope, cord, or line. That we may have a clear conception of the principle which regulates this part of the process, we shall begin with the simplest possible case, the union of two yarns into one line. This is not a very usual fabric for rigging, but we select it for its simplicity.

When hemp has been split into very fine fibres by the hatchel, it becomes exceedingly soft and pliant, and after it has lain for some time in the form of fine yarn, it may be unreeled and thrown loose, without losing much of its twist. Two such yarns may be put on the whirl of a spinning-wheel, and thrown, like flaxen yarn, so as to make sewing thread. It is in this way, indeed, that the sailmakers' sewing thread is manufactured; and when it has been kept on the reel, or on balls or bobbins, for some time, it retains its twist as well as its uses require. But this is by no means the case with yarns spun for great cordage. The hemp is so elastic, the number of fibres twisted together is so great, and the diameter of the yarn (which is a sort of lever on which the elasticity of the fibre exerts itself) is so considerable, that no keeping will make the fibres retain this constrained position. The end of a rope-yarn being thrown loose, it will immediately untwist, and this with considerable force and speed. It would, therefore, be a fruitless attempt to twist two such yarns together; yet the ingenuity of man has contrived to make use of this very tendency to untwist not only to counteract itself, but even to produce another and a permanent twist, which requires force to undo it, and which will recover itself when this force is removed. Every person must recollect, that when he had twisted a packthread very hard with his fingers between his two hands, if he slackens the thread by bringing his hands nearer together, the packthread will immediately curl up, running into loops or kinks, and will even twist itself into a neat and firm cord.

The component parts of a rope are called strands, and the operation of uniting them with a permanent twist is called laying or closing, the latter term being chiefly appropriated to cables and other very large cordage.

Lines and cordage less than 1½ inches circumference are laid at the spinning-wheel. The workman fastens the ends of each of two or three yarns to separate whirl-hooks. The remote ends are united in a knot. This is put on one of the hooks of a swivel called the loper, represented in fig. 213, and care is taken that the yarns are of equal length and twist. A piece of soft cord is put on the other hook of the loper; and, being put over a pulley several feet from the ground, a weight is hung on it, which stretches the yarn. When the workman sees that they are equally stretched, he orders the wheel to be turned in the same direction as when twining the yarns. This would twine them harder; but the swivel of the loper gives way to the strain, and the yarns immediately twist around each other, and form a line or cord. In doing this, the yarns lose their twist. This is restored by the wheel. But this simple operation would make a very bad line, which would be slack, and not hold its twist; for, by the turning of the loper, the strands twist immediately together, to a great distance from the loper. By this turning of the loper the yarns are untwisted. The wheel restores their twist only to that part of the yarns that remains separate from the others, but cannot do it in that part where they are already twined round each other, because their mutual pressure prevents the twist from advancing. It is, therefore, necessary to retard this tendency to twine, by keeping the yarns apart. This is done by a little tool called the top, represented in fig. 214.

It is a truncated cone, having three or more notches along its sides, and a handle called the staff. This is put between the strands, the small end next the loper, and it is pressed gently into the angle formed by the yarns which lie in the notches. The wheel being now turned, the yarns are more twisted, or hardened up, and their pressure on the top gives it a strong tendency to come out of the angle, and also to turn round. The workman does not allow this till he thinks the yarns sufficiently hardened. Then he yields to the pressure, and the top comes away from the swivel, which immediately turns round, and the line begins to lay. Gradually yielding to this pressure, the workman slowly comes up towards the wheel, and the laying goes on, till the top is at last close to the wheel, and the work is done. In the mean time, the yarns are shortened, both by the twining of each and the laying of the cord. The weight, therefore, gradually rises. The use of this weight is evidently to oblige the yarn to take a proper degree of twist, and not run into kinks.

A cord, or line, made in this way, has always some tendency to twist a little more. However little friction there may be in the loper, there is some, so that the turns which the cord has made in the laying, are not enough to balance completely the elasticity of the yarns; and the weight being appended, causes the strands to be more nearly in the direction of the axis, in the same manner as it would stretch and untwist a little any rope to which it is hung. On the whole, however, the twist of a laid line is permanent, and not like that upon thread doubled or thrown in a mill, which remains only in consequence of the great softness and flexibility of the yarn.

The process for laying or closing large cordage is considerably different from this. The strands of which the rope is composed consist of many yarns, and require a considerable degree of hardening. This cannot be done by a whirl driven by a wheel-band; it requires the power of a crank turned by the hand. The strands, when properly hardened, become very stiff, and when bent round the top, are not able to transmit force enough for laying the heavy and unpliant rope which forms beyond it. The elastic twist of the hardened strands must, therefore, be assisted by an external force. All this requires a different machinery and a different process.

At the upper end of the walk is fixed up the tackle-board, fig. 215. This consists of a strong oaken plank called a breast-board, having three or more holes in it, such as A, B, C, fitted with brass or iron plates. Into these are put iron cranks, called heavers, which have hooks or forelocks, and keys, on the ends of their spindles. They are placed at such a distance from each other, that the workmen do not interfere with each other while turning them round. This breast-board is fixed to the top of strong posts well secured by struts or braces facing the lower end of the walk. At the lower end is another breast-board fixed to the upright posts of a sledge, which may be loaded with stones or other weights. Similar cranks are placed in the holes of this breast-board. The whole goes by the name of the sledge; (see fig. 216). The top necessary for closing large cordage is too heavy to be held in the hand: it therefore has a long staff, which has a truck on the end. This rests on the ground; but even this is not enough in laying great cables. The top must be supported on a carriage, as shown in fig. 217, where it must lie very steady, and it needs attendance, because the master workman has sufficient employment in attending to the manner in which the strands close behind the top, and in helping them by various methods. The top is, therefore, fixed to the carriage by lashing its staff to the two upright posts. A piece of soft rope, or strap, is attached to the handle of the top by the middle, and its two ends are brought back and wrapped several times tight round the rope, in the direction of its twist, and bound down. This is shown at W, and it greatly assists the laying of the rope by its friction. This both keeps the top from flying too far from the point of union of the strands, and brings the strands more regularly into their places.

The first operation is warping the yarns. At each end of the walk are frames called warping frames, which carry a great number of reels or winches filled with rope-yarn. The foreman of the walk takes off a yarn end from each, till he has made up the number necessary for his rope or strand, and bringing the ends together, he passes the whole through an iron ring fixed to the top of a stake driven into the ground, and draws them through: then a knot is tied on the end of the hundle, and a workman pulls it through this ring till the intended length is drawn off the reels. The end is made fast at the bottom of the walk, or at the sledge, and the foreman comes back along the skain of yarns, to see that none are hanging slacker than the rest. He takes up in his hand such as are slack, and draws them tight, keeping them so till he reaches the upper end, where he cuts the yarns to a length, again adjusts their tightness, and joins them all together in a knot, to which he fixes the hook of a tackle, the other block of which is fixed to a firm post, called the warping-post. The skain is well stretched by this tackle, and then separated into its different strands. Each of these is knotted apart at both ends. The knots at their upper ends are made fast to the hooks of the cranks in the tackle-board; and those at the lower ends are fastened to the cranks in the sledge. The sledge itself is kept in its place by a tackle, by which the strands are again stretched in their places, and every thing adjusted, so that the sledge stands square on the walk, and then a proper weight is laid on it. The tackle is now cast off, and the cranks are turned at both ends, in the contrary direction to the twist of the yarns. (In some kinds of cordage the cranks are turned the same way with the spinning twist). By this the strands are twisted and hardened up; and as they contract by this operation, the sledge is dragged up the walk. When the foreman thinks the strands sufficiently hardened, which he estimates by the motion of the sledge, he orders the heavers at the cranks to stop. The middle strand at the sledge is taken off from the crank. This crank is taken out, and a stronger one put in its place at D, fig. 216. The other strands are taken off from their cranks, and are all joined on the hook which is now in the middle hole. The top is then placed between the strands, and being pressed home to the point of their union, the carriage is placed under it, and it is firmly fixed down. Some weight is taken off the sledge. The heavers now begin to turn at both ends. Those at the tackle-board continue to turn as they did before; but the heavers at the sledge turn in the opposite direction to their former motion, so that the cranks at both ends are now turning one way. By the motion of the sledge-crank the top is forced away from the knot, and the rope begins to close. The heaving at the upper end restores to the strand the twist which they are constantly losing by the laying of the rope. The workmen judge of this by making a chalk mark on intermediate points of the strands, where they lie on the stakes which are set up along the walk for their support. If the twist of the strands is diminished by the motion of closing, they will lengthen, and the chalk mark will move away from the tackle-board; but if the twist increases by turning the cranks at the tackle-board, the strands will shorten, and the mark will come nearer to it.

As the closing of the rope advances, the whole shortens, and the sledge is dragged up the walk. The top moves faster, and at last reaches the upper end of the walk, the rope being now laid. In the mean time, the sledge has moved several fathoms from the place where it was when the laying began.

These motions of the sledge and top must be exactly adjusted to each other. The rope must be of a certain length. Therefore the sledge must stop at a certain place. At that moment the rope should be laid; that is, the top should be at the tackle-board. In this consists the address of the foreman. He has his attention directed both ways. He looks at the strands, and when he sees any of them hanging slacker between the stakes than the others, he calls to the heavers at the tackle-board to heave more upon that strand. He finds it more difficult to regulate the motion of the top. It requires a considerable force to keep it in the angle of the strands, and it is always disposed to start forward. To prevent or check this, some straps of soft rope are brought round the staff of the top, and then wrapped several times round the rope behind the top, and kept firmly down by a lanyard or bandage, as is shown in the figure. This both holds back the top, and greatly assists the laying of the rope, causing the strands to fall into their places, and keep close to each other, which is sometimes very difficult, especially in ropes composed of more than three strands. It will greatly improve the laying the rope, if the top has a sharp, smooth, tapering pin of hard wood, pointed at the end, projecting so far from the middle of its smaller end, that it gets in between the strands which are closing. This supports them, and makes their closing more gradual and regular. The top, its notches, the pin, and the warp or strap, which is lapped round the rope, are all smeared with grease or soap to assist the closing. The foreman judges of the progress of closing chiefly by his acquaintance with the walk, knowing that when the sledge is abreast of a certain stake, the top should be abreast of a certain other stake. When he finds the top too far down the walk, he slackens the motion at the tackle-board, and makes the men turn briskly at the sledge. By this the top is forced up the walk, and the laying of the rope accelerates, while the sledge remains in the same place, because the strands are loosing their twist, and are lengthening, while the closed rope is shortening. When, on the other hand, he thinks the top too far advanced, and fears that it will be at the head of the walk before the sledge has got to its proper place, he makes the men heave briskly on the strands, and the heavers at the sledge-crank work softly. This quickens the motion of the sledge by shortening the strands; and by thus compensating what has been overdone, the sledge and top come to their places at once, and the work appears to answer the intention.

When the top approaches the tackle-board, the heaving at the sledge could not cause the strands immediately behind the top to close well, without having previously produced an extravagant degree of twist in the intermediate rope. The effort of the crank must therefore be assisted by men stationed along the rope, each furnished with a tool called a woolder. This is a stout oak stick, about three feet long, having a strap of soft rope-yarn or cordage fastened on its middle or end. The strap is wrapped round the laid rope, and the workman works with the stick as a lever, twisting the rope round in the direction of the crank's motion. The woolders should keep their eye on the men at the crank, and make their motion correspond with his. Thus they send forward the twist produced by the crank, without either increasing or diminishing it, in that part of the rope which lies between them and the sledge.

Such is the general and essential process of rope-making. The fibres of hemp are twisted into yarns, that they may make a line of any length, and stick among each other with a force equal to their own cohesion. The yarns are made into cords of permanent twist by laying them; and that we may have a rope of any degree of strength, many yarns are united in one strand, for the same reason that many fibres were united in one yarn; and in the course of this process it is in our power to give the rope a solidity and hardness which make it less penetrable by water, which would rot it in a short while. Some of these purposes are inconsistent with others; and the skill of a rope-maker lies in making the best compensation, so that the rope may on the whole be the best in point of strength, pliancy, and duration, that the quantity of hemp in it can produce.

The following rule for judging of the weight which a rope will bear is not far from the truth. It supposes them rather too strong; but it is so easily remembered that it may be of use.

Multiply the circumference in inches by itself, and take the fifth part of the product, it will express the tons which the rope will carry. Thus, if the rope has 6 inches circumference, 6 times 6 is 36, the fifth of which is $7\frac{1}{5}$ tons; apply this to the rope of $3,\frac{1}{5}$, on which sir Charles Knowles made his experiments $3\frac{1}{5} \times 3\frac{1}{5} = 10,25$, $\frac{1}{5}$ of which is 2,05 tons, or 4592 pounds. It broke with 4550.

This may suffice for an account of the mechanical part of the manufacture. But we have taken no notice of the operation of tarring; and our reason was, that the methods practised in different rope-works are so exceedingly different, that we could hardly enumerate them, or even give a general account of them. It is evidently proper to tar in the state of twine or yarn, this being the only way that the hemp could be uniformly penetrated. The yarn is made to wind off one reel, and having passed through a vessel containing hot tar, it is wound up on another reel; and the superfluous tar is taken off by passing through a hole surrounded with spongy oakum; or it is tarred in skains or hauls, which are drawn by a capstern through the tar-kettle, and through a hole formed of two plates of metal, held together by a lever loaded with a weight.

It is established beyond a doubt, that tarred cordage when new is weaker than white, and that the difference increases by keeping. The following experiments were made by Mr. Du Hamel at Rochefort on cordage of three inches (French) in circumference, made of the best Riga hemp.

	White.	Tarred.
	August 8, 1741.	
Broke with	4500 pounds.	3400 pounds.
	4900	3300
	4800	3250
	April 25, 1743.	
	4600	3500
	5000	3400
	5000	3400
	Sept, 3, 1746.	
	3800	3000
	4000	2700
	4200	2800

A parcel of white and tarred cordage was taken out of a quantity which had been made February 12, 1746. It was laid up in the magazines, and comparisons were made from time to time as follows:

	White bore.	Tarred bore.	Differ.
1746, April 14,	2645 lbs.	2312 lbs.	333
1747, May 18,	2762	2155	607
1747, Oct. 21,	2710	2050	660
1748, June 19,	2575	1752	823
1748, Oct. 2,	2425	1837	588
1749, Sept. 25,	2917	1865	1052

Mr. Du Hamel says, that it is decided by experience, 1. That white cordage in continual service is one-third more durable than tarred. 2. That it retains its force much longer while kept in store. 3. That it resists the ordinary injuries of the weather one-fourth longer.

We know this one remarkable fact: in 1758 the shrowds and stays of the Sheer hulk at Portsmouth dock-yard were over-hauled, and when the worming and service were taken off, they were found to be of white cordage. On examining the store-keeper's books, they were found to have been formerly the shrowds and rigging of the Royal William, of 110 guns, built in 1715, and rigged in 1716. She was thought top-heavy, and unfit for sea, and unrigged, and her stores laid up. Some few years afterwards, her shrowds and stays were fitted on the Sheer hulk, where they remained in constant and very hard service for about 30 years, while every tarred rope about her had been repeatedly renewed.

Why then do we tar cordage? It is chiefly serviceable for cables and ground tackle, which must be continually wetted, and even soaked. The result of careful observation is, 1. That white cordage, exposed to be alternately very wet and dry, is weaker than tarred cordage. 2. That cordage which is superficially tarred is constantly stronger than what is tarred throughout, and it resists better the alternatives of wet and dry. The shrowds of the Sheer hulk were well tarred and blacked, so that it was not known that they were of white cordage.

Attempts have been made to increase the strength of cordage by tanning. But although it remains a constant practice in the manufacture of nets, it does not appear that much addition, either of strength or durability, can be given to cordage by this means. The trial has been made with great care, and by persons fully able to conduct the process with propriety. But it is found that the yarns take so long time in drying, and are so much hurt by drying slowly, that the room required for a considerable rope-work would be immense; and the improvement of the cordage is but trifling, and even equivocal.

ROSA, the *rose*, a genus of the polygynia order, in the icosandria class of plants, and in the natural method ranking under the 35th order, senticosæ. There are five petals; the calyx is urceolated, quinquefid, carnous, and straitened at the neck. The seeds are numerous, hispid, and affixed to the inside of the calyx. The sorts of roses are very numerous; and the botanists find it very difficult to determine with accuracy which are species and which are varieties, as well as which are varieties of the respective species. On this account Linnæus, and some other eminent authors, are inclined to think that there is only one real species of rose, which is the rosa canina, or dog-rose of the hedges, &c. and that all the other sorts are accidental varieties of it. According, however, to the present arrangement, they stand divided into 40 supposed species, each comprehending varieties, which in some sorts are but few, in others numerous. The most remarkable species, and their varieties, according to the arrangement of modern botanists, are as follow:

1. The canina, canine rose, wild dog-rose of the hedges, or hep-tree. There are two varieties, red-flowered and white-flowered. They grow wild in hedges abundantly all over the kingdom; and are sometimes admitted into gardens; a few to increase the variety of the shrubbery collection.

2. The alba, or common white-rose. The varieties are; large double white rose; dwarf single white rose; maidens-blush white rose, being large, produced in clusters, and of a white and blueish-red colour.

3. The gallica, or Gallican rose, &c. This species is very extensive in supposed varieties, several of which have been formerly considered as distinct species, but are now ranged among the varieties of the Gallican rose, consisting of the following noted varieties.

Common red officinal rose. Rosa mundi (rose of the world) or striped red rose; York and Lancaster variegated rose; monthly rose, producing middle-sized, moderately-double, delicate flowers, of different colours in the varieties. The varieties are, common red-flowered monthly rose, blush-flowered, white-flowered, stripe-flowered: all of which blow both early and late, and often produce flowers several months in the year, as May, June, and July; and frequently again in August or September, and sometimes in fine mild seasons, continue till November or December. Hence the name monthly rose, double virgin rose.

4. The damascena, including the red damask rose, white damask rose, blueish Belgic rose, red Belgic rose. Velvet rose grows three or four feet high, armed with but few prickles; producing large velvet-red flowers, comprising semidouble and double varieties, all very beautiful roses. Marbled rose grows four or five feet high, having brownish branches, with but few prickles; and a large, double, finely-marbled, red flower.

5. The lutea, including the red and yellow Austrian rose, yellow Austrian rose, double yellow rose.

6. The centifolia, or hundred leaved red rose, &c. The varieties are; common Dutch hundred-leaved rose, bluish hundred-leaved rose.

7. The provincialis, or Provence rose. The varieties are; common red Provence rose, and pale Provence rose; both of which having larger and somewhat looser petals than the following sort. Cabbage Provence rose, having the petals closely folded over one another like cabbages; Dutch cabbage rose, very large, and cabbages tolerably; childing Provence rose; great royal rose, producing remarkably large, somewhat loose, but very elegant flowers. All these are large double red flowers, somewhat globular at first blowing, becoming gradually a little spreading at top, and are all very ornamental fragrant roses.

8. The muscosa, or moss Provence rose, supposed by some a variety of the common rose, having the calyx and upper part of the peduncle surrounded with a rough mossy-like substance, effecting a curious singularity.

9. The cinnamomea, or cinnamon rose. There are varieties with double-flowers.

10. The alpina, or Alpine inermous rose. This species, as being free from all kind of armature common to the other sorts of roses, is esteemed as a singularity; and from this property is often called the virgin rose.

11. The Carolina, or Carolina and Virginia rose, &c. grows six or eight feet high, or more. The varieties are; dwarf Pennsylvania rose, with single and double red flowers. American pale-red rose. This species and varieties grow naturally in different parts of North America; they effect a fine variety in our gardens, and are in estimation for their late-flowering property, as they often continue in blow from August until October; and the flowers are succeeded by numerous red berry-like heps in autumn, causing a variety all winter.

12. The villosa, or villose apple-bearing rose, grows six or eight feet high. This species merits admittance into every collection as a curiosity for the singularity of its fruit, both for variety and use; for having a thick pulp of an agreeable acid relish; this is often made into a tolerably good sweetmeat.

13. The pimpinellifolia, or burnet-leaved rose. There are varieties with red flowers, and with white flowers. They grow wild in England, &c. and are cultivated in shrubberies for variety.

14. The spinosissima, or most spinous, dwarf burnet-leaved rose, commonly called Scotch rose. The varieties are: common white-flowered, red-flowered, striped-flowered, marble-flowered. They grow naturally in England, Scotland, &c. The first variety rises near a yard high, the others, but one or two feet, all of which are single-flowered; but the flowers, being numerous all over the branches, make a pretty appearance in the collection.

15. The eglanteria, eglantine rose, or sweet-brier. The varieties are; common single-flowered, semi-double-flowered, double-flowered, blaish double-flowered, yellow flowered. This species grows naturally in some parts of England and Switzerland. It claims culture in every garden for the odoriferous property of its leaves; and should be planted in the borders, and other compartments contiguous to walks, or near the habitation, where the plants will impart their refreshing fragrance very profusely all around; and the young branches are excellent for improving the odour of nosegays and bowpots.

16. The moschata, or musk rose, supposed to be a variety only of the ever-green musk-rose; has all the branches terminated by large, umbellate clusters of pure white musk-scented flowers in August, &c.

17. The sempervirens, or evergreen musk-rose. The sempervirent property of this elegant species renders it a curiosity among the rose tribe; it also makes a fine appearance as a flowering shrub. There is one variety, the deciduous musk-rose above-mentioned. This species and variety flower in August, and is remarkable for producing them numerously in clusters, continuing in succession till October or November.

18. The semper flowers, or deep-red China rose, a most beautiful little plant, and well deserving the epithet of ever-blowing.

19. The chinensis, or pale China rose, which flowers almost the whole year.

These two last species were supposed to be so tender, as always to require the shelter of a green-house; but we can say from experience that they are nearly as hardy as any of our English roses.

The white and red roses are used in medicine. The former distilled with water yields a small portion of a butyraceous oil, whose flavour exactly resembles that of the roses themselves. This oil, and the distilled water, are very useful and agreeable cordials. These roses also, besides the cordial and aromatic virtues which reside in their volatile parts, have a mild purgative one, which remains entire in the decoction after distillation. The red rose, on the contrary, has an astringent and gratefully corroborating virtue.

ROSE. See Rosa.

ROSEMARY. See Rosmarinus.

ROSIDULA, a genus of the class and order pentandria monogynia. The calyx is five-leaved; corolla five-petalled; anthers scrotiform; capsule three-valved. There is one species, a suffructicose plant of the Cape.

ROSMARINUS, *rosemary*, a genus of the monogynia order, in the diandria class of plants, and in the natural method ranking under the 42d order, verticillatæ. The corolla is unequal, with its upper lip bipartite; the filaments are long, curved, and simple, each having a small dent. There are two species, the officinalis and chilensis. There are two varieties, of the first sort, one with white, striped leaves, called the silver rosemary, and the other with yellow, whence it is called the gold-striped rosemary. These plants grow naturally in the southern parts of France, Spain, and Italy; where, upon dry rocky soils near the sea, they thrive prodigiously, and perfume the air in such a manner as to be smelt at a great distance from the land. They are, however, hardly enough to bear the cold of our ordinary winters, provided they are planted upon a poor, dry, gravelly soil, on which they all endure the cold much better than in a richer ground, where, growing more vigorously in summer, they are more apt to be injured by frost in winter; nor will they have such a strong aromatic scent as those on a dry and barren soil. They are to be propagated either by slips or cuttings.

Rosemary has a fragrant smell, and a warm pungent bitterish taste, approaching to those of lavender: the leaves and tender tops are strongest; next to those, the cup of the flower; the flowers themselves are considerably the weakest, but most pleasant. Aqueous liquors extract a great share of the virtues of rosemary leaves by infusion, and elevate them in distillation: along with the water arises a considerable quantity of essential oil, of an agreeable strong penetrating smell. Pure spirit extracts in great perfection the whole aromatic flavour of the rosemary, and elevates very little of it in distillation. Hence the resinous mass left upon extracting the spirit, proves an elegant aromatic, very rich in the peculiar qualities of the plant. The flowers of rosemary give over great part of their flavour in distillation with pure spirit; by watery liquors, their fragrance is much injured; by beating, destroyed.

ROTALA, a genus of the monogynia order, in the triandria class of plants. The calyx is tridentate: there is no corolla; the capsule is trilocular and polyspermous. There is one species, an annual of the East Indies.

ROTANG. See CALAMUS.

ROTATION, in geometry, a term chiefly applied to the circumvolution of any surface round a fixed and immoveable line, which is called the axis of its rotation; and by such rotations it is, that solids are conceived to be generated.

The late ingenious M. de Moivre shews how solids, thus generated, may be measured or cubed. His method is this: for the fluxion of such solids, take the product of the fluxion of the absciss, multiplied by the circular base; and suppose the ratio of a square to the circle inscribed in it to be $\frac{n}{x}$: then the equation expressing the nature of any circle, whose diameter is d, is $yy = dx - xx$. Therefore $\frac{4dx\dot{x} - x^2\dot{x}}{n}$ is the fluxion of a portion of the sphere; and, consequently, the portion itself $4\frac{1}{2}d\dot{x}x - x\frac{1}{3}x^3$, and the circumscribed cylinder is $\frac{4dxx - x^3}{n}$; and therefore the portion of the sphere is to the portion of the circumscribed cylinder, as $\frac{1}{2}d - \frac{1}{3}x$ to $d - x$.

ROTHIA, a genus of the class and order syngenesia polygamia æqualis. The calyx is many-leaved in a single row; woolly recept. in the ray chaffy in the disk villose-seeds; in the ray bald in the disk pappose. There is one species.

ROTONDO, or ROTUNDO, in architecture, an appellation given to any building that is round both within and without, whether it is a church, a saloon, or the like.

ROTTBOELLIA, a genus of the digynia order, in the triandria class of plants. The rachis is jointed, roundish, and in many cases filiform: the calyx is ovate, lanceolated, flat, simple, or bipartite; the florets are alternate on the winding rachis. There are 17 species, grasses of Africa and the East Indies.

ROTTEN-STONE, a mineral found in Derbyshire, and used by mechanics for all sorts of finer grinding and polishing, and sometimes for cutting of stones. According to Ferber, it is a tripoli mixed with calcareous earth. See TRIPOLI.

ROUND, in a military sense, signifies a walk which some officer, attended with a party of soldiers, takes in a fortified place around the ramparts, in the night-time, in order to see that the centries are watchful, and every thing in good order.

The centries are to challenge the rounds at a distance, and rest their arms as they pass, to let none come near them; and when the round comes near the guard, the centry calls aloud, who comes there? and being answered, the rounds; he says, stand; and then calls the corporal of the guard, who draws his sword, and calls also, who comes there? and when he is answered, the rounds, he who has the word advances, and the corporal receives it with his sword pointed to the giver's breast. In strict garrison the rounds go every quarter of an hour.

ROUNDELAY, a kind of antient poem, thus termed, according to Menage, from its form, because it turns back again to the first verse, and thus goes round. This poem is little known among us, but is very common among the French, who call it rondeau. It consists commonly of thirteen verses, eight whereof are in one rhyme, and five in another. It is divided into couplets, at the end of the second and third of which the beginning of the roundelay is repeated, and that if possible in an equivocal or pausing sense.

ROUT, in law. See RIOT.

ROUSSEA, a genus of the tetrandria monogynia class and order. The calyx is four-leaved; corolla one-petalled, bell-shaped, four-cleft, inferior; berry quadrangular, many seeded. There is one species, a small shrub of St. Mauritius.

ROXBURGHIA, a genus of the octandria monogynia class and order. The calyx is four-leaved; corolla four-petalled; nectarines four, awl-shaped; anthers linear; capsule one-celled, two-valved; seeds many. There is one species, native of Coromandel.

ROYENIA, a genus of the digynia order, in the decandria class of plants; and in the natural method ranking under the 18th order, bicornes. The calyx is urceolated; the corolla monopetalous, with the limb revoluted; the capsule is unilocular and quadrivalved. There are seven species, herbs of the Cape.

RUBIA, *madder*, a genus of the monogynia order, in the tetrandia class of plants; and in the natural method ranking under the 47th order, stellatæ. The corolla is monopetalous and campanulated; and there are two monospermous berries. There are seven species, of which the most remarkable is the tinctorum, or dyer's madder, so much used by the dyers and callico-printers. This hath a perennial root, and annual stalk: the root is composed of many long, thick, succulent fibres, almost as large as a man's little finger; these are joined at the top in a head like asparagus, and run very deep into the ground. From the upper part, or head of the root, come out many side-roots, which extend just under the surface of the ground to a great distance, by which it propagates very fast; for these send up a great number of shoots, which, if carefully taken off in the spring soon after they are above ground, become so many plants. These roots are of a reddish colour, somewhat transparent; and have a yellowish pith in the middle, which is tough, and of a bitterish taste. From this root arise many large four-cornered jointed stalks, which in good land will grow five or six feet long, and, if supported, sometimes seven or eight: they are armed with short herbaceous prickles; and at each joint are placed five or six spear-shaped leaves: their upper surfaces are smooth; the branches are terminated by loose branching spikes of yellow flowers, which are cut into four parts resembling stars. These appear in June, and are sometimes succeeded by seeds, which seldom ripen in England. For its principal uses, see DYEING, and CALICO PRINTING.

Madder-root is used in medicine. The virtues attributed to it are those of a detergent and aperient; whence it has been usually ranked among the opening roots, and recommended in obstructions of the viscera, particularly of the kidneys, in coagulations of the blood from falls or bruises, in the jaundice, and beginning dropsies. It is an ingredient in the icteric decoction of the Edinburgh pharmacopœia.

It is observable, that this root, taken internally, tinges the urine of a deep red colour; and in the Philosophical Transactions we have an account of its producing a like effect upon the bones of animals who had it mixed with their food: all the bones, particularly the more solid ones, were said to be changed, both externally and internally, to a deep red; but neither the fleshy nor cartilaginous parts suffered any alterations: some of these bones macerated in water for many weeks together, and afterwards steeped and boiled in spirit of wine, lost none of their colour, nor communicated any tinge to the liquors. This root, therefore, was concluded to be possessed of great subtilty of parts, and its medical virtues hence to deserve inquiry. The same trials, however, made by others, have not been found to produce the same effects as those above mentioned. Of late the root has come into great reputation as an emmenagogue.

RUBRIC, in the canon law, signifies a title or article in certain antient law-books; thus called because written, as the titles of the chapters in our antient bibles are, in red letters. Rubrics also denote the rules and directions given at the beginning, and in the course of, the liturgy, for the order and manner in which the several parts of the office are to be performed. There are general rubrics and special rubrics, a rubric for the communion, &c. In the Romish Missal and Breviary are rubrics for matins, for lauds, for translations, beatifications, commemorations, &c.

RUBUS, the *bramble*, a genus of the polygamia order, in the icosandria class of plants; and in the natural order ranking under the 35th order, senticosæ. The calyx is quinquefid, the petals five; the berry consisting of monospermous acini or pulpy grains. The principal species is the idæus, or common raspberry, which, with its varieties, demands culture in every garden for their fruit; particularly the common red kind, white sort, and twice-bearing raspberry; all of which are great bearers: but, for the general plantations, we choose principally the common red and the white kind, as being generally the greatest bearers of all; planting also a share of the twice-bearing sort, both as a curiosity, and for the sake of its autumnal crops of fruit, which in favourable seasons ripen in tolerable perfection; observing to allow all the sorts some open exposure in the kitchen garden, though they will prosper in almost any situation.

Some other species are considered as plants of variety, for hardy plantations in the shrubbery. Some of them are also very ornamental flowering plants; particularly the Virginian flowering raspberry, and the double-blossomed bramble, which have great merit as furniture for ornamental compartments; and the white-berried bramble, which is a great curiosity.

RUBY, a genus of precious stones of various colours; as, 1. Of a deep red colour, inclining a little to purple: the carbuncle of Pliny. 2. The spinell, of the colour of a bright corn poppy flower. 3. The balass, or pale red, inclining to violet. 4. The rubicell, of a reddish yellow. According to Cronstedt, the ruby crystallises into an octoedral form, as well as the diamond, from which it differs very little in hardness and weight. Tavernier and Dutens inform us, that in the East Indies all coloured gems are named rubies, without regard to what their colours may be; and that the particular colour is added to the name of each, in order to distinguish them from one another. There are, however, some soft stones of this kind, which they call bacan: and it is certain, that the hard and brilliant rubies, named oriental, as well as the sapphires and topazes, are all the same, excepting only the circumstance of colour. Some are partly red, and partly blue, yellow, and some quite colourless. The spinell rubies are about half the value of diamonds of the same weight; the balass is valued at 30 shillings per carat. Tavernier mentions 108 rubies in the throne of the great Mogul, from 100 to 200 carats, and of a round one almost $2\frac{1}{4}$ ounces: there is also mention made by other travellers, of rubies exceeding 200 carats in weight. According to Dutens, a perfect ruby, if it weighs more than $3\frac{1}{2}$ carats, is of greater value than a diamond of the same weight. If it weighs one carat, it is worth 10 guineas; if two carats, 40 guineas; three carats, 150 guineas; if six carats, upwards of 1000 guineas.

According to the experiments of Bergman and Achard, the texture of the ruby is foliated like that of diamonds: it is fusible with borax in a strong and long-continued heat, running into a transparent glass of a pale green colour. From the experiments of M. d'Arcet, it appears that the ruby does not lose its colour in the greatest fire; but Henckel says, that, by means of a burning glass, he softened it in such a manner as to receive the impression of a seal of jasper. It becomes electric by being rubbed. Its specific gravity, according to Bergman, is from 3,180 to 4,240: but Brisson tells us that it is 4,283. The specific gravity of the spinell is 3,760, of the Brasilian ruby 3,531.

Rubies are met with in the Capelan mountains of Pegu, in the East Indies; and at Caos, Ava, Bisnagar, Calicut, Cananor, Ceylon, and Brasil. They are found in sands of rivers of a red colour, in an argillaceous earth of a hard texture and greenish colour; sometimes they adhere to red rocks. The spinell rubies are met with in Hungary, Silesia, Bohemia, and Brasil. The balass comes principally from Brasil, though some are also brought from the East Indies. The rubicell comes also from Brasil, but they are said to lose their colour in the fire. See Corandum, Topaz, &c.

RUDBECKIA, *dwarf sun-flower*, in botany, a genus of the syngenesia-polygamia frustranea class of plants, the compound flower of which is radiated; but the hermaphrodite corollulæ of the disc are tubulose and very numerous: the stamina are five very short capillary filaments; and there is a small orbiculated seed after each of the hermaphrodite corollulæ, and are all contained in the cup, affixed to a paleaceous receptacle. There are seven species.

RUDDER, in navigation, a piece of timber turning on hinges in the stern of the ship, and which, opposing sometimes one side to the water, and sometimes another, turns or directs the vessel this way or that. See Ship-Building.

The rudder of a ship is a piece of timber hung on the stern-posts by four or five iron hooks, called pintles, serving for the bridle of a ship to turn her about at the pleasure of the steersman. The rudder being perpendicular, and withoutside the ship, another piece of timber is fitted to it at right angles, which comes into the ship, by which the rudder is managed and directed. This latter properly is called the helm or tiller; and sometimes, though improperly, the rudder itself. The power of the rudder is reducible to that of the lever. As to the angle the rudder should make with the keel, it is shewn, that in the working of ships, in order to stay or bear up the soonest possible, the tiller of the ruder ought to make an angle of 55° with the keel. A narrow rudder is best for a ship's sailing, provided she can feel it; that is, be guided and turned by it: for a broad rudder will hold much water when the helm is put over to any side; but if a ship has a fat quarter, so that the water cannot come quick and strong to her rudder, she will require a broad rudder. The aft-most part of the rudder is called the rake of the rudder.

RUELLIA, in botany, a genus of the angiospermia order, in the didynamia class of plants; and in the natural method ranking under the 40th order, personatæ. The calyx is quinquepartite; the corolla sub-campanulated; the stamina approaching together in pairs; the capsule springing asunder by means of its elastic segments. There are 43 species, shrubs of the East and West Indies.

RUFF. See Perca.

Ruff. See Tringa.

RUIZIA, a genus of the polyandria order, in the monadelphia class of plants; and in the natural method ranking under the 37th order, columniferæ. The calyx is double; the external are triphyllous. The corolla consists of five petals, inclining to the right hand side, and adhering to the stamina, which are from 30 to 40. It has ten styli, and as many capsulæ. These are compressed and membranous. In each capsule are two seeds. There are three species, viz. 1. Cordata; 2. Lobata; 3. Vanibilis; all natives of Asia and the Cape of Good Hope.

RULES *of court*, in law, are certain orders made, from time to time, in the courts of law, which attornies are bound to observe, in order to avoid confusion; and both the plaintiff and defendant are at their peril also bound to pay obedience to rules made in court relating to the cause depending between them.

It is to be observed, that no court will make a rule for any thing that may be done in the ordinary course; and that if a rule is made, grounded upon an affidavit, the other side may move the court against it, in order to vacate the same, and thereupon shall bring into court a copy of the affidavit and rule. On the breach and contempt of a rule of court, an attachment lies; but it is not granted for disobedience to a rule when the party has not been personally served; nor for disobeying a rule made by a judge in his chamber, which is not of force to ground a motion upon, unless the same is entered.

Rule, or *Ruler*, an instrument of wood or metal, with several lines delineated on it, of great use in practical mensuration.

When a ruler has the lines of chords, tangents, sines, &c. it is called a plane scale.

The carpenter's joint-rule is an instrument usually of box, &c. twenty-four inches long, and one and a half broad; each inch being subdivided into eight parts. On the same side with these divisions, is usually added Gunter's line of numbers. On the other side, are the lines of timber and board-measure; the first beginning at 82, and continued to 36, near the other end; the latter is numbered from 7 to 36, four inches from the other end.

Use of the carpenter's joint-rule. The application of the inches, in measuring lengths, breadths, &c. is obvious.

The use of the other side is all we need here to notice. 1. The breadth of any surface, as board, glass, &c. being given, to find how much in length makes a square foot. Find the number of inches the surface is broad, in the line of broad-measure, and right against it is the number of inches required. Thus, if the surface was eight inches broad, eighteen inches will be found to make a superficial foot. Or more readily thus: Apply the rule to the breadth of the board, or glass, that end, marked 36, being equal with the edge, the other edge of the surface will shew the inches, and quarters of inches, which go to a square foot. 2. Use of the table at the end of the board-measure. If a surface is one inch broad, how many inches long will make a superficial foot? look in the upper row of figures for one inch, and under it in the second row is twelve inches, the answer to the question. 3. Use of the line of timber-measure. This resembles the former; for having learned how much the piece is square, look for that number on the line of the timber-measure; the space thence to the end of the rule is the length which, at that breadth, makes a foot of timber. Thus, if the piece is nine inches square, the length necessary to make a solid foot of timber, is 21 $\frac{1}{3}$ inches. If the timber is small, and under nine inches square, seek the square in the upper rank of the table, and immediately under it are the feet and inches that make a solid foot. If the piece is not exactly square, but broader at one end than the other, the method is to add the two together, and take half the sum for the side of the square. For round timber the method is to girt it round with a string, and to allow the fourth part for the side of the square; but this method is erroneous, for hereby you lose nearly one-fifth of the true solidity; though this is the method at present practised in buying and selling timber.

The mason's rule is twelve or fifteen feet long, in order to be applied under the level to regulate the courses, and make the piedroits equal, &c.

Everard's sliding Rule. See GAUGING.

RUM, a species of brandy, or vinous spirit, distilled from sugar-canes. See DISTILLATION, and SPIRIT.

RUMEN, in comparative anatomy, the paunch, or first stomach of such animals as chew the cud, thence called ruminant animals. See COMPARATIVE ANATOMY.

RUMEX, *dock*, a genus of the trigynia order, in the hexandria class of plants; and in the natural method ranking under the 12th order, holoraceæ. The calyx is triphyllous; there are three connivent petals, and one triquetrous seed. There are 36 species; of which the most remarkable are: 1. The patientia, commonly called patience rhubarb. This was formerly much more cultivated in the British gardens than at present: the roots of this have been generally used for the monk's rhubarb, and it has even been thought to be the true kind; but others suppose the second sort should be used as such. 2. The alpinus, or monk's rhubarb, grows naturally on the Alps, but has long been cultivated in the gardens of this country. This has large roots, which spread and multiply by their offsets: they are shorter and thicker than the former, are of a very dark brown on the outside, and yellow within. 3. The aquaticus, or water-dock, grows naturally in ponds, ditches, and standing waters, in many parts of Britain. It is supposed to be the herba Britannica of the antients. 4. The acutus, or sharp-pointed dock (the oxylapathum of the shops); but the markets are supplied with roots of the common docks, which are indifferently gathered by those who collect them in the fields, where the kind commonly called butter dock (from its leaves being used to wrap up butter) is much more common than this. These plants are but seldom cultivated, and so easily multiply by their numerous seeds, that they soon become troublesome weeds where they once get an entrance.

RUMINANT, in natural history, is applied to an animal which chews over again what it has eaten before; which is popularly called chewing the cud. Payer, in a treatise De Ruminantibus et Ruminatione, shews that there are some animals which really ruminate; as oxen, sheep, deer, goats, camels, hares, and squirrels; and that there are others which only appear to do so, as moles, crickets, bees, beetles, crabs, mullets, &c. The latter class, he observes, have their stomachs composed of muscular fibres, by which the food is ground up and down as in those which really ruminate. Mr. Ray observes, that ruminants are all four-footed, hairy, and viviparous; some with hollow and perpetual horns, others with deciduous ones.

RUMPHIA, a genus of the monogynia order, in the triandria class of plants, and in the natural method ranking with those of which the order is doubtful. The calyx is trifid; the petals three; the fruit a trilocular plum. There is one species, a tree of the East Indies.

RUNDLE, or ROUNDLLE. See HERALDRY.

RUNDLET, or RUNLET, a small vessel, containing an uncertain quantity of any liquor, from three to twenty gallons.

RUNNER, in the sea language, a rope belonging to the garnet, and to the two bolt-tackles. It is reeved in a single block, joined to the end of a pennant, and has at one end a hook to hitch into any thing, and at the other end a double block, into which is reeved the fall of the tackle, or the garnet, by which means it purchases more than the tackle would without it.

RUNNET, or RENNET, is the juice or gastric fluid found in the stomachs of sucking quadrupeds, which as yet have received no other nourishment than their mother's milk. In ruminating animals, which have several stomachs, it is generally found in the last, though sometimes in the next to it. If the runnet is dried in the sun, and then kept close, it may be preserved in perfection for years. Not only the runnet itself, but also the stomach in which it is found, curdles milk without any previous preparation. But the common method is, to take the inner membrane of a calf's stomach, to clean it well, to salt and hang it up in brown paper: when this is used, the salt is washed off, then it is macerated in a little water during the night, and in the morning the infusion is poured into the milk to curdle it. See DIGESTION, Vol. I. p. 521, col. 3.

RUPALA, a genus of the tetrandria monogynia class and order. There is no calyx; the petals are four; stamina inserted in the middle of the petals; pericarpium one-celled, two-seeded.

RUPERT'S DROPS, a sort of glass-drops with long and slender tails, which burst to pieces on the breaking off those tails in any part; said to have been invented by prince Rupert, and therefore called by his name. Concerning the cause of this surprising phænomenon scarcely any thing that bears the least appearance of probability has been offered. Their explosion is attended in the dark with a flash of light; and, by being boiled in oil, the drops are deprived of their explosive quality.

RUPPIA, a genus of the tetragynia order, in the tetrandria class of plants; and in the natural method ranking under the 15th order, inundatæ. There is neither calyx nor corolla; but four pedicellated seeds. There is one species.

RUPTURE, in surgery, the same with hernia. See SURGERY.

RUSCUS, *knee-holly*, or *butcher's broom*, a genus of the syngenesia order, in the diœcia class of plants; and in the natural method ranking under the 11th order, sarmentaceæ. The male calyx is hexaphyllous; there is no corolla; the nectarium is central, ovate, and perforated at the top. The female calyx, corolla, and nectarium, are the same as in the male; there is one style, with a trilocular two-seeded berry. There are five species. The most remarkable is the aculeatus, or common butcher's broom, common in the woods in many parts of England. As this plant grows wild in most parts of England, it is rarely admitted into gardens; but if some of the roots are planted under tall trees in large plantations, they will spread into large clumps; and as they retain their leaves in winter, at that season they will have a good effect. The seeds of this plant generally lie a year in the ground before they vegetate; and the plants so raised are long before they arrive at a size large enough to make any figure, and therefore it is much better to transplant the roots. The root of this plant is accounted aperient, and in this intention is sometimes made an ingredient in apozems and diet-drinks, for opening slight obstructions of the viscera, and promoting the fluid secretions. This plant is used by the butchers for besoms to sweep their blocks. Hucksters place the boughs round their bacon and cheese, to defend them from the mice; for they cannot make their way through the prickly leaves.

RUSH, in botany. See JUNCUS.

RUSSELIA, a genus of the didynamia angiospermia class and order. The calyx is five-leaved; corolla tube, very long; capsule acuminate. There is one species, a shrubby plant of the Havannah.

RUSSIA COMPANY, in commerce. See COMPANY.

RUST, the oxide of a metal. Iron, for instance, when exposed to the air, soon becomes tarnished, and gradually changed into a brown or yellow powder, well known by the name of rust. This change is occasioned by the gradual combination of the iron with the oxygen of the atmosphere, and, according to the new chemistry, it is now denominated the oxide of iron.

RUSTIC, in architecture, implies a manner of building in imitation of nature, rather than according to the rules of art.

RUTA, *rue*, a genus of the monogynia order, in the decandria class of plants; and in the natural method ranking under the 26th order, multisiliquæ. The calyx is quinquepartite; the petals concave; the receptacle surrounded with 10 melliferous pores; the capsule is lobed. In some flowers, a fifth part of the number is excluded. There are seven species, of which the most remarkable is the hortensis, or common broad-leaved garden rue, which has been long cultivated for medicinal use.

Rue has a strong ungrateful smell, and a bitterish penetrating taste: the leaves, when full of vigour, are extremely acrid, insomuch as to inflame and blister the skin, if much handled.

RUTHILE, an ore found in Hungary, Italy, and France. It is generally crystallized. The primitive form of the crystals is a rectangular prism, whose base is a square, and the form of its molecules is a triangular prism, whose base is a right-angled isosceles triangle; and the height is to any of the sides of the base about the right angle, nearly as three to five. Specific gravity from 4.18 to 4.24. It is not affected by the mineral acids.

RUYSCHIA, in botany, a genus of the monogynia order, in the pentandria class of plants; and in the natural method ranking with those that are doubtful. The calyx is pentaphyllous; the corolla is pentapetalous; and the berry many-seeded. There are two species, parasitical shrubs of Guiana.

RYANIA, a genus of the polyandria monogynia class and order. The calyx is five-leaved; corolla none; stigmas four; berry suberous, one-celled, many-seeded. There is one species, a tree of Trinidad.

RYE. See Secale.

RYNCHOPS, *skimmer*, in ornithology, a genus belonging to the order of anseres. The bill is straight: and the superior mandible much shorter than the inferior, which is truncated at the point. The species are two, viz. the nigra and fulva, both natives of America. The fulva is perpetually flying about and skimming over water, out of which it scoops small fish with its lower mandible: in stormy seasons it frequents the shores in search of shell-fish. See Plate Nat. Hist. fig. 348.

S

S, the eighteenth letter of our alphabet, in abbreviations stands for societas, or socius; as R. S. S. for regiæ societatis socius, *i. e.* fellow of the royal society. In medicinal prescriptions, S. A. signifies secundum artem, *i. e.* according to the rules of art; and in the notes of the antients, S. stands for Sextus; SP. for spurius; S. C. for senatus consultum; S. P. Q. R. for senatus populusque Romanus; S. S. S. for stratum super stratum, *i. e.* one layer above another alternately; S. V. B. E. E. Q. V. for si vales bene est, ego quoque valeo, a form used in Cicero's time, in the beginning of letters. Used as a numeral, S. antiently denoted seven; in the Italian music, S. signifies solo; and in books of navigation, S. stands for south; S. E. for south-east; S. W. for south-west; S. S. E. for south-south-east; S. S. W. for south-south-west. See Compass.

SABELLA, a genus of vermes testacea: animal a nereis, with a ringent mouth, and two thicker tentacula behind the head: shell tubular, composed of particles of sand, broken shells, and vegetable substances united to a membrane by a glutinous cement. There are 24 species.

SABELLIANS, a sect of Christians of the third century, who embraced the opinions of Sabellius, a philosopher of Egypt, who openly taught that there is but one person in the Godhead.

SABLE. See Mustela.

Sable. See Heraldry.

SABURRÆ. See Gritt.

SACBUT, a bass wind-instrument, resembling the trumpet, so contrived as to be capable of being drawn out to different lengths, according to the acuteness and gravity of the scale required.

The sacbut is usually about eight feet long, and when extended to its full length, about fifteen. There are, however, sacbuts of different sizes to execute different parts; particularly a small one called by the Italians trombone picciolo, and the Germans cleine alt possaune, proper for the counter-tenor.

SACCHARINE ACID. See Oxalic Acid.

SACCHARUM, *sugar*, or the *sugar-cane*, a genus of the digynia order, in the triandria class of plants; and in the natural method ranking under the 4th order, gramina. The calyx is two-valved; the corolla is also bivalved. There are eleven species of this genus. The most remarkable is the officinarum. It is a native of Africa, the East Indies, and of Brazil, whence it was introduced into our West India islands soon after they were settled. In the manner of their growth, form of their leaves, and make of their panicle, the sugar-canes resemble the reeds which grow in wet marshy grounds in England, or elsewhere; except that the canes are far larger, and, instead of being hollow as the reeds, are filled with a white pith, containing the sweet juice or liquid, which stamps such value upon these plants. The intermediate distance between each joint of a cane is of different lengths, according to the nature of the soil, richness of the manure, and different temperature of the weather during its growth; it seldom exceeds, however, four inches in length, and an inch in diameter. The length of the whole cane likewise depends upon the above circumstances. It generally grows to perfection in about fourteen months, when its height, at a medium, is about six feet, sometimes more, sometimes less. The body of the cane is strong, but brittle; of a fine straw-colour, inclining to a yellow. The extremity of each is covered, for a considerable length, with many long grassy leaves or blades, sharply and finely sawed on their edges; the middle longitudinal rib being high and prominent. The sugar-cane is propagated by planting cuttings of it in the ground in furrows, dug parallel for that purpose; the cuttings are laid level and even, and are covered up with earth; they soon shoot out new plants from their knots or joints; the ground is to be kept clear, at times, from weeds; and the canes grow so quick, that in eight, ten, or twelve months, they are fit to cut for making of sugar from them. When ripe, they cut off the reeds at one of the joints near the roots; they are then cleared of the leaves, and tied up in bandles, and sent to the mills, which are worked either by water or horses.

The bottom part of the sugar-cane top is about the thickness of one's finger; and as it contains a good deal of the natural sweetness of the plant, it is usually cut into pieces of an inch and a half long, and given to the saddle-horses in the West Indies. It is very nourishing food, and fattens them apace. The mill-horses, mules, and asses, are likewise fed, during crop time, on sugar-cane tops and the skimming of the sugar-coppers; which last must be administered sparingly at first, for fear of griping, and perhaps killing them. For the manufacture, &c. of sugar, see Sugar.

SACCOLATS, salts formed from the saclactic acid, and but little known. 1. Saccolat of potass, small crystals soluble in eight times their weight of water. 2. Saccolat of soda, the same, soluble in five times their weight of water. 3. Saccolat of ammonia, has a sourish taste: heat separates the ammonia. Saccolat of lime, of barytes, of magnesia, and of alumina, are all insoluble in water.

SACK *of wool*, a quantity of wool containing just twenty-two stone, and every stone fourteen pounds. In Scotland, a sack is twenty-four stone, each stone containing sixteen pounds.

Sack *of cotton-wool*, a quantity from one hundred and a half to four hundredweight.

Sacks *of earth*, in fortification, are canvas bags filled with earth. They are used in making intrenchments in haste, to place on parapets, or the head of the breaches, &c. or to repair them, when beaten down.

SACLACTIC ACID. This acid was discovered by Scheele in 1780. After having obtained oxalic acid from sugar, he wished to examine whether the sugar of milk would furnish the same product. Upon four ounces of pure sugar of milk, finely powdered, he poured twelve ounces of diluted nitric acid, and put the mixture into a large glass retort, which he placed in a sand-bath. A violent effervescence ensuing, he was obliged to remove the retort from the sand-bath till the commotion ceased. He then continued the distillation till the mixture became yellow. As no crystals appeared in the liquor remaining in the retort after standing two days, he repeated the distillation as before, with the addition of eight ounces of nitric acid, and continued the operation till the yellow colour, which had disappeared on the addition of the nitric acid, returned. The liquor in the retort contained a white powder, and when cold, was observed to be thick. Eight ounces of water were added to dilute this liquor, which was then filtrated, by which the white powder was separated; which being edulcorated and dried, weighed 7½ drachms. The filtrated solution was evaporated to the consistence of a syrup, and again subjected to distillation, with four ounces of nitric acid as before; after which, the liquor, when cold, was observed to contain many small, oblong, sour crystals, together with some white powder. This powder being separated, the liquor was again distilled with more nitric acid, as before; by which means the liquor was rendered capable of yielding crystals again; and by one distillation more, with more nitrous acid, the whole of the liquor was converted into crystals. These crystals, added together, weighed five drachms; and were found, upon trial, to have the properties of the oxalic acid.

Mr. Scheele next examined the properties of the white powder, and found it to be an acid of a peculiar nature; he therefore called it the acid of sugar of milk. It was afterwards called saclactic acid by the French chemists. Fourcroy has lately given it the name of mucous acid, because it is obtained by treating gum arabic, and other mucilaginous substances, with nitric acid.

Mr. Hermstadt, of Berlin, had made similar experiments on sugar of milk at the same time with Scheele, and with similar results; but he concluded that the white powder which he obtained was nothing else than oxalat of lime with excess of acid, as indeed Scheele himself did at first. After he became acquainted with Scheele's conclusions, he published a paper in defence of his own opinions; but his proofs are very far from establishing it, or even rendering its truth probable. He acknowledges himself, that he has not been able to decompose this supposed salt: he allows that it possesses properties distinct from the oxalic acid; but he ascribes this difference to the lime which it contains; yet all the lime which he could discover in 240 grains of this salt was only 20 grains; and if the alkali which he employed was a carbonat (as it probably was), these 20 must be reduced to 11. Now Morveau has shewn, that oxalic acid, containing the same quantity of lime, exhibits very different properties. Besides, this acid, whatever it is, when united with lime, is separated by the oxalic, and must therefore be different from it: as it would be absurd to suppose that an acid could displace itself. The saclactic acid must therefore be considered as a distinct acid, since it possesses peculiar properties.

1. Saclactic acid may be obtained by the following process: Upon one part of gum arabic, or other similar gum, previously put into a retort, pour two parts of nitric acid. Apply a slight heat for a short time, till a little nitrous gas and carbonic acid gas comes over; then allow the mixture to cool. A white powder gradually precipitates, which may easily be separated by filtration. This powder is saclactric acid.

2. Saclactric acid, thus obtained, is under the form of a white gritty powder, with a slightly acid taste.

Heat decomposes it. When distilled, there comes over an acid liquor which crystallizes in needles on cooling, a red-coloured acrid oil, carbonic acid gas, and carbureted hydrogen gas. There remains in the retort a large proportion of charcoal.

Saclactic acid, according to Scheele, is soluble in 60 parts of its weight of boiling water; but Messrs. Hermstadt and Morveau found, that boiling water only dissolved $\frac{1}{80}$th part: it deposited about $\frac{1}{4}$th part on cooling in the form of crystals.

The solution has an acid taste, and reddens the infusion of turnsole. Its specific gravity, at the temperature of 53.7°, is 1.0015. The compounds which it forms with earths, alkalies and metallic oxides are denominated saccolats.

SAFFRON. See CROCUS.

SAGAPENUM, *gum resins*. See PHARMACY.

SAGATHEE, in commerce, a slight kind of woollen stuff, serge, or ratteen, sometimes mixed with a little silk.

SAGE. See SALVIA.

SAGENE, a Russian long measure, five hundred of which make a werst. The sagene is equal to seven English feet.

SAGENITE. See RUTHILE.

SAGINA, *pearlmist*, a genus of the tetragynia order, in the tetrandia class of plants, and in the natural method ranking under the 22d order, caryophyllei. The calyx is tetraphyllous; the petals four; the capsule is unilocular, quadrivalved and polyspermous. There are 5 species.

SAGITTA, in astronomy, the arrow or dart, a constellation of the northern hemisphere, near the eagle. See ASTRONOMY.

SAGITTA, in trigonometry, the same with the versed sine of an arch.

SAGITTARIA, *arrow-head*, a genus of the polyandria order, in the monœcia class of plants, and in the natural method ranking under the fifth order, tripetaloideæ. The male calyx is triphyllous; the corolla tripetalous; the filaments generally about 14: the female calyx is triphyllous; the corolla tripetalous; many pistils; and many naked seeds. There are five species, of which the most remarkable is the sagittifolia, growing naturally in many parts of England. The root is composed of many strong fibres, which strike into the mud; the footstalks of the leaves are in length proportionable to the depth of the water in which they grow; so they are sometimes almost a yard long: they are thick and fungous: the leaves, which float upon the water, are shaped like the point of an arrow, the two ears at their base spreading wide asunder, and are very sharp-pointed. There is always a bulb at the lower part of the root, growing in the solid earth beneath the mud. This bulb constitutes a considerable part of the food of the Chinese; and upon that account they cultivate it. Horses, goats, and swine, eat it; cows are not fond of it.

SAGITTARIUS, the *archer*, in astronomy, the ninth sign of the zodiac. See ASTRONOMY.

SAGO, a simple brought from the East Indies, of considerable use in diet as a restorative. It is produced from the ~~pith of~~ a kind of palm which grows in the East Indies, called the cycas circinalis. See CYCAS, STARCH, &c.

SAHLITE, another name for malacolite, which see.

SAIL, in navigation. See SHIP-BUILDING.

SALE. If a man agrees for the purchase of goods, he shall pay for them before he carries them away, unless some term of a credit is expressly agreed upon.

If one man says the price of an article is 100*l*. and the other says I will give you 100*l*. but does not pay immediately, it is at the option of the seller whether he shall have it or no, except a day was given for the payment.

If a man upon the sale of goods, warrants them to be good, the law annexes to this contract a tacit warranty, that if they are not so, he shall make compensation to the purchaser; such warranty, however, must be on the sale. But if the vendor knew the goods to be unsound, and has used any art to disguise them, or if in any respect they differ from what he represents them to be to the purchaser, he will be answerable for their goodness, though no general warranty will extend to those defects that are obvious to the senses.

If two persons come to a warehouse, and one buys, and the other to procure him credit, promises the seller, if he does not pay you, I will; this is a collateral undertaking, and void without writing, by the statutes of frauds; but if he says, let him have the goods, I will be your pay-master, this is an absolute undertaking as for himself, and he shall be intended to be the real buyer, and the other to act only as his servant. 2 T. R. 73.

After earnest is given, the vendor cannot sell the goods to another without a default in the vendee; and therefore if the vendee does not come and pay, and take the goods, the vendor ought to give him notice for that purpose; and then if he does not come and pay, and take away the goods in convenient time, the agreement is dissolved, and he is at liberty to sell them to any other person. 1 Salk. 113.

An earnest only binds the bargain, and gives the party a right to demand; but demand without payment of money is void. See also AUCTION, CONTRACT, &c.

SALEP. See STARCH.

SALIANT, in fortification, denotes projecting. There are two kinds of angles: the one saliant, which are those that present their point outwards; the other re-entering, which have their points inwards. Instances of both kinds we have in tenailles and star-works.

SALIENT. See HERALDRY.

SALIC, or SALIQUE LAW, *lex salica*, an antient and fundamental law of the kingdom of France, usually supposed to have been made by Pharamond, or at least by Clovis, in virtue of which males are only to inherit. Du Haillan, after a critical examination, declares it to have been an expedient of Philip the Long, in 1316, for the exclusion of the daughter of Lewis Hutin from inheriting the crown. Father Daniel, on the other hand, maintains that it is quoted by authors more antient than Philip the Long, and that Clovis is the real author of it. This law has not any particular regard to the crown of France; it only imports, in general, that in salic land no part of the inheritance shall fall to any female, but the whole to the male sex. By salic lands, or inheritances, were antiently denoted, among us, all lands, by whatever tenure held, whether noble or base, from the succession to which women were excluded by the salic law; for they were by it admitted to inherit nothing but moveables and purchases wherever there were any males.

SALISBURIA, a genus of the class and order monœcia polyandria. The male is an ament; antheræ incumbent; female solitary; calyx four-cleft, drupe. There is one species, a tree of Japan.

SALICORNIA, *jointed glass-wort*, or *salt-wort*, a genus of the monogynia order, in the monandria class of plants, and in the natural method ranking under the 12th order, holoraceæ. The calyx is ventricose, or a little swelling out and entire; there are no petals, and but one seed. There are nine species, of which the most remarkable are: 1. The fruticosa, with obtuse points, grows plentifully in most of the salt marshes which are overflowed by the tides in many parts of England. It is an annual plant, with thick, succulent, jointed stalks, which trail upon the ground. 2. The perennis, with a shrubby branching stalk, grows naturally in Sheppey island. They are perennial, and produce their flowers in the same manner as the former. The inhabitants near the sea-coasts where these plants grow, cut them up toward the latter end of summer, when they are fully grown; and after having dried them in the sun, they burn them for their ashes, which are used in making of glass and soap. These herbs are by the country people called kelp, and promiscuously gathered for use.

SALIVA. The fluid secreted in the mouth, which flows in considerable quantity during a repast, is known by the name of saliva. All the properties of this liquor which had been observed by philosophers before the middle of the 18th century have been collected by Haller; but since that time several additional facts have been related by Fourcroy, Du Tennetar, and Brugnatelli, and a very numerous set of experiments have been published by Mr. Siebold in 1797, in his Treatise on the Salivary System.

Saliva is a limpid fluid like water; but much more viscid: it has neither smell nor taste. Its specific gravity, according to Hamberger, is 1.0167; according to Siebold, 1.080. When agitated, it froths like all other adhesive liquids; indeed it is usually mixed with air, and has the appearance of froth.

It neither mixes readily with water nor oil; but by trituration in a mortar it may be so mixed with water as to pass through a filtre. It has a great affinity for oxygen, absorbs it readily from the air, and gives it out again to other bodies. Hence the reason why gold or silver, triturated with saliva in a mortar, is oxidized, as Du Tennetar has observed; and why the killing of mercury by oils is much facilitated by spitting into the mixture. Hence also, in all probability, the reason that saliva is a useful application to sores of the skin. Dogs, and several other animals, have constantly recourse to this remedy, and with much advantage.

When boiled in water, a few flakes of albumen precipitate. When evaporated, it swells exceedingly, and leaves behind it a thin brown-coloured crust; but if the evaporation is conducted slowly, small cubic crystals of muriat of soda, (common salt) are formed; and when the evaporation is completed, there remains behind a substance which resembles vegetable gluten, and which takes fire on burning coals, exhaling the odour of prussic acid, and of burning feathers. The viscidity of saliva, the property which it has of absorbing oxygen, and of being inspissated, and this glutinous residuum, announce the presence of animal mucilage as a component part.

When saliva is distilled in a retort, it froths very much: 100 parts yield 80 parts of water nearly pure, then a little carbonat of ammonia, some oil, and an acid, which perhaps is the prussic. The residuum amounts to about 1.56 parts, and is composed of muriat of soda, phosphat of soda, and phosphat of lime.

When saliva is left exposed to the air, it absorbs a considerable portion of it, a slight pellicle appears on its surface, it becomes muddy, and deposits some flakes, exhaling at the same time a strong ammoniacal odour. Soon after it putrefies, and becomes exceedingly fetid.

The acids and alcohol inspissates saliva; the alkalies disengage ammonia; oxalic acid precipitates lime; and the nitrats of lead, mercury, and silver, precipitate phosphoric and muriatic acids.

From these facts, it follows that saliva, besides water, which constitutes at least four-fifths of its bulk, contains the following ingredients:

1. Mucilage,	4. Phosphat of soda,
2. Albumen,	5. Phosphat of lime,
3. Muriat of soda,	6. Phosphat of ammonia.

But it cannot be doubted that, like all the other animal fluids, it is liable to many changes from disease, &c. Brugnatelli found the saliva of a patient, labouring under an obstinate venereal disease, impregnated with oxalic acid.

The concretions which sometimes form in the salivary ducts, &c. and the tartar or bony crust which so often attaches itself to the teeth, are composed of phosphat of lime.

Such are the properties of human saliva. The saliva of the horse was analysed by Hapel Delachenier in 1780. He collected 12 ounces of it in the space of 24 hours by puncturing the salivary duct. Its colour was greenish-yellow; its feel soapy; it had a weak disagreeable smell, and a saline taste. Boiling water and alcohol coagulated it in part; as did the acids. When sulphuric acid was used, sulphat of soda was obtained. It putrefied in about 14 days; and when allowed to evaporate spontaneously, it left a black residuum like earth. When distilled, it yielded an insipid watery liquid, crystals of carbonat of ammonia, a thick black empyreumatic oil, carbureted hydrogen, and carbonic acid; and a charcoal remained.

It is rather surprising that no experiments have been hitherto made on the saliva of dogs; though the hydrophobia has been usually ascribed to the infusion of the saliva of that animal rendered morbid by disease.

SALIVATION. See MEDICINE.

SALIX, the *willow*, a genus of the diandria order, in the diœcia class of plants, and in the natural method ranking under the 50th order, amentaceæ. The amentum of the male is scaly; there is no corolla; but a nectariferous glandule at the base of the flower. The female amentum is scaly; there is no corolla; the style bifid; the capsule unilocular and bivalved; the seeds pappous. There are 53 species, of which the most remarkable are,

1. The caprea, or common sallow-tree, grows to but a moderate height, having smooth, dark-green, brittle branches; oval, waved, rough leaves, indented at top, and woolly underneath. It grows abundantly in this country, but more frequently in dry than moist situations. It is of a brittle nature, so is unfit for the basket-makers; but will serve for poles, stakes, and to lop for fire-wood; and its timber is good for many purposes.

2. The alba, white, or silver-leaved willow, grows to a great height and considerable bulk, having smooth, pale-green shoots; long, spear-shaped, acuminated, sawed, silvery-white leaves, being downy on both sides, with glands below the serratures. This is the common white willow, which grows abundantly about towns and villages, and by the sides of rivers and brooks, &c.

3. The vitellina, yellow or golden willow, grows but to a moderate height, having yellow, very pliant shoots; oval, acute, serrated, very smooth leaves, with the serratures cartilaginous, and with callous punctures on the footstalks.

4. The purpurea, purple or red willow, grows to a large height, having long, reddish, very pliable shoots, and long, spear-shaped, serrated, smooth leaves, the lower ones being opposite.

5. The viminalis, or osier-willow, grows but a moderate height, having slender rod-like branches; very long, pliant, greenish shoots; and very long, narrow, spear-shaped, acute, almost entire leaves, hoary, and silky underneath.

6. The pentandra, pentandrous, broad-leaved, sweet-scented willow, grows to some considerable stature, having brownish-green branches; oblong, broad, serrated, smooth, sweet-scented leaves, shining above; and pentandrous flowers.

7. The triandria, or triandrous willow, grows to a large stature, having numerous, erect, greyish-green branches, and pliant shoots; oblong, acute-pointed, serrated, smooth, shining-green leaves, eared at the base; and triandrous flowers.

8. The fragilis, fragile or crack willow, rises to a middling stature, with brownish, very fragile, or brittle branches, long, oval-lanceolate, sawed, smooth leaves of a shining green on both sides, having dentated glandular footstalks. This sort in particular being exceedingly fragile, so that it easily cracks and breaks, is unfit for culture in osier-grounds.

9. The Babylonica, Babylonian pendulous salix, commonly called weeping willow, grows to a largish size, having numerous, long, slender, pendulous branches, hanging down loosely all round in a curious manner, and long, narrow, spear-shaped, serrated, smooth leaves. This curious willow is a native of the East.

All the species of salix are of the tree kind, very hardy, remarkably fast growers, and several of them attaining a considerable stature when permitted to run up to standards. They are mostly of the aquatic tribe, being generally the most abundant, and of most prosperous growth, in watery situations; they, however, will grow freely almost any where, in any common soil and exposure; but grow considerably the fastest and strongest in low moist land, particularly in marshy situations, by the verges of rivers, brooks, and other waters; likewise along the sides of watery ditches, &c. which places often lying waste, may be employed to good advantage in plantations of willows for different purposes.

SALMASIA, a genus of the pentandria trigynia class and order. The calyx is five-parted; corolla five-petalled; style none; capsule three-celled, three-valved, many-seeded. There is one species, a shrub of Guinea.

SALMO, *salmon*, a genus of fishes of the order abdominales. The generic character is, head smooth, compressed; tongue cartilaginous; teeth both in the jaws and on the tongue; gill-membrane from four to ten rayed; body compressed, furnished at the hind part with an adipose fin.

1. Salmo salar, the common salmon, so highly esteemed for the delicacy of its flavour, and so important an article in a commercial

view, is chiefly an inhabitant of the northern regions, where it occurs at different periods both in salt and fresh waters; quitting the sea at certain seasons to deposit its spawn in the gravelly beds of rivers, at a great distance from their mouths. In order to arrive at the spots proper for this purpose, there are scarcely any obstacles which the fish will not surmount. They will ascend rivers for hundreds of miles; force themselves against the most rapid streams, and spring with amazing agility over cataracts of several feet in height. They are taken, according to Mr. Pennant, in the Rhine as high as Basil; they gain the sources of the Lapland rivers, in spite of their torrent-like currents; they surpass the perpendicular falls of Leixlip, Kennerth, and Pont Aberglastyn. At the latter of these places, Mr. Pennant assures us that he has himself witnessed the efforts of the salmon, and seen scores of fish, some of which succeeded, while others miscarried in the attempt during the time of his observation. It may be added, that the salmon, like the swallow, is said to return each season to the self-same spot to deposit its spawn. This has been ascertained by the experiments of Monsr. De la Lande, who fastening a small ring of copper to the tails of some individuals, and then setting them at liberty, found that some of them made their appearance in the same place for three succeeding seasons. The experiment of fastening gold or silver rings to salmon is said by Dr. Bloch to have been occasionally practised by some of the Eastern princes, and it is added that by this method a communication has been proved between the Caspian and Northern seas and the Persian Gulf.

The general history of the salmon-fishery on the river Tweed, is amply detailed by Mr. Pennant. "At the latter end of the year, or in the month of November, the salmon begin to press up the river as far as they can reach, in order to spawn. When that time approaches they seek for a place fit for the purpose; the male and female unite in forming a proper receptacle for it in the sand or gravel, about the depth of 18 inches. In this the female deposits the spawn, which they afterwards cover carefully up by means of their tails, which are observed to have no skin on them for some time after this period. The spawn lies buried till spring, if not disturbed by violent floods, but the salmon hasten to the sea as soon as they are able, in order to recover their strength; for after spawning they are observed to become very lean, and are then called by the name of kippers. When the salmon first enter the rivers they are observed to have a great many small animals adhering to them, especially about the gills: these are the lernææ salmoneæ of Linnæus, and are signs that the fish is in high season: soon after the salmon have left the sea, the lernææ die, and drop off. About the latter end of March the spawn begins to exclude the young, which gradually increase to the length of four or five inches, and are then called smelts or smouts. About the beginning of May, the river is full of them; it seems to be all alive; and there is no having an idea of their numbers without seeing them; but a seasonable flood then hurries them all to sea, scarcely any or very few of them being left in the river. About the middle of June the earliest of the fry begin to drop into the river again from the sea, at that time about twelve, fourteen, or sixteen inches in length, and by a gradual progress, increase in number and size, till about the end of July, which is at Berwick termed the gilse time (the name given to the fish at that age). At the end of July, or the beginning of August, they lessen in number, but increase in size, some being six, seven, eight, or nine pounds weight. This appears to be a surprising growth; yet we have received from a gentleman at Warrington an instance still more so. A salmon weighing seven pounds three quarters, taken on the seventh of February, being marked with scissars on the back fin and tail, and turned into the river, was again taken on the 17th of the following March, and then found to weigh seventeen pounds and a half.

"All fishermen agree that they never find any food in the stomach of this fish. Perhaps during the spawning-time, they may entirely neglect their food, as the phocæ, called sea-lions and sea-bears, are known to do for months together during the breeding-season; and it may be that, like those animals, the salmon return to sea lank and lean, and come from it in good condition. It is evident that at times their food is both fish and worms, for the angler uses both with good success, as well as a large gaudy artificial fly, which the fish probably mistakes for a gay libellula or dragon-fly. The capture about the Tweed is prodigious in a good fishery. Some few years ago there were above seven hundred fish taken at one hawl, but from fifty to a hundred is very frequent." See FISHERY, Vol. 1, p. 736.

The general length of the salmon is from two and a half to three feet, but sometimes much more. The male is principally distinguished by the curvature of the jaws; both the upper and lower mandible bending towards each other more or less in different individuals, and at different seasons. The general colour of both sexes is a silvery grey, of a much darker cast on the back; the sides of the male are marked with numerous, small, irregular, dusky, and copper-coloured spots, while those of the female exhibit only several rather large, distant, roundish, or somewhat lunated spots of a dark colour. Exclusive of these differences, the male is of a somewhat longer or more slender shape than the female. The scales in the salmon are middle-sized, and not very strongly adherent.

In the intestinal canal of the salmon is often found a species of tænia, or tape-worm, of about three feet in length. Dr. Bloch informs us that in a salmon which had been three weeks dead, he found one of those worms still living. See Plate Nat. Hist. fig. 349.

2. Salmo trutta, salmon-trout, greatly allied in point of general appearance to the salmon, but rarely of equal size; colour purplish or violet, with the head and whole body pretty thickly marked with rather small round dark or blackish spots, surrounded by a paler circle; scales rather small. Native of the European seas, passing, like the salmon, into rivers to deposit its spawn; is of equal delicacy with the salmon, and the flesh of similar colour; varies occasionally both in colour and spots, which are sometimes rather angular than round; possesses a considerable degree of phosphoric quality, which seems to reside in the viscid mucus covering the skin. Like the salmon, this fish is prepared in different methods for sale, being sold both fresh and salted, as well as smoked, pickled, &c. &c.

3. Salmo fario, common trout. The trout is an inhabitant of clear and cold streams and lakes in most parts of Europe, and admits of considerable variety as to the tinge both of its ground-colour and spots. Its general length is from six to fifteen or sixteen inches, and its colour yellowish-grey, darker or browner on the back, and marked on the sides by several rather distant, round, bright-red spots, each surrounded by a tinge of pale-blue grey. Sometimes the ground-colour of the body is a purplish grey; the red spots much larger, more or less mixed with black, and the belly of a white or silvery cast; the fins are of a pale purplish brown; the dorsal fin marked with several darker spots; the head is rather larger in proportion than that of the salmon, the scales small, and the lateral line straight. The female fish is of a brighter and more beautiful appearance than the male.

Mr. Pennant informs us that in the lake Llyndivi in South Wales are trouts marked with red and black spots as large as sixpences; and others unspotted and of a reddish hue, sometimes weighing near ten pounds; but these latter are said to be bad-tasted.

In general the trout prefers clear, cold, and briskly-running waters, with a stony or gravelly bottom. It swims with rapidity, and, like the salmon, springs occasionally to a very considerable height in order to surmount any obstacle in its course. It lives on worms, small fishes, shell-fish, and aquatic insects, and is particularly delighted with May-flies (ephemeræ), as well as with phryganeæ, gnats, and their larvæ. It generally spawns in September, or in the colder parts of Europe, in October, and at those times gets among the roots of trees, stones, &c. in order to deposit its eggs, which are observed to be far less numerous than those of other river-fish. Yet the trout, as Bloch observes, is a fish that admits of very considerable increase; owing, no doubt, to the circumstance of most of the voracious kind of fishes avoiding waters of so cold a nature as those which trouts delight to inhabit; and their increase would be still greater, were they not themselves of a voracious disposition, frequently preying even on each other.

The merit of the trout as an article of food is too well known to require particular notice. In this respect, however, as in other fishes, those are most esteemed which are natives of the clearest waters.

The stomach of this fish is uncommonly strong and thick; but this circumstance is observed to be no where so remarkable as in those found in some of the Irish lakes, and particularly in those of the county of Galway. These are called gillaroo trouts; on the most accurate examination, however, it does not appear that they are specifically different from the common trout; but by living much on shell-fish, and swallowing small stones at the same time, their stomachs acquire a much greater degree of thickness, and a kind of muscular appearance, so as to resemble a sort of gizzard.

Mr. Pennant observes, that it is a matter of surprise that the trout, though so common a fish, should appear to be unnoticed by the antients, except Ausonius, who is supposed to have intended it by the name of salar. He mentions it, however, merely on account of its beauty, and without any thing relative to its merit as a food.

4. Salmo salmulus. The samlet is, according to Pennant, the least of the British species of this genus, and is frequently seen in the river Wye, in the upper part of the Severn, and in the rivers that run into it, in the north of England, and in Wales. It is by several imagined to be the fry of the salmon; but Mr. Pennant dissents from this opinion for the following reasons: first, it is well known that the salmon-fry never continue in fresh water the whole year, but, as numerous as they appear on their first escape from the spawn, all vanish on the first vernal flood that happens, which sweeps them into the sea, and leaves scarcely one behind; secondly, the growth of salmon-fry is so quick and so considerable as suddenly to exceed the bulk of the largest samlet; for example, the fry that have quitted the fresh water in spring, not larger than gudgeons, return into it again a foot or more in length; thirdly, the salmon obtains a considerable bulk before it begins to breed; the samlets, on the contrary, are found both male and female of their common size, and are readily distinguished by being furnished with either the hard or soft roe; fourthly, they are found in the fresh waters all times of the year, and even at seasons when the salmon-fry have gained a considerable size. It is well known that at Shrewsbury (where they are called Samsons), they are found in such quantities in the month of September, that a skilful angler, in a coracle, will take with a fly from twelve to sixteen dozen in a day. They spawn in November and December, at which time those of the Severn push up towards the head of that river, quitting the smaller brooks, and return into them again when they have done spawning. They have a general resemblance to the trout, and must therefore be described comparatively.

The head is proportionally narrower, and the mouth smaller; the body deeper; the length seldom more than six or seven inches, or at most about eight and a half; the pectoral fins have generally but one large black spot, though sometimes a single small one attends it; whereas the pectoral fins of the trout are more numerously marked; the spurious or fat fin on the back is never tipped with red, nor is the edge of the anal fin white; the spots on the body are fewer, and not so bright; the body is also marked from back to sides with six or seven large blueish bars; but this Mr. Pennant allows to be not a certain character, as the same is sometimes observed in young trouts; lastly, the tail of the samlet is much more forked than that of the trout. The samlet is very frequent in the rivers of Scotland, where it is called the parr. It is also common in the Wye, and is there known by the title of skirling or laspring.

5. Salmo salvelinus, salvelin trout. Length about twelve inches; shape resembling that of the salmon, but rather more slender; colour of the back dark-brownish blue; of the sides silvery, marked with pretty numerous, moderately distant, small, round, red spots, which are sometimes surrounded with a pale margin; belly red or orange-colour; pectoral, ventral, and anal fins the same, but with the two first rays white; dorsal and caudal fin blueish brown; adipose fin small, pale, and tipped with brown; scales rather small than large; lateral line strait; tail moderately bifurcated; both jaws of equal length; irides silvery. Native of mountainous lakes in several parts of Germany, and of several of the rivers in Siberia, and (if this species is the red charr of the English) in some of the lakes of our own country, as those of Westmoreland, &c. As in others of this genus, those which inhabit the clearest and coldest waters are observed to be of the richest colours. It is a fish of great delicacy of flavour, and much esteemed as a food.

6. Salmo eperlanus, smelt. Of this species there appear to be two varieties: one not exceeding the length of three or four inches; the other arriving at the general length of six, eight, or nine inches, and sometimes even to twelve or thirteen. The larger variety seems to be that so frequently seen about the British coasts, and which is distinguished by Dr. Bloch under the name of eperlano-marinus, or sea-smelt. These fishes are found about our coasts throughout the whole year, and rarely go to any great distance from the shores, except when they ascend rivers either at or some time before the spawning-season. It is observed by Mr. Pennant that in the river Thames and in the Dee, they are taken in great abundance in November, December, and January; but in other rivers not till February, spawning in the months of March and April. The smelt is a very elegant fish; its form beautifully taper; the skin thin, and the whole body, but particularly the head, semitransparent; the colour of the back is whitish, with a cast of green, beneath which it is varied with blue, and then succeeds the beautiful silvery gloss of the abdomen; the scales are small, and easily rubbed off; the eyes are silvery; the under jaw longer than the upper; in front of the upper are four large teeth, those in the sides of the jaws being small; the tail is forked. This fish is an inhabitant of the European seas; it has generally a peculiar odour, which in those of British growth is commonly compared to that of a cucumber, but by some to that of a violet.

7. Salmo Groenlandicus, Greenland salmon. Length about seven inches, which it very rarely exceeds; shape lengthened, contracting somewhat suddenly towards the tail; dorsal fin placed in the middle of the back; fins rather large for the size of the fish; scales small; tail forked; colour pale-green, with a tinge of brown above; abdomen and sides silvery; in the male fish, just above the lateral line, is a rough fascia, beset with minute pyramidal scales standing upright like the pile of a shag. The use of this villous line is highly singular, since it is affirmed that while the fish is swimming, and even when thrown on shore, two, three, or even as many as ten will adhere, as if glued together, by means of this pile, insomuch that if one is taken, the rest are also taken up at the same time. This species swarms off the coasts of Greenland, Iceland, and Newfoundland, and is said to be one of the chief supports of the Greenlanders, and a sort of dessert at their most delicate repasts. The inhabitants of Iceland are said to dry great quantities of it, in order so serve as a winter food for their cattle, whose flesh is apt to acquire an oily flavour in consequence. This fish lives at sea the greatest part of the year; but in April, May, June, and July, comes in incredible shoals into the bays, where immense multitudes are taken in nets, and afterwards dried on the rocks. When fresh they are by some said to have the smell of a cucumber, though others affirm that the scent is highly unpleasant. They feed on small crabs and other marine insects, as well as on the smaller fuci and confervæ, on which they are also observed to deposit their ova.

8. Salmo thymallus, grayling salmon. This elegant species grows to the length of about eighteen inches, and is an inhabitant of the clearer and colder kind of rivers in many parts of Europe and Asia, particularly such as flow through mountainous countries. In England it is found in the rivers of Derbyshire; in some of those of the North; in the Tame near Ludlow; in the Lug and other streams near Leominster; and in the river near Christchurch in Hampshire. In Lapland it is said to be very common, where the natives make use of its intestines instead of rennet, in preparing the cheese which they make from the milk of the rein-deer.

The shape of the grayling resembles that of the trout, but is rather more slender; its colour is a beautiful silvery grey, with numerous longitudinal deeper stripes, disposed according to the rows of scales, which are of a moderately large size; the head, lower fins, and tail, are of a brownish or rufous cast; the dorsal fin, which is deeper and broader than in the rest of the genus, is of a pale violet-colour, crossed by several dusky bars; the adipose fin is very small, and the tail forked. The largest English grayling recorded by Mr. Pennant was taken at Ludlow, and measured above half a yard in length, its weight being four pounds eight ounces; the general size of the British specimens being far short of this measure.

The grayling, says Mr. Pennant, is a voracious fish, rising freely to the fly, and will very eagerly take a bait; it is a very swift swimmer, disappearing like the transient passage of a shadow, from whence perhaps is derived its antient name of umbra. It is said to be a fish of very quick growth, feeding on water-insects, the smaller kind of testacea, and the roe of other fishes, as well as on the smaller fishes themselves; its stomach is so strong as to feel almost cartilaginous. It spawns in April and May, the full-grown ova being nearly of the size of peas. The grayling is much esteemed for the delicacy of its flesh, which is white, firm, and of a fine flavour, and is considered as in the highest season in the depth of winter.

SALON, or Saloon, in architecture, a very lofty spacious hall, vaulted at top, and sometimes comprehending two stories or ranges of windows.

SALOP, or Salep. See Starch.

SALPA, a genus of insects of the order mollusca. Body loose, nayant, gelatinous, tubular, and open at each extremity; intestines obliquely placed. The animals of this genus are of a gregarious nature, and often adhere together; they swim with great facility, and possess the power of contracting and opening at pleasure. There are two divisions: A is furnished with an appendage which differs in the several species; B without the terminal appendage.

SALSOLA, *saltwort, kali, &c.* a genus of the class and order pentandria digynia, and in the natural method ranking under the 12th order, holoraceæ. The calyx is pentaphyllous; there is no corolla; the capsule is monospermous, with a screwed seed. The species are 31, of which the principal are:

1. Salsola kali grows naturally in the salt marshes in divers parts of England. It is an annual plant, which rises above five or six inches high, sending out many side branches, which spread on every side, with short awl-shaped leaves, which are fleshy, and terminate in acute spines.

2. Salsola rosacea grows naturally in Tartary. This is an annual plant, whose stalks are herbaceous, and seldom rise more than five or six inches high.

3. Salsola soda rises with herbaceous stalks near three feet high, spreading wide. The leaves on the principal stalk, and those on the lower part of the branches, are long, slender, and have no spines; those on the upper part of the stalk and branches are slender, short, and crooked. All the sorts of glass-wort are sometimes promiscuously used for making soda or mineral alkali, but this species is esteemed best. The manner of making it is as follows: Having dug a trench near the sea, they place laths across it, on which they lay the herbs in heaps, and, having made a fire below, the liquor which runs out of the herbs drops to the bottom, which at length thickening, becomes soda, which is partly of a black, and partly of an ash-colour, very sharp and corrosive, and of a saltish taste. This, when thoroughly hardened, becomes like a stone, and in that state is transported to different countries for the making of glass, soap, &c.

4. Salsola tragus grows naturally on the sandy shores of the south of France, Spain, and Italy. This is also an annual plant, which sends out many diffused stalks, with linear leaves an inch long, ending with sharp spines.

5. Salsola vermiculata grows naturally in Spain. This has shrubby perennial stalks, which rise three or four feet high, sending out many side branches, with fleshy, oval, acute-pointed leaves, coming out in clusters from the side of the branches; they are hoary, and have stiff prickles See SODA.

SALT, *common*. The preparation of that kind of salt which is used for culinary and economical purposes (muriat of soda) depends upon the well-known fact, that the salt contained in the sea-water, or brine-springs, being a fixed body, will not rise with the vapour of the water. All, therefore, that is wanted, is to expose any water containing salt to evaporation. The salt commonly known by the name of bay-salt is obtained from the water of the sea by evaporation. This evaporation is in some places performed by the heat of the sun, the water being let into shallow trenches, in order to expose as large a surface as possible. This method is practised in the southern provinces of France, and on a very large scale near Aveiro in Portugal. In the northern countries, where the heat of the sun is not sufficiently great, artificial fires are employed. In some salt-works these two methods are united; and in England, and countries where salt-rock is plentiful, that substance is dissolved in salt water, and then evaporated. In very cold countries another method is employed to separate the salt from sea-water. The water is exposed in trenches on the sea-shore, where it forms so thin a stratum, that the cold of the atmosphere acts powerfully in congealing it. As the frozen part consists of mere water, the fluid which remains is consequently more concentrated. The operation is then completed by means of artificial heat.

The most convenient works for making salt from brine by boiling are constructed in the following manner: The saltern, or boiling-house, is erected near the sea-shore, and is furnished with a furnace and one or two large pans, which are commonly made of iron plates, joined together with nails, and the joints filled with a strong cement; and the bottom of the pans is prevented from bending down, by being supported by strong iron bars.

The salt-pan being filled with sea-water, a strong fire of pit-coal is lighted in the furnace; and then, for a pan which contains about 1400 gallons, the salt-boiler takes the whites of three eggs, and incorporates them all with two or three gallons of sea-water, which he pours into the salt-pan, while the water contained therein is only lukewarm, and mixes this with the rest by stirring it about with a rake. In many places they use, instead of eggs, the blood of sheep or oxen to clarify the sea-water: and in Scotland they do not give themselves the trouble to clarify it at all. As the water heats, there arises a black frothy scum upon it, which is to be taken off with wooden skimmers. After this the water appears perfectly clear, and by boiling it briskly about four hours, a pan loaded in the common way, that is, about fifteen inches deep, will begin to form crystals upon its surface. The pan is then filled up a second time with fresh sea-water; and about the time when it is half-filled, the scratch-pans are taken out and emptied of a white powder, seeming a kind of calcareous earth, which separates itself from the sea-water, during its boiling, before the salt begins to shoot. When these have been emptied, they are again put into their places, where they are afterwards filled again. This powder being violently agitated by the boiling liquor, does not subside till it comes to the corners of the pan, where the motion of the mass is smaller, and it there falls into these pans placed on purpose to receive it.

The second filling of the pan is boiled down after clarifying in the same manner as the first, and so a third and a fourth; but in the evaporation of the fourth, when the crystals begin to form themselves, they slacken the fire, and only keep the liquor simmering. In this heat they keep it all the while that the salt is granulating, which is nine or ten hours. The granules, or crystals, all fall to the bottom of the pan; and when the water is almost all evaporated, and the salt lies nearly dry at the bottom, they rake it all together into a long heap on one side of the pan, where it lies a while to drain from the brine, and then is put into barrows, and carried to the storehouse, and delivered into the custody of his majesty's officers. In this manner the whole process is usually performed in 24 hours, the salt being commonly drawn out every morning. This is the method in most of our salt-works; but in some they fill the pan seven times before they boil up the salt, and so take it out but once in two days, or five times in a fortnight. In the common way of four boilings, from a pan of the usual size, containing 1300 gallons, they draw from fifteen to twenty bushels of salt every day, each bushel weighing fifty-six pounds.

When the salt is carried into the storehouse, it is put into brabs, which are partitions, like stalls for horses, lined at three sides, and the bottom with boards, and having a sliding-board on the foreside to draw up on occasion. The bottoms are made shelving, being highest at the back, and gradually inclining forward; by this means the brine remaining among the salt, easily separates and runs from it, and the salt in three or four days becomes sufficiently dry; in some places they use cribs and barrows, which are long and conic wicker-baskets, for this purpose; and in some places wooden troughs, with holes in the bottom. The saline liquor which remains from the making of salt is what is called bittern, from which Epsom salt or muriat of magnesia is often extracted.

Much in the same manner is the salt obtained from the brine of salt-springs, pits, &c. White salt is prepared from sea-water, or any other kind of salt-water, first heightened into a strong brine by the heat of the sun, and the operation of the air. It may also be prepared from a strong brine, or lixivium, drawn from earths, stones, or sands, strongly impregnated with common salt. Refined rock-salt is that obtained by dissolving fossil or rock-salt in salt or fresh water, and afterwards boiling the solution.

A great quantity of rock-salt is used at Northwich, in order to strengthen their brine-springs; and a much greater quantity is sent coastwise to Liverpool, and other places, where it is either used for strengthening brine-springs or sea-water; much of this rock-salt was formerly exported to Holland, and it is still sent to Ireland for the same purpose.

The Northwich rock-salt is never used at our tables in its crude state; and its application to the pickling or curing of flesh or fish, or preserving any provisions, without its being previously refined into white salt, that is, without its being dissolved in water, and boiled down in what is called white-salt, is prohibited under a penalty of 40*s*. for every pound of rock-salt so applied. The pure transparent masses, however, of rock-salt, might probably be used by us with our food, without any sort of danger or inconvenience; at least we know that rock-salt is so used, without being refined, both in Poland and in Spain.

The quantity of rock-salt which may be dissolved in a definite quantity, suppose a pint of 16 avoirdupois ounces of water, is differently estimated by different authors. Boerhaave is of opinion that 16 ounces of water will not dissolve quite five ounces of rock-salt; Spielmann thinks that they will dissolve $6\frac{2}{3}$ ounces; Newman agrees with Spielman; Eller says, that seven ounces of fossil salt may be dissolved in 16 ounces of water; lastly, Hoffmann assures us, that 16 ounces of water will not dissolve above six ounces of common salt. It is not wholly improbable, that different sorts of rock-salt may differ somewhat with respect to their solubility in water.

If it is admitted, that 16 ounces of water can dissolve six ounces of salt and no more, then we may be certain, that no brine-spring in any part of the world, can yield six ounces of salt from a pint of the brine. For brine springs are, ordinarily, nothing but water in which fossil salt has been dissolved; but a pint of the strongest brine cannot contain so much salt as is contained in a pint of water, which has been saturated with six ounces of salt; for a pint of water, in which six ounces of salt have been dissolved, is increased a little in bulk; it will do more than fill a pint-measure, and the salt left in the surplus will shew how much the salt contained in a pint of the strongest brine falls short of six ounces. Or we may consider the matter in the following manner, which will perhaps be more intelligible; 16 ounces of water, impregnated with six ounces of salt, constitute a saturated brine, weighing 22 ounces; if therefore we would know how much salt is contained in 16 ounces of such brine, by the rule of proportion we may argue, that if 22 ounces of brine contain six ounces of salt, 16 ounces of brine will contain $4\frac{4}{11}$ ounces of salt. Hence we may infer, that the strongest brine-springs will not yield much above one quarter of their weight of salt.

There are a great many brine-springs in Cheshire, in Worcestershire, Staffordshire, Hampshire, and in other parts of Great Britain; some of which are sufficiently rich in salt to be wrought with profit, others not. From what has been before advanced, the reader will readily comprehend that 16 tons of the strongest brine consist of 12 tons of water, and of four tons of salt; and that, in order to obtain these four tons of salt, the 12 tons of water must be, by some means or other, evaporated, so as to leave the salt in a concrete form. Suppose there should be a brine, which in 16 tons should contain 15 tons of water, and only one ton of salt; yet it may chance, that such a weak brine may be wrought with more profit than the strongest; for the profit arising from the boiling of brine into salt, depends as much upon the price of the fuel used in boiling it, as upon the quantity of salt which it yields. Thus the sea-water, which surrounds the coasts of Great Britain, is said to hold seldom more than one-thirtieth, or less than one-fiftieth part of common salt; but fuel is so cheap at Newcastle, that they can evaporate thirty or forty tons of water, in order to obtain one ton of salt, and yet gain as much clear profit as those do, who, in countries less favourably situated for fuel, boil down the strongest brine.

The advantage resulting from strengthening weak brine or sea-water, by means of rock-salt, is very obvious. Suppose that the sea-water at Liverpool, where large quantities of rock-salt are refined, would yield one ton of salt from 48 tons of water; then must a quantity of fuel sufficient to evaporate 47 tons of water be used, in order to obtain one ton of salt. But if as much rock-salt is put into the forty-eight tons of sea-water; as can be dissolved in it, then will the sea-water resemble a brine fully saturated, each 16 tons of which will give four tons of salt, and the whole quantity yielded by the evaporation of 47 tons of water will be 12 tons of salt.

SALTS. The word salt was originally confined to muriat of soda, or common salt, a substance which has been known, and in common used, from the remotest ages. It was afterwards generalized by chemists, and employed by them in a very extensive and not very definite sense. Every body which is sapid, easily melted, soluble in water, and not combustible, has been called a salt.

Salts, were considered by the older chemists as a class of bodies intermediate between earths and water. Many disputes arose about what bodies ought to be comprehended under this class, and what ought to be excluded from it. Acids and alkalies were allowed by all to be salts; but the difficulty was to determine concerning earths and metals; for several of the earths possess all the properties which have been ascribed to salts, and the metals are capable of entering into combinations which possess saline properties.

In process of time, however, the term salt was restricted to three classes of bodies, viz. acids, alkalies, and the compounds which acids form with alkalies, earths, and metallic oxides. The first two of these classes were called simple salts; the salts belonging to the third class were called compound or neutral. This last appellation originated from an opinion long entertained by chemists, that acids and alkalies, of which they are composed, were of a contrary nature, and that they counteracted one another; so that the resulting compounds possessed neither the properties of acids nor of alkalies, but properties intermediate between the two.

Chemists have lately restricted the term salt still more, by tacitly excluding acids and alkalies from the class of salts altogether. At present, then, it denotes *only the compounds formed by the combination of acids with alkalies, earths, and metallic oxides.*

No part of chemistry has been cultivated with more zeal than the salts, especially for these last 40 years. During that time the number of saline bodies has been enormously increased, and the properties of a very great number have been determined with precision. Still, however, this wide and important region is far from being completely explored.

Chemists have agreed to denominate the salts from the acids which they contain. The earth, alkali, and metallic oxide, combined with that acid, is called the base of the salt. Thus common salt being a compound of muriatic acid and soda, is called a muriat; and soda, is called the base of common salt. Now since there are 32 acids and 57 bases, it would appear, at first sight, that there are 1824 salts; but of the 45 metallic oxides at present known, there are a considerable number which cannot combine with many of the acids. This is the case also with silica, and perhaps with some of the other earths. We must therefore subtract all these from the full number 1824. To compensate, however, this deficiency, at least in part, there are several acids capable of combining with two bases at once. Thus the tartaric acid combines at once with potass and soda. Such combinations are called triple salts, and they increase the number of salts considerably. There are some salts, too, which are capable of combining with an additional dose of their acid, and others which combine with an additional dose of their base. The French chemists denote the first of these combinations by adding to the usual name of the salt the phrase with excess of acid, or by prefixing it to the word acidulous: they denote the second by subjoining the phrase with excess of base. This method of naming has the merit indeed of being precise, but it is exceedingly awkward, and intolerably tedious. The ingenious mode of naming these combinations proposed by Dr. Pearson ought certainly to be preferred. It is equally precise, if not more so, and far more convenient in every respect. It consists in prefixing to the usual name of the salt the preposition super, to denote an excess of acid, and the preposition sub to denote an excess of base. Thus sulphat of potass denotes the salt in its state of perfect neutralization, without any excess either of the sulphuric acid or of the potass; supersulphat of potass is the same salt with an excess of acid; subsulphat of potass is the same salt with excess of base. These three different kinds must increase the number of saline compounds very considerably; but the precise number of salts is not known, as many of them remain still unexamined by chemists. Probably they are not much fewer than 2000. Some idea may be formed of the progress which this branch of chemistry has made, by recollecting that 40 years ago not more than 30 salts in all were known.

Of these 2000, however, a considerable number may be considered as still unknown, as they have been merely formed without being examined. Of those which are known, the greater number have not been applied to any use, and therefore do not deserve a very particular description.

As the different genera of salts are denominated from their acids, it is evident that there are as many genera as there are acids. The terminations of the names of these genera differ according to the nature of the acids which constitute them. When that acid contains a maximum of oxygen, the termination of the genius is *at*; when it does not contain a maximum of oxygen, the termination of the genus is *ite*. Thus the salts which contain sulphuric acid are called sulphats; those which contain sulphurous acid are called sulphites. This distinction is of some consequence, because the salts differ very much, according as the acid is saturated with oxygen or not. The *ites* are seldom permanent; when exposed to the air, they usually attract oxygen, and are converted into *ats*.

Every particular species of salt is distinguished by subjoining to the generic term the name of its base. Thus the salt composed of sulphuric acid and soda is called sulphat of soda. Triple salts are distinguished by subjoining the names of both the bases connected by hyphens. Thus the compound of tartaric acid, potass, and soda, is called tartrat of potass-and-soda.

The salts then naturally divide themselves into two grand classes; the first of which comprehends the alkaline and earthy salts, which derive their most important characters from their acids; the second comprehends the metalline salts, whose bases on the contrary stamp their most important properties.

Salts, or the combinations of alkalies with acids which exist in the mineral kingdom, constitute the following genera and species:

Genus I. Potass.

Sp. 1. Nitrat of potass.

Genus II. Soda.

Sp. 1. Carbonat of soda,
2. Sulphat of soda,
3. Muriat of soda,
4. Borax.

Genus III. Ammonia.

Sp. 1. Muriat of ammonia.

Genus I. *Salts of potass.*

Sp. 1. *Nitrat of potass.* This salt is found native, mixed with nitrat of lime, muriat of potass, and other impurities, encrusting the surface of the earth in different parts of India, the Cape of Good Hope, Peru, Spain, Molfetta, &c. It is most commonly in fine capillary crystals. Sometimes, though rarely, massive, or in six-sided prisms.

Its primitive form is a rectangular octahedron. It occurs sometimes in that form, but more frequently the apexes of the pyramids are truncated. But its most usual variety is a six-sided prism, terminated by six-sided pyramids. A specimen of native nitre from Molfetta, analysed by Klaproth, contained

44.55 nitrat of potass
25.45 sulphat of lime
30.40 carbonat of lime
0.20 muriat of potass

100.60

Genus II. *Salts of soda.*

Sp. 1. *Carbonat of soda.* This salt is found in Egypt on the surface of the earth, and on the margin of certain lakes which become dry during the summer. It has often the appearance of a rough dusty powder, of a grey colour and alkaline taste. It occurs in China, where it is called kien; near Tripoli, where it is denominated trona; and likewise in Hungary, Syria, Persia, and India.

It is said sometimes to have been observed in crystals. The primitive form is a rhomboidal octahedron; but the pyramids are usually truncated.

A specimen of this salt from Egypt was found by Klaproth to consist of

32.6 dry carbonat of soda
20.8 dry sulphat of soda
15.0 dry muriat of soda
31.6 water

100.0

A specimen of fibrous carbonat from the interior of Africa, yielded the same chemist

37.0 soda
38.0 carbonic acid
22.5 water
2.5 sulphat of soda

100.0

Sp. 2. *Sulphat of soda.* This salt is found in Austria, Hungary, Styria, Switzerland, and Siberia, always in the neighbourhood of a mineral spring. It occurs usually in the state of powder, sometimes massive, and even crystallized. Colour greyish, or yellowish white.

Sp. 3. *Muriat of soda.* Common salt is found in immense masses under the earth's surface in many countries, particularly in Poland, Hungary, England, &c. Near Cordova in Spain there is said to be a mountain of common salt 500 feet high, and nearly three miles in circumference. There are two varieties of native common salt distinguished by their texture.

1. Foliated. This variety is usually found in vast masses, and sometimes crystallized in cubes. Colour various shades of grey and of red. Internal lustre glassy. Texture foliated. Fragments cubic. Streak grey. Specific gravity 2.143. Taste salt.

2. Fibrous. Found in masses, strata, or stalactitic. Colour various shades of grey, blue, red. Texture fibrous; fibres delicately curved. Fragments angular.

Sp. 4. *Borax.* This mineral is found in different parts of Thibet, &c. It is usually mixed with foreign bodies; that of Persia is in large crystals, enclosed in a fatty matter. The primitive form of its crystals is a rectangular prism, but it occurs usually in six-sided prisms, whose edges are variously truncated. Its colour is greyish, yellowish, or greenish white. Fracture foliated or conchoidal. Refracts doubly. Taste sweet, and somewhat acrid.

Genus III. *Salts of ammonia.*

Sp. 1. *Muriat of ammonia.* This salt occurs near volcanoes, of which it is a product. It is found also in Persia. It is found usually in the state of powder in the middle of lava. Sometimes in mass, and even in very irregular crystals. Colour white, often with a shade of yellow or green. Very soft.

A specimen of this salt from Tartary yielded Klaproth,

97.5 muriat of ammonia
2.5 sulphat of ammonia

100.0

There is no necessity for entering any further in this article into the detail of the compound salts, as the reader will find them under the different heads of Acetites, Fluats, Gallats, Lactats, Malats, Mellats, Muriats, Nitrats, Nitrites, Phosphats, Phosphites, Sulphats, Sulphites; also under the different acids: and the metallic compounds under the respective metals. See also Chemistry.

SALVADORA, a genus of the monogynia order, in the tetrandria class of plants, and in the natural method ranking with those of which the order is doubtful. The calyx is quadrifid; there is no corolla; the berry is monospermous; and the seed covered with an antlus or loose coat. There are three species, herbs of China.

SALVAGE MONEY, a reward allowed by the civil and statute law for the saving of ships or goods from the danger of the seas, pirates, or enemies.

Where any ship is in danger of being stranded, or driven on shore, justices of the peace are to command the constables to assemble as many persons as are necessary to preserve it; and on its being preserved by their means, the persons assisting therein shall in thirty days after be paid a reasonable reward for the salvage, otherwise the ship or goods shall remain in the custody of the officers of the customs as a security for the same.

SALVIA, *sage*, a genus of the monogynia order, in the digynia class of plants, and in the natural method ranking under the 42d order, verticillatæ. The corolla is unequal; and the filaments placed crosswise on a pedicle. The most remarkable species, out of 79, are,

1. The officinalis, or common large sage, which is cultivated in gardens, of which there are the following varieties: 1. The common green sage. 2. The wormwood sage. 3. The green sage with a variegated leaf. 4. The red sage. 5. The red sage with a variegated leaf. These are accidental variations, and therefore are not enumerated as species. The common sage grows naturally in the southern parts of Europe, but is here cultivated in gardens for use; but the variety with red or blackish leaves is the most common in the British gardens; and the wormwood sage is in greater plenty here than the common green-leaved sage, which is but in few gardens.

2. The tomentosa, generally titled balsamic sage by the gardeners. The stalks of this do not grow so upright as those of the common sage; they are very hairy, and divide into several branches; the flowers are of a pale blue, about the size of those of the common sort. This sage is preferred to all the others for making tea.

3. The auriculata, common sage of virtue, which is also well known in the gardens and markets. The leaves of this are narrower than those of the common sort; they are hoary, and some of them are indented on their edges towards the base, which indentures have the appearance of ears.

4. The pomifera, with spear-shaped oval entire leaves, grows naturally in Crete.

5. and 6. The coccinea and formosa, are beautiful hot-house plants, with scarlet flowers.

All the sorts of sage may be propagated by seeds, if they can be procured; but, as some of them do not perfect their seeds in this country, and most of the sorts, but especially the common kinds for use, are easily propagated by slips, it is not worth while to raise them from seeds.

SAMARA, a genus of the monogynia order, in the tetrandria class of plants. The calyx is quadripartite; the corolla tetrapetalous; the stamina immersed in the base of the petal; the stigma funnel-shaped. There are three species, trees of the Cape.

SAMARITANS, an antient sect among the Jews, still subsisting in some parts of the Levant, under the same name.

SAMBUCUS, *elder*, a genus of the trigynia order, in the pentandria class of plants, and in the natural method ranking under the 43d order, dumosæ. The calyx is quinquepartite; the corolla quinquefid; the berry trispermous. The species are only five, and the most remarkable are,

1. The nigra, or common black elder, with a tree-stem, branching numerously into a large spreading head, twenty or thirty feet high, and large five-parted umbels of white flowers towards the ends of the branches, succeeded by bunches of black and other different-coloured berries, in the varieties; which are, common black-berried elder-tree, white-berried elder, green-berried elder, laciniated or parsley-leaved elder, having the folioles much laciniated, so as to resemble parsley-leaves, gold-striped-leaved elder, silver-striped elder, silver-dusted elder.

2. The racemosa, racemose red-berried elder. This is a resident of the mountainous parts of the south of Europe, and is retained in our gardens as a flowering shrub, having a

peculiar singularity in its oval-clustered flowers and berries.

3. The Canadensis, or Canada shrubby elder.

SAMIELS, the Arabian name of a hot wind, peculiar to the desert of Arabia. It blows over the desert in the months of July and August from the north-west quarter, and sometimes it continues with all its violence to the very gates of Bagdad, but never affects any body within the walls. Some years it does not blow at all, and in others it appears six, eight, or ten times, but seldom continues more than a few minutes at a time. It often passes with the apparent quickness of lightning. The Arabians and Persians, who are acquainted with the appearance of the sky at or near the time this wind rises, have warning of its approach by a thick haze, which appears like a cloud of dust arising out of the horizon; and they immediately upon this appearance throw themselves with their faces to the ground, and continue in that position till the wind is passed, which frequently happens almost instantaneously; but if, on the contrary, they are not careful or brisk enough to take this precaution, which is sometimes the case, and they get the full force of the wind, it is instant death.

The above method is the only one which they take to avoid the effects of this fatal blast; and when it is over, they get up and look round them for their companions; and if they see any one lying motionless, they take hold of an arm or leg, and pull and jerk it with some force; and if the limb thus agitated separates from the body, it is a certain sign that the wind has had its full effect; but if, on the contrary, the arm or leg does not come away, it is a sure sign there is life remaining, although to every outward appearance the person is dead; and in that case they immediately cover him or them with clothes, and administer some warm diluting liquor to cause a perspiration, which is certainly but slowly brought about.

The Arabs themselves can say little or nothing about the nature of this wind, only that it always leaves behind it a very strong sulphureous smell, and that the air at these times is quite clear, except about the horizon, in the north-west quarter, before observed, which gives warning of its approach. We have not been able to learn whether the dead bodies are scorched or dissolved into a kind of gelatinous substance; but from the stories current about them, there has been frequent reason to believe the latter; and in that case such fatal effects may be attributed rather to a noxious vapour than to an absolute and excessive heat. The story of its going to the gates of Bagdad and no further, may be reasonably enough accounted for, if the effects are attributed to a poisonous vapour, and not an excessive heat.

SAMOLUS, *water pimpenal*, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 21st order, preciæ. The corolla is salver-shaped, the stamina surrounded by small scales at its throat. The capsule is unilocular, inferior. There is one species.

SAMPSEANS, in church history, an antient sect, who were properly neither Jews, Christians, nor Gentiles, though they took their name from the Hebrew word *semes*, sun, as though they worshipped that planet.

SAMYDA, a genus of the monogynia order, in the decandria class of plants, and in the natural method ranking with those of which the order is doubtful. The calyx is quinquepartite and coloured; there is no corolla; the capsule in the inside resembles a berry, is trivalved and unilocular; the seeds nestling. There are nine species, chiefly shrubs of the West Indies.

SAND, in natural history, a genus of fossils, the characters of which are, that they are found in minute concretions, forming together a kind of powder, the genuine particles of which all have a tendency to one determinate shape, and appear regular, though more or less complete concretions; not to be dissolved or disunited by water, or formed into a coherent mass by means of it, but retaining their figure in it; transparent, vitrifiable by extreme heat, and not soluble in, nor effervescing with, acids. Sands are subject to be variously blended both with homogeneous and heterogeneous substances, as that of talcs, &c. and hence, as well as from their various colours, are subdivided into, 1. White sands, whether pure or mixed with other arenaceous or heterogeneous particles; of all which there are several species, differing no less in the fineness of their particles than in the different degrees of colour, from a bright and shining white to a brownish, yellowish, greenish, &c. white. 2. The red and reddish sands, both pure and impure. 3. The yellow sands, whether pure or mixed, are also very numerous. 4. The brown sands, distinguished in the same manner. 5. The black sands, of which there are only two species, viz. a fine shining greyish-black sand, and another of a fine shining reddish-black colour. 6. The green kind, of which there is only one known species, viz. a coarse variegated dusky-green sand, common in Virginia.

Sand is of great use in the glass manufacture; the white writing-sand being employed for making of the white glass, and a coarse greenish-looking sand for the green glass.

In agriculture it seems to be the office of sand to make unctuous earths fertile, and fit to support vegetables, &c. For earth alone, we find, is liable to coalesce, and gather into a hard coherent mass. Common sand is, therefore, a very good addition, by way of manure, to all sorts of clay-lands; it warms them, and makes them more open and loose. The best sand for the farmer's use is that which is washed by rains from roads or hills, or that which is taken from the beds of rivers; the common sand that is dug in pits never answers so well. However, if mixed with dung, it is much better than laid on alone; and a very fine manure is made by covering the bottom of sheep-folds with several loads of sand every week, which are to be taken away, and laid on cold stiff lands, impregnated as they are with the dung and the urine of the sheep.

The sea-sand, used as manure in different parts of the kingdom, is of three kinds: that about Plymouth, and on other of the southern coasts, is of a blue-grey colour, like ashes, which is probably owing to the shells of muscles, and other fish of that or the like colour, being broken and mixed among it in great quantity. Westward, near the Land's-end, the sea-sand is very white, and about the isles of Scilly it is very glistening, with small particles of talc; on the coasts of the North Sea the sand is yellowish, brown, or reddish, and contains so great a quantity of fragments of cockle-shells, that it seems to be chiefly composed of them. That sea-sand is accounted best which is of a reddish colour: the next in value to this is the blueish; and the white is the worst of all. Sea-sand is best when taken up from under the water, or from sand-banks which are covered by every tide. The small-grained sand is most sudden in its operation, and is therefore best for the tenant who is only to take three or four crops; but the coarse or large-grained sand is much better for the landlord, as the good it does lasts many years. See HUSBANDRY.

SAND-BAGS, in the art of war, are bags filled with earth or sand, holding each about a cubic foot. Their use is to raise parapets in haste, or to repair what is beaten down.

SAND-EEL. See AMMODYTES.

SANDARACH, in natural history, a very beautiful native fossil, though too often confounded with the common factitious red arsenic, and with the red matter formed by melting the common yellow orpiment. It is a pure substance, of a very even and regular structure, is throughout of that colour which our dyers term an orange-scarlet, and is considerably transparent even in the thickest pieces. But though with respect to colour it has the advantage of cinnabar while in the mass, it is vastly inferior to it when both are reduced to powders. It is moderately hard, and remarkably heavy; and when exposed to a moderate heat, melts and flows like oil. If set on fire, it burns very briskly.

It is found in Saxony and Bohemia, in the copper and silver mines, and is sold to the painters, who find it a very fine and valuable red; but its virtues or qualities in medicine are no more ascertained at this time than those of the yellow orpiment.

SANDARACH, *gum*. See RESIN.

SANDARACHA. The resinous substance called sandarach is not a pure resin; for when dissolved in alcohol an insoluble residuum remains. Giese, an apothecary of Augsburg, examined this residuum in 1802, and found that it possessed peculiar properties. We have therefore distinguished it by the name of sandaracha. It amounts to about one-fifth of the sandarach. When purified by repeated digestions in alcohol, it possesses the following properties:

1. Its colour is greyish white. It is brittle, and easily pounded.

2. It burns with a bright flame and much smoke, leaving a black residue like colophonium, partly soluble in hot alcohol.

3. It is insoluble in water and in alcohol; but ether dissolves it. The solution, when evaporated, leaves on bodies a stain like lime. When alcohol is added to the solution, the sandaracha is precipitated; but water does not produce this effect.

4. It is soluble in sulphuric acid. But,

5. Nitric acid has no action on it cold.

SANDIVER, a whitish salt, continually cast up from the metal, as it is called, whereof glass is made, and swimming on its surface, is skimmed off. See GLASS.

SANDORICUM, a genus of the monogynia order, in the decandria class of plants, and in the natural method ranking under the 23d order, trihilatæ. The calyx is quinquedentate; the petals five, and linear-shaped; the nectarium has ten dentæ, on which the antheræ grow; the fruit is a drupe, and five in number, each of which has one seed.

There is only one species, viz. the indicum, a tree of Africa and the East Indies.

SANGUIFICATION. See PHYSIOLOGY.

SANGUINARIA, *blood-wort*, a genus of the monogynia order, in the polyandria class of plants, and in the natural method ranking under the 27th order, rhœadeæ. The corolla is octopetalous; the calyx diphyllous; the siliqua ovate and unilocular. There is only one species, viz. the canadensis, a native of the northern parts of America, where it grows plentifully in the woods; and in the spring, before the leaves of the trees come out, the surface of the ground is in many places covered with the flowers, which have some resemblance to our wood anemone; but they have short naked pedicles, each supporting one flower at top. Some of these flowers will have ten or twelve petals, so that they appear to have a double range of leaves, which has occasioned their being termed double flowers; but this is only accidental, the same roots in different years producing different flowers. The plant can bear the open air in this country, but should be placed in a loose soil and sheltered situation, not too much exposed to the sun. It is propagated by the roots, which may be taken up and parted in September every other year. The Indians paint themselves yellow with the juice of these plants.

SANGUISORBA, *greater wild burnet*, a genus of the monogynia order, in the tetrandria class of plants, and in the natural method ranking under the 54th order, miscellaneæ. The calyx is diphyllous; the germen situated betwixt the calyx and corolla. The most remarkable species, of three, is the officinalis, with oval spikes. This grows naturally in moist meadows in many parts of Britain. The cultivation of this plant has been greatly recommended as food to cattle. See HUSBANDRY.

SANHEDRIM, or SANHEDRIN, among the Jews, the great council of the nation, consisting of seventy senators, taken partly from among the priests and levites, and partly out of the inferior judges, who formed what was called the lesser sanhedrim. The room they met in was a rotunda, half of which was built without the temple, and half within. The nasi, or president of the sanhedrim, sat upon a throne, with his deputy on his right hand, his sub-deputy on his left, and the other senators ranged in order on each side. The authority of this council was very extensive, for they decided such causes as were brought before them by way of appeal from the inferior courts; and the king, the high priests, and prophets, were under the jurisdiction of this tribunal. They had the right of judging in capital cases, and sentence of death might not be pronounced in any other place; for which reason the Jews were forced to quit this hall, when the power of life and death was taken out of their hands, forty years before the destruction of the temple, and three years before the death of Christ.

There were several inferior sanhedrims in Palestine, each of which consisted of twenty-three persons; all these depended on the great sanhedrim of Jerusalem.

SANICULA, *sanicle* or *self-heal*, a genus of the digynia order, in the pentandria class of plants, and in the natural method ranking under the 45th order, umbellatæ. The umbels are close together, almost in a round head; the fruit is scabrous; the flowers of the disk abortive. There are three species. The europæa is found in many parts both of Scotland and England. This plant was long celebrated for its healing virtues both internally and externally; but it is now totally disregarded.

SANIDIUM, in natural history, the name of a genus of fossils of the class of the selenitæ, but neither of the rhomboidal nor columnar kinds, nor any other way distinguishable by its external figure, being made up of several plain flat plates.

SANTALUM, a genus of the monogynia order, in the octandria class of plants, and in the natural method ranking with those of which the order is doubtful. The calyx is superior; the corolla monopetalous; the stamina placed in the tube; the stigma is simple; the fruit a berry.

The santalum, sanders or sandel wood, grows to the size of a walnut-tree. Its leaves are entire, oval, and placed opposite to each other. Its wood is white in the circumference, and yellow in the centre, when the tree is old. This difference of colour constitutes two kinds of sanders, both employed for the same purposes, and having equally a bitter taste, and an aromatic smell. With the powder of this wood a paste is prepared, with which the Chinese, Indians, Persians, Arabians, and Turks, anoint their bodies. It is likewise burnt in their houses, and yields a fragrant and wholesome smell. The greatest quantity of this wood, to which a sharp and attenuating virtue is ascribed, remains in India. The red sanders, though in less estimation, and less generally used, is sent by preference into Europe. This is the produce of a different tree, which is common on the coast of Coromandel. Some travellers confound it with the wood of Caliatour, which is used in dyeing.

The santalum album, or white sanders, is brought from the East Indies in billets about the thickness of a man's leg, of a pale-whitish colour. It is that part of the yellow sanders wood which lies next the bark. Great part of it, as met with in the shops, has no smell or taste, nor any sensible quality that can recommend it to the notice of the physician.

The santalum flavum, or yellow sanders, is the interior part of the wood of the same tree which furnishes the former, is of a pale yellowish colour, of a pleasant smell, and a bitterish aromatic taste, accompanied with an agreeable kind of pungency. This elegant wood might undoubtedly be applied to valuable medical purposes, though at present very rarely used. Distilled with water, it yields a fragrant essential oil, which thickens in the cold into the consistence of a balsam. Digested in pure spirit, it imparts a rich yellow tincture; which being committed to distillation, the spirit arises without bringing over any thing considerable of the flavour of the sanders. The residuum contains the virtues of six times its weight of the wood. Hoffman looks upon this extract as a medicine of similar virtues to ambergris; and recommends it as an excellent restorative in great debilities.

SANTOLINA, *lavender-cotton*, a genus of the order of polygamia æqualis, in the syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The receptacle is paleaceous; there is no pappus; the calyx imbricated and hemispherical. There are six species. The most remarkable are,

1. Chamæcyparisus, or common lavender-cotton, which has been long known in the English gardens. It was formerly titled abrotanum fœminea, or female southernwood, and by the corruption of words was called brotany by the market-people. It grows naturally in Spain, Italy, and the warm parts of Europe. 2. The rosmarinifolia. 3. The anthemoides.

All these plants may be cultivated so as to become ornaments to a garden, particularly in small bosquets of evergreen shrubs, where, if they are artfully intermixed with other plants of the same growth, and placed in the front line, they will make an agreeable variety. They may be propagated by planting slips or cuttings during the spring.

SANIES, in medicine, a serous putrid matter, issuing from wounds; it differs from pus, which is thicker and white.

SAP. See PLANTS, *physiology of*.

SAP, or SAPP, in the art of war, is the digging deep under the earth of the glacis, in order to open a covered passage into the moat. It is only a deep trench, covered at top with boards, hurdles, earth, sand-bags, &c. and is usually begun five or six fathoms from the saliant angle of the glacis. See FORTIFICATION.

SAP-COLOURS, a name given to various expressed juices of a viscid nature, which are inspissated by slow evaporation for the use of painters; as sap-green, gamboge, &c.

SAPINDUS, the *soap-berry tree*, a genus of the trigynia order, in the octandria class of plants, and in the natural method ranking under the 23d order, trihilatæ. The calyx is tetraphyllous; the petals four; the capsules are fleshy, connate, and ventricose.

The species are 13, of which the most noted are, the saponaria, spinosus, trifoliatus, and chinensis. The saponaria, with winged leaves, grows naturally in the islands of the West Indies, where it rises with a woody stalk from 20 to 30 feet high, sending out many branches with winged leaves composed of several pair of spear-shaped lobes. The flowers are produced in loose spikes at the end of the branches; they are small and white, so make no great appearance. These are succeeded by oval berries as large as middling cherries, sometimes single, at others, two, three, or four are joined together; these have a saponaceous skin or cover, which incloses a very smooth roundish nut of the same form, of a shining black when ripe. The skin or pulp which surrounds the nuts is used in America to wash linen; but it is very apt to burn and destroy it if often used, being of a very acrid nature.

These plants are propagated by seeds, and kept in the stove.

SAPONARIA, *sopewort*, a genus of the digynia order, in the decandria class of plants, and in the natural method ranking under the 22d order, caryophylleæ. The calyx is monophyllous and naked; there are five ungulated petals; the capsule is oblong and unilocular.

There are nine species, the officinalis, vaccaria, cretica, porrigens, illyrica, ocymoides, orientalis, lutea, and bellidifolia. The officinalis, which is a British plant, has a creeping root, so that in a short time it would fill a large space of ground. The stalks are above two feet high, and of a purplish colour. The footstalks of the flowers arise from the wings of the leaves opposite; they sustain four, five, or more purple flowers each, which have generally two small leaves placed under them. The stalk is also terminated by a loose bunch of flowers growing in form of an umbel; they have each a large swelling cylindrical empalement, and five broad obtuse petals, which spread open, of a purple colour. These are succeeded by oval capsules, with one cell filled with small seeds. The decoction of this plant is used to cleanse and scour woollen cloths: the poor people in some countries use it instead of soap for washing; from which use it had its name.

SAPPHIRE, a genus of precious stones, of a blue colour, and the hardest of all except the ruby and diamond. They are found in the same countries with the ruby; also in Bohemia, Alsace, Siberia, and Auvergne. M. Romé de l'Isle mentions one found at Auvergne, which appeared quite green or blue according to the position in which it was viewed. Cronstedt, however, informs us, that the blue fluor spars are frequently met with in collections under the name of sapphires; and it is certain from Pliny, b. 37. chap. 9. that the sapphire of the antients was our lapis lazuli. They are seldom found of a deep-blue colour throughout, or free from parallel veins; and when they are but slightly tinged, they are named white sapphires. The late unfortunate king of France had one with a stripe of fine yellow topaz in the middle. Some are found half green and half red, and are foliated like the ruby. The fine hard sapphires, called by the jewellers oriental, are of the same nature with the ruby and topaz, excepting the mere circumstance of colour. They are commonly in two oblong hexagon pyramids, joined at their base, and pointed at top; sometimes also in hexagonal columns.

The specific gravity of these precious stones, according to Bergman, is from 3.650 to 3.940. According to others, the specific gravity of the oriental sapphires is 3.994; that of the Brasilian 3.1307; and of those from Puy in Auvergne, 4.0769. When powdered, they are fusible with borax or microcosmic salt, into a transparent glass; and the same thing happens on treating them with magnesia alba. They are said to lose their colour by fire, and to become so hard and transparent as sometimes to pass for diamonds; but Mr. Achard found this to be a mistake, and that the true sapphires are not in the least altered either in colour, hardness, or weight, by the most intense fire. Those of Puy in Auvergne, however, though by their colour and hardness they seem to approach the oriental sapphires, lose both their colour and transparency in the fire, becoming black, and even vitrifying; which plainly shows them to be of a different kind. See CORUNDUM.

SARABANDE, a dance said to be originally derived from the Saracens. According to some authors, it had its appellation from a comedian named Sarabandi, who first introduced it in France. The tune of the sarabande is written in $\frac{3}{2}$ or $\frac{3}{4}$, and its character is both expressive and majestic. One of its distinguishing features is the lengthening the second note of the measure, which at once gives a gravity and consequence to the movement.

SARACA, a genus of the hexandria order, in the diadelphia class of plants. There is no calyx; the corolla is funnel-shaped and quadrifid; the filaments are on each side the throat of the corolla; the legumen is pedicellated. There is one species, a tree of the East Indies.

SARCASM, in rhetoric, a keen bitter expression, which has the true point of satire, by which the orator scoffs and insults his enemy: such was that of the Jews to our Saviour, "He saved others, himself he cannot save."

SARCOCELE. See SURGERY.

SARCOCOLL, a vegetable substance that possesses the following properties:

1. Solid, semi-transparent bodies; usually having a tinge of yellow: taste sweet, but leaving an impression of bitterness. Dissolves in the mouth like gum.

2. Equally soluble in water and alcohol; solution yellow. The watery solution has the appearance of mucilage, and may be used for the same purposes.

3. Cannot be made to crystallize.

4. When heated, softens, but does not melt. It emits a slight smell of calomel. When strongly heated, it blackens, and assumes the consistence of tar, emitting a white heavy smoke having an acrid odour. In a strong fire it scarcely leaves any residuum.

These properties shew us that sarcocoll is a substance intermediate between sugar and gum, partaking in some measure of the properties of each, but certainly approaching nearer to sugar than to gum. How far the combination of sugar and the bitter principle would resemble sarcocoll, has not been tried. The three following species may be referred to sarcocoll.

1. *Common sarcocoll.* This substance is usually sold in the state of oblong globules from the size of a pea to that of a particle of sand. Its colour is usually yellow; and it has the semitransparency and much of the appearance of gum arabic. But some of the grains are reddish-brown. Its smell is peculiar, and not unlike that of anise-seed. When carefully examined, four different substances may be detected: the first, and by far the most abundant, is pure sarcocoll; the second consists of small woody fibres, and a soft yellowish-white substance, not unlike the covering of the seeds of some of the cruciform plants; the third is a reddish-brown substance apparently earthy; and the fourth is only detected when the sarcocoll is dissolved in water or alcohol. It then appears in soft transparent tremulous masses like jelly.

The pure sarcocoll amounts to 0.8 of the whole. When the sarcocoll is dissolved in alcohol or water, and obtained again by evaporation, it loses its smell. It then assumes the form of semitransparent brittle brown cakes very like gum.

Sarcocoll exudes spontaneously from the penæa sarcocolla; a shrub which is said by botanical writers to be indigenous in the north-eastern parts of Africa. Nothing precise is known concerning the way in which it exudes.

SARDONYX, a precious stone consisting of a mixture of the chalcedony and carnelian, sometimes in strata, but at other times blended together. It is found, 1. Striped with white and red strata, which may be cut in cameo as well as the onyx. 2. White with red dendritical figures, greatly resembling the mocha-stone; but with this difference, that the figures in the sardonyx are of a red colour, in the other black. There is no real difference, excepting in the circumstance of hardness, between the onyx, carnelian, chalcedony, sardonyx, and agate, notwithstanding the different names bestowed upon them. Mongez informs us, that the yellow, or orange-coloured agates, with a wavy or undulating surface, are now commonly called sardonyx.

SARMENTOSÆ (from *sarmentum*, a long shoot like that of a vine), the name of the 11th class in Linnæus's Fragments of a Natural Method, consisting of plants which have climbing stems and branches, that, like the vine, attach themselves to the bodies in their neighbourhood for the purpose of support. See BOTANY.

SAROTHRA, a genus of the trigynia order, in the pentandria class of plants, and in the natural method ranking under the 20th order, rotaceæ. The corolla is pentapetalous; the capsule unilocular, trivalved, and coloured. There is one species, an annual of Virginia.

SARPLAR *of wool*, a quantity of wool, otherwise called a pocket or half-sack; a sack containing 80 tod; a tod two stone; and a stone 14 pounds. In Scotland it is called sarpliath, and contains 80 stone.

SARRACENIA, *side-saddle plant*, a genus of the monogynia order, in the polyandria class of plants, and in the natural method ranking under the 54th order, miscellaneæ. The corolla is pentapetalous; the calyx is double, and triphyllous below, pentaphyllous above; the capsule quinquelocular; the style has a stigma of the form of a shield. There are five species, herbs of North America.

SARSAPARILLA. See SMILAX.

SARTORIUS. See ANATOMY.

SASH, a mark of distinction, which in the British service is generally made of crimson silk for the officers, and of crimson mixed with white cotton for the serjeants. It is worn round the waist in most regiments; in some few, particularly in the Highland corps, it is thrown across the shoulder. Sashes were originally invented for the convenience and ease of wounded officers, &c. by means of which, in case any of them were so badly wounded as to render them incapable of remaining at their posts, they might be carried off with the assistance of two men. They are now reduced to a very small size, and of course unfit for the original purpose. Both the sash and gorget, indeed, must be considered as mere marks of distinction, to point out officers on duty. In some instances they are worn together; in others, the gorget is laid aside, and the sash only worn. The British cavalry tie the sash on the right, the infantry on the left, side. The sashes for the imperial army are made of crimson and gold, for the Prussian army black silk and silver, the Hanoverians yellow silk, the Portuguese crimson silk with blue tassels. The modern French have their sashes made of three colours, viz. white, pink, and light-blue, to correspond with the national flag.

SASSAFRAS, the wood of an American tree. See LAURUS. It is said to be warm, aperient, and corroborant; and frequently employed as an infusion, in the way of tea, is a very pleasant drink: its oil is very fragrant, and possesses most of the virtues of the wood.

SATELLITE. See ASTRONOMY.

SATRAPA, or SATRAPES, in Persian antiquity, denotes an admiral, but more commonly the governor of a province.

SATURATION, like most other technical terms introduced into chemistry before the science had acquired much precision, has been used with a great deal of latitude, being sometimes taken in one sense and sometimes in another. But in order to be understood, it is necessary to use the word with some degree of precision.

If we make the attempt, we shall find that water will not dissolve any quantity of salt that we please. At the temperature of 60°, it dissolves only 0.354 parts of its weight of salt; and if more salt than this is added, it remains in the water undissolved. When water has dissolved as much salt as possible, it is said to be saturated with salt. This sense is at least analogous to the original meaning of the word. Whenever, then, a substance A refuses to combine with an additional quantity of another body B, we may say that it is saturated with B. It takes place whenever the affinity of the water and salt, is balanced by the cohesion of the particles of the salt, and therefore indicates that these two forces are equal.

In the same manner, water, after having absorbed a certain quantity of carbonic acid gas, refuses to absorb any more. We may indeed pass carbonic acid gass through water in this state, but it makes its escape unaltered. Water which refuses to absorb carbonic acid gas is saturated with that acid. This saturation takes place when the affinity between the gas and the water is balanced by the elasticity of the gas, and indicates of course that these two forces are equal.

In these two instances the saturation is occasioned by opposite causes. The salt refuses to dissolve in the water when the cohesion of its particles equals its affinity for the water; the carbonic acid gas, when the repulsion of its particles equals its affinity for water. In the first case, it is the attractive force of cohesion which opposes farther solution; in the second case, it is the repulsive force of elasticity. Hence the different method which must be followed to diminish these forces, and enable the water to dissolve a greater proportion of these respective bodies. Heat, by diminishing the force of cohesion, enables water to dissolve a greater proportion of saline bodies. Accordingly we find that in most cases hot water dissolves more salt than cold water. Common salt is almost the only exception to this general law. On the other hand, cold, by diminishing the elasticity, or at least the expansibility of gaseous bodies, enables water to dissolve a greater proportion of them. Thus the colder the water is, the greater a proportion of carbonic acid is it capable of dissolving. The freezing point of water limits this increase of solubility, because at that point the cohesive force of the particles of water becomes so great as to cause them to cohere, to the exclusion of those bodies with which they were formerly combined. Hence the reason, that most bodies separate from water when it freezes. But they generally retard the freezing considerably, by opposing with all the strength of their affinity the cohesion of the water. The consequence is, that the freezing point of water, when it holds bodies in solution, is lower than the freezing point of pure water. A table of the freezing points of different saline solutions would be a pretty accurate indication of the affinity of the different salts for water: for the affinity of each salt is of course proportional to the degree of cold at which it separates from the water, that is, to the freezing point of the solution.

In this sense of the word saturation, which is certainly the only one that it ought to bear, it may be said with propriety that there are certain bodies which cannot be saturated by others. Thus water is capable of combining with any quantity whatever of sulphuric acid, nitric acid, and alcohol; and all bodies seem capable of combining with almost any quantity whatever of caloric. Several of the metals, too, are capable of combining with any quantity whatever of some other metals. In general, it may be said that those bodies called solvents are capable of combining in any quantity with the substances which they hold in solution. Thus water may be added in any quantity, however great, to the acids, and to the greater number of salts.

If we take a given quantity of sulphuric acid diluted with water, and add to it slowly the solution of soda by little at a time, and examine the mixture after every addition, we shall find that for a considerable time it will exhibit the properties of an acid, reddening vegetable blues, and having a taste perceptibly sour; but these acid properties gradually diminish after every addition of the alkaline solution, and at last disappear altogether. If we still continue to add the soda, the mixture gradually acquires alkaline properties, converting vegetable blues to green, and manifesting an urinous taste. These properties become stronger and stronger the greater the quantity of the soda is which is added. Thus it appears that when sulphuric acid and soda are mixed together, the properties either of the one or the other preponderate according to the proportions of each; but that there are certain proportions, according to which when they are combined, they mutually destroy or disguise the properties of each other, so that neither predominates, or rather, so that both disappear.

When substances thus mutually disguise each other's properties, they are said to neutralize one another. This property is common to a great number of bodies; but it manifests itself most strongly, and was first observed, in the acids, alkalies, and earths. Hence the salts which are combinations of these different bodies received long ago the name of neutral salts. When bodies are combined in the proportion which produces neutralization, they are often said to be saturated; but in this case the term is used improperly. It would be much better to confine the word saturation to the meaning assigned to it in the beginning of this article, and to employ the term neutralization to denote the state in which the peculiar properties of the component parts mutually disappear; for very frequently neutralization and saturation by no means coincide. Thus in tartrite of potass the acid and alkali neutralize each other; yet it cannot be said that the potass is saturated; for it is still capable of combining with more tartarous acid, and of forming supertartrite of potass, a compound in which the ingredients do not neutralize each other; for the salt has manifestly a preponderance of the properties of the acid.

SATUREIA, *savoury*, a genus of the gymnospermia order, in the didynamia class of plants, and in the natural method ranking under the 42d order, verticillatæ. The segments of the corolla are nearly equal; the stamina standing asunder. There are eight species; the most noted are: 1. The hortensis, or summer savoury, is an annual plant, which grows naturally in the south of France and Italy, but is cultivated in this country both for the kitchen and medicinal use. 2. The montana, or winter savoury, a perennial plant, growing naturally in the south of France and Italy, but is cultivated in gardens both for culinary and medicinal purposes. Both kinds are propagated by seeds. Summer savoury is a very warm pungent aromatic, and affords in distillation with water a subtile essential oil, of a penetrating smell, and very hot acrid taste. It yields little of its virtues by infusion to aqueous liquors; rectified spirit extracts the whole of its taste and smell, and elevates nothing in distillation.

SATURN. See ASTRONOMY.

SATYR, or SATIRE. See POETRY.

SATYRIUM, a genus of the diandria order, in the gynandria class of plants; and in the natural method ranking under the 42d order, verticillatæ. The nectarium is scrotiform, or inflated double behind the flower. There are 21 species.

SAUCISSON, in fortification, a mass of large branches of trees bound together; and differing only from a fascine, as this is composed of small branches of twigs.

SAVIN. See JUNIPERUS.

SAVIOUR, *Order of St.* a religious order in the Romish church, founded by St. Bridget, about the year 1345; and so called from its being pretended that our Saviour himself dictated to the foundress its constitutions and rules.

According to the constitutions, this order is principally founded for religious women who pay a particular honour to the holy virgin; but there are some monks of the order, to administer the sacraments, and spiritual assistance to the nuns. The number of nuns is fixed at sixty in each monastery; and that of the religious priests at thirteen, according to the number of the apostles, of whom St. Paul was the thirteenth. There are also four deacons, representing the four doctors of the church, St. Ambrose, St. Augustin, St. Gregory, and St. Jerome; and eight lay-brothers; who altogether make up the number of the thirteen apostles, and the seventy-two disciples of Jesus Christ. The nuns are not admitted till eighteen years of age, nor the friars before twenty-five; and they are to perform a year's novitiate.

SAUNDERS. See SANTALUM.

SAURURUS, a genus of the tetragynia order, in the heptandria class of plants; and in the natural method ranking under the second order, piperitæ. The calyx is a catkin, with uniflorous scales: there is no corolla;

there are four germina, and four monospermous berries. There is one species, a herb of Virginia.

SAUVAGESIA, a genus of the monogynia order, in the pentandria class of plants; and in the natural method ranking with those of which the order is doubtful. The corolla is pentapetalous and fringed; the calyx pentaphyllous; the nectarium the same, having its leaves placed alternately with the petals; the capsule unilocular. There is one species, a native of St. Domingo.

SAW, an instrument which serves to cut into pieces several solid matters; as wood, stone, ivory, &c. The best saws are of tempered steel ground bright and smooth; those of iron are only hammer-hardened: hence, the first, besides their being stiffer, are likewise found smoother than the last. They are known to be well hammered by the stiff bending of the blade; and to be well and evenly ground, by their bending equally in a bow. The edge in which are the teeth is always thicker than the back, because the back is to follow the edge. The teeth are cut and sharpened with a triangular file, the blade of the saw being first fixed in a whetting-block. After they have been filed the teeth are set, that is, turned out of the right line, that they may make the kerf or fissure the wider, that the back may follow the better. The teeth are always set ranker for coarse cheap stuff than for hard and fine, because the ranker the teeth are set, the more stuff is lost in the kerf. The saws by which marble and other stones are cut, have no teeth: these are generally very large, and are stretched out and held even by a frame.

The lapidaries, too, have their saw, as well as the workmen in mosaic; but of all mechanics, none have so many saws as the joiners; the chief are as follows: The pit-saw, which is a large two-handed saw, used to saw timber in pits; this is chiefly used by the sawyers. The whip-saw, which is also two-handed, used in sawing such large pieces of stuff as the hand-saw will not easily reach. The hand-saw, which is made for a single man's use, of which there are various kinds; as the bow, or frame saw, which is furnished with cheeks: by the twisted cords which pass from the upper parts of these cheeks, and the tongue in the middle of them, the upper ends are drawn closer together, and the lower set further apart. The tenon-saw, which being very thin, has a back to keep it from bending. The compass-saw, which is very small, and its teeth usually not set: its use is to cut a round, or any other compass-kerf: hence the edge is made broad, and the back thin, that it may have a compass to turn in.

SAW-MILLS. In early periods, the trunks of trees were split with wedges into as many and as thin pieces as possible; and if it was necessary to have them still thinner, they were hewn on both sides to the proper size. This simple and wasteful manner of making boards has been still continued in some places, to the present time. Peter the Great of Russia endeavoured to put a stop to it, by forbidding hewn deals to be transported on the river Neva. The saw, however, though so convenient and beneficial, has not been able to banish entirely the practice of splitting timber used in building, or in making furniture and utensils, for we do not speak here of fire-wood; and, indeed, it must be allowed that this method is attended with peculiar advantages, which that of sawing can never possess. The wood-splitters perform their work more expeditiously than sawyers, and split timber is much stronger than that which has been sawn; for the fissure follows the grain of the wood, and leaves it whole; whereas the saw, which proceeds in the line chalked out for it, divides the fibres, and by these means lessens its cohesion and solidity. Split timber, indeed, turns out often crooked and warped; but in many purposes to which it is applied this is not prejudicial; and these faults may sometimes be amended. As the fibres, however, retain their natural length and direction, thin boards, particularly, can be bent much better. This is a great advantage in making pipe-staves, or sieve-frames, which require still more art, and in forming various implements of the like kind.

Our common saw, which needs only to be guided by the hand of the workman, however simple it may be, was not known to the inhabitants of America when they were subdued by the Europeans. The inventor of this instrument has by the Greeks been inserted in their mythology, with a place in which, among their gods, they honoured the greatest benefactors of the earliest ages. By some he is called Talus, and by others Perdix. Pliny alone ascribes the invention to Dædalus; but Hardouin, in the passage where he does so, chooses to read Talus rather than Dædalus. Diodorus Siculus, Apollodorus, and others, name the inventor Talus. He was the son of Dædalus's sister; and was by his mother placed under the tuition of her brother, to be instructed in his art. Having once found the jaw-bone of a snake, he employed it to cut through a small piece of wood; and by these means was induced to form a like instrument of iron, that is, to make a saw. This invention, which greatly facilitates labour, excited the envy of his master, and instigated him to put Talus to death privately. We are told, that being asked by some one, when he was burying the body, what he was depositing in the earth, he replied, "A serpent." This suspicious answer discovered the murder; and thus, adds the historian, a snake was the cause of the invention, of the murder, and of its being found out.

Others call the inventor Perdix. That he was the son of a sister of Dædalus they all agree; but they differ respecting the name of his parents. The mother is by Fulgentius called Polycastes, but without any proof; and Lactantius gives to the father the name of Calaus. In Apollodorus, however, the mother of Talus is called Perdix; and the same name is given by Tzetzes to the mother of the inventor, whose name Talus he changes into Attalus. Perdix, we are told, did not employ for a saw the jaw-bone of a snake, like Talus, but the back-bone of a fish; and this is confirmed by Ovid, who, nevertheless, is silent respecting the name of the inventor.

The saws of the Grecian carpenters had the same form, and were made in the like ingenious manner as ours are at present. This is fully shewn by a painting still preserved among the antiquities of Herculaneum. Two genii are represented at the end of a bench, which consists of a long table that rests upon two four-footed stools. The piece of wood which is to be sawn through is secured by cramps. The saw with which the genii are at work has a perfect resemblance to our frame-saw. It consists of a square frame, having in the middle a blade, the teeth of which stand perpendicular to the plane of the frame. The piece of wood which is to be sawn extends beyond the end of the bench, and one of the workmen appears standing, and the other sitting on the ground. The arms, in which the blade is fastened, have the same form as that given to them at present. In the bench are seen holes, in which the cramps that hold the timber are struck. They are shaped like the figure 7; and the ends of them reach below the boards that form the top of it.

The most beneficial and ingenious improvement of this instrument was, without doubt, the invention of saw-mills, which are driven either by water or by the wind. Mills of the first kind were erected so early as the fourth century, in Germany, on the small river Roeur or Ruer: for though Ausonius speaks properly of water-mills for cutting stone, and not timber, it cannot be doubted that these were invented later than mills for manufacturing deals, or that both kinds were erected at the same time. The art, however, of cutting marble with a saw is very old. Pliny conjectures that it was invented in Caria; at least he knew no building incrusted with marble of greater antiquity than the palace of king Mausolus, at Halicarnassus. This edifice is celebrated by Vitruvius, for the beauty of its marble; and Pliny gives an account of the different kinds of sand used for cutting it; for it is the sand properly, says he, and not the saw, which produces that effect. The latter presses down the former, and rubs it against the marble; and the coarser the sand is, the longer will be the time required to polish the marble which has been cut by it. Stones of the soap-rock kind, which are indeed softer than marble, and which would require less force than wood, were sawn at that period: but it appears that the far harder glassy kinds of stone were sawn then also; for we are told of the discovery of a building which was encrusted with cut agate, carnelian, lapis lazuli, and amethysts. We have, however, found no account in any of the Greek or Roman writers of a mill for sawing wood; and as the writers of modern times speak of saw-mills as new and uncommon, it would seem that the oldest construction of them has been forgotten, or that some important improvement has made them appear entirely new.

Becher says, with his usual confidence, that saw-mills were invented in the 17th century. In this he erred, for when the infant Henry sent settlers to the island of Madeira, which was discovered in 1420, and caused European fruits of every kind to be carried thither, he ordered saw-mills to be erected also, for the purpose of sawing into deals the various species of excellent timber with which the island abounded, and which were afterwards transported to Portugal. About the year 1427 the city of Breslau had a saw-mill, which produced a yearly rent of three marks; and in 1490 the magistrates of Erfurt purchased a forest, in which they caused a saw-mill to be erected, and they rented another mill in the neighbourhood besides.

Norway, which is covered with forests, had the first saw-mill about the year 1530. This mode of manufacturing timber was called the new art; and because the exportation of deals was by these means increased, that circumstance gave occasion to the deal-tythe, introduced by Christian III. in the year 1545. Soon after the celebrated Henry Canzau caused the first mill of this kind to be built in Holstein. In 1552 there was a saw-mill at Joachimsthal, which, as we are told, belonged to Jacob Geusen, mathematician. In the year 1555 the bishop of Ely, ambassador from Mary queen of England to the court of Rome, having seen a saw-mill in the neighbourhood of Lyons, the writer of his travels thought it worthy of a particular description. In the sixteenth century, however, there were mills with different saw-blades, by which a plank could be cut into several deals at the same time. The first saw-mill was erected in Holland at Saardam, in the year 1596; and the invention of it is ascribed to Cornelius Cornelissen. Perhaps he was the first person who built a saw-mill at that place, which is a village of great trade, and has still a great many saw-mills, though the number of them is becoming daily less; for within the last thirty years a hundred have been given up. The first mill of this kind in Sweden was erected in the year 1653. At present, that kingdom possesses the largest perhaps ever constructed in Europe, where a water-wheel, twelve feet broad, drives at the same time seventy-two saws.

In England saw-mills had at first the same fate that printing had in Turkey, the ribbon-loom in the dominions of the church, and the crane at Strasburgh. When attempts were made to introduce them, they were violently opposed, because it was apprehended that the sawyers would be deprived by them of their means of getting a subsistence. For this reason, it was found necessary to abandon a saw-mill erected by a Dutchman near London, in 1663; and in the year 1700, when one Houghton laid before the nation the advantages of such a mill, he expressed his apprehension that it might excite the rage of the populace. What he dreaded was actually the case in 1767 or 1768, when an opulent timber-merchant, by the desire and approbation of the Society of Arts, caused a saw-mill, driven by wind, to be erected at Limehouse, under the direction of James Stansfield, who had learned, in Holland and Norway, the art of constructing and managing machines of that kind. A mob assembled, and pulled the mill to pieces; but the damage was made good by the nation, and some of the rioters were punished. A new mill was afterwards erected, which was suffered to work without molestation, and which gave occasion to the erection of others. It appears, however, that this was not the only mill of the kind then in Britain; for one driven also by wind had been built at Leith, in Scotland, some years before.

The mechanism of a sawing-mill may be reduced to three principal things: the first, that the saw is drawn up and down as long as is necessary, by a motion communicated by water to the wheel: the second, that the piece of timber to be cut into boards is advanced by an uniform motion to receive the strokes of the saw; for here the wood is to meet the saw, and not the saw to follow the wood, therefore the motion of the wood and that of the saw ought immediately to depend the one on the other: the third, that when the saw has cut through the whole length of the piece, the whole machine stops of itself, and remains immoveable; for fear, lest having no obstacle to surmount, the force of the water should turn the wheel with too great rapidity, and break some part of the machine.

The upper part of Plate Saw-mill, &c. represents the circular saw-mill introduced by Mr. George Smart, and used by him in his manufactory at Ordnance-wharf, Westminster-bridge. ABD, fig. 1, is a strong bench, similar to those used by carpenters. In the middle of this, is an opening through which the saw E comes. The saw L, figs. 1 and 2, is a circular plate of steel, with teeth like those of a large pit-saw on its circumference, and a round hole in the middle of it, through which the spindle E, fig. 2, of the saw passes. It is prevented from slipping round it, by a flanch *e* fixed to the spindle E, and another, *f*, which slips on the spindle, and is pressed against the saw by a nut *b*, screwed on the end of the spindle, so as to hold the saw tight between the flanches, and by unscrewing the nut, the saw can be taken off to be sharpened, and another put in its place in a very short time. The ends of the spindle are brought to points, which work in small holes in the ends of screws, one of which is seen at *d*, fig. 1: the other screw is put through a piece of wood F, supported by the two uprights GG, and can be raised or lowered at pleasure by wedges, so as to bring the plane of the saw exactly at right angles. To the surface of the bench the saw is turned round with a great velocity by a strap passing round the rigger H and the wheel I, which receives its motion from a horse-wheel

The piece of wood to be sawn is guided by a straight bar K, which is always made to move parallel to the plane of the saw by two iron coupling-rods *hh*, so that it can be set at any distance from the saw, according to the width of the piece to be cut, and held there by screws.

The machine before us is chiefly used for ripping up three-inch deal planks. The bar K is set the proper distance from the saw, and screwed fast. The workman takes the plank, and laying its edge against the bar K, shoves it endways against the saw, which, as it turns, cuts the wood with surprising quickness.

SAXIFRAGA, *saxifrage*, a genus of the digynia order, in the decandria class of plants; and in the natural method ranking under the 13th order, succulentæ. The calyx is quinquepartite; the corolla pentapetalous; the capsule birostrated, unilocular, and polyspermous.

There are 50 species, of which the most remarkable are, 1. The granulata, or white saxifrage, which grows naturally in the meadows in many parts of England. The roots of this plant are like grains of corn, of a reddish colour without: there is a variety of this with double flowers, which is very ornamental. The leaves are tongue-shaped, gathered into heads, rounded at their points, and have cartilaginous and sawed borders. The stalk rises two feet and a half high, branching out near the ground, forming a natural pyramid to the top. The flowers have five white wedge-shaped petals, and ten stamina, placed circularly the length of the tube, terminated by roundish purple summits. When these plants are strong, they produce very large pyramids of flowers. 2. The umbrosa, commonly called London pride, or none-so-pretty, grows naturally on the Alps, and also in great plenty on a mountain of Ireland, called Mangerton, in the county of Kerry, in that island. The roots of this are perennial. 3. The oppositifolia grows naturally on the Alps, Pyrenees, and Helvetian mountains: it is also found pretty plentifully growing upon Ingleborough hill, in Yorkshire; Snowdon, in Wales; and some other places. It is a perennial plant, with stalks trailing upon the ground. The flowers are produced at the end of the branches, of a deep blue.

SAY, or SAYE, in commerce, a kind of serge, or woollen stuff, much used abroad for linings, and by the religious for shirts: with us it is used for aprons by several sorts of artificers, being usually dyed green.

SCABBARD, *to*, to punish with the scabbard of a bayonet. Infantry soldiers are sometimes scabbarded, under the sanction of the captains of companies, for slight offences committed among themselves. A court-martial is held in the serjeant's room or tent, to ascertain the culprit's guilt; it having been previously left to him to abide by the judgment of his comrades, in this manner, or to be tried by a regimental court-martial.

The word scabbard has been sometimes used in a figurative sense, to distinguish those persons who have obtained rank and promotion in the army without seeing much hard service, from those who have fought their way through all the obstacles of superior interest, &c. Hence the favourite expression of the late sir William Erskine: "Some rise by the scabbard, and some by the sword;" which means more than we are at liberty to illustrate, but which may be easily applied to cases in point.

SCABIOSA, *scabious*, a genus of the monogynia order, in the tetrandria class of plants; and in the natural method ranking under the 48th order aggregatæ. The common calyx is polyphyllous; the proper one is double, superior; the receptacle is paleaceous or naked. There are 42 species. The most remarkable are, 1. The arvensis, or meadow-scabious, grows naturally in many places of Britain. The flowers are produced upon naked footstalks at the ends of the branches; they are of a purple colour, and have a faint odour. 2. The succisa, or devil's bit, grows naturally in woods and moist places. This has a short tap-root, the end of which appears as if it was bitten or cut off, whence the plant has taken its name. Both these have been recommended as aperient, sudorific, and expectorant; but the present practice has no dependance on them.

SCÆVOLA, a genus of the monogynia order, in the pentandria class of plants. The corolla is monopetalous; the tube slit longitudinally; the border quinquefid and lateral. The fruit is a prism inferior and monospermous; the nucleus bilocular. There are three species.

SCALA. See ANATOMY, *Ear*.

SCALDS, in the history of literature, a

name given by the antient inhabitants of the northern countries to their poets, in whose writings their history is recorded.

SCALE, a mathematical instrument, consisting of several lines drawn on wood, brass, silver, &c. and variously divided, according to the purposes it is intended to serve; whence it acquires various denominations, as the plain scale, diagonal scale, plotting scale, Gunter's scale, &c. See INSTRUMENTS, MATHEMATICAL.

SCALE, in music (from the Latin, scala), the denomination first given to the arrangement made by Guido, of the six syllables ut, re, mi, fa, sol, la: also called gamut. This order of sounds, to which the French have added that of si, bears the name of scale, *i. e.* ladder, because it represents a kind of ladder, by means of which the voice or instrument rises to acute, and descends to grave; each of the seven syllables being, in a manner, one step of the ladder.

The word scale is also used to signify a series of sounds rising or falling from any given pitch or tone, to the greatest practicable distance, through such intermediate degrees as make the succession most agreeable and perfect, and in which we have all the harmonical divisions most commodiously divided. This scale is properly called the universal system, as including all the particular systems.

This enumeration of all the diatonic sounds of our system, ranged in order, and which we call scale, was denominated by the Greeks tetrachord, because, in effect, their scale was composed of only four sounds, which they repeated from tetrachord to tetrachord, as we repeat ours from octave to octave.

SCALENE TRIANGLE. See GEOMETRY.

SCALENUS, in anatomy. See NECK.

SCALES *of fish*. See HORN, Vol. I. p. 924, 3d col.

SCAMMONY, in the materia medica. See CONVOLVULUS, and GUM RESINS.

SCANDALUM MAGNATUM, is the special name of a statute, and also of a wrong done to any high personage of the land, as prelates, dukes, marquises, earls, barons, and other nobles; and also the chancellor, treasurer, clerk of the privy seal, steward of the house, justice of one bench or other, and other great officers of the realm, by false news, or horrible or false messages, whereby debates and discord, betwixt them and the commons, or any scandal to their persons, might arise. 2 R. II. c. 5. This statute has given name to a writ, granted to recover damages thereupon. Cowel.—It is now clearly agreed, that though there are no express words in the statute which give an action, yet the party injured may maintain one on this principle of law; that when a statute prohibits the doing of a thing, which, if done, might be prejudicial to another, in such case he may have an action on that very statute for his damage. 2 Mod. 152.

SCANDIX, *cherril, shepherd's needle,* or *Venus's comb*, a genus of the digynia order, in the pentandria class of plants; and in the natural method ranking under the 45th order, umbellatæ. The corolla is radiating; the fruit subulated; the petals emarginated; the florets of the disc frequently male. There are eleven species. The most remarkable is the odorata, with angular furrowed seeds. It is a native of Germany; and has a very thick perennial root, composed of many fibres, of a sweet aromatic taste, like aniseed, from which come forth many large leaves that branch out somewhat like those of fern, whence it is named sweet fern.

SCAPEMENT, a general term for the manner of communicating the impulse of the wheels to the pendulum of a clock. Common scapements consist of the swing wheel and pallets only. See CLOCK-WORK.

SCAPOLITE, a mineral found at Arendal, in Norway. It is of a pearl colour, and is crystallized in long, four-sided, rectangular prisms. Faces longitudinally streaked. Its specific gravity is 3.68, and it is hard enough to scratch glass. Fracture foliated in two directions. Before the blowpipe, it froths and melts into white enamel. It is composed of

48	silica
30	alumina
14	lime
1	oxide of iron
2	water
—	
95.	

SCAPULA. See ANATOMY.

SCAPULAR. See ANATOMY.

SCARABÆUS, *beetle*, a genus of insects of the order coleoptera. The generic character is, antennæ or horns clavate, with a fissile tip; legs generally toothed; body thick and compact. This genus is extremely extensive, there being nearly one hundred species. Among these the most remarkable is, 1. The scarabæus Hercules, or Hercules beetle, which sometimes measures not less than five, or even six inches in length: the wing-shells are of a smooth surface, of a blueish or brownish grey colour, sometimes nearly black, and commonly marked with several small, round, deep-black spots, of different sizes: the head and limbs are coal-black: from the upper part of the breast or thorax proceeds a horn or process of enormous length, in proportion to the body: it is sharp at the tip, where it curves slightly downwards, and is marked beneath by two or three denticulations, and furnished throughout its whole length with a fine, short, velvet-like pile, of a brownish orange-colour: from the front of the head proceeds also a strong horn, about two-thirds the length of the former, toothed on its upper face, but not furnished with any of the velvet-like pile which appears on the former. This species is a native of several parts of South America, where great numbers are said to be sometimes seen on the tree called mammæa, rasping off the rind of the slender branches by working nimbly round them with the horns, till they cause the juice to flow, which they drink to intoxication, and thus fall senseless from the tree. This, however, as the learned Fabricius has well observed, seems not very probable; since the thoracic horn, being bearded on its lower surface, would undoubtedly be made bare by this operation. This species, from the large size of all its parts, affords an admirable example of the characters of the genus. It varies much in size, and it may even be doubted whether some of the smaller specimens have not been occasionally regarded by authors as distinct species. The female is destitute both of the frontal and thoracic horn, but in other points resembles the male. See Plate Nat. Hist. fig. 352.

2. Scarabæus Goliathus, the Goliah beetle, is highly remarkable both in point of size and colour: it is larger in body than the preceding, and has a rose-coloured thorax, marked with longitudinal black stripes or variegations, and purple-brown wing-sheaths: the head is divided in front into two forked processes: the limbs are black, and very strong. It is a native of some parts of Africa. A supposed variety sometimes occurs, in which both the thorax and wing-sheaths are of a pale yellowish brown instead of rose-colour, and are marked with black variegations.

3. Scarabæus melolonthas, or cockchafer, is one of the most common European beetles. This insect is extremely familiar in our own island, the larva or caterpillar inhabiting ploughed lands, and feeding on the roots of corn, &c. and the complete insect making its appearance during the middle and the decline of summer. The cockchafer sometimes appears in such prodigious numbers as almost to strip the trees of their foliage, and to produce mischiefs nearly approaching to those of the locust tribe. It appears from a paper by a Mr. Molineux, printed in the Philosophical Transactions for the year 1697, that some particular districts in Ireland were overrun by this insect in a wonderful manner; and the failure of the wheat in the year 1804 has been by some attributed to the numbers of the larva of this insect which were lodged in the earth.

The larva, or caterpillar, of this insect, is said to be two, and sometimes three years, in passing from its first form into that of the perfect insect. The eggs are laid in small detached heaps beneath the surface of some clod, and the young, when first hatched, are scarcely more than the eighth of an inch in length, gradually advancing in their growth, and occasionally shifting their skins, till they arrive at the length of near two inches. At this period they begin to prepare for their change into a chrysalis or pupa, selecting for the purpose some small clod of earth, in which they form an oval cavity, and, after a certain space, divest themselves of their last skin, and immediately appear in the chrysalis form, in which they continue till the succeeding summer, when the beetle emerges from its retirement, and commits its depredations on the leaves of trees, &c. breeds, and deposits its eggs in a favourable situation, after which its life is of very short duration.

4. A much more elegant insect of this kind is the scarabæus fullo, or variegated beetle. It is nearly twice the size of the cockchafer, and of an elegant chesnut-colour, with the wing-sheaths beautifully marbled with white variegations. It is common in many parts of Europe, but extremely rare in England. See Plate Nat. Hist. fig. 351.

5. A species of peculiar beauty is the golden beetle, scarabæus auratus; it is about the size of the common or black garden-beetle, but of a somewhat flatter shape; and of the most brilliant, varnished, golden-green colour, with the wing-shells varied towards the lower part by a few slight, transverse, white streaks. This beautiful species is not uncommon during the hottest part of

summer, frequenting various plants and flowers; its larva or caterpillar is commonly found in the hollows of old trees, or among the loose dry soil at their roots, and sometimes in the earth of ant-hills. It remains about three years before it changes to a pupa or chrysalis, out of which the insect emerges in a short time afterwards.

This may be sufficient for a general idea of the Linnæan genus scarabæus. It may be added that the species are extremely numerous, and that so great is the singularity of appearance in many kinds, that even the most romantic imagination can hardly conceive a structure of horn or process which is not exemplified in some of the tribe. See Plate Nat. Hist. fig. 353.

SCARIFICATION, in surgery, the operation of making several incisions in the skin by means of lancets, or other instruments, particularly the cupping-instrument.

SCARLET, a beautiful bright red. See Dyeing.

SCARUS, a genus of fishes of the order thoracici. The generic character is, jaws bony, divided in the middle, crenated on the edge; the teeth connate and conglomerate. There are 15 species. The most remarkable are, 1. Scarus Cretensis, Cretan scarus. General length about 12 inches; body broad, sloping, scales extremely large, lateral line ramified on every scale over which it passes. Native of the Mediterranean, and particularly about the coasts of Crete, but is also found in the Indian seas.

2. Scarus rivulatus, rivulated scarus. Native of the Red Sea, observed by Forskal: said to arrive at a great size; scales very small; dorsal and anal fin occasionally recumbent in a channel; tail forked; supposed to feed principally on the different kinds of fuci, and considered as an edible fish; but said to be sometimes productive of disagreeable symptoms from the wounds inflicted by the sharp rays of its dorsal fin.

3. Scarus purpuratus, purpled scarus, an elegant species; in habit allied to the labri: body abruptly lanceolate; the purple stripes on the body serrated at their upper edges: pectoral fins green, and marked at the tip by a large lunated, marginal, black spot: dorsal and anal marked towards the base by a purple stripe; ventral fins blue: tail marked with longitudinal purple spots, and on each side by a purple stripe; shape slightly rounded; lateral line ramified; scales lax, as in the mullet. Native of the Arabian seas; observed by Forskal.

SCAVAGE, a toll or custom antiently exacted by mayors, sheriffs, and bailiffs, of cities and towns-corporate, and of merchant-strangers, for wares exposed and offered to sale within their liberties, which was prohibited by 19 Hen. VII. But the city of London still retains this custom.

SCAVENGERS, two officers annually chosen in every parish in London and its suburbs, by the churchwardens, constables, and other inhabitants, to hire persons called rakers, with carts, to clean the streets, and carry away the dirt and filth, with the ashes and dust from every house. For which purpose a scavenger's tax may be made and levied on the inhabitants, being allowed by the justices of the peace; but it must not exceed fourpence in the pound, on the rent paid for the houses. Persons who refuse to take upon themselves the office of scavenger, forfeit ten pounds. 2 W. and M. c. 2. 1 Geo. I. c. 48. 10 Geo. II. c. 22.

SCENOGRAPHY, in perspective, the perspective representation of a body on a plane; or a description and view of it in all its parts and dimensions, such as it appears to the eye in any oblique view.

This differs essentially from the ichnography and the orthography. The ichnography of a building, &c. represents the plan or ground-work of the building, or section parallel to it; and the orthography the elevation, or front, or one side, also in its natural dimensions; but the scenography exhibits the whole of the building that appears to the eye, front, sides, height, and all, not in their real dimensions or extent, but raised on the geometrical plan in perspective.

In architecture and fortification, scenography is the manner of delineating the several parts of a building or fortress, as they are represented in perspective.

To exhibit the scenography of any body. 1. Lay down the basis, ground-plot, or plan, of the body, in the perspective ichnography; that is, draw the perspective appearance of the plan or basement, by the proper rules of perspective. 2. Upon the several points of the perspective plan, raise the perspective heights, and connect the tops of them by the proper slope or oblique lines. So will the scenography of the body be completed, when a proper shade is added. See Perspective.

SCEPTRE, one of the six new constellations of the southern hemisphere, consisting of seventeen stars. See Astronomy.

SCHÆFFERA, a genus of the tetrandria order, in the diœcia class of plants; and in the natural method ranking with those that are doubtful. The calyx is quadripetalous; the corolla is quadripetalous, quinquepetalous, and often wanting; the fruit is a bilocular berry, with one seed. Of this there are two species, both natives of Jamaica; and grow in the lowlands near the sea, viz. 1. The completa. 2. Lateriflora.

SCHERARDIA, a genus of the monogynia order, in the tetrandria class of plants. The corolla is monopetalous and funnel-shaped; there are two three-toothed seeds.

SCHEUCHZERIA, a genus of the trigynia order, in the hexandria class of plants; and in the natural method ranking under the fifth order, tripetaloideæ. The calyx is sexpartite; there is no corolla, nor are there any styles; there are three inflated and monospermous capsules. Eleven species.

SCHIEFERSPAR, a mineral ranked among the species of carbonat of lime. Colour greyish, reddish, greenish, or yellowish white. Found massive: texture curve foliated: brittle: feels unctuous, and may be scratched by the nail. Specific gravity 27. It is composed of carbonat of lime, with a small portion of silica and oxide of iron.

SCHINUS, a genus of the decandria order, in the diœcia class of plants; and in the natural method ranking under the 43rd order, dumosæ. The male calyx is quinquefid; the petals five. The female flower is the same as in the male; the berry tricoccous. There are two species, of South America.

SCHIROCCO. See Wind.

SCHISTUS, in mineralogy, a name given to several different kinds of stones, but more especially to some of the argillaceous kind; as, 1. The bluish purple schistus, schistus tegularis, or common roof-slate. This is so soft, that it may be slightly scraped with the nail, and is of a very brittle lamellated texture, of the specific gravity of 2.876. It is fusible per se in a strong heat, and runs into a black scoria. By a chemical analysis it is found to consist of 26 parts of argillaceous earth, 46 of silex, 8 of magnesia, 4 of lime, and 14 of iron. The dark-blue slate, or schistus scriptorius, contains more magnesia and less iron than the common purple schistus, and effervesces more briskly with acids. Its specific gravity is 2.701. 2. The pyritaceous schistus is of a grey colour, brown, blue, or black; and capable of more or less decomposition by exposure to the air, according to the quantity of pyritous matter it contains, and the state of the iron in it. The aluminous schistus belongs to this species. 3. The bituminous schistus is generally black, and of a lamellated texture, of various degrees of hardness, not giving fire with steel, but emitting a strong smell when heated, and sometimes without being heated. M. Magellan mentions a specimen which burns like coal, with a strong smell of mineral bitumen, but of a yellowish brown, or rather dark ash-colour, found in Yorkshire. This kind of schistus does not show any white mark when scratched, like the other schistus.

SCHLEFFLERA, a genus of the class and order pentandria decagynia. The calyx is five-toothed; corolla five-petalled; capsule eight or ten celled; seeds solitary, semicircular. There is one species, of New Zealand.

SCHMIDELIA, a genus of the digynia order, in the octandria class of plants. The calyx is diphyllous; the corolla tetrapetalous; the germina pedicellated, and longer than the flower. There is one species, a tree of the East Indies.

SCHOENUS, a genus of the monogynia order, in the triandria class of plants; and in the natural method ranking under the third order, calamariæ. The glumes are paleaceous, univalved, and thick-set; there is no corolla, and only one roundish seed between the glumes. There are 41 species.

SCHOLIUM, a note, annotation, or remark, occasionally made on some passage, or proposition, of an old author. This term is much used in geometry, and other parts of mathematics, where after demonstrating a proposition, it is customary to point out how it might be done some other way, or to give some advice, or precaution, in order to prevent mistakes, or add some particular use or application of it.

SCHOTIA, a genus of the monogynia order, in the decandria class of plants; and in the natural method ranking under the 33d order, lomentaceæ. The calyx is semiquinquefid; the corolla has five petals, which are equal; the tube is turbinated, carnous, and persistent; the legumen pedicellated, and contains two seeds. There is only one species, viz. the speciosa, or African lignum vitæ.

SCHRADERA, a genus of the class and order hexandria monogynia. The calyx is superior; corolla five or six-cleft; stigmas two; berry one-seeded. There are two species, parasites of the West Indies.

SCHREBERA, a genus of the digynia order, in the pentandria class of plants; and in the natural method ranking with those of which the order is doubtful. The calyx is quinquepartite; the corolla funnel-shaped, with the filaments in the throat, and having each a scale at the base. There is one species, a tree of the East Indies.

SCHWALBEA, a genus of the class and order didynamia angiospermia. The calyx is four-cleft; the upper lobe very small; the lowest very large and emarginate. There is one species, of North America.

SCHWENKFELDIA, a genus of the monogynia order, in the pentandria class of plants; and in the natural method ranking with those that are doubtful. The calyx is quinquefid; the corolla funnel-shaped; the stigma parted into five; the berry quinquelocular, with a number of seeds. Of this there are three species, viz. 1. Cinerea; 2. Aspera; 3. Hirta. The two first are natives of Guiana, the other of Jamaica. The leaves of all of them are remarkably rough, and stick to the fingers or clothes.

SCHWENKIA, a genus of the monogynia order, in the diandria class of plants. The corolla is almost equal, plaited at the throat, and glandulous; there are three barren stamina; the capsule bilocular and polyspermous. There is one species.

SCIÆNA, a genus of fishes of the order thoracici. The generic character is, head scaly; dorsal fins two, seated in a furrow, into which they may occasionally withdraw; gill-membrane six-rayed. There are two divisions in this genus, 1. with divided or lunated tail; 2. with even or rounded tail. There are twenty species. The most remarkable are: 1. Sciæna cirrosa, bearded sciæna. Habit that of a carp; length from one to two feet; colour pale yellow, brownish on the back, and marked on each side by many obliquely longitudinal dusky-blue lines, which assume a slightly silvery cast towards the abdomen: upper lip obtuse, and longer than the lower; teeth small; first dorsal fin triangular, and pale brown; the second white, with a brown stripe: pectoral, ventral, and caudal, dusky; anal red; tail slightly lunated: at the base of the gill-covers a black spot, and beneath the chin a short fleshy beard: native of the Mediterranean and other seas: known to the antient Greeks and Romans, by whom it was held in considerable estimation as a food.

2. Sciæna labrax, basse sciæna. Habit of a salmon; size considerable, growing, according to some authors, to the length of several feet: colour blueish silvery, with a dusky cast on the back: scales rather small; eyes reddish; mouth and gill-covers tinged with pale red; tail slightly forked; lateral line nearly straight: native of the Mediterranean and northern seas, and often entering rivers; known to the antients by the names of labrax and lupus, and much esteemed as a food, particularly by the Romans.

SCIATICA. See MEDICINE.

SCILLA, the *squill*, in botany, a genus of the monogynia order, in the hexandria class of plants, and in the natural method ranking under the 10th order, coronariæ. The corolla is hexapetalous and deciduous; the filaments filiform. There are 22 species. The most remarkable is the maritima, or sea-onion, whose roots are used in medicine. Of this there are two sorts, one with a red, and the other with a white root; which are supposed to be accidental varieties, but the white are generally preferred for medicinal use. The roots are large, somewhat oval-shaped, composed of many coats lying over each other like onions; and at the bottom come out several fibres. From the middle of the root rise several shining leaves, which continue green all the winter, and decay in the spring. Then the flower-stalk comes out, which rises two feet high, and is naked half-way, terminating in a pyramidal thyrse of flowers, which are white, composed of six petals, and spread open like the points of a star. This grows naturally on the sea-shores, and in the ditches where the salt water naturally flows with the tide, in most of the warm parts of Europe, so cannot be propagated in gardens; the frost in winter always destroying the roots, and for want of salt water they do not thrive in summer. The root is very nauseous to the taste, intensely bitter, and so acrimonious that it ulcerates the skin if much handled. Taken internally, it powerfully stimulates the solids, and promotes urine, sweat, and expectoration. If the dose is considerable, it proves emetic, and sometimes purgative. The principal use of this medicine is where the primæ viæ abound with mucous matter, and the lungs are oppressed by tenacious phlegm.

SCIOPTIC, a sphere, or globe of wood, with a circular hole or perforation, wherein a lens is placed. It is so fitted that, like the eye of an animal, it may be turned round every way, to be used in making experiments in a darkened room. See OPTICS.

SCIRE FACIAS, is a judicial writ, and properly lies after a year and a day after judgment given; whereby the sheriff is commanded to summon or give notice to the defendant, that he appear and shew cause why the plaintiff should not have execution. 1 Inst. 290. A scire facias is deemed a judicial writ, and founded on some matter of record, as judgments, recognizances, and letters patent, on which it lies to enforce the execution of them, or to vacate or set them aside; and though it is a judicial writ of execution, yet it is so far in nature of an original, that the defendant may plead to it, and is in that respect considered as an action; and therefore it is held, that a release of all actions, or a release of all executions, is a good bar to a scire facias. See Rol. Abr.

SCIRPUS, a genus of the monogynia order, in the triandria class of plants, and in the natural method ranking under the third order, calamariæ. The glumes are paleaceous, and imbricated all round. There is no corolla, and only one beardless seed. There are 69 species, rushes of the East Indies.

SCIRRHUS. See SURGERY.

SCIURUS, SQUIRREL, a genus of quadrupeds of the order glires: the generic character is, upper front-teeth cuneated, lower sharp; grinders in the upper jaw five on each side, in the lower four; clavicles in the skeleton; tail (in most species) spreading towards each side. The animals composing this elegant genus are remarkable for the liveliness of their disposition, the celerity of their motions, and the general beauty and neatness of their appearance. They inhabit woods, live entirely on vegetable food, and take up their residence in the hollows of trees, where they prepare their nests. Some species are furnished with an expansile lateral skin, reaching from the fore legs to the hind; by the help of which they are enabled to spring to a greater distance than the rest of the genus, and to transport themselves occasionally from tree to tree; but this momentary support in air is all that they are capable of; and though called, from this circumstance, flying squirrels, they are unable to continue that action in the manner of bats. The species of squirrels enumerated in the twelfth edition of the Systema Naturæ of Linnæus amounted to no more than eleven; but such has been the spirit of research among modern naturalists, that the number is now increased to near thirty. The most noted are,

1. Sciurus maximus, great squirrel. Of all the species yet discovered, this is the largest, being equal in size to a cat. It is a native of India, and was first described by Mons. Sonnerat, who informs us that it is found in the Malabar country, and especially about the mountains of Cardamone, where it feeds on fruits, and is particularly fond of the milk of the cocoa-nut, which it pierces, when ripe, in order to obtain the liquor. The fur on the whole animal is long and full; the top of the head, ears, back, and sides, are ferruginous, and a small band of a similar colour commences beneath each ear, passing along the neck towards the sides. This animal, according to Sonnerat, is easily tamed, and is called about the coasts of Malabar by the name of the great wood-rat. See Plate Nat. Hist. fig. 354.

2. Sciurus vulgaris, common squirrel. The general appearance and manners of this species are so well known that it is unnecessary to particularize them. It is a native of almost all parts of Europe as well as of the northern and temperate parts of Asia, but is observed to vary in the cast of its colours in different climates, and in the northern regions becomes grey in winter; it also varies occasionally in size. The general measure of the European squirrel seems to be about eight inches from nose to tail, and of the tail about seven. In the spring these animals seem peculiarly active, pursuing each other among the trees, and exerting various efforts of agility. During the warm summer nights they may be also observed in a similar exercise. They seem, as Buffon observes, to dread the heat of the sun; for during the day they commonly remain in their nests, making their principal excursions by night. Their habitation is so contrived as to be perfectly clean, warm, and impenetrable by rain, and is composed of moss, dried leaves, &c. and situated between the fork of two branches; it has only a small aperture near the top, which is of a conical form, so as to throw off the rain. The young are generally three or four in number, and are produced about the middle of summer, or sometimes earlier.

The squirrel feeds on the buds and young shoots of trees, and is said to be particularly fond of those of the fir and pine; it also collects great quantities of nuts, which it deposits in the hollows of trees for its winter food, together with beech-mast, acorns, &c. Dr. Pallas also assures us, that those of Siberia collect various kinds of fungi for this purpose. In a state of captivity, nuts form its principal food, but it will also eat a great variety of fruits and other vegetable substances, and is delighted with sugar and various sweets.

In some parts of Siberia the squirrel is found entirely white, with red eyes. About lake Baikal it is often entirely black, or black with the belly white; and in some parts of Europe, and particularly in our own country, it is occasionally found with the tail milk-white, and all the other parts of the usual colour.

3. Sciurus cinereus, grey squirrel. This species is confined to North America, in many parts of which it is extremely common, and in its general form, as well as in its way of life, resembles the European squirrel. It is a large and elegant animal, being of the size of a half-grown rabbit, and measuring about twelve inches to the tail; different individuals, however, vary somewhat in point of size. The whole animal is of an elegant pale-grey, with the insides of the limbs and the under parts of the body white. This animal is said to be found in Canada, Pennsylvania, Virginia, and other American districts; though, according to Mr. Pennant, it scarcely extends farther north than New England. Mr. Pennant also allows that it is a native of South as well as North America. In the latter it is in some years so extremely numerous as to do incredible damage to plantations, especially those of maize or Indian corn; for which reason it is one of the proscribed animals among the colonists. This species resides principally among trees, in the hollows of which it makes its nest, with straw, moss, &c. feeding on acorns, fir-cones, maize, &c. as well as on fruits of various kinds. It is said to amass great quantities of provision for winter, which it deposits in holes which it prepares beneath the roots of trees, &c. It is a difficult animal to kill, changing its place on the trees with such expedition, as generally to elude the shot of the quickest marksman.

4. Sciurus striatus, the striped squirrel, is a native of the northern regions of Asia, and of several of the colder parts of North America; it has also been found, though very rarely, in some parts of Europe, and differs from the major part of the squirrel tribe in its manner of life, which rather resembles that of the dormouse, being chiefly passed in subterraneous retreats or burrows, the apartments of which are filled with various stores of acorns, nuts, grain, &c. collected for winter use. It also resembles some of the murine tribe, in being provided with cheek-pouches, for the temporary reception of food: a particularity not to be found in any other species of squirrel. Its general length is about five inches and a half, and of the tail rather more. Its colour on the upper parts is a reddish brown, and on the under white; down the ridge of the back runs a black streak; and on each side the body are two others, the included space between each being of a pale-yellow tinge.

These animals are, according to the observations of Dr. Pallas, extremely common in Siberia, inhabiting the maple and birch woods of that country, and generally forming their nests or burrows near the root of some tree: they are never known to ascend trees in the manner of other squirrels, unless suddenly surprised or pursued, when they climb with great expedition, and conceal themselves among the branches; they collect their stores during the autumnal season, and on the setting in of winter conceal themselves in their burrows, the entrances of which they stop; and pass the greatest part of the rigorous season in sleep, and in feeding on their collected stores; but if, by an unusual continuance of severe weather, their provisions happen to fail, they then sally out in quest of fresh supplies, and occasionally make their way into granaries, and even into houses. In the choice of their food they are remarkably nice, and have been observed, after filling their pouches with rye, to fling it out on meeting with wheat, and replace it with the superior grain. They are of a wild nature, and are by no means easily reconciled to a state of captivity; continuing timid, and shewing no symptoms of attachment to their owners. They are taken merely on account of their skins, which, though forming but a slight or ordinary fur, have a very pleasing appearance, when properly disposed, and are said to be chiefly sold to the Chinese.

5. Sciurus volans, common flying squirrel. This highly elegant animal is the only flying squirrel yet discovered in Europe, where it is extremely rare, being found chiefly in the most northern regions, as in Finland, Lapland, &c. It also occurs in some districts of Poland. In many parts of Asia it is far more common, and abounds in the birch and pine woods of Siberia in particular. It appears to have been confounded by authors with the Virginian flying squirrel (S. volucella), but is a totally distinct species. Its colour on the upper parts is an elegant pale or whitish grey, and on the under parts milk-white. Its general size is inferior to that of a common squirrel, measuring about six inches and a quarter to the tail, which is shorter than the body, thickly furred, of a slightly flattened form, and rounded at the extremity. The flying squirrel generally resides in the hollows of trees towards the upper part; preparing its nest of the finer mosses. It is a solitary animal, and is only seen in pairs during the breeding-season. It rarely makes its appearance by day, emerging only at the commencement of twilight, when it may be seen climbing about the trees, and darting with great velocity from one to the other. The colour of its upper part so much resembles that of the pale silvery bark of the birch-trees which it frequents, that it is by no means easy to distinguish it, while engaged in climbing about during its evening exercise. It feeds chiefly on the young shoots, buds, and catkins of the birch, as well as on those of the pine, &c. In winter it continues in its nest, coming out only in mild weather; but does not become torpid during that season.

This animal readily springs to the distance of twenty fathoms or more, and by this motion conveys itself from the top of one tree to the middle part of that to which it directs its flight, which is always slightly downwards. It very rarely descends to the surface, and, when taken, and placed on the ground, runs or springs somewhat awkwardly, with its tail elevated, and as soon as it gains a tree, instantly begins to climb it with great activity; sometimes elevating, and sometimes depressing its tail. If thrown from the top of a tree, it immediately spreads its membranes, and, balancing itself, endeavours to direct its motion by the assistance of the tail. The young are produced about the beginning or before the middle of May, and are two, three, and sometimes four, in number; they are at first blind, and nearly void of hair; and the parent fosters them by covering them with her flying-membrane; leaving her nest only at the approach of evening, and carefully concealing the young with the moss of the nest.

SCIURUS, a genus of the monogynia order, in the diandria class of plants; and in the natural method ranking with those that are doubtful. The calyx is quinquedentate; the corolla bilabiated; the filaments are barren; the capsules five, and joined together; bivalved, unilocular, with one seed. Of this there is one species, viz. aromatica, a native of Guiana.

SCLERANTHUS, Knawel, a genus of the digynia order, in the dodecandria class of plants, and in the natural method ranking under the 22d order, caryophyllei. The calyx is monophyllous; there is no corolla; there are two seeds contained in the calyx: There are three species.

SCLEROCARPUS, a genus of the class and order syngenesia polygamia æqualis. The calyx is six-leaved; recept. chaffy. There is one species, a herb of the Cape.

SCLEROTICA, in anatomy, one of the tunics, or coats, of the eye. See Optics, &c.

SCOLD. A common scold is a public nuisance to her neighbourhood, for which offence she may be indicted.

SCOLEX, a genus of vermes intestina. The generic character is, body gelatinous, variously shaped, brandished on the fore part, and pointed behind; sometimes linear and long; sometimes wrinkled and short, round, flexuous, and depressed; head protrusile, and retractile. There are two species, found in the intestinal mucus of the turbot, &c. invisible to the naked eye.

SCOLIA, a genus of insects of the order hymenoptera: the generic character is, mouth with a curved sharp mandible, crenate within; jaw compressed, projecting entire, and horny; tongue inflected, trifid, very short; lips projecting, membranaceous at the tip, and entire: feelers four, equal, short, filiform, in the middle of the lip; antennæ thick, filiform, the first joint longer. There are 40 species.

SCOLOPAX, in ornithology, a genus belonging to the order of grallæ. The back is cylindrical, obtuse, and longer than the head; the nostrils are linear; the face is covered, and the feet have four toes. There are eighteen species, of which the following are the principal:

1. The arquata, or curlew, frequents our sea-coasts and marshes in the winter-time in large flocks, walking on the open sands; feeding on shells, frogs, crabs, and marine insects. In summer they retire to the mountainous and unfrequented parts of the country, where they pair and breed. Their eggs are of a pale olive-colour, marked with irre-

gular but distinct spots of pale brown. Their flesh is rank and filthy, notwithstanding an old English proverb in its favour. Curlews differ much in weight and size; some weighing 37 ounces, others not 22; the length of the largest to the tip of the tail, 25 inches; the breadth, three feet five inches; the bill is seven inches long; the head, neck, and coverts of the wings are of a pale brown; the middle of each feather black; the breast and belly white, marked with narrow oblong black lines; the back is white, spotted with a few black strokes; the quill-feathers are black, but the inner webs spotted with white; the tail is white, tinged with red, and beautifully barred with black; the legs are long, strong, and of a blueish grey colour; the bottoms of the toes flat and broad, to enable it to walk on the soft mud, in search of food.

2. The phæopus, or whimbrel, is much less frequent on our shores than the curlew; but its haunts, food, and general appearance, are much the same. It is observed to visit the neighbourhood of Spalding (where it is called the curlew knot) in vast flocks in April, but continues there no longer than May, nor is it seen there any other time of the year; it seems at that season to be on its passage to its breeding-place. The specific difference is the size, this never exceeding the weight of twelve ounces.

3. The rusticola, or woodcock, during summer inhabits the Alps of Norway, Sweden, Polish Prussia, the march of Brandenburg, and the northern parts of Europe; they all retire from those countries in the beginning of winter, as soon as the frosts commence, which force them into milder climates, where the ground is open, and adapted to their manner of feeding. They live on worms and insects, which they search for with their long bills in soft grounds and moist woods. Woodcocks generally arrive here in flocks, taking advantage of the night or a mist; they soon separate; but, before they return to their native haunts, they pair. They feed and fly by night, beginning their flight in the evening, and return the same way or through the same glades to their day retreat. They leave England the latter end of February, or beginning of March; not but they have been known to continue here accidentally.

4. The gallenago, or common snipe, is well known. Its usual weight is about four ounces. The jack snipe (which is by some thought a different species) does not weigh above half as much.

5. The calidris, or red-shank.

6. The glottis, or green-shank.

7. The œgocephala, or godroit.

SCOLOPENDRA, Centipede, a genus of insects of the order aptera: the generic character is, antennæ setaceous; body depressed; legs numerous, equalling the number of segments of the body on each side; feelers two, setaceous. The larger species of the genus scolopendra, found only in the hotter regions of the globe, are insects of a formidable appearance, and possess the power of inflicting severe pain and inflammation by their bite. Of these one of the most conspicuous is the scolopendra morsitans, a native of many parts of Asia, Africa, and South America. Its length is sometimes not far short of ten inches; its colour is yellowish brown, the legs and under parts of the body being much paler; the head is armed on each side with a very large curved fang, of the same strong or horny nature as those of the aranea avicularia, but placed in a different direction, the two fangs meeting horizontally when in action; these fangs are furnished on the inside, near the tip, with an oblong slit, through which, during the act of wounding, an acrimonious or poisonous fluid is discharged; the eyes are several in number on each side the head, and are placed in a small oval groupe; the legs are twenty on each side the body, and the tail is terminated by a pair of processes, which perfectly resemble the rest of the legs, except that they are larger, and have the first joints strongly spined or muricated on the inside. These horrible insects are said to be chiefly found in woods, but, like the small European species, they are occasionally seen in houses, and are said to be so common in some particular districts that the inhabitants are obliged to place the feet of their beds in vessels of water, in order to prevent their attacks during the night.

2. Scolopendra Plumieri, or Plumier's scolopendra, is of much greater length than the former, sometimes measuring a foot and a half. According to the description and figure of Seba, the body consists of thirty-two joints, exclusive of the head and tail.

3. Scolopendra forficata, is a very common insect, and is met with in similar situations with the oniscus asellus and armadillo; it is an animal of swift motion, and is furnished with fifteen legs on each side; its colour is a polished chesnut-brown, somewhat paler beneath, and its usual length an inch and a half. See Plate Nat. Hist. fig. 355.

4. Scolopendra electrica is, like the former, an inhabitant of damp situations, and not unfrequently makes its appearance in houses; its general length is about an inch and a half, and its diameter scarcely more than the tenth of an inch, being of an extremely long and slender form; its colour is a dusky brown, with the legs yellowish; these are about seventy on each side. The motions of this insect are tortuous and undulatory, seldom continuing long in the same direction; it is possessed of a high degree of phosphoric splendour, which however seems to be only exerted when the animal is pressed or suddenly disturbed, when it diffuses a beautiful smaragdine light, so powerful as not to be obliterated by two candles on the same table. It is also tenacious of life, remaining seemingly uninjured for a great many days in the closest confinement.

5. Scolopendra subterranea so much resembles the former, that it might be easily confounded with it; it is however of a still more slender form, and of a much paler colour, viz. a light yellow brown; it is found in damp places, and often under ground; is not possessed of any phosphoric splendour, nor is it capable of surviving many hours in a state of confinement, unless placed in a very moist situation.

The scolopendræ are oviparous animals, and the young, at their first exclusion, are furnished only with a few feet on each side; acquiring after a certain period, the legitimate number peculiar to their species, of which there are eleven.

SCOLOPIA, a genus of the tetrandria monogynia class and order. The calyx is inferior, three or four-parted; corolla three or four-petalled; berry one-celled, six-seeded; seeds arilled. There is one species, the thorny cinnamon of Ceylon.

SCOLOSANTHUS, a genus of the class and order tetrandria monogynia. The calyx is four-cleft; corolla tubular; drupe one-seeded. There is one species, a shrub of Santa Cruz.

SCOLYMUS, a genus of the polygamia æqualis order, in the syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The receptacle is paleaceous; the calyx imbricated and prickly, without any pappus. There are three species.

SCOMBER, Mackrel, a genus of fishes of the order thoracici; the generic character is, body oblong, smooth, sometimes carinated by the lateral line; finlets (in most species) above and below, towards the tail. There are 22 species, of which the most remarkable are:

1. Scomber scomber, common mackrel. This beautiful fish is a native of the European and American seas, generally appearing at stated seasons, and swarming, in vast shoals, round particular coasts. Its great resort, however, seems to be within the Arctic circle, where it resides in innumerable troops, grows to a larger size than elsewhere, and is supposed to find its favourite food, consisting chiefly of marine insects, in far greater plenty than in warmer latitudes. During the severity of the northern winter it is said to lie imbedded in the soft mud, beneath the vast crusts of ice surrounding the polar coasts, being thus sufficiently protected from the effects of frost; and, on the return of spring, is generally believed to migrate in enormous shoals, of many miles in length and breadth, and to visit the coasts of more temperate climates in order to deposit its spawn. Its route has been supposed nearly similar to that of the herring, passing between Iceland and Norway, and proceeding towards the northern part of our own island, where a part throws itself off into the Baltic, while the grand column passes downwards, and enters the Mediterranean through the straits of Gibraltar.

This long migration of the mackrel, as well as of the herring, seems at present to be greatly called in question; and it is thought more probable that the shoals which appear in such abundance round the more temperate European coasts, in reality reside during the winter at no very great distance; immersing themselves in the soft bottom, and remaining in a state of torpidity; from which they are awakened by the warmth of the returning spring, and gradually recover their former activity. At their first appearance their eyes are observed to appear remarkably dim, as covered with a kind of film, which passes off as the season advances, when they appear in their full perfection of colour and vigour.

The shape of the mackrel is highly elegant, and it is justly considered as one of the most beautiful of the European species. Its merit as an article of food is universally established, and it is one of those fishes which have maintained their reputation through a long succession of ages; having been highly esteemed by the antients, who prepared from it the particular condiment or sauce known to the Romans by the title of garum, and made by salting the fish, and after a certain period straining the liquor from it. This preparation, once so famous, has been long superseded by the introduction of the anchovy for similar purposes.

2. Scomber thynnus, tunny. The tunny is a very large species, growing to the length of eight, or even ten feet, but much more commonly seen of about the length of two feet. It is an inhabitant of the Mediterranean, Northern, Indian, and American seas, and is of a gregarious nature, frequently assembling in large shoals. It is an animal of great strength and fierceness, preying on all kinds of smaller fishes, and is said to be the peculiar persecutor of the mackrel and the flying-fish. Its flesh, though rather coarse, was much esteemed by the antient Greeks, and Romans, who established their tunny-fisheries as in modern times, on many parts of the Mediterranean coasts, where this fish still continues to be taken in great plenty, more especially round the island of Sicily. In the British seas it is rarely observed in shoals; the individuals which occur being rather considered as accidental stragglers. Mr. Pennant records an instance of one which he saw on the northern coasts of Scotland, weighing 460 pounds, and measuring seven feet ten inches in length. Much larger specimens, however, are occasionally taken in the Sicilian sea. In the Indian ocean this species is said to be seen of an enormous size, and to assemble in vast shoals.

The tunny-fishery is of equal importance to the inhabitants of the Mediterranean coasts as the herring-fishery to those of the more northern parts of Europe. The smaller fishes are chiefly sold fresh, while the larger are cut in pieces and salted, and barrelled up for sale.

The general colour of the tunny is a dark or dull blue on the upper parts, and silvery with a cast of flesh-colour on the sides and abdomen.

3. Scomber trachurus, shad, horse-mackrel, inhabits the European, American, and Pacific seas. See Plate Nat. Hist. fig. 356.

SCOPARIA, a genus of the monogynia order, in the tetrandria class of plants, and in the natural method ranking under the 40th order, personatæ. The calyx is quadripartite; the corolla the same, and rotaceous; the capsule unilocular, bivalved, and polyspermous. There are three species.

SCOPOLIA, a genus of the octandria order, in the gynandria class of plants; and in the natural method ranking under the 11th class, sarmentaceæ. The calyx is diphyllous; the corolla quadrifid; the antheræ coalesce in two columns, one placed above the other. There are two species.

SCORE, in music, the original and entire draught, or its transcript, of any composition. In the score all the parts of the piece are ranged perpendicularly under each other, so that the eye, catching the corresponding bars of the several staves, sees at a glance the whole construction and design of the harmony.

As in this disposition, one single line of music comprehends as many staves as there are parts; these staves are held together by a brace drawn down the margin at the beginning of the line.

The use of the score is indispensable in composition; to the conductor of any performance it is also highly requisite, in order to his knowing whether each performer follows his part, and to enable him to supply any accidental omission with the piano-forte, or organ, at which he presides.

SCORIA, or DROSS, is that mass which is produced by melting metals and ores, and when cold is brittle, and not unsoluble in water; being properly a kind of glass.

SCORING, the art of forming a score by collecting and properly arranging under each other the several detached parts of any composition.

SCORPÆNA, a genus of fishes of the order thoracici: the generic character is, head large, aculeated, cirrhose, obtuse, without scales, subcompressed; eyes placed near each other; teeth in the jaws, palate, and throat; gill-membrane seven-rayed: body fleshy; dorsal fin single, with the rays of the fore part spiny. There are nine species; the most remarkable are:

1. Scorpæna porcus, porcine scorpæna. The genus scorpæna is distinguished by a peculiar uncouthness of appearance; the head, in some species, being abruptly truncated in front, of vast size, and armed with various protuberances and spines. Among the most common of the European species is the scorpæna porcus, which is frequently seen in considerable numbers in various parts of the Mediterranean, where it chiefly frequents the shores, lying in ambush among stones, sea-weeds, &c. and preying on the smaller fishes and sea-insects; the head is large; the mouth wide, with many rows of small sharp teeth; the eyes large; the gill-covers armed with strong spines intermixed with cirri; the body covered with small rough scales, of a dusky colour, varied with black on the back, and beneath pale, with a reddish cast; the dorsal fin is furnished with very strong spiny rays, which the fish, when caught, erects, and thus wounds its adversary; its general length is about twelve or fifteen inches.

2. Scorpæna scrofa, rufous scorpæna, in general appearance so nearly allied to the preceding, that at first view it might be mistaken for the same species; but differs in its superior size, as well as in its larger scales; and particularly in having several cirri or processes disposed along the lateral line; the colour also is rather rufous than brown as in the former kind. Of this species it is reported that it preys not only on the smaller fishes, but even occasionally seizes on such of the marine birds as happen to swim in its way. It grows to a very considerable size, and is said to have been seen of the length of four feet; it must consequently prove a very formidable enemy to the smaller marine animals. Notwithstanding its forbidding appearance, it is considered as an edible fish.

3. Scorpæna horrida, horrid scorpæna. Of all the species yet discovered, the present exhibits the most uncouth and forbidding appearance, resembling rather some imaginary monster of deformity than any regular production of nature. The head is very large, perfectly abrupt in front, and marked by numerous tubercles, depressions, and spines; on the top is a semilunar cavity; the mouth opens from the upper part, and is large and of a shape somewhat resembling a horseshoe, and when closed the lower jaw is in a perpendicular direction; both jaws are armed with numerous small teeth; and the upper is furnished with three cirri, viz. one on each side, and one in the middle. The general colour of this hideous fish is a ferruginous brown, deepest on the upper parts; the abdomen being much paler. It is a native of the Indian seas, and measures twelve or fifteen inches in length. See Plate Nat. Hist. fig. 357.

4. Scorpæna volitans, flying scorpæna, a fish of a highly singular appearance: general length ten or twelve inches; colour brownish-yellow, variegated by very numerous, deep brown, transverse stripes; native of the rivers of Japan, Amboina, &c. and considered as an excellent food; it probably uses its pectoral fins for the purposes of occasional flight, like the fishes of the genus exocœtus and some of the triglæ.

5. Scorpæna didactyla, didactyle scorpæna. General length about a foot; form extremely grotesque; general colour dusky brown, varied above by transverse yellow streaks, and beneath by roundish spots of the same colour; skin destitute of scales; head depressed, and furnished on different parts with several abrupt fleshy cirri; eyes large, and situated on two approximated protuberances; snout truncated, and marked on the sides by several angular wrinkles, as are also the lower parts of the gill-covers; lower jaw longer than the upper; tongue prominent, and marked with yellow granules and black streaks; on the lower mandible are strong fleshy beards; lateral line near the back; fins furnished with many far-projecting radii, as in the volitans and antennata: it preys on the smaller fishes, sea-insects, &c. and, notwithstanding its forbidding appearance, is considered as an excellent fish for the table.

SCORPIO, SCORPION, a genus of insects of the order aptera; the generic character is, body ovate-elongated; legs eight, besides two frontal claspers; eyes eight, three on each side the thorax, and two on the back: tail elongated, jointed, and terminated by a curved piercer; combs or toothed processes two, situated beneath, between the thorax and abdomen. The malignant genus scorpio (about six), so proverbially remarkable for the effect of its poisonous sting, seems chiefly confined to the warmer parts of the globe, and may be considered as a stranger to the northern regions. 1. The common Italian scorpion usually measures something more than an inch in length from the head to the setting on of the tail; but, if measured from the tips of the claspers to the tip of the tail, about three inches; its colour is brown, with considerable variation in different individuals, some inclining to a reddish, and some to a yellowish cast. This animal is found in neglected places, beneath boards, stones, &c. and frequently makes its appearance in houses: its sting is painful, but seldom productive of any very serious consequences, and the usual remedy is sweet oil, well rubbed on the punctured part. Like the rest of the genus, this insect preys on other insects, and particularly on spiders.

2. Scorpio Americanus or the American scorpion, is of somewhat smaller size than the preceding, and of a more slender or lengthened form; its colour is a yellowish brown. It is a native of many parts of America.

3. The largest and by far the most formidable of the genus, is the scorpio Afer of Linneus, or great African scorpion. This species is of so large a size as often to measure four inches from the head to the beginning of the tail, and ten inches if measured from the tip of the claspers to that of the tail. Its colour is a dark brown, inclining to yellow beneath, and in the interstices of the joints; and the claspers have often a reddish cast. This species is found in many parts of Africa, where it is held in great dread; the effect of its sting producing very severe symptoms, and sometimes even proving fatal.

The poison of the scorpion is evacuated through two very small oblong foramina situated on each side the tip of the sting. It is well known that a diversity of opinion has subsisted among authors relative to this particular. The celebrated Redi, assisted by the best microscopes he could procure, was not able to detect any orifice, though he was well convinced of the existence of such, from observing a minute drop of poison exsude from near the tip. Others have denied the existence of any foramen; but Vallisneri and Lewenhoek have properly described two foramina, viz. one on each side; so that the sting of the scorpion can with greater facility discharge its poisonous fluid than that of any other insect. A third foramen is said to have been sometimes observed.

The part in scorpions which is situated beneath the breast, bearing the appearance of two minute combs, has been fixed upon by Linnæus as a criterion of the species; the number of teeth, however, varying occasionally in the same species, renders this character uncertain. The use of these organs remains as yet uninvestigated.

Scorpions are viviparous insects, producing a very considerable number of young at once; these are at first entirely white, but acquire their dusky colour in the space of a few days. They are observed to cast their skin from time to time, in the manner of spiders. There are 10 species.

Scorpio. See Astronomy.

SCORPION, in the antient art of war, an engine chiefly used in the defence of the walls of fortified places, by throwing arrows, fireballs, or great stones.

Marcellinus describes the scorpion as consisting of two beams bound together by ropes. From the middle of the two, rose a third beam, so disposed, as to be pulled up and let down at pleasure; and on the top of this were fastened iron hooks, where a sling was hung, either of iron or hemp; and under the third beam lay a piece of hair-cloth full of chaff, tied with cords. It had its name scorpio, because when the long beam or tiller was erected, it had a sharp top in manner of a sting.

To use the engine, a round stone was put into the sling; and four persons on each side, loosening the beams bound by the ropes, drew back the erect beam to the hook; then the engineer, standing on an eminence, gave a stroke with a hammer on the cord to which the beam was fastened with its hook, which set it at liberty; so that hitting against the soft hair-cloth, it struck out the stone with a great force.

SCORPIURUS, Caterpillar, in botany, a genus of the decandria order, in the diadelphia class of plants; and in the natural method ranking under the 32d order, papilionaceæ. The legumen is contracted by incisions on the inside betwixt every two seeds, revoluted round. There are four species; the most remarkable of which is the vermiculata, a native of Italy and Spain. It is an annual plant, with trailing herbaceous stalks, which at each joint have a spatular-shaped leaf with a long footstalk. From the wings of the leaves come out the footstalks of the flowers, which sustain at the top one yellow butterfly-flower, succeeded by a thick twisted pod having the size and appearance of a large caterpillar, whence it had this title. This has long been preserved in the gardens of this country, more on account of its odd shape than for any great beauty.

SCORZA, a mineral of a green-coloured sand, the specific gravity of which is 3.35. It is found in Transylvania, and is composed of

43.00	silica
21.00	alumina
14.00	lime
16.50	oxide of iron
0.25	oxide of manganese
94.75	

SCORZONERA, Viper's grass; a genus of the polygamia æqualis order, in the syngenesia class of plants; and in the natural method ranking under the 49th order, compositæ. The receptacle is naked; the pappus plumy; the calyx imbricated, with scales membranaceous on their margins. There are 19 species; the most remarkable is the hispanica, or common scorzonera, which is cultivated in the gardens of this country, both for culinary and medicinal purposes. The root is carrot-shaped, about the thickness of a finger, covered with a dark-brown skin, is white within, and has a milky juice. The stalk rises three feet high, is smooth, and branching at the top. The flowers are of a bright yellow colour.

SCOTLAND. By 5 Anne c. 8, the union of England and Scotland was effected, and the twenty-five articles of union agreed to by the parliaments of both nations, were ratified and confirmed as follows; viz. the succession to the monarchy of Great Britain, shall be the same as was before settled with regard to that of England. The united kingdoms shall be represented by one parliament. There shall be a communication of all rights and privileges between the subjects of both kingdoms, except where it is otherwise agreed. When England raises 2,000,000*l.* by land-tax, Scotland shall raise 48,000*l.*; the standards of the coin, of weights and measures, shall be reduced to those of England, throughout the united kingdoms. The laws relating to the trade, customs, and the excise, shall be the same in Scotland as in England; but all the other laws of Scotland shall remain in force, though alterable by the parliament of Great Britain; and particularly laws relating to public policy, are alterable at the discretion of parliament; laws relating to private right are not to be altered, but for the evident utility of the people of Scotland. Sixteen peers are to be chosen to represent the peerage of Scotland in parliament, and forty-five members to sit in the house of commons.

The sixteen peers of Scotland shall have all privileges of parliament, and all peers of Scotland shall be peers of Great Britain, ranking next after those of the same degree at the time of the union, and shall have all privileges of peers, except sitting in the house of lords, and voting on the trial of a peer.

It was formerly resolved by the house of lords, that a peer of Scotland, claiming and having a right to sit in the British house of peers had no right to vote in the election of the sixteen Scotch peers; but it seems now settled, that a Scotch peer, made a peer of Great Britain, has a right to vote in the election of the sixteen Scotch peers; and that if any of the sixteen Scotch peers are created peers of Great Britain, they thereby cease to sit as representatives of the Scotch peerage, and new Scotch peers must be elected in their room.

SCREW. See Mechanics.

Screw, *Archimedes'*. See Hydraulics.

SCRIBING, in joinery, &c. is a term used when one side of a piece of stuff is to be fitted to another that is irregular. In order to make these join close all the way they scribe it, that is, they lay the piece to be scribed close to the other they intend to scribe it to, and opening their compasses to the widest distance these two pieces stand from each other, they bear the point of one of the legs against the side they intend to scribe to, and with the other point draw a line on the stuff to be scribed. Thus they form a line on the irregular piece parallel to the edge of the regular one; and if the stuff is cut exactly to the line, when these pieces are put together they will seem a joint.

SCRIPTURE. All profane scoffing at the holy scripture, or exposing any part thereof to contempt or ridicule, is punishable by fine and imprisonment. 1 Haw. 7.

SCROPHULA. See Medicine.

SCROPHULARIA, Figwort; a genus of the angiospermia order, in the didynamia class of plants; and in the natural method ranking under the 40th order, personatæ. The calyx is quinquefid; the corolla almost globose, and resupinated; the capsule bilocular. There are 22 species, of which the most remarkable are: 1. Nodosa, or the common figwort, which grows in woods and hedges. The leaves have a fetid smell and bitter taste. A decoction of them is said to cure hogs of the measles. An ointment made of the root was formerly used to cure the piles and scrophulous sores, but is at present out of practice. 2. Aquatica, water-figwort, or betony. It grows on the sides of rivulets and other wet places, and has a fetid smell, though not so strong as the preceding. The leaves are used in medicine as a corrector of senna, and in powder to promote sneezing. 3. Scorodonia, or balm-leaved figwort. It grows on the banks of rivulets, &c. in Cornwall. 4. Vernalis, or yellow figwort. It grows in hedges in Surry.

SCROTUM. See Anatomy.

SCRUPLE, a weight equal to the third part of a drachm, or to twenty grains. See Weight.

SCULPTURE. Sculpture is an art, in which, by means of taking away, or adding to, matter, all sorts of figures are formed, either in clay or wax, wood, marble or other stones, or metal.

The art of sculpture, in its most extensive sense, comprehends not only carving in wood, stone, or marble, but also enchasing, engraving in all its kinds, and casting in bronze, or lead, wax, and plaister of Paris, as well as modelling in clay, wax, or stucco.

All these are branches of sculpture (of which we shall occasionally make mention); but as they are ranged in their respective practice, under different denominations, we propose to treat here principally of the first branch (and chiefly of carving in stone and marble, which is at present peculiarly considered as the sculptor's art), and of its necessary preliminary, modelling in clay or wax.

Powers of sculpture. Sculpture is not only able, in common with other imitative arts, to express the forms of visible objects and the conceptions of the mind, but it possesses this superior distinction, that by means of its various branches, it is eminently capable of transmitting the most durable records of men's actions to distant ages. Were it not for this art, we should at the present moment be ignorant of every event which has distinguished the course of time in the long period of earthly existence; at least our only knowledge would be gathered from tradition, whose fallacy and inaccuracy are every hour evinced. Without this art, we could form no conjecture of the permanency or variation even of human forms, much less of human passions and taste; nor is it to be forgotten, that the first communication of the laws of God was made to the Israelites by the means of sculpture.

The art of sculpture, like its sister, painting, is imitative, not for the gratification of the eye only, but also of the intellect. It is capable of expressing all forms that fall under our inspection, and also of conveying more select expressions of beauty than are to be found, either by ordinary observation, or are generally united in one body, and which are therefore called ideal forms.

Sculpture, in its confined and proper sense (in which we here proposed to treat of it), divides itself into the carving of bas-reliefs, and of statues, or groups: and its productions may be classed generally, like those of painting, under the respective terms, *historical, allegorical, portraiture,* &c. See Painting.

Bas-relief has been already described (see Relievo). Works of this kind seem to have been invented for the purpose of representing subjects of history or fancy, and may be regarded as a species of painting in stone. They are chiefly used to adorn the pediments, friezes, and pannels of buildings, as well as the pedestals of statues, &c.

Statues are defined to be figures in full or insulated relievo. They are of various descriptions. (See Statues.) They have chiefly been employed for the purposes of religious worship, as among the heathen nations and the Roman-catholics; and for the commemoration of heroic characters, or of men distinguished by any remarkable achievements.

Groups are an assemblage and union of statues, and are generally employed to the same purposes as single statues.

Of the methods of study. The studies necessary for the young sculptor, towards the attainment of his art, are so similar to those which form the painter (with the obvious exceptions arising from the difference of materials employed in the two arts), that very little remains here to be enlarged on, under the head of studies. The principal acquisitions to which the student must direct his endeavours, are, a knowledge of composition, form (including anatomy), and expression; to which, as in painting, must be added the difficult study of grace. These have been already treated of, under the articles painting, design or drawing, and expression. See Drawing, Expression, and Painting.

The method of study most recommended to young sculptors is, to begin with copying, and end with rivalling, the forms of the Greek statues.

——— "Vos exemplaria Græca
Nocturnâ versate manu, versate diurnâ;"

says Du Fresnoy: nor can it be questioned that the sculptors are, generally speaking, the safest guides to the study of nature. But it should not pass unnoticed, that although the forms of the Greek sculpture are, in general, not only more beautiful, but more appropriately so than any other; yet in some instances they have been surpassed by modern sculptors, as in the forms of infants by Fiamingo. See Statues, *antique.*

The method of execution in the Greek statues and other works of sculpture, seems to have been extremely different from that which is generally in use among modern artists. In the antient statues, we frequently find striking proofs of the freedom and boldness that accompanied each stroke of the chisel, and which resulted from the artist's being perfectly sure of the accuracy of the method which he pursued. Even in the most minute parts of the figure, no indication of timorousness or diffidence appears; nothing that can induce us to believe, that the artist feared he might have occasion to correct his strokes. It is difficult to find, even in the second-rate productions of the Grecian artists, any mark of a false stroke or a random touch. This firmness and precision of the Grecian chisel, were certainly derived from a more determined and perfect set of rules, than those of which we are masters.

Besides studying, therefore, in the productions of the Grecian masters, their choice and expression of select nature, whether beautiful, sublime, or graceful, together with that sedate grandeur and simplicity which pervade all their works, the artist will do well to investigate the manual and mechanical part of their operations, as this may lead to the perception of their mode of progress.

It is certain that the antients, almost always formed their first models in wax; to this modern artists have substituted clay, which they prefer on account of its yielding nature, and its sticking in some measure to every thing it touches. We must not, however, imagine from hence, that the method of forming models of wet clay, was either unknown or neglected among the Greeks; on the contrary, it was in Greece that models of this kind were invented. Their author is said by Pliny to have been Dibutades, of Sicyon; and by others Rhæcus, of Samos; and it is well known that Arcelaus, the friend of Lucullus, obtained a higher degree of reputation by his clay models, than by all his other productions.

Clay was, therefore, the first material employed by the Grecians in statuary; an instance of which may be seen in a figure of Alcamenes in bas-relief, in the Villa Albani. The antients used their fingers, and especially their nails, to render certain parts more delicate and lively; hence arose the phrase, ad unguem factus homo, "an accomplished man." It was the opinion of count Caylus, that the antients did not use models in forming their statues. But to disprove this, it is only necessary to mention an engraving on a stone, in the cabinet of Hosch, which represents Prometheus engraving the figure of a man, with a plummet in his hand, to measure the proportions of his model.

As soon as the artist has rendered himself familiarly acquainted with the beauties of the Grecian statues, and formed his taste on the admirable models they exhibit, he may then proceed with advantage and assurance to the imitation of nature. The ideas he has already formed of the perfection of nature, by observing her dispersed beauties combined and collected in the compositions of the antient artists, will enable him to acquire with facility, and to employ with advantage, the detached and partial ideas of beauty which will be exhibited to his view in a survey of nature, in her actual state. When he discovers these partial beauties, he will be capable of combining them with those perfect forms of beauty, with which he is already acquainted. In a word, by having always present to his mind the noble models already mentioned, he will form an accurate judgment of the powers of his art, and will draw rules from his own mind.

There are, however, two ways of imitating nature. In the one, a single object occupies the artist, who endeavours to represent it with precision and truth; in the other, certain lines and features are taken from a variety of objects, and combined and blended into one regular whole. All kinds of copies belong to the first kind of imitation; and productions of this sort must necessarily be executed in a confined and servile manner, with high finishing, and little or no invention. But the second kind of imitation leads directly to the investigation and discovery of true beauty, of that beauty whose perfect idea is only to be found within the mind.

Of the different modes of process in sculpture.—Works of sculpture are performed, either by hollowing or excavating, as in metals, agates, and other precious stones, and in marbles of every description; or by working in relief, as in bas-reliefs in the materials just mentioned, or in statues in metal, clay, wood, wax, marble, or stone.

The excavation of precious stones forms a particular branch of art called intaglio, which, together with the working them in relievo, when the term camayeu is applied to them, belongs to the art of seal-engraving. See Engraving.

The excavation of metals constitutes the art of engraving, in its various branches, on metal of any kind; and its relief comprises enchasing, casting in bronze, &c.

Of the last only, viz. casting in bronze, we take this opportunity of observing, in addition to the account given under the head bronzes, that a highly improved method has lately been put in practice by professor Zauner, an eminent sculptor at Vienna, in the casting of an equestrian statue of the emperor Joseph II. The student may find an accurate detail of Zauner's mode of process, in the Academic Annals of Painting, &c. published by the royal academy of London.

We proceed, as before proposed, to the other more immediate and proper parts of the sculptor's art.

The process of hollowing hard stone or marble, will need no particular description; especially as it is now wholly in disuse, except for the forming of letters in monumental or other inscriptions.

In working in relief, the process is necessarily different, according to the materials in which the work is performed.

As not only the beginning of sculpture was in clay, for the purpose of forming statues, but as models are still made in clay or wax, for every work undertaken by the sculptor; we shall first consider the method of modelling figures in clay or wax.

Few tools are necessary for modelling in clay. The clay being placed on a stand or sculptor's easel, the artist begins the work with his hands, and puts the whole into form by the same means. The most expert practitioners of this art seldom use any other tool than their fingers, except in such small or sharp parts of their work as the fingers cannot reach. For these occasions, they are provided with three or four small tools of wood, about seven or eight inches in length, which are rounded at one end, and at the other flat and shaped into a sort of claws. These tools are called by the French ebauchoirs. In some of these the claws are smooth, for the purpose of smoothing the surface of the model; and in others are made with teeth, to rake or scratch the clay, which is the first process of the tool on the work, and in which state many parts of the model are frequently left by artists, to give an appearance of freedom and skill to their work.

If clay could be made to preserve its original moisture, it would undoubtedly be the fittest substance for the models of the sculptor; but when it is placed either in the fire, or left to dry imperceptibly in the air, its solid parts grow more compact, and the work shrinks, or loses a part of its dimensions. This diminution in size would be of no consequence, if it affected the whole work equally, so as to preserve its proportions. But this is not always the case: for the smaller parts of the figure drying sooner than the larger; and thus losing more of their dimensions in the same space of time, than the latter do; the symmetry and proportions of the work inevitably suffer.

This inconvenience, however, is obviated by forming the model first in clay, and moulding it in plaister of Paris before it begins to dry, and the taking a plaister cast from that mould, and the repairing it carefully from the original work; by which means you have the exact counterpart of the model in its most perfect state; and you have, besides, your clay at liberty for any other work.

In order to model in wax, you must prepare the wax in the following manner: to a pound of wax add half a pound of scammony (some mix turpentine also), and melt the whole together with oil of olives; putting more or less oil as you would have your modelling wax harder or softer. Vermilion is sometimes mixed with this composition, to give it a reddish colour, in imitation of flesh.

In modelling in wax, the artist sometimes uses his fingers, and sometimes tools of the same sort as those described for modelling in clay. It is at first more difficult to model in wax than in clay, but practice will render it familiar and easy.

Of the use of the model. Whatever considerable work is undertaken by the sculptor, whether bas-relief, or statue, &c. it is always requisite to form a previous model, of the same size as the intended work; and the model being perfected, according to the method before described, whether it is in clay, or in wax, or a cast in plaister of Paris, becomes the rule, whereby the artist guides himself in the conduct of his work, and the standard from which he takes all its measurements. In order to regulate himself more correctly by it, he puts over the head of the model an immoveable circle, divided into degrees, with a moveable rule fastened in the centre of the circle, and likewise divided into parts. From the extremity of the rule hangs a line with a lead, which directs him in taking all the points, which are to be transferred from the model to the marble; and from the top of the marble is hung also a line, tallying with that which is hung from the model; by the correspondence of which two lines, the points are ascertained in the marble.

Many eminent sculptors prefer measurements taken by the compasses to the method just described; for this reason, that if the model is moved but ever so little from its level, the points are no longer the same.

This method, however, offers the best means, by which mechanical precision may be attained; but it is manifest, that enough yet remains to exercise and display the genius and skill of the artist. For, first, as it is impossible, by the means of a straight line, to determine with precision the procedure of a curve, the artist derives from this method no certain rule to guide him, as often as the line which he is to describe deviates from the direction of the plumb-line. It is also evident, that this method affords no certain rule to determine exactly the proportion, which the various parts of the figure ought to bear to each other, considered in their mutual relation and connections. This defect, indeed, may be partly supplied by intersecting the plumb-lines by horizontal ones; but even this resource has its inconveniences; since the squares formed by transversal lines that are at a distance from the figure (though they are exactly equal), yet represent the parts of the figure as greater or smaller, according as they are more or less removed from our point of view.

Of sculpture in wood. A sculptor in wood should first take care to choose wood of the best quality, and the most proper for the work which he intends to execute. If he undertakes a large work, requiring strength and solidity, he ought to choose the hardest wood, and that which keeps best, as oak and chesnut; but for works of moderate size, pear or apple-tree serve very well. As even these latter woods are still of considerable hardness, if the work consists only of delicate ornaments, the artist will find it preferable to take some more tender wood, provided it is at the same time firm and close: as, for instance, the Indian tree, which is excellent for this purpose, as the chisel cuts it more neatly and easily than any other wood.

The ancients made statues out of almost every different kind of wood. At Sicyon was a statue of Apollo, made of box; the statue of Diana at Ephesus, was of cedar. As these two sorts of wood are extremely hard and undecaying; and as cedar, in particular, is of such a nature, that, according to Pliny, it ought never to come to an end; the antients preferred them for the images of their divinities.

In the temple built on mount Cyllene in honour of Mercury, Pausanias relates, that there was a statue of that god made of citron-wood, eight feet in height. This wood was also much esteemed.

The cypress likewise, being a wood not apt to spoil, nor to be damaged by worms, was also used for statues; as were the palm-tree, olive, and ebony, of which latter, according to Pliny's account, there was another statue of Diana at Ephesus.

Several other kinds of wood were equally employed for this purpose, even the vine, of which the same author says, there were statues of Jupiter, Juno, and Diana.

Felibien speaks of a French artist at Florence, of the name of Janni, who executed several statues in wood, in a style of finishing equal to marble, and particularly one of St. Rocque, which Vasari considered as a marvellous production.

The beauty of sculpture in wood consists in the tender manner of cutting the wood, free from all appearance of hardness or dryness.

For any work of large dimensions, even though it consists of a single figure, it is better to join together several smaller pieces of wood than to make the whole of a single large piece; which is more able to warp and crack, on account of its not being always dry at heart, although it appears perfectly dry on the outside.

No wood can be properly fit for works of this kind, that has not been cut at least ten years before.

The tools used for sculpture in wood, are the same as those of the joiner or cabinet-maker.

Of sculpture in stone and marble. For sculpture in marble and other stone, the artist must make use of tools of good steel, well tempered, and of strength proportioned to the hardness of the material.

The first thing to be done is, to saw out from a larger block of marble, a block proportioned to the size of the work which is undertaken. After this, the sculptor shapes the gross masses of the forms he designs to represent, by knocking off the superfluous parts of marble with a strong mallet or beel, and a strong steel tool called a point.

When the block is thus hewn out agreeably to the measures previously taken for the performance of the work, the sculptor brings it nearer to the intended form by means of a finer point; and sometimes of a tool called a dog's tooth, having two points, but less sharp than the single one.

After this he uses the gradine, which is a flat cutting tool, with three teeth, but is not so strong as the point.

Having advanced his work with the gradine, he uses the chisel to take off the ridges left by the former tools; and by the dexterous and delicate use of this instrument, he gives softness and tenderness to the figure, till at length, by taking a rasp, which is a sort of file, he brings his work into a proper state for being polished.

Rasps are of several kinds, some straight, some curved, and some harder or softer than others.

When the sculptor has thus far finished his work with the best tools he can procure, wherever certain parts or particular works require polishing, he uses pumice-stone to make all the parts smooth and even. He then goes over them with tripoli, and when he would give a still higher gloss, he rubs them with leather and straw-ashes.

Besides the tools already mentioned, sculptors use also the pick, which is a small hammer pointed at one end, and at the other formed with teeth made of good steel and squared, to render them the stronger. This serves to break the marble, and is used in all places where the two hands cannot be employed to manage the mallet and chisel.

The bouchard, which is a piece of iron, well steeled at the bottom, and formed into several strong and short points like a diamond, is used for making a hole of equal dimensions, which cannot be done with cutting tools. The bouchard is driven with the mallet or beetle, and its points bruise the marble and reduce it to powder. Water is thrown into the hole from time to time, in proportion to the depth that is made, to bring out the dust of the marble, and to prevent the tool from heating, which would destroy its temper; for the free-stone dust on which tools are edged, is only moistened with water to prevent the iron from heating and taking off the temper of the tool by being rubbed dry; and the trepans are wetted for the same reason.

The sculptor uses the bouchard to bore or pierce such parts of his work as the chisel cannot reach without danger of spoiling or breaking them. In using it, he passes it through a piece of leather, which leather covers the hole made by the bouchard, and prevents the water from spirting up in his face.

The other tools necessary for sculpture on marble or stone, are the roundel, which is a sort of rounded chisel; the hougnet, which is a chisel squared and pointed; and various compasses to take the requisite measures.

The process of sculpture in stone is the same as in marble, excepting that the material being less hard than marble, the tools used are not so strong, and some of them are of a different form, as the rasp, the hand-saw, the ripe, the straight chisel with three teeth, the roundel, and the grater.

If the work is executed in free-stone, tools are employed which are made on purpose, as the free-stone is apt to scale, and does not work like hard stone or marble.

Sculptors in stone have commonly a bowl in which they keep a powder composed of plaister of Paris, mixed with the same stone in which their work is executed. With this composition they fill up the small holes, and repair the defects which they meet with in the stone itself.

HISTORY OF SCULPTURE.

Antient art.

The art of sculpture is of such immemorial antiquity, that it has been by some conceived to have had its being from eternity; but without regarding it in this exalted light, St. Augustin has attributed a date to its invention as early as the time of the Protoplast, our common father Adam, who, he affirms, was the inventor of letters. Sculpture, therefore, may trace its pedigree from the infancy of the world, and contend for pre-eminence with the most remote antiquities which it has been employed to celebrate. Josephus, Cedrenus, and some other authors, make mention of some antediluvian sculptures in stone and brick erected at Joppa, which are imagined to have contained the system of sidereal and celestial sciences, and to have remained unhurt for some thousands of years after the universal cataclysm.

Cham, who is supposed to be the same as Zoroaster, is spoken of by the author of the scholastic work on Genesis, as having engraved the liberal arts on fourteen columns, seven of brass, and seven of brick. Serenus also mentions the same circumstance, with this variation, that he says they were engraved on plates of different metals (diversorum metallorum laminis).

Concerning the art of sculpture immediately after the Flood, it is scarcely to be questioned that it was transmitted by Noah to his descendants. About three hundred years after the Deluge, Mercurius Trismegistus reports of himself, that he engraved his most abstruse mysteries on stone, reforming all that had been depraved by Cham. Some of these records were in letters, some in figures and enigmatical characters, probably not unlike to those contained in the stupendous obelisks erected by Misra, the first Egyptian Pharaoh, about four hundred years (according to Kircher) before Moses.

The first mention that is made of the art of sculpture in the writings of Moses, is in the book of Genesis, where we are informed that when Jacob, in obedience to the divine command, was returning to Canaan, his wife Rachel carried along with her the theraphim, or idols, of her father's house. These must certainly have been very small images, since Rachel found it so easy to conceal them from her father, notwithstanding his anxious search; but we are ignorant in what form they were made, or of what materials they were composed. The first persons mentioned in the Bible as artists, are Aholiab and Bezaleel, who formed the cherubim which covered the mercy-seat, and wrought the ornaments of the pectoral to be worn by the high priest.

As Chaldea, therefore, was the first peopled region of the earth after the Flood, and as it appears from various accounts that the art of engraving upon bricks baked in the sun was there carried to a considerable degree of perfection at a very early period, it appears highly probable that the Chaldeans derived the rudiments of the art of sculpture immediately from their antediluvian ancestors.

The origin of idolatrous worship is generally thought to be derived from images first made to preserve the memory of the dead, and, in process of time, converted by the flatterers of great men into objects of adoration. This also affords presumptive evidence that the Chaldeans were the first who invented the art of hewing blocks of wood and stone into the figures of men and other animals; for the Chaldeans were unquestionably the first idolaters, and their early progress in sculpture is confirmed by the united testimonies of Berosus, Alexander, Polyhistor, Apollodorus, and Pliny.

Against this conclusion some plausible arguments have been urged on the authority of a theory established by a French writer, who maintains that in the year of the world 1949, about 300 years after the Deluge, the Scythians under Brouma, a descendant of Magog, extended their conquests over the greater part of Asia; and that Brouma was not only the civilizer of India, and the author of the Braminical doctrines, but also diffused the principles of the Scythian mythology over Egypt, Phœnicia, Greece, and the continent of Asia.

Leaving the consideration of this question, as too extensive for our present purpose, we shall endeavour to trace the progress of the art of sculpture through some other nations of antiquity, till we bring it to Greece, where it was carried to the highest perfection to which it has yet attained.

Phœnicia, in the immediate vicinity of Chaldea, must necessarily have very early acquired a knowledge of sculpture. The Phœnicians possessed both a character and situation highly favourable to the cultivation of this art. They beheld the most beautiful models in their own persons, and their industrious character qualified them to attain perfection in every art for which they had a taste. But as their situation raised a spirit of commerce, it is at all times questionable whether commerce induced them to cultivate the arts. Their temples shone with statues and columns of gold, and a profusion of emeralds were every where scattered; but the beauties of art do not consist in finery or ostentation of wealth. The greatest works of the Phœnicians have been unfortunately destroyed; many Carthaginian models indeed are still preserved, ten of which were deposited in the cabinet of the grand duke of Florence. But though the Carthaginians were a colony of Phœnicians, we should probably deduce from their works a very unfair estimate of the merit of their ancestors.

Very high pretensions to antiquity of every kind are made by the Persians; but we do not find that they ever made any distinguished figure in either of the arts of sculpture or painting. They were indeed sensible to the charms of beauty, but they did not study to imitate them. Their dress, which consisted of long flowing robes, concealing the whole person, prevented them from attending to the beauties of form. Their religion too, which taught them to worship the divinity in the emblem of fire, and that it was impious to represent him under a human form, seemed almost to prohibit the exercise of this art, by taking away the strongest incentives to art during the reign of superstition; and as it was not customary among them to raise statues to great men, it was impossible that statuary could flourish in Persia

The Persians, however, represented in their bas-reliefs many symbolical expressions of the powers of the Divinity, as well as of their religious ceremonies or heroic achievements. The bas-reliefs on the palace of Persepolis and the tombs of the Persian sovereigns, are arranged in horizontal and perpendicular lines, answering the double purpose of description and architectural decoration. The style of drawing in these bas-reliefs resembles that of later hieroglyphics, except in the dresses of the figures, which are different from those either of the Egyptians or Hindoos. The Persians are represented with long beards and ringlets, caps, full tunics, with regular folds and large sleeves. The Medes, in the same ruins of Persepolis, have close tunics. The drapery in these bas-reliefs is superior to that of the Egyptians, as bearing a greater resemblance to nature.

In Hindostan and Egypt the art of sculpture has been exercised in a similar manner in the shaping or adorning large rude masses of the hardest materials, and the works of these two nations may not improperly be considered together. The reader will find some accounts of their sculpture under the article ANTIQUITIES.

In India, bas-reliefs have been found in great numbers in the caves of Ellora and Elephantis: the subjects are religious. The drawing of the figures bears a strong resemblance to the Egyptian style, but they are less correct in their forms, the heads being generally very large, and the limbs disproportioned to the bodies. It may be questioned, from the greater simplicity of execution, whether the Egyptian hieroglyphics are not also more antient than the Hindoo; the ground in the former being level with the highest relievo, and in the latter cut down to the lowest outline of the figure.

The character and style of design among the Egyptians have been more fully noticed by writers, because the first progress of the art among that people is conceived to elucidate that of most other antient nations.

In the Egyptian idols, composed of parts of different animals, each part appears to have been distinctively studied from nature. In the human figure, the body and limbs were represented by general forms: the face, as being the most interesting part, was more minutely expressed. The form of a face was a rounded egg; the lines of the eye-brows and lids were simple curves, inclining upwards from the nose; and the bottom of the nose and the line of the mouth were also in a similar direction. The eyes were full, nearly on a level with the forehead and cheeks, and the lines of the eye-brows, lids, and borders of the lips, marked with precision. The chin appears small and bony, the neck round, the shoulders high and broad, and the muscles of the breast are almost the only ones that are distinguished in the whole body. The loins are narrow, the limbs in general round and slender, the joints slightly indicated, the hands and feet flattish, and the fingers and toes rounded without any appearance of joints, and nearly of the same length. This, with the allowance of some national peculiarities of form, may serve for the description of early sculpture in general among the antients.

The quadrupeds on Egyptian monuments are represented in profile, and in the simplest attitudes. The Egyptians excelled more in these than in the human figure; but the anatomy of these also is insufficient and incorrect. The lion and the sphinx are particularly to be noticed in their works.

The larger Egyptian hieroglyphics (whether engraven on the surface of their architecture, or on the forms of animals), in which the figure is cut or sunk, in such a manner that the surface of the ground is level with its highest projection, may be considered as a species of bas-relief, more simple, and consequently more antient, than any other. The greater part of their temples, and other public edifices, were covered with hieroglyphics, or sacred figure-writing, in this kind of bas-relief; the largest of which formed regular ornaments in the friezes, centres over the doors, and other architectural parts.

Besides the hieroglyphics, the Egyptians worked in bas-relief, with the ground levelled to the lowest part of the figures. In these they represented the great actions of their heroes, as may be seen in the palace of Karnac, engraved by Denon, and in those described in the Bird's Well, of which there is a specimen in the hall of the British Museum.

Winckelmann thought he discovered two different styles of Egyptian sculpture, which prevailed at different periods. The first of these ends with the conquest of Egypt by Cambyses. The second begins at that time, and extends beyond the reign of Alexander the Great. In the first style, the lines are straight, or projecting very little; the position is stiff and unnatural. In sitting figures, the legs are parallel, the feet squeezed together, and the arms fixed to the sides; but in the figures of women, the left arm is folded across the breast. The forms of the head and body are such as have been already described. The statues of men are naked, excepting only that they have a short apron, and a few folds of drapery surrounding their waist. The vestments of women are only distinguishable by the border which rises a little above the surface of the statue. In this age it is evident the Egyptians knew little of drapery.

Of the second style of sculpture practised among the Egyptians, Winckelmann found specimens in the two figures of basaltes in the capitol, and in another figure in the Villa Albani, the head of which has been restored. The two first of these, he remarks, bear visible traces of the former style, which appear especially in the form of the mouth and shortness of the chin. The hands possess more elegance; and the feet are placed at a greater distance from one another than was customary in more antient times. In the first and third figures the arms hang down close to the sides. In the second they hang more freely. Winckelmann suspects that these three statues were made after the conquest of Egypt by the Greeks. They are clothed with a tunic, a robe, and a mantle. The tunic, which is pleated in numerous folds, descends from the neck to the ground. The robe in the first and third statues appears to be every where close to the body, and is only perceptible by some little folds. It is tied under the breast, and covered by the mantle, the two buttons of which are placed under the epaulet.

The Antinous of the capitol is composed of two pieces, which are joined under the haunches; but as all the Egyptian statues which now remain have been hewn out of one block, we must believe that Diodorus, in saying the stone was divided, and each half finished by a separate artisan, spoke only of a Colossus. The same author informs us that the Egyptians divided the human body into 24¼ parts; but it is to be regretted that he has not given a more minute detail of that division.

The Egyptian statues were not only formed by the chisel; they were also polished with great care. Even those on the summit of an obelisk, which could only be viewed at a distance, were finished with as much labour as if they had admitted a close inspection. As they are generally executed in granite or basaltes, stones of a very hard texture, it is impossible not to admire the indefatigable patience of the artists.

The eyes were often of different materials from the rest of the statue; sometimes they were composed of precious stones or metal. We are assured that the valuable diamond of the empress of Russia, the largest and most beautiful hitherto known, formed one of the eyes of the famous statue of Scheringham in the temple of Brama.

After the Egyptian works of art, the most antient are those of the Etrurians or antient Tuscans, who, in the opinion of the same learned writer Winckelmann, made advances in sculpture at an earlier period than the Greeks. The art is said to have been introduced among them before the siege of Troy, by Dedalus; who, in order to escape the resentment of Minos, king of Crete, took refuge in Sicily, from whence he passed into Italy, where he left many monuments of his art. Pausanias and Diodorus Siculus inform us, that some works ascribed to him were to be seen when they wrote, and that these possessed that character of majesty by which the Etrurian sculpture was afterwards distinguished.

A character strongly marked forms the chief feature of those productions of Etruria which have descended to us. Their style was indeed harsh and overcharged; for it is not to be supposed that a people of such rude manners as the Etrurians could communicate to their works that refinement and beauty which the elegance of Grecian manners inspired. On the other hand, there are many of the Tuscan statues which bear so close a resemblance to those of Greece, that antiquarians have thought it probable that they were conveyed from that country or Magna Grecia into Etruria, about the time of the Roman conquest, when Italy was adorned with the spoils of Greece.

Among the monuments of Etrurian art, two different styles have also been observed. In the first the lines are straight, the attitude stiff, and the shape of the head without beauty. The general form of the figure is likewise too slender: the head is oval, the chin peaked, the eyes flat, and looking obliquely.

All these are evidently the defects of an art in a state of infancy, and some of them are equally conspicuous in the early statues of all nations. The style of the Etrurian sculpture is so similar to that of the Egyptians, that one is almost induced to suppose that there had once been a communication between these two nations; but the introduction of this style by Dedalus is generally credited.

Winckelmann supposes that the second epoch of the art commenced in Etruria about the time at which it had reached its greatest perfection in Greece, in the age of Phidias; but this conjecture is not supported by any proofs. To describe the second style of sculpture among the Etrurians, is almost the same as to describe the style of the modern restorers of the art in Tuscany. The joints are strongly marked, the muscles raised, the bones distinguishable, but the whole appearance is harsh, particularly in the representation of ordinary life. The statues of the gods are designed with more delicacy. In forming them the artists were anxious to show that they could exercise their power without that violent distension of the muscles which they conceived necessary in the exertions of beings merely human; but in general their attitudes are unnatural, and the actions strained. If a statue, for instance, holds any thing with its fore fingers, the rest are stretched out in a stiff position.

Greece. The earliest examples of Grecian sculpture remind us still more of the Egyptian, in the principles of design, than those of any other nation. The face of the human figure has the same kind of oval, the features are described by the same curves, the eye full, and the body and limbs represented nearly in the same general forms. The works of the early Greeks may, however, be justly said to be equal to the Egyptians in the proportions of their figures, and superior in the drawing of the body and limbs.

It is probable that sculpture preceded the use of letters in Greece, as in other nations; but the small bronze figures with inscriptions on them in Cadmean letters, are such weak and barbarous resemblances of the human form, that it is needless to trace its origin in any more remote period.

The Grecians began very early to study the proportions of the human form. Vitruvius informs us that "as the height of the human figure was six times the length of the foot, that was made the rule of proportion for the Doric column." Their knowledge, therefore, in this part of art, was antecedent to their architectural proportions.

Whether Greece received the principles of the arts from Egypt and Phœnicia, or, as they asserted, were the original inventors of them, it is certain that the native genius of the Grecians, combined with other peculiarly favourable circumstances, very soon raised sculpture from a state of barbarism.

In the earliest æra of sculpture in Greece, schools of design were established in the island of Ægina, at Corinth, and at Sicyon. This last city was styled the mother of the arts, as Diapænus and Scillides, and their disciples also, had flourished there; and after seven generations, Aristocles, the brother of Canacus, likewise a sculptor of eminence, presided over the same establishment with undiminished fame. The school of Ægina traced its origin to Dedalus, of fabulous renown: and his cotemporary Smilis made two statues of Juno; one for her temple at Samos, and the other for that at Argos.

From these auspicious dawnings of the art of sculpture, three distinct schools arose, one of which was peculiar to Ionia; the others were in Greece, at Athens, and at Sicyon, each of them shining with nearly equal splendour for several ages.

At the head of the first Grecian artists, stands Myron, whose statues in bronze attracted universal admiration. A Discobulus made by Myron, is particularly noticed by Quinctilian.

Phidias, whose name is better known in the present day than that of any other sculptor, was the disciple of Eladas and Ageladas, the probable cotemporaries of Myron, and who flourished in the sixteenth olympiad. We collect from Quinctilian, that he excelled in imparting a celestial dignity to his figures of the deities, two of which are celebrated in this respect, the Minerva at Athens, and Jupiter Olympius at Elis. Many of his most beautiful works were in ivory, frequently less than the natural size. He cast likewise in bronze.

In the same age lived Polycletus, whose works were distinguished by exquisite grace and most correct finishing: the latter quality was the effect of his singular diligence. To the human figure he is said to have given more than human beauty, but he failed in expressing the majestic character of the gods.

The works of Egesias were of a sublime style, but hard manner.

Of the school of Phidias, the most distinguished sculptors were Alcamenes of Athens, and Agoracritus of the island of Paros. Their rival skill was exerted in finishing a statue of Venus, and the palm was adjudged by the Athenians to their own citizen.

Polycletus of Sicyon was the competitor with Phidias in an undertaking of more grandeur and consequence than his general works. He was employed by the inhabitants of Argos to make a colossal statue of Juno, composed of gold and ivory, in order to emulate, rather than to imitate, the Olympic Jupiter of Phidias. Two figures in bronze by Polycletus representing the canephoræ or nymphs bearing in baskets the symbols of Ceres to a sacrifice, were taken from the Thespians by Verres, and brought to Rome. They were esteemed beyond any bronze figures existing at that time. Such was the skill of this eminent master, that he completed so perfect a human figure that it served as a model to his successors, and was considered by Lysippus as the acme of his art.

While Phidias in gold and ivory, and Polycletus in bronze, engrossed to themselves every excellence, Scopas acquired a scarcely inferior celebrity for his statues in marble. The groupe of Niobe and her children is attributed by Pliny to Scopas or Praxiteles, he does not decide which.

The last sculptor (of whose works we have any knowledge) coeval with Phidias, was Ctesilaus, who, jointly with him and Polycletus, finished one of the three Amazons designed to decorate the temple of Diana at Ephesus, and the statue of Pericles, commended by Pliny, who allows to Ctesilaus the felicity of giving to his heroes a still more noble air than they possessed.

The names of Policles, Cephisodorus, Leochares, and Hippodotus, are preserved from oblivion by Pliny, but none of their works remain. Leochares was one of the four artists employed in adorning the mausoleum built by the celebrated Artemisia, queen of Caria, to the memory of her husband.

Menestratus, Socrates, Philiscus, Lysias, Mirmecides, and many others, are also spoken of with praise by various writers; but we have unfortunately no other remaining testimonies of their merits.

Of the first style of the Grecian sculptors, so remarkable for simplicity and grandeur, the æra was circumscribed to the limits of fifty years, during which period the art had arrived at its meridian of sublimity. The succeeding age introduces Praxiteles, who may be called the father of the second manner, and whose works were discriminated by their flowing outline and delicate finishing. The elevation of Thebes by Epaminondas above the other states of Greece, produced a complete change in her whole system; but as soon as the Athenians recovered their former splendour, the arts, which had ever accompanied the vicissitudes of her fortunes, revived with unabated splendour. The works of Praxiteles are celebrated by historians and poets. His Venus of Gnidus in marble, attracted then no less admiration than the Medicean Venus has done in the modern world; and his Apollo in bronze, called (from the lizard in the trunk of the tree against which he leans) Sauroctonos, is still among the most admired productions of sculpture.

Not long after Praxiteles had signalized himself in statuary, and particularly in bronze, Lysippus appeared, whose great merit consisted in following nature more scrupulously than any of his immediate predecessors. If, as Pliny reports, his works were so numerous as to amount to not less than fifteen hundred, we have the more cause to regret that they were all of bronze, and are irretrievably destroyed. He flourished under the reign of Alexander.

To Agesander, Polydorus, and Athenodorus, is ascribed (by Pliny) the celebrated group of the Laocoon and his sons, and conjecture has been frequently busied in endeavouring to discriminate the particular portion of each artist; but conjecture only has hitherto been produced. Abbé Winckelmann conjectures that Agesander was the father of the other two artists, and that he himself finished the statue of Laocoon, leaving the children to be wrought by his sons.—"Credat Judæus apella." No authentic document remains by which the time in which these artists flourished can be ascertained.

Neither do we know the precise date of Apollonius and Tauriscus, the authors of a no less celebrated group representing Dirce tied to the horns of a bull (in order to be precipitated into the sea) by Zethus and Amphion, the sons of Antiopa. This work is generally supposed to have been cotemporary with the rival group of Laocoon. In an inscription on it, now obliterated, was traced the name of another artist, Menecrates. This vast mass of sculpture is said to have been formed out of a single block, in the island of Rhodes. It has suffered greatly in the course of time.

Greece, after the death of Alexander the Great, lapsing into a state of dependance little better than slavery, the arts were for a time wholly neglected; and might have been nearly annihilated, had they not found refuge in Asia, under the patronage of the Seleucidæ. Men of talents also in every profession, sought at that time in Egypt the encouragement afforded them by Ptolemy Soter, who exhibited a munificence worthy of Alexander, his predecessor in that kingdom. But when the Roman consul, Quintus Flaminius, proclaimed, at Corinth, universal liberty to Greece (about a hundred and ninety-four years before Christ), the public tranquillity, consequent on that event, renewed the spirit of the arts, and introduced another of their most memorable æras.

Callistratus, Athenæus, and Policles, were immediately at this period the most renowned masters of sculpture. Policles distinguished himself by the statue of the Hermaphrodite, so long admired in the Borghese Villa at Rome.

To Apollonius the Athenian, at the same period, is attributed the wonderful Torso of the Hercules, preferred by the judgment of Michael Angelo beyond the most perfect statues of Rome.

Causes of the excellence of sculpture among the Greeks.

The great superiority of the Greeks in the art of sculpture, may be ascribed to a variety of causes. Their love of beauty was so great, that the Lacedemonian women kept in their chambers the statues of Nereus, of Narcissus, of Hyacinthus, and of Castor and Pollux; hoping that by often contemplating them, they might have beautiful children.

The noble and virtuous freedom of the Grecian manners likewise contributed in a more peculiar degree to the cultivation of the fine arts. There were no laws, as among the Egyptians, to check their progress. The artist had the best opportunities to study them in the public places, where the youth, who needed no other veil than chastity and purity of manners, performed their various exercises quite naked.

The strongest motives were also held forth for the cultivation of sculpture, for a statue was the highest honour which public merit could attain. It was an honour ambitiously sought, and granted only to those who had distinguished themselves in the eyes of their fellow-citizens. As statues were often raised to those who excelled in the public exercises, the most eminent men of Greece, in their youth, sought renown in the gymnasia. Here Chrysippus and Cleanthes distinguished themselves before they were known as philosophers. Plato appeared as a wrestler both at the Isthmian and Pythian games; and Pythagoras carried off the prize at Elis. The number of statues erected on different occasions was immense; of course, the number of artists must have been great, their emulation ardent, and their progress rapid. Moreover, at these public games, the artists could not fail of seeing the most excellent models; for those who surpassed in running, boxing, and wrestling, must not only, in general, have been well formed, but would exhibit different kinds of beauty.

The high estimation in which sculptors were held, was also very favourable to their art. An artist could be a legislator, a commander of armies, and might hope to have his statue placed at the side of those of Miltiades and Themistocles, or those of the gods themselves. The productions of art were estimated and rewarded by the general assembly of Greece; and the sculptor who had executed his work with ability, was confident of obtaining immortality.

Character of Grecian sculpture.

Winckelmann has assigned four different styles to this art among the Greeks. The antient style, which continued until the time of Phidias; the grand style, formed by that celebrated statuary; the beautiful, introduced by Praxiteles, Apelles, and Lysippus; and the imitative style practised by those artists who copied the works of the antient masters.

The most authentic monuments of the antient style have been already described. The statues formed in this style were neither distinguished by beauty of shape, nor by proportion, but bore a close resemblance to those of the Egyptians and Etrurians. The eyes were long and flat; the section of the mouth not horizontal; the chin was pointed; the curls of the hair were ranged in little rings, and it was impossible by inspecting the head to distinguish the sex.

The character of the antient style was energetic, but harsh; it was animated, but without gracefulness; and the violence of the expression deprived the whole figure of beauty.

The grand style was brought to perfection by Phidias, Polycletus, Scopas, Alcamanes, Myron, and other illustrious artists. It is probable, from some passages of antient writers, that in this style were preserved some characters of the antient manner, such as the straight lines, the squares, and angles. The antient masters, such as Polycletus, being the legislators of proportion, says Winckelmann, and of consequence thinking they had a right to distribute the measures and dimensions of the parts of the human body, have undoubtedly sacrificed some degree of the form of beauty to a grandeur which is harsh, in comparison of the flowing lines and graceful forms of their successors. The most considerable monuments of the grand style, are the statues of Niobe and her daughters; and a figure of Pallas, to be seen in Villa Albani; which, however, must not be confounded with another statue, modelled according to the first style, and also found in the same place; the head of which possesses all the characters of dignified beauty, at the same time exhibiting the rigidness of the antient style. The figures of Niobe and her daughters have not, in the opinion of Winckelmann, that austerity of appearance which marks the age of the last-mentioned statue of Pallas. They are particularly characterised by grandness and simplicity.

The third style was the graceful or beautiful. Lysippus was, perhaps, the artist who introduced this style. Being more conversant than his predecessors with the flowing and beautiful lines of nature, he avoided the square forms which the masters of the second style had too frequently admitted. He was of opinion that the art ought rather to please than to astonish, and that the aim of the artist should be to raise admiration by giving delight. The artists who cultivated this style, did not, however, neglect to study the sublime works of their predecessors. They knew that grace is consistent with the most dignified beauty; and that while it possesses charms which must ever please, those charms are enhanced by dignity. Grace is inspired into all the movements and attitudes of their statues. It appears in the delicate turn of the hair, and even in the adjusting of the drapery.

The last, or imitative style, is of an inferior degree of excellence to that which has just been mentioned. The great reputation of Praxiteles and Apelles raised an ardent emulation in their successors, who, despairing to surpass such illustrious masters, were satisfied with imitating their works.

Every species of beauty of form appears to have been well known to the antients; and great as the ravages of time have been amongst the works of art, specimens are still preserved in which can be distinguished dignified beauty, attractive beauty, and a beauty peculiar to tender age. A specimen of dignified beauty may be seen in the statue of one of the muses in the palace Barberini at Rome, and in the garden of the pope. On the Quirinal is a statue of another muse, which affords a fine instance of attractive beauty. Winckelmann says that the most excellent model of infant beauty which antiquity has transmitted to us, is a satyr of a year old, which is preserved, though a little mutilated, in the Villa Albani.

Nor were the sculptors who represented with such success the most perfect beauty of the human form, regardless of the drapery of their statues. They clothed their figures in the most proper stuff, which they wrought into that shape which was best calculated to give effect to their design.

The vestments of women in Greece generally consisted of linen cloth, or some other light stuff, and in latter times of silk, and sometimes of woollen cloth. They had also garments embroidered with gold. In the works of sculpture, as well as in those of painting, one may distinguish the linen by its transparency and small folds. The other light stuffs which were worn by the women, were generally of cotton, sometimes striped, and sometimes embellished with a profusion of flowers. Silk was also employed; but whether it was known in Greece before the time of the Roman emperors, cannot easily be determined.

The vestments of the Greeks, which deserve particular attention, are the tunic, the robe, and the mantle.

The tunic was that part of the dress which was next to the body. It may be seen in the Flora Farnese, and in the statues of the Amazons in the capitol. The youngest of the daughters of Niobe, who throws herself into her mother's arms, is clothed only with a tunic. It was of linen, or some other light stuff, without sleeves, fixed to the shoulders by a button, so as to cover the whole breast. None but the tunics of the goddess Ceres, and of comedians, have long straight sleeves.

The robes of women commonly consisted of two long pieces of woollen cloth, without any particular form, attached to the shoulders by a great many buttons, and sometimes by a clasp. They had straight sleeves, which came down to the wrists. The young girls, as well as the women, fastened their robe to their side by a cincture, fastened on the side in a knot, as it is still done in many parts of Greece; a knot of ribbons sometimes resembling a rose in shape, which has been particularly remarked in the two beautiful daughters of Niobe. In the younger of these, the cincture is seen passing over the shoulders.

and the back. Venus has two cinctures, the one passing over the shoulder, and the other surrounding the waist. The latter is the cestus so celebrated by the poets.

The mantle was called peplon by the Greeks, which signifies properly the mantle of Pallas. The name was afterwards applied to the mantles of the other gods, as well as to those of men. This part of the dress was not square, as some have imagined, but of a roundish form. The antients, indeed, speak in general of square mantles, but they received this shape from four tassels which were affixed to them: two of these were visible, and two were concealed under the mantle. The mantle was brought under the right arm, and over the left shoulder: sometimes it was attached to the shoulder by two buttons, as may be seen in the beautiful statue of Leucothoe at Villa Albani.

With respect to the head, women generally wore no covering but their hair; when they wished to cover their head, they used the corner of their mantle. Sometimes we meet with veils of a fine transparent texture. Old women wore a kind of bonnet upon their head, an example of which may be seen in a statue in the capitol, called the Præsica; but Winckelmann thinks it is a statue of Hecuba.

The covering of the feet consisted of shoes or sandals. The sandals were generally an inch thick, and composed of more than one sole of cork. Those of Pallas in Villa Albani have two soles, and other statues had no less than five.

But in no part of art are the Grecian sculptors more eminently excellent than in the general characteristic expression which they gave to their figures.

The most elevated species of tranquillity and repose was studied in their figures of the gods. The father of the gods, and even inferior divinities, are represented without emotion or resentment. But Jupiter is not always exhibited in this tranquil state. In a bas-relief belonging to the marquis Rondini, he appears seated with a melancholy aspect. The Apollo, once called of the Belvedere, in the Vatican, represents the god in the act of discharging from his bow the mortal shaft against the serpent Python.

To express the action of a hero, the Grecian sculptors delineated the countenance of a noble virtuous character repressing his groans, and allowing no expression of pain to appear.

Philoctetes is introduced by the poets shedding tears, uttering complaints, and rending the air with his groans and cries; but the artist exhibits him silent, and bearing his pains with dignity; in the same manner as the Ajax of the celebrated painter Timomachus was not drawn in the act of destroying the sheep which he took for the Grecian chiefs, but in the moments of reflection which succeeded that frenzy.

Illustrious men, and those invested with offices of dignity, are represented with a noble assurance and firm aspect. The statues of the Roman emperors (executed by Greek artists) resemble those of heroes, and are far removed from every species of flattery, in the gesture, in the attitude, and action. They never appear with haughty looks, or with the splendour of royalty. None but captives are ever represented as offering any thing to them with bended knee.

The Greek works of ivory and silver were not always of a small size. The colossal Minerva of Phidias, which was composed of these materials was twenty-six cubits high. It is indeed scarcely possible to believe that statues of such a size could entirely consist of gold and ivory. The quantity of ivory necessary to a colossal statue is beyond conception. M. de Pauw calculates, that the statue of Jupiter Olympus, which was 54 feet high, would consume the teeth of 300 elephants.

The Greeks generally hewed their marble statues out of one block, though they afterwards worked the heads separately, and sometimes the arms. The heads of the famous group of Niobe and her daughters appear to have been adapted to their bodies after being separately finished. It is proved by a large figure representing a river, which is preserved in Villa Albani, that the antients first hewed their statues roughly, before they attempted to finish any part. When the statue had received its perfect figure, they next proceeded to polish it with pumice-stone, and again carefully retouched every part with the chisel.

The antients, when they employed porphyry, usually made the head and extremities of marble. It is true, that at Venice there are four figures entirely composed of porphyry; but these are the productions of the Greeks of the middle age. They also made statues of basaltes and alabaster.

The antients, as well as the moderns, made works in plaister; but no specimens remain, except some figures in bas-relief, of which the most beautiful were found at Baiæ, near Naples.

We have been thus minute in our account of the Grecian sculpture, because it is the opinion of the ablest critics, that modern artists have been more or less eminent, as they have studied with the greater or less attention the models left us by that ingenious people. Winckelmann goes so far as to contend, that the most finished works of the Grecian masters ought to be studied in preference even to the works of nature. The reason assigned by the abbé for his opinion is, that the fairest lines of beauty are more easily discovered, and make a more striking and powerful impression, by their reunion in these sublime copies, than when they are scattered far and wide in the original of nature. Allowing, therefore, the study of nature the high degree of merit it so justly claims, it must nevertheless be granted, that it leads to true beauty by a much more tedious, laborious, and difficult path, than the study of the antique, which presents immediately to the artist's view the object of his researches, and combines in a clear and strong point of light the various rays of beauty that are dispersed through the wide domain of nature. But this reasoning is too paradoxical to be admitted, without great allowances for the peculiar creed of the writer.

Decline of Greek sculpture.

When the restless genius of the Grecians, and the aggressive spirit of the Romans, conspired to the second thraldom of the Greek states, and L. Mummius was directed to lay siege to Corinth, the capture of a city so famed as the repository of all that was most perfect in the arts, provoked the avarice of the conqueror; who, by transporting many of the most superb works of taste to Rome, to grace his triumph, excited in his fellow-citizens so insatiable an ardour of possessing treasures of the same kind, as totally transferred the seat of the arts from Athens to the growing metropolis of the world.

Sicyon, at the same period, had been ravaged by M. Scaurus, and Sparta by Muræna and Varro: and Greece began thus to be exhausted of all it once boasted in art. Nor was the fate of the arts in Egypt more auspicious; whence, after the defeat of the Seleucidæ, they took refuge in the court of Attalus; but their security was there of short duration. On the death of Attalus, his territory devolved to the Romans; and the treasures of sculpture which adorned his palace, were also transferred to Rome.

Rome. After taking a view of the extinction of the arts in Greece, we may find some satisfaction in directing our minds to the introduction of them at Rome, and to the liberal encouragement which men of talents experienced even from their haughty and rapacious conquerors.

Pasiteles, a name which has been confounded with Praxiteles, was a native of Calabria; and cast in silver a statue of Roscius, the celebrated actor, as an infant lying in a cradle, and entwined by a serpent, a situation of danger from which his nurse is said to have preserved him. Nearly about the same time, Archesilaus and Evander were in great request at Rome. Archesilaus was patronized by the profuse and wealthy Lucullus; and both these artists had gained celebrity by their works in chalk, modelled probably from the finest antiques, as well as being specimens of their own invention. A Venus, made for Julius Cæsar, and the restoration of a head of Diana for a statue, the original work of Timotheus, the contemporary of Scopas, by the command of Augustus, are noticed by Pliny as their work, and ascertain their æra, and their fame. Horace alludes to the superior style of Evander in bas-reliefs.

Among the monuments of sculpture made at Rome, in these last days of her republic, and certainly by Grecian artists, are the two statues of the Thracian kings, as prisoners at a triumph, in grey marble. These were kings of the Scordisci, a rude people, who were defeated by M. Licinius Lucullus. Exasperated by their repeated perfidy, he commanded their hands to be cut off, a circumstance of cruelty represented in the marble, which now remains in the museum of the capitol.

The statue of Pompey (now in the hall of the Spada palace, but originally standing in the curia or basilica of Pompey), at the base of which Cæsar fell, affords a singular proof of a deviation from the known custom of the Romans, who represented their living heroes in armour. But the great triumvir is sculptured as a deified hero, naked, and of colossal proportions.

Abbate Winckelmann, with great ingenuity, asserts the statue denominated Cincinnatus at Versailles, and another called Marcus Agrippa at Venice, to have been of an earlier æra than that of those celebrated Romans; and shews, with sufficient evidence, that the style in which they are executed is of a prior date.

We must now consider the arts as transplanted to Rome, although still professed, almost exclusively, by Greek sculptors. Julius Cæsar, who, while in a private station, had made an extensive collection of intaglios, and small figures in ivory and bronze; and who, when dictator, dedicated them as a public benefaction in the temple of Venus Genitrix; may be said to have left the love of the arts as an inheritance to the Romans.

Augustus, after he assumed the imperial government, dispatched Memmius Regulus to collect from every city of Greece the statues yet remaining in them. His orders were so well observed, that the finest pieces of sculpture were brought to Rome, with a profusion by which his palaces were crowded; and many were distributed in his numerous villas. The Olympian Jupiter, of Phidias, composed of gold and ivory, was almost the only statue that escaped; the artists of Greece asserting, that from the state of its materials, it would not bear removal.

Augustus encouraged also the prevailing mode of representing in statuary the most distinguished characters of the age, and placed many of their statues in public situations of eminence.

Succeeding emperors followed the example of Augustus. We are informed by Pausanias, that from the temple of Delphos only, five statues were transported to Rome by Nero, who also emplyed Zenodorus to cast a colossal statue of him in bronze 110 feet high.

Nero, however, indulged the perverseness of his taste in gilding, and otherwise disfiguring, many of these exquisite works.

The triumphal arch built by Titus, and the frieze in the temple of Minerva, built by Domitian, give a very favourable idea of the arts under those emperors.

In the sculpture of triumphal bas-reliefs and trophies, the artists were particularly eminent. The architectural plans adopted by Trajan were of such magnitude, that men of every kind of talents were invited to signalize themselves under his munificent patronage. His bridge over the Danube, his triumphal arch at Ancona, his forum including the column which now bears his name, appear to have given employment to all the powers of human skill.

Under the auspices of Hadrian, the successor of Trajan, the arts maintained a progressive degree of excellence. He was eminently accomplished, not only as an admirer, but was himself an artist. Every province in Greece enjoyed his munificence; and the temple of Jupiter at Athens, which he restored, and that of Cyzicum, on the shores of Propontis, which he built, were stupendous monuments of imperial splendour. Having for eighteen years been engaged in visiting the most distant parts of the Roman empire, he resolved to construct his villa at Tivoli; in which, not only exact models of the most celebrated buildings he had seen, should be erected, but that they should be furnished with originals, or the finest copies, of the most admirable statues. His correct judgment in all works of art contributed more to the absolute superiority of this collection, than the mere power of expending unlimited treasures to procure it.

It was by Hadrian that the fashion of having portraits in statuary was so generally extended amongst the noble and opulent citizens of Rome. In his own villa at Tivoli were placed, by his command, the statues and busts not only of all his living, but of his deceased, friends. Of his favourite Antinous, in various characters, there are infinite repetitions. That most valued was found on the Esquiline hill, and was placed by Leo X. in the Vatican: but it has lately been described as Mercury, by the abate Visconti. Another was found about 1770, in the Thermæ Maritimæ of Hadrian, near Ostia. It represents Antinous in the mythological character of Abundance, and is now in the collection of the Hon. J. Smith Barry, at Beaumont, in Cheshire.

Some curiosity will be excited to enquire the names of those artists who were so constantly employed, and so amply patronised, by Hadrian. Those only of Aristæus, Papias, and Zeno, occur on the plinths of fragments discovered amongst the Tiburtine ruins.

We are now advancing rapidly to the decline of sculpture among the Romans. Of the two Antonines, M. Aurelius appears to have been the greater friend of the arts. His equestrian statue in bronze in the area of the capitol, still defies the competition of the modern artists. This last epoch includes the reigns of Trajan, Hadrian, and the Antonines, and terminates within that of Commodus. It was most remarkable for the character and high-finishing of heads intended as portraits, particularly of the imperial busts, as of M. Aurelius, Commodus when young, and of Lucius Verus.

A statue, said to be of that degenerate monster Commodus, in the character of a young Hercules, is in the Belvedere; but the superior style of the hair is a decisive proof, according to the judicious Winckelmann, that it is a genuine Hercules of much higher antiquity.

But a far inferior state of sculpture, in which none of its pristine elegance could be traced, is apparent in the bas-reliefs of two triumphal arches, erected at Rome in the reign of Septimius Severus. The arts, however, cannot be supposed to have declined so suddenly from a scarcity of those persons who professed them; for many portraits in marble, both of this emperor and his favourite minister Plautianus, afford a convincing proof, that the sculptors were many, yet that the art was in decay.

The several authors who have pursued this inquiry with the most ample and critical investigation, are undecided in fixing the exact period of the extinction of the arts at Rome. Some allow no proofs of their existence later than the Gordians; and by others they are extended to the reign of Licinius Gallienus, in the 268th year of Christianity. Why the profession of the arts should, in a great measure, cease, several causes have been given; but the principal and most obvious one is, that when Constantine determined to establish at Byzantium another capital of the Roman world, he pillaged the old metropolis of its most valuable statuary, to embellish a rival city. Those cities of Greece also which were contiguous, supplied, of course, an easy prey. Implicit credit perhaps is not to be given to an author of such questionable veracity as Cedrenus; but from him we learn, that Constantine had collected the Olympic Jupiter of Phidias, the Gnidian Venus of Praxiteles, and a colossal Juno, in bronze, from her temple at Samos; not to detail more of his catalogue. These, according to Nicætas, were broken in pieces, or melted down, at the surrender of the Eastern empire, and its metropolis, in 1204, to the French and Venetians. The four bronze horses in the Duomo of St. Mark at Venice, were preserved from destruction, and transported in triumph.

From the reigns of the first Byzantine emperors, to the immediate successors of Theodosius, we may perceive a ray of their former genius still animating the Greek artists. The historical column of Arcadius rose in no very unequal emulation of those of Trajan and Antonine at Rome. But from many epigrams of the Anthologia, it is evident that able artists were to be found; and it may be candid to suppose, that such praise was not, in every instance, extravagant or unmerited. At the same time that Rome was laid waste by the Goths, the works in bronze by the artists at Constantinople were held in considerable estimation.

In the conclusion of his History of the Decline and Fall of the Roman Empire, the erudite Gibbon has given a perspicuous account of the causes to which the ruins of Rome may be ascribed.

During the fifteenth century, Petrarch and Poggius, the celebrated Florentine rhetorician and lawyer, very eloquently describe the dilapidation by which they were surrounded in their view of the imperial city, after many centuries of injury sustained from the Goths, the zeal of the primitive Christians, the civil wars of her own nobility, and the waste of materials, or the gradual decay of time.

Poggius asserts, that six perfect statues only remained, of all the former splendour of the mistress of the world. Four were extant in the baths of Constantine; the others were that now on the Monte-cavollo, and the equestrian statue of M. Aurelius. Of these, five were of marble; the sixth and last is of bronze.

Poggius was the first collector of antique statues; and from him the great Cosmo de Medici acquired a love of the arts, and learned to enrich his cabinet with their productions. His successors, with hereditary emulation, exerted every power of wealth and influence, to render that cabinet the envy of Europe.

An investigation of the remains of Roman grandeur, so long and sedulously pursued, was rewarded by frequent discoveries of the finest antique sculptures; and the artists of the modern schools established at the Florence, gave the first proofs of their ingenuity in restoring and adapting those precious fragments.

Many curious particulars relative to the discovery of antique statues in the sixteenth century, may be found in Ficoroni, in an account by Flaminius Vacca, printed at the end of Nardini's Roma Antica, and in Montfaucon. Several of these are also to be found in Dallaway's Anecdotes, from which many parts of this account of the arts have been selected.

Modern art of sculpture.

Of the sculptors of the modern school, the first who are deserving of notice are Niccolo Pilani, and his son Giovanni, whose works in bas-relief became the principal ornaments of the cathedrals which were built in Italy in their time. They were born at Pisa, and flourished in the middle of the 13th century. To their names is to be added that of Niccolo dell' Arca.

To these succeeded Donatello, born at Florence, in 1393, whom an Italian author calls the reviver of sculpture: and Lorenzo Ghiberti, celebrated for his admirable bas-reliefs in bronze on the gates of the Baptistery of St. John at Florence, of which Michael Angelo said, that they deserved to be the gates of Paradise. The compartments of these gates are filled with subjects taken from the Old Testament. The accompanying ornaments of fruits, flowers, &c. are of the most exquisite workmanship.

The list of succeeding sculptors, in Tuscany, is very numerous. Those of the greatest celebrity are Michael Angelo Buonaroti, no less eminent in sculpture than in painting; Baccio Bandinelli; Niccolo, called il Tribolo; Gulielmo della Porta; Jacopo Sansovino; Annibale Fontana; Benvenuto Cellini; Mont Orsoli; Giambologna, &c. &c.

To these is to be added the name of Propertia di Rossi distinguished as much by her misfortunes as her talents. Her history is singularly interesting, if the circumstances related of her are authentic.

Propertia di Rossi was born at Bologna, at the close of the fifteenth century. She was not only versed in sculpture, but had reached also no common excellence in music. Her first works were carvings in wood, and on peach-stones, eleven of which were in the museum of the marquis Grassi at Bologna, each representing on one side one of the apostles, and on the other several saints. In these minute attempts having gained universal applause, she then gave a public proof of her genius in a work of considerable importance, which she finished in marble, for the front of the cathedral of St. Petronius. A bust of count Guido Pepoli was likewise greatly admired. The rules of perspective and architecture were equally familiar to her. With all these talents, and a fame unrivalled by her sex, Propertia was most unfortunate. In early life she had been married without sympathy, and had fixed her affections on one whose heart was totally insensible. While her health was daily yielding to despair, she undertook the bas-relief, representing the story of Joseph and Potiphar's wife, which forms the principal subject of the work above-mentioned, belonging to the church of St. Petronius. It was at once a monument of her hopeless passion, and of her admirable skill.

The juvenile talents of Michael Angelo were displayed in the imitation, first of Donatello, and next of the antique; but he soon formed his own distinct style, consistent with the character of his native genius. This style was, like his painting, invariably grand. His anatomical knowledge was at all times conspicuous, and the display of it sometimes exceded the just bounds. His works in various cities of Italy are numerous. The principal ones are at Rome and Florence. In the former city, the monument of Julius II. in the church of St. Pietro in Vincoli, (which comprises the well-known statue of Moses) and the celebrated work of the Pieta, in a chapel in St. Peter's, are worthy of the highest admiration. At Florence, his greatest work is in the sacristy of St. Lorenzo, where he has placed the statues of the dukes Lorenzo and Giuliano Medici, together with four emblematic figures of Night, Day, Twilight, and Dawn.

The superior genius of this great artist established the school of sculpture in Florence; and his successors were, for a long period, little more than imitators of his style. But although they succeeded in giving to their figures an appearance of anatomical knowledge, they were far from equalling their great exemplar in his profound conception of the principles of art. They may of course all be considered as his inferiors in a line which he had marked out for them.

With the decline of the republic of Florence, the arts also sunk into decay, or took their flight to Rome, where Algardi became the author of a new style, by studying to unite the effects of painting with those of sculpture, and thus deserting the real intent of his art; which is to imitate the forms, not the appearances, of objects, the latter being the province of painting.

By these means sculpture assumed, under the hands of Algardi, a mannered air, which it has never since wholly lost.

One of the most extraordinary works of Algardi, is a large bas-relief, placed over an altar in St. Peter's church; in which he has represented St. Peter and St. Paul in the air, averting by their menaces the haughty Attila, who was advancing to the attack of Rome. The principal figures in this singular work are of the highest relievo; those which are supposed less in front are in mezzo-relievo; and in the others the degree of relief is proportionally diminished, until the most distant figures are only marked with a simple line. This was considered in his time as the mode of perfecting bas-relief; and Pope Innocent the Tenth rewarded the artist with a present of 30,000 Roman crowns.

To Algardi succeeded Lorenzo Bernini, born in 1598, who, pursuing the track which Algardi had begun, and distinguishing himself at an early age by extraordinary maturity of talents, consulted ever afterwards no other rules than the indulgence of his own fancy, and sought celebrity from the flights of caprice and extravagance. His first group was Apollo and Daphne, at the moment that the nymph begins to exhibit the change from her natural form to that of the laurel-tree. The figures are remarkably light and graceful, and the fame which this work acquired for its author was of the most excessive degree. His latter works at Rome were the celebrated chair of St. Peter's church, the monument of the popes Urban the Eighth and Alexander the Seventh, the equestrian statue of Constantine, and the fountain in the Piazza Navona.

The sculptors who followed were the imitators sometimes of one, and sometimes of the other, of these two masters.

At the same period flourished Francois du Quesnoy, called Fiammingo, unrivalled in the beautiful and tender forms of his infantine figures. In his statue of Saint Susanna, he proposed to imitate the simplicity of the antique; and succeeded (says Mengs) in imitating the superficial appearance, but not the essential maxims, of the antients.

Rusconi is the last sculptor worthy of particular notice, until the appearance of Antonio Canova, a Venetian, now living, and whose productions exhibit talents of a very extraordinary rank. Many accounts of his works are to be found in the relations of modern travellers.

Of a date very little later than the revival of art at Florence, is the commencement of its cultivation in France. While Michael Angelo was disclosing his wonderful powers at Rome, under the pontificate of Leo the Tenth, Jean Goujon attracted the admiration of Paris, in the reign of Francis the First, and continued to receive it in that of Henry the Second. His name is frequently placed in competition with the sculptors of the Italian school. "The works of Goujon (says a French writer) recal to our view the simple and sublime beauties of the antique." His figures were however more esteemed on the score of grace than of correctness. He excelled particularly in works of mezzo-relievo. The Fontaine des Saints Innocens, in the Rue St. Denis at Paris, is an instance of his merit in this kind; as is also the tribune, supported by colossal Caryatides, in the Salle des Cent Suisses at the Louvre.

Girardon, born in 1627, was at once (like the preceding artist) a sculptor and architect. His works were admired for the correctness of design, and beauty of composition; and he was said by his countrymen to have produced chefs-d'œuvres only. The magnificent mausoleum of cardinal Richelieu in the church of the Sorbonne, the equestrian statue of Louis the Fourteenth in the Place Vendome, and numerous statues and groups in the gardens of Versailles, are testimonials of his merit.

Cotemporary in age and fame with Girardon, was Puget, born at Marseilles, in 1622, and denominated by Louis the Fourteenth "the Inimitable." He studied from the age of 16 to 21, in Italy, where he distinguished himself equally for the quickness of his talents, and his extraordinary diffidence in them. Soon after his return to his own country, he was invited to Paris by M. Colbert, and executed many admirable works, particularly the groups of Milo, and of Andromeda rescued by Perseus, in the park of Versailles. His works are celebrated by the French for their elevated taste, correctness of drawing, nobleness of character, and in general the most happy fertility of genius. His artful disposition of drapery for the display of the form beneath it, is much admired. Puget's reputation was at its height when Bernini became eminent at Rome; and it is not more creditable to one than to the other of these sculptors, that when Louis the Fourteenth sent an invitation to Bernini to come to Paris, that artist replied, that the king of France had no occasion for his talents, while he had such a sculptor as Puget in his dominions.

The other countries on the continent having chiefly received the rudiments of art from the two already mentioned, have cultivated a similar taste in most of their works of sculpture. Many artists, however, have appeared worthy of high praises: and in modern days the names of Zauner in Vienna, Sergel in Stockholm, and Koslovski in Petersburgh, stand high in estimation.

It is now requisite to turn our attention to England; where, although the early period of the kingdom have left many memorials of the talents of our artists, the present school of sculpture is of a very recent date. From the time of the Reformation, the art of sculpture has been almost wholly in the hands of foreign artists. Cibber, Gibbons, Rysbrack, Scheemaker, Roubillac, and some others, were employed on all public occasions to the exclusion of native artists.

The principal works of Cibber are the statues on the front of Bedlam, those of several of our kings round the Royal Exchange, and others at Chatsworth and Cambridge. He was the father of the celebrated dramatic writer Colley Cibber.

Of Grinling Gibbons is a statue in bronze of James II. now in Scotland-yard, in the Roman costume. In minute ornaments, carved in wood, Gibbons has few equals. His works of that kind are frequent: some of the best are at lord Egrement's at Petworth, Windsor, and the duke of Norfolk's at Holm Lacey. In the chapel of Trinity-college, Oxford, are other striking proofs of his genius.

Rysbrack's first appearance in England was about the year 1720, when the statuaries of Paris, particularly Le Paûtre, Vancleve, Bouchardon, and Le Gros, enjoyed the first reputation, and had many scholars, whose invention was exhausted in the classical fopperies of the royal gardens. Wherever he acquired the elements of his art, he displayed talents of a masterly artist in England. His bronze equestrian statue of king William at Bristol, and his monument of bishop Hough in Worcester-cathedral, are counted among his superior works.

Some of the busts by his hand are, John Baliol, king of Scots, at Baliol college; Alfred, at the university, finished by Wilton; Gibbs, the architect, in the Radcliff library; Dr. R. Friend, archbishop Boulter, and probably the busts of George I. and II. at Christchurch.

Scheemakers has left many valuable works: his statue of Shakspeare, on the monument of our immortal bard, in Westminster-abbey, procured him the greatest celebrity.

Roubillac was a native of Lyons, a city which has given birth to several French sculptors; to Coysevox, N. Coustou, and l'Amoureux, the cotemporary of Roubillac, and with some probability his fellow-scholar under Coustou. There is a want of simplicity in the works of this artist, from which the celebrated statue of Newton at Trinity-college, Cambridge, is by no means exempt. Mr. Nightingale's monument in Westminster-abbey, says Walpole, although finely thought and well executed, is more theatric than sepulchral.

At Christchurch are fine busts of Dr. Matthew Lee, Dr. R. Frewen, and one of the founders at All-souls.

Since the time of the foreign artists above mentioned, many eminent English sculptors have appeared, whose works are to be found in our churches and other public buildings. Wilton, Nollekens, Banks, Bacon, Flaxman, Westmacott, are some of the most conspicuous names of our modern school. Wilton executed some good monuments in Westminster-abbey; Nollekens has established a fame which has stood the test of a long life of constant practice, and remains undiminished.

The characteristic merits of Banks and Bacon are thus described by Mr. Hoare, in his inquiry into the State of The Arts in England. "Banks was among those who most zealously sought the enlargement of professional knowledge in the stores of Rome. A mind ardently roused to competition with the works of excellence which he beheld, and a hand trained from infancy to a ready expression of his conceptions, imparted to his productions an air of antient art.

"Bacon's genius was of native growth; he traversed no distant regions for improvement of his art, but drew from the researches of others sufficient food for an active and ready fancy. His conceptions were quick and sparkling, his execution polished, and his whole work characteristically graceful."

The sculpture of Flaxman denotes a chaste and correct taste, founded on the most critical study of the works of Grecian art.

Westmacott is an able pupil of the Venetian Canova.

England also boasts her female sculptors. The Hon. Mrs. Damer, and the illustrious a tress Siddons, have shewn distinguished talents in this art.

SCURVY. See Medicine, Vol. II. p. 154, col. 2.

SCUTAGE was antiently a tax imposed on such as held lands, &c. by knight's service, towards furnishing the king's army: hence scutagio habendo was a writ that lay for the king, or other lord, against tenants holding by knight's service, to serve in person, or send a sufficient man in their room, or pay a certain sum, &c.

SCUTELLARIA, *scull-cap*, a genus of the gymnospermia order, in the didynamia class of plants, and in the natural method ranking under the 40th order, personatæ. The calyx is short, tubulated, has the mouth entire, and close after flowering. There are two species in Britain, the galericulata and minor. 1. The galericulata, blue scull-cap, or hooded willow-herb. It grows on the banks of rivers and lakes, is bitter, and has a garlic smell. 2. Minor, little red scull-cap, or willow-herb. The stalks are about eight inches high; the leaves are heart-shaped, oval; the flowers are purple. It grows in fens, and on the sides of lakes. There are fourteen other species.

SCUTTLES, in a ship, square holes cut in the deck, big enough to let in the body of a man, serving to let people down into any room below upon occasion, or from one deck to another. They are generally before the main-mast, before the knight in the fore-castle; in the gun-room, to go down to the stern-sheets; in the round-house, to go down into the captain's cabin, when forced by the enemy in a fight aloft. There are also some smaller scuttles, which have gratings over them: and all of them have covers that people may not fall down through them in the night.

Scuttle is also a name given those little windows and long holes which are cut out in cabins to let in light.

SCYLLARUS, a genus of insects, according to Fabricius, of the order aptera; but by the Linnæan system it is ranked with the genus cancer. See Plate Nat. Hist. fig. 358.

SCYLLÆA, a genus of insects of the order vermes mollusca. The generic character is, body compressed, and grooved along the back; mouth consisting of a terminal toothless aperture; tentacula three on each side, and placed beneath. There are two species.

SCYTHROPS, a genus of birds of the order picæ. The generic character is, bill large, convex, sharp-edged, channelled at the sides, hooked at the point; nostrils naked, rounded at the base of the bill; tongue cartilaginous, split at the point; feet climbers. There is but a single species, viz. the psittacus, which inhabits New South Wales; the size of a crow, but from the length of the tail measures 26 inches long.

SEA, in a strict sense, signifies a large portion of water almost surrounded by land, as the Baltic and Mediterranean seas; but it is frequently used for that vast body of water which encompasses the whole earth. See Ocean.

What proportion the superficies of the sea bears to that of the land, cannot easily be ascertained. Buffon has supposed that the surface of our globe is equally divided between land and water, and has accordingly calculated the superficies of the sea to be 85,490,506 square miles. But it is now well known that the ocean covers much more than half of the earth's surface. Buffon believed the existence of a vast southern continent, which captain Cook has shewn to be visionary. It was this circumstance which misled him. According to the most accurate observations hitherto made, the surface of the sea is to the land as three to one; the ocean, therefore, extends over 128,235,759 square miles, supposing the superficies of the whole globe to be 170,981,012 square miles. To ascertain the depth of the sea is still more difficult than its superficies; both on account of the numerous experiments which it would be necessary to make, and the want of proper instruments for that purpose. Beyond a certain depth the sea has hitherto been found unfathomable; and though several very ingenious methods have been contrived to obviate this difficulty, none of them has completely answered the purpose. We know in general that the depth of the sea increases gradually as we leave the shore; but if this continued beyond a certain distance, the depth in the middle of the ocean would be prodigious. Indeed the numerous islands every where scattered in the sea demonstrate the contrary, by showing us that the bottom of the water is unequal like the land; and that, so far from uniformly sinking, it sometimes rises into lofty mountains. If the depth of the sea is in proportion to the elevation of the land, as has generally been supposed, its greatest depth will not exceed five or six miles, for there is no mountain six miles perpendicular above the level of the sea. The sea has never been actually sounded to a greater depth than a mile and sixty-six feet; every thing beyond that therefore rests entirely upon conjecture and analogical reasoning, which ought never to be admitted to determine a single point that can be ascertained by experiment, because, when admitted, they have too often led to false conclusions. Along the coasts, where the depth of the sea is in general well known, it has always been found proportioned to the height of the shore: when the coast is high and mountainous, the sea that washes it is deep; when, on the contrary, the coast is low, the water is shallow. Whether this analogy holds at a distance from the shore, experiments alone can determine.

To calculate the quantity of water contained in the sea, while its depth is unknown, is impossible. But if we suppose with Buffon that its medium depth is the fourth part of a mile, the ocean, if its superficies is 128,235,759 square miles, will contain 32,058,939,75 cubic miles of water.

Let us now endeavour to compute the quantity of water which is constantly discharged into the sea. For this purpose let us take a river whose velocity and quantity of water are known, the Po, for instance, which, according to Riccioli, is 1000 feet (or 100 perches of Boulogne) broad, ten feet deep, and runs at the rate of four miles in an hour; consequently that river discharges into the sea 200,000 cubic perches of water in an hour, or 4,800,000 in a day. A cubic mile contains 125,000,000 cubic perches; the Po therefore will take twenty-six days to discharge a cubic mile of water into the sea. Let us now suppose, what is perhaps not very far from the truth, that the quantity of water which the sea receives from the rivers in any country is proportioned to the extent of that country. The Po from its origin to its mouth traverses a country 380 miles long, and the rivers which fall into it on every side rise from sources about sixty miles distant from it. The Po, therefore, and the rivers which it receives, water a country of 45,600 square miles. Now since the whole superficies of the dry land is about 42,745,253 square miles, it follows, from our supposition, that the quantity of water discharged by all the rivers in the world, in one day, is thirty-six cubic miles. If, therefore, the sea contains 32,058,939 cubic miles of water, it would take all the rivers in the world 2439 years to discharge an equal quantity.

It may seem surprising that the sea, since it is continually receiving such an immense supply of water, does not visibly increase, and at last cover the whole earth. But our surprise will cease, if we consider that the rivers themselves are supplied from the sea, and that they do nothing more than carry back those waters which the ocean is continually lavishing upon the earth. Dr. Halley has demonstrated that the vapours raised from the sea and transported upon land are sufficient to maintain all the rivers in the world. The simplicity of this great process is astonishing: the sea not only connects distant countries, and renders it easy to transport the commodities of one nation to another, but its waters rising in the air descend in showers to fertilise the earth and nourish the vegetable kingdom, and collecting into rivers flow onwards, bringing fertility and wealth and commerce along with them, and again return to the sea to repeat the same round.

As the sea covers so great a portion of the globe, we should no doubt, by exploring its bottom, discover a vast number of interesting particulars. Unfortunately, in the greater part of the ocean this has hitherto been impossible. Part, however, has been examined; and the discoveries which this examination has produced may enable us to form some idea at least of the whole. The bottom of the sea, as might have been conjectured indeed beforehand, bears a great resemblance to the surface of the dry land, being, like it, full of plains, rocks, caverns, and mountains; some of which are abrupt and almost perpendicular, while others rise with a gentle declivity, and sometimes tower above the water and form islands. Neither do the materials differ which compose the bottom of the sea and the basis of the dry land. If we dig to a considerable depth in any part of the earth, we uniformly meet with rock; the same thing holds in the sea. The strata too are of the same kind, disposed in the same manner, and form indeed but one whole. The same kind of mineral and bituminous substances are also found interspersed with these strata; and it is to them probably that the sea is indebted for its bitter taste. Over these natural and original strata an artificial bed has pretty generally been formed, composed of different materials in different places. It consists frequently of muddy tartareous substances firmly cemented together, sometimes of shells or coral reduced to powder, and near the mouths of rivers it is generally composed of fine sand or gravel.

The ocean differs more in saltness in different climates towards the equator than nearer the poles. This seems to arise from the different quantities of water which are evaporated, in proportion to those which fall in rain. One pound of sea-water in the Baltic yields about a quarter of an ounce of salt; near Holland half an ounce; and in the British seas about two ounces. Boyle has also observed, that in places of great depth the water is saltest at the bottom.

In the voyage made towards the north pole in 1773, it was found that the sea-water at the Nore contained not quite one thirty-sixth of salt; at the back of Yarmouth sands, not quite one thirty-second; off Flamborough Head, rather more than one twenty-ninth; off Scotland, rather less than one twenty-ninth; latitude 74°, at sea, one twenty-ninth; and in latitude 78°, rather less than one twenty-eighth.

The cause of the saltness of the ocean has been a subject of investigation among philosophers in almost all ages, but it still remains in great obscurity. There can be little doubt that a large quantity of saline matter existed in this globe from the creation; and, at this day, we find immense beds of sal gem, or common salt, buried in the earth, particularly at Cracow; but whether these collections have been derived from the ocean, and deposited in consequence of the evaporation of its waters in certain circumstances; or whether the ocean was itself originally fresh, and received its salt from collections of saline matter situated at its bottom, or from that brought by the influx of rivers; cannot now be ascertained. No accurate observations on the degree of saltness of the ocean in particular latitudes were made till the present century, and it is not possible, therefore, to ascertain what was the state of the sea at any considerable distance of time, nor, consequently, whether its degree of saltness increases, decreases, or is stationary. From differences among aquatic animals, however, some of which seem adapted to salt water, and some to fresh, it is probable, that both these states of water existed from the creation of the world. We know, it is true, that some kinds of fish, as salmon, are capable of existing both in fresh and in salt water, and that habit has a powerful influence over all animals; but this is not sufficient to refute the main fact, that some kinds of fish thrive only in salt water, others in fresh; some in standing pools, and others in rapid currents.

That excellent philosopher and chemist, the bishop of Landaff, has recommended a most simple and easy mode of ascertaining the saltness of the sea in any latitude; and as the language, in point of perspicuity and correctness, cannot be improved, we take the liberty of inserting it in his own words:

"As it is not every person who can make himself expert in the use of the common means of estimating the quantity of salt contained in sea-water, I will mention a method of doing it which is so easy and simple, that every common sailor may understand and practise it, and which, from the trials I have made of it, seems to be as exact a method as any that has yet been thought of. Take a clean towel or any other piece of cloth, dry it well in the sun or before the fire, then weigh it accurately, and note down its weight; dip it in the sea water, and when taken out, wring it a little till it will not drip, when hung up to dry; weigh it in this wet state, then dry it either in the sun or at the fire, and, when it is perfectly dry, weigh it again. The excess of the weight of the wetted cloth above its original weight, is the weight of the sea-water imbibed by the cloth; and the excess of the weight of the cloth after being dried, above its original weight, is the weight of the salt retained by the cloth; and by comparing this weight with the weight of the sea-water imbibed by the cloth, we obtain the proportion of salt contained in that species of sea-water.

"Whoever undertakes to ascertain the quantity of salt, contained in sea-water, either by this or any other method, would do well to observe the state of the weather preceding the time when the sea-water is taken out of the sea, for the quantity of salt contained in the water near the surface may be influenced both by the antecedent moisture and the antecedent heat of the atmosphere."

Whether the sea is salter or not at different depths, notwithstanding Mr. Boyle's observations before quoted, has not yet been properly ascertained; but that its temperature varies considerably in proportion to the depth we have decisive proof.

"With respect to the temperature," says bishop Watson, "of the sea at different depths, it seems reasonable enough to suppose, that in summer time it will be hotter at the surface than at any considerable depth below it, and that in winter it will be colder.

"Mr. Wales describes the instrument he made use of for trying the temperature of the sea at different depths, in the following terms: 'The apparatus for trying the sea-water at different depths consisted of a square wooden tube of about eighteen inches long and three inches square externally. It was fitted with a valve at the bottom, and another at the top, and had a contrivance for suspending the thermometer exactly in the middle of it. When it was used it was fastened to the deep sea-line, just above the lead, so that all the way as it descended the water had a free passage through it, by means of the valves which were then both open; but the instant it began to be drawn up, both the valves closed by the pressure of the water, and of course the thermometer was brought up in a body of water of the same temperature with that it was let down to.' With this instrument, which is much the same with one formerly described by Mr. Boyle, in his observations about the saltness of the sea, water was fetched up from different depths, and its temperature accurately noticed, in different seasons and latitudes.

"August 27, 1772, south latitude 24°. 40′. The heat of the air was 72½,—of the water at the surface 70,—of water from the depth of 80 fathoms 68.

"December 27, 1772, south latitude 58°, 21′. The heat of the air was 31,—of the water at the surface 32,—of water from the depth of 160 fathoms 33¼.

"In the voyage to the high northern latitudes before mentioned, they made use of a bottle to bring up water from the bottom, which is thus described: 'The bottle had a coating of wool, three inches thick, which was wrapped up in an oiled skin, and let into a leather purse, and the whole inclosed in a well-pitched canvas bag, firmly tied to the mouth of the bottle, so that not a drop of water could penetrate to its surface. A bit of lead shaped like a cone, with its base downwards, and a cord fixed to its small end, was put into the bottle; and a piece of valve leather, with half a dozen slips of thin bladder, were strung on the cord, which, when pulled, effectually corked the bottle on the inside.' We have here put down two of the experiments which were made during that voyage.

"August 4, 1773, north latitude 80°. 30′. The heat of the air was 32,—of the water at the surface 36,—of water fetched up from the depth of 60 fathoms under the ice 39.

"September 4, 1773, north latitude 65°. The heat of the air was 66½, of the water at the surface 55,—of water from the depth of 683 fathoms 40.

"It appears from all these experiments that, when the atmosphere was hotter than the surface of the sea, the superficial water was hotter than that at a great depth; and when the atmosphere was colder than the surface of the sea, it is evident that the superficial water was somewhat colder than at a considerable distance below it."

Sea-water may be rendered fresh by freezing, which excludes or precipitates the saline particles; or by distillation, which leaves the salt in a mass at the bottom of the vessel. Upon these principles, a mode of obtaining a supply of fresh water at sea was recommended some years ago to the admiralty, by Dr. Irving. It consisted in only adapting a tin tube of suitable dimensions to the lid of the common ship's kettle, and condensing the steam in a hogshead which served as a receiver. By this mode a supply of twenty-five gallons of fresh water per hour might be obtained from the kettle of one of our ships of war.

The sea shall be open by the laws of England, to all merchants. The main sea beneath the low-water mark, and round England, is part of England, for there the admiralty has jurisdiction. 1 Inst. 260.

SEAL, is either in wax, impressed with a device and attached to deeds, &c. or the instrument with which the wax is impressed. Sealing of a deed, is an essential part of it; for if a writing is not sealed, it cannot be a deed. See DEED.

SEALER, an officer in chancery, appointed by the lord chancellor or keeper of the great seal, to seal the writs and instruments there made in his presence.

SEALING, in architecture, the fixing a piece of wood or iron in a wall with plaister, mortar, cement, lead, and other solid binding.

SEAMEN: by various statutes, sailors having served the king for a limited time, are free to use any trade or profession, in any town of the kingdom, except in Oxford or Cambridge.

By 2 Geo. II. c. 36, made perpetual by 2 Geo. III. c. 31, no master of any vessel shall carry to sea any seaman, his own apprentices excepted, without first entering into an agreement with such seaman for his wages: such agreement to be made in writing, and to declare what wages such seaman is to receive during the whole of the voyage, or for such time as shall be therein agreed upon; and such agreement shall also express the voyage for which such seaman was shipped to perform the same. The provisions of this act are enforced by a penalty of ten pounds for each mariner carried to sea without such agreement, to be forfeited by the master to the use of Greenwich-hospital. This agreement is to be signed by each mariner within three days after entering on board such ship, and is, when executed, binding on all parties.

SEAM or SEME *of corn*, is a measure of eight bushels.

SEAM *of glass*, the quantity of 120 pound, or 24 stones each five pounds weight. The seam of wood is a horse-load.

SEAMS *of a ship*, are places where her planks meet and join together. There is also a kind of peculiar seam in the sowing of sails, which they call monk-seam; the other seam of a sail is the round seam, so called from its being round like the common seams.

SEARCHER, an officer of the customs, whose business is to search and examine all ships outward-bound, to see whether they have any prohibited or unaccustomed goods on board.

SEASIN, or SEASING, in a ship, the name of a rope by which the boat rides by the ship's side when in the harbour, &c.

SEBATS. As the sebacic acid was, strictly speaking, unknown till the late experiments of Thenard, the description of the sebats published by former chemists cannot be admitted as exact till they are verified by a new examination. These salts of course are unknown, if we except the few facts pointed out by Thenard. This chemist, however, has announced his intention of publishing a detailed account of them.

1. When sebacic acid is dropt into barytes water, lime water, or strontian water, it does not render these liquids turbid. Hence we learn, that the sebats of the alkaline earths are soluble in water.

2. The alkaline sebats are likewise soluble. Sebat of potass has little taste, does not attract moisture from the air; and when sulphuric, nitric, or muriatic acid is poured upon it, sebacic acid is deposited. When the concentrated solution of this salt is mixed with any of these acids, it becomes solid from the crystallization of the sebacic acid.

SEBACIC ACID. Chemists had long suspected that an acid could be obtained from tallow, on account of the acrid nature of the fumes which it emits at a high temperature; but it was M. Grutzmacher who first treated of it particularly in a dissertation De Ossium Medulla, published in 1748. Mr. Rhodes mentioned it in 1753; Segner published a dissertation on it in 1754; and Crell examined its properties very fully in two dissertations published in the Philosophical Transactions for 1780 and 1782. It was called at first acid of fat, and afterwards sebacic acid.

But at the period when these chemists made their experiments, the characteristic properties of the different acids were not sufficiently known to enable them to distinguish acids from each other with precision. Thenard examined the subject in 1801, tried all the processes of Crell and Guyton Morveau, and found that the acids procured by them were either acetic, or the acid employed in the process. Real sebacic acid had hitherto escaped the examination of chemists. It may be procured by the following method, for which we are indebted to Thenard.

1. Distil hog's lard, wash the product with hot water, separate this water, and drop into it acetat of lead. A flaky precipitate appears, which is to be washed and dried, mixed with sulphuric acid, and heated. A melted substance analogous to fat, swims on the surface, which is to be carefully separated. This substance is sebacic acid. It may be dissolved in hot water, and on cooling crystalline needles are deposited. This acid may be obtained also by evaporating the water employed in washing the product of distilled hog's lard. Or this water may be saturated with potass, and afterwards precipitated with acetat of lead as above. Its properties are the following.

2. It has no smell, its taste is slightly acid, and it reddens the tincture of turnsole. When heated it melts like tallow. It is soluble in cold, but much more soluble in hot water. Boiling water saturated with it becomes solid on cooling; alcohol also dissolves it abundantly. It crystallizes in needles; but by proper precautions it may be obtained in long, large, and very brilliant plates.

It occasions a precipitate in the acetat and nitrat of lead, the nitrat of silver, the acetat and nitrat of mercury. It forms peculiar salts with the alkalies and earths. It does not render lime water, barytes, or strontian water turbid. Sebat of potass has little taste, does not attract moisture from the air; and when sulphuric, nitric, or muriatic acid is poured upon it, sebacic acid is deposited: when its solution is concentrated and mixed with any one of these acids it becomes solid.

SECALE, *rye*, a genus of the digynia order, in the triandria class of plants; and in the natural method ranking under the 4th order, gramina. The calyx is a glume of two leaves, which are opposite to one another, erect, linear, pointed, and less than the corolla. The corolla consists of two valves, the exterior of which ends in a beard. There are four species: the villosum, orientale, creticum, and cercale. The villosum, or wood rye-grass, is distinguished by a calyx with wedge-shaped scales, and by the fringe of the glume being woolly. The glumes of the orientale are shaggy, and the scales of the calyx are shaped like an awl. The glumes of the creticum are fringed on the outside. The cereale, or common rye, has glumes with rough fringes. It is a native of the island of Candia, was introduced into England many ages ago, and is the only species of rye cultivated in this kingdom. There are, however, two varieties, the winter and spring rye.

The winter rye, which is larger in the grain than the spring rye, is sown in autumn at the same time with wheat, and sometimes mixed with it; but as the rye ripens sooner than the wheat, this method must be very exceptionable. The spring rye is sown along with the oats, and usually ripens as soon as the winter rye; but the grain produced is lighter, and it is therefore seldom sown except where the autumnal crop has failed.

Rye is commonly sown on poor, dry, limestone, or sandy soils, where wheat will not thrive. By continuing to sow it on such a soil for two or three years, it will at length ripen a month earlier than that which has been raised for years on strong cold ground.

Rye is commonly used for bread either alone or mixed with wheat. This mixture is called meslin, and was formerly a very common crop in some parts of Britain. Mr. Marshall tells us, that the farmers in Yorkshire believe that this mixed crop is never affected by mildew, and that a small quantity of rye sown among wheat will prevent this destructive disease. Rye is much used for bread in some parts of Sweden and Norway by the poor people. About a century ago rye-bread was also much used in England; but being made of a black kind of rye, it was of the same colour, clammy, very detergent, and consequently not so nourishing as wheat.

Rye is subject to a disease which the French call ergot, and the English horned rye; which sometimes happens when a very hot summer succeeds a rainy spring. According to Tissot, horned rye is such as suffers an irregular vegetation in the middle substance between the grain and the leaf, producing an excrescence of a brownish colour, about an inch and a half long, and two-tenths of an inch broad. Bread made of this kind of rye has a nauseous acrid taste, and produces spasmodic and gangrenous disorders.

SECANT, in geometry, is a line that cuts another, or divides it into two parts. See TRIGONOMETRY.

SECHIUM, a genus of the syngenesia order, in the monœcia class of plants; and in the natural method ranking under the 34th order, cucurbitaceæ. The male calyx is quinquedentate and monophyllous; the corolla monopetalous; the five filaments are united in an erect tube. In the female flower the pistillum is cylindrical and erect; the stigma large, peltated, and reflected; the pericarpium large, oval, unequal, fleshy, and unilocular, containing one seed, which is smooth, compressed, and fleshy. Of this there is only one species, viz. the edulis, or chocho vine. This is cultivated and grows very luxuriantly in many places in Jamaica. The vines run and spread very much. The fruit is boiled, and served up at table by way of greens; and the root of the old vine is somewhat like a yam (dioscorea), and on being boiled or roasted tastes farinaceous and wholesome.

SECOND, in geometry, chronology, &c. the sixtieth part of a prime or minute, whether of a degree, or of an hour: it is denoted by two small accents, thus (″).

SECOND, in music, an interval of a conjoint degree. There are four kinds of seconds. The diminished second, containing four commas; the minor second, consisting of five commas; the major second, consisting of nine commas; and the redundant second, composed of a whole tone and a minor semitone.

SECONDARY, in general, something that acts as second, or in subordination to another. Secondary circles of the sphere, are circles passing through the poles of some great circle: thus the meridians and hour-circles are secondaries to the equinoctial. There are also secondaries passing through the poles of the ecliptic, by means of which all stars are referred to the ecliptic.

SECONDARY, an officer who is second, or next to the chief officer; as the secondaries to the prothonotaries in the courts of B. R. and C. B.

SECRETARY, an officer who by his master's orders writes letters, dispatches, and other instruments, which he renders authentic by his signet. Of these there are several kinds; as, 1. Secretaries of state, who are officers that have under their management and direction the most important affairs of the kingdom, and are obliged constantly to attend on the king: they receive and dispatch whatever comes to their hands, either from the crown, the church, the army, private grants, pardons, dispensations, &c. as likewise petitions to the sovereign: which when read, are returned to them; all which they dispatch according to the direction of the king in council. They have authority to commit persons for treason, and other offences against the state, as conservators of the peace at common law, or as justices of the peace throughout the kingdom. They are members of the privy and cabinet council, which is seldom or never held without one of them being present; as to the business and correspondence in all parts of this kingdom, it is managed by the secretary for the home department. With respect to foreign affairs, the business is in the foreign office. There has been lately established a secretary of state for the war department, which must not be confounded with the secretary at war. The secretaries have each two under-secretaries, and one chief clerk. To the secretaries of state belong the custody of that seal properly called the signet, and the direction of two other offices, one called the paper-office, and the other the signet-office. See PAPER-OFFICE and SIGNET-OFFICE.

2. Secretary of an embassy, a person attending an ambassador for writing dispatches relating to the negotiation. There is a great difference between the secretary of an embassy, and the ambassador's secretary; the last being a domestic or menial of the ambassador, and the first, a servant or minister of the prince. 3. The secretary at war, an officer of the war-office, who has two chief clerks under him, the last of which is the secretary's messenger. There are also secretaries in most of the other offices.

SECRETION, in the animal economy, the separation of some fluid mixed with the blood by means of the glands. See PHYSIOLOGY.

SECRETIONS, *morbid*. In different diseases to which the animal body is subject, various fluids make their appearance which did not previously exist, at least under the forms which they assume. Thus in the dropsy the cellular substance, frequently the cavities of the head, breast, or abdomen, are filled with a whitish liquid. Where any part of the skin is irritated into a blister, the interval between the cutis and cuticle is filled with a transparent fluid; and when any part of the muscles or skin is wounded, the ulcer is soon covered with a matter called pus. See PUS. A thin sanies exudes from cancers and carious bones. The liquor of the dropsy is found upon examination to agree almost exactly with the serum of the blood. The liquor of blisters is composed also of the same constituents as the serum of blood: from 200 parts has been obtained by chemical analysis

36 albumen,
4 muriat of soda,
2 carbonat of soda,
2 phosphat of lime,
156

200.

SECTION, in geometry, denotes a side or surface appearing of a body or figure cut by another; or the place where lines, planes, &c. cut each other.

The common section of two planes is always a right line; being the line supposed to be drawn on one plane by the section of the other, or by its entrance into it.

SECTION *of a building*, in architecture, is the same with its profile; or a delineation of its heights and depths raised on a plane, as if the fabric was cut asunder to discover its inside.

SECTIONS, *conic*, in geometry. See CONIC SECTION.

SECTOR, in geometry, is a part of a circle, comprehended between two radii and the arch; or it is a mixed triangle, formed by two radii and the arch of a circle.

SECTOR. See INSTRUMENTS MATHEMATICAL.

SECUNDINES. See MIDWIFERY.

SECURIDACA, a plant belonging to the class of diadelphia, and to the order of octandria. The calyx has three leaves, which are small, deciduous, and coloured. The corolla is papilionaceous. The vexillum, consisting of two petals, is oblong, straight, and conjoined to the carina at the base. The carina is of the same length with the alæ. The legumen is ovated, unilocular, monospermous, and ending in a legulated ala. There are three species. The erecta has an upright stem: the scandens is a climbing plant, and is a native of the West Indies.

SECUTORES, in antiquity, a kind of gladiators among the Romans, who fought against the retiarii. The secutores were armed with a sword and buckler, to keep off the net or noose of their antagonists, and they wore a cask on their head.

SEDATIVES. See Materia Medica, vol. II. p. 110, col. 2, *Narcotics*.

SE DEFENDENDO, in law, a plea used for him that is charged with the death of another, by alleging that he was under a necessity of doing what he did in his own defence; as that the other assaulted him in such a manner, that if he had not done what he did, he must have been in hazard of his own life. But here the danger must appear so great, as to be inevitable. See Homicide.

SEDITION, among civilians, is used for a factious commotion of the people, or an assembly of a number of citizens without lawful authority, tending to disturb the peace and order of the society. This offence is of different kinds: some seditions more immediately threatening the supreme power, and the subversion of the present constitution of the state; others tending only towards the redress of private grievances. Among the Romans, therefore, it was variously punished, according as its end and tendency threatened greater mischief. See lib. i. God. de Seditiosis, and Mat. de Crimin. lib. ii. n. 5. de Læsa Majestate. In the punishment, the authors and ringleaders were justly distinguished from those who, with less wicked intentions, joined and made part of the multitude.

The same distinction holds in the law of England and in that of Scotland. Some kinds of sedition in England amount to high treason, and come within the stat. 25 Edw. III. as levying war against the king. And several seditions are mentioned in the Scotch acts of parliament as treasonable. Bayne's Crim Law. of Scotland, p. 33, 34. The law of Scotland makes riotous and tumultuous assemblies a species of sedition. But the law there, as well as in England, is now chiefly regulated by the riot act, made 1 Geo. I. only it is to be observed, that the proper officers in Scotland, to make the proclamation thereby enacted, are sheriffs, stewards, and bailies of regalities, or their deputies; magistrates of royal boroughs, and all other inferior magistrates; high and petty constables, or other officers of the peace, in any county, stewartry, city, or town. And in that part of the island, the punishment of the offence is any thing short of death which the judges, in their discretion, may appoint.

SEDUM, *orpine*, a genus of the pentagynia order, in the decandria class of plants; and in the natural method ranking under the 13th order, succulentæ. The calyx is quinquefid; the corolla is pentapetalous, pointed, and spreading; there are five nectariferous squamæ, or scales, at the base of the germen. The capsules are five.

The species are 30. The most noted are, 1. The verticillatum; 2. Telephium; 3. Anacampseros; 4. Aizoon; 5. Hybridum; 6. Populifolium; 7. Stellatum; 8. Cepaea, 9. Libanoticum; 10. Dasyphyllum; 11. Reflexum; 12. Rupestre; 13 Lineare; 14. Hispanicum; 15. Album; 16. Acre; 17. Sexangulare; 18. Annuum; 19. Villosum; 20. Atratum.

All these species of sedum are hardy herbaceous succulent perennials, durable in root but mostly annual in stalk, &c. which, rising in spring, flower in June, July, and August, in different sorts; the flowers consisting universally of five spreading petals, generally crowning the stalks numerously in corymbose and cymose bunches and spikes, appearing tolerably conspicuous, and are succeeded by plenty of seeds in autumn, by which they may be propagated, also abundantly by parting the roots, and by slips or cuttings of the stalks in summer; in all of which methods they readily grow, and spread very fast into tufted bunches: being all of succulent growth, they consequently delight most in dry soils, or in any dry rubbishy earth.

As flowering plants, they are mostly employed to embellish rock-work, ruins, and the like places; planting either the roots or cuttings of the shoots in a little mud or any moist soil at first, placing it in the crevices, where they will soon root and fix themselves, and spread about very agreeably. For economical purposes, the reflexum and rupestre are cultivated in Holland and Germany, to mix with lettuce in sallads. The wall-pepper is so acrid, that it blisters the skin when applied externally. Taken inwardly, it excites vomiting. In scorbutic cases and quartan agues, it is said to be an excellent medicine under proper management. Goats eat it; cows, horses, sheep, and swine, refuse it.

SEED. See Plants, Physiology, and Semen.

SEELING, at sea, is used in the same sense nearly with heeling: when a ship lies down constantly, or steadily on one side, the seamen say, she heels; and they call it seeling when she tumbles violently and suddenly, by the sea forsaking her, as they call it, that is, the waves leaving her for a time in a bowling sea.

SEGMENT *of a circle*. See Geometry.

Segment *of a sphere*, is a part of a sphere terminated by a portion of its surface, and a plane which cuts it off, passing somewhere out of the centre; being more properly called the section of a sphere.

The base of a segment is always a circle. And the convex surfaces of different segments, are to each other as their altitudes, or versed sines. And as the whole convex surface of the sphere is equal to four of its great circles, or four circles of the same diameter; so the surface of any segment is equal to four circles on a diameter equal to the chord of half the arc of the segment. So that if d denotes the diameter of the sphere, or the chord of half the circumference, and c the chord of half the arc of any other segment, also a the altitude or versed sine of the same; then,

$3.1416d^2$ is the surface of the whole sphere, and

$3.1416c^2$, or $3.1416d$, the surface of the segment.

For the solid content of a segment, there are two rules usually given; viz. 1. To three times the square of the radius of its base, add the square of its height; multiply the sum by the height, and the product by .5236. Or, 2dly, From three times the diameter of the sphere, subtract twice the height of the frustum; multiply the remainder by the square of the height, and the product by .5236.

That is, in symbols, the solid content is either $= .5236a \times \overline{3r^2 + a^2}$, or $= \cdot 5236a^2 \times \overline{3d - 2a}$; where a is the altitude of the segment, r the radius of its base, and d the diameter of the whole sphere.

SEGUERIA, in botany, a plant belonging to the class of polyandria and the order of monogynia. The calyx is pentaphyllous; the phylla are oblong, concave, coloured, and permanent; there is no corolla. The capsule is oblong and monospermous, the large ala terminating in small lateral alæ. There are two species, the Americana and Asiatic.

SEIGNIORY, dominium, in our law, is used for a manor or lordship of a seigneur, or lord of the fee or manor.

SEIGNORAGE, signifies the right, or due belonging to a seigneur, or lord; but it is particularly used for a duty belonging to the prince, for the coining of money, called also coinage; which under our antient kings was five shillings for every pound of gold brought in the mass to be coined, and a shilling for every pound weight of silver. At present the king claims no seignorage at all, but the subject has his money coined at the public expence; nor has the king any advantage, but what he has from the alloy. See Coining.

SEISIN, in law, signifies possession. Seisin is two-fold; seisin in law, and seisin in fact. Seisin in fact, is when an actual possession is taken; seisin in law, when something is done which the law accounts a seisin, as an enrollment.

SEIZE, Seaze, or Sease, in the sea-language, is to make fast, or bind, particularly to fasten two ropes together, with rope-yarn. The seizing of a boat is a rope tied to a ring, or little chain in the foreship of the boat, by which means it is fastened to the side of the ship.

SEIZURE, in commerce, an arrest of some merchandize, moveable, or other matter, either in consequence of some law, or of some express order of the sovereign. Contraband goods, those fraudulently entered, or landed without entering at all, or at wrong places, are subject to seizure. In seizures, among us, one half goes to the informer, and the other half to the king.

SELAGO, a genus of the angiospermia order, in the didynamia class of plants; and in the natural method ranking under the 48th order, aggregatæ. The calyx is quinquefid: the tube of the corolla capillary, with the limb nearly equal, and a single seed. There are 20 species.

SELENITE, in chemistry. See Sulphat of Lime.

Selenites, in natural history, the name of a large class of fossils, the characters of which are these: they are bodies composed of slender and scarce visible filaments, arranged into fine, even, and thin flakes; and those disposed into regular figures in the several different genera, approaching to a rhomboid or hexangular column, or a rectangled parallelogram; fissile, like the talcs, but they not only lie in a horizontal, but also in a perpendicular direction; they are flexile in a small degree, but not at all elastic; they do not ferment with acid menstrua, but readily calcine in the fire. Of this class there are seven orders of bodies, and under those ten genera. The selenitæ of the first order are those composed of horizontal plates, and approaching to a rhomboidal form: of the second are those composed of horizontal plates, arranged into a columnar and angular form: of the third are those whose filaments are scarce visibly arranged into plates, but which, in the whole masses, appear rather of a striated than of a tubulated structure: of the fourth are those which are flat, but of no determinately angular figure: of the fifth are those formed of plates perpendicularly arranged: of the sixth are those formed of congeries of plates, arranged into the figure of a star; and of the seventh are those of a complex and indeterminate figure.

The structure of the selenitæ of all the genera of the first order is exactly alike; they are all composed of a great number of broad flakes or plates, in a great measure externally resembling the flakes of the foliaceous talcs: these are of the length and breadth of the whole mass; the top and bottom being each only one such plate, and those between them, in like manner, each complete and single; and the body may always be easily and evenly split, according to the direction of these flakes. These differ, however, extremely from the talcs; for they are each composed of a number of parallel threads or filaments, which are usually disposed parallel to the sides of the body, though sometimes parallel to its ends. In many of the species they are also divided by parallel lines, placed at a considerable distance from each other, and the plates in splitting often break at these lines; add to this, that they are not elastic, and that they readily calcine. The structure of those of the second is the same with that of the first: but that in many of the specimens of them, the filaments of which the plates are composed run in two directions, and meet in an obtuse angle; and in the middle there is generally seen in this case a straight line running the whole length of the column; and small parcels of clay insinuating themselves into this crack, represent in it the figure of an ear of grass so naturally, as to have deceived many into a belief that there was really an ear of grass there. The other orders consisting only of single genera, the structure of each is explained under the generical name. See Plate Nat. Hist. fig. 359.

SELEUCIDÆ, in chronology: æra of the Seleucidæ, or the Syro-Macedonian æra, is a computation of time, commencing from the establishment of the Seleucidæ, a race of Greek kings, who reigned as successors of Alexander the Great, in Syria, as the Ptolemies did in Egypt. This æra we find expressed in the book of Maccabees, and on a great number of Greek medals, struck by the cities of Syria, &c. The rabbins call it the æra of contracts; and the Arabs therik dilkarnain, that is, the æra of the two horns. According to the best accounts, the first year of this æra falls in the year 311 before Christ, being twelve years after Alexander's death.

SELF-HEAL, the prunella vulgaris of Linnæus. The stem is erect, and about eight or ten inches high. The leaves grow on footstalks, are ovato-oblong, slightly indented, and somewhat hairy. The bracteæ are heart-shaped, opposite, and fringed. The flowers are white or purplish, grow in dense spikes, and are terminal. This plant is perennial, grows wild in meadows and pasture-grounds, and flowers in June and July. This herb is recommended as a mild restringent and vulnerary in spittings of blood, and other hemorrhages and fluxes; and in gargarisms against aphthæ and inflammations of the fauces. Its virtues do not appear to be very great; to the taste it discovers a very slight austerity or bitterishness, which is more sensible in the flowery tops than the leaves.

SELINUM, a genus of the digynia order, in the pentandria class of plants; and in the natural method ranking under the 45th order, umbellatæ. The fruit is oval, oblong, compressed, plane, and striated in the middle: the involucrum is reflexed; the petals cordate and equal. There are nine species, the sylvestre, palustre, austriacum, carufolia, chabraci, seguieri, monnieri, sibiricum, and deceprens.

SELL, in building, is of two kinds, viz. ground-sell, which denotes the lowest piece of timber, in a timber building, and that on which the whole superstructure is raised; and the window-sell, called also window-soil, is the bottom pi ce in a window-frame.

SELLA EQUINA. See Anatomy.

SELTZER-WATER. See Waters, Mineral.

SEMECARPUS, a genus of the trigynia order, in the pentandria class of plants. The corolla is quinquepetalous; the drupa is heart-shaped, cellulous, and monospermous. There is but one species.

SEMEN, a substance prepared by nature for the reproduction and conservation of the species both in animals and plants. The peculiar liquid secreted in the testes of males, and destined for the impregnation of females, is known by the name of semen. The human semen alone has hitherto been subjected to chemical analysis. Nothing is known concerning the seminal fluid of other animals. Vauquelin published an analysis of the human semen in 1791.

Semen, when newly ejected, is evidently a mixture of two different substances: the one, fluid and milky, which is supposed to be secreted by the prostate gland; the other, which is considered as the true secretion of the testes, is a thick mucilaginous substance, in which numerous white shining filaments may be discovered. It has a slight disagreeable odour, an acrid irritating taste, and its specific gravity is greater than that of water. When rubbed in a mortar it becomes frothy, and of the consistence of pomatum, in consequence of its enveloping a great number of air-bubbles. It converts paper stained with the blossoms of mallows or violets to a green colour, and consequently contains an alkali.

As the liquid cools, the mucilaginous part becomes transparent, and acquires greater consistency; but in about twenty minutes after its emission, the whole becomes perfectly liquid. This liquefaction is not owing to the absorption of moisture from the air, for it loses instead of acquiring weight during its exposure to the atmosphere; nor is it owing to the action of the air, for it takes place equally in close vessels.

Semen is insoluble in water before this spontaneous liquefaction, but afterwards it dissolves readily in it. When alcohol or oxymuriatic acid is poured into this solution, a number of white flakes are precipitated. Concentrated alkalies facilitate its combination with water. Acids readily dissolve the semen, and the solution is not decomposed by alkalies; neither indeed is the alkaline solution decomposed by acids.

Lime disengages no ammonia from fresh semen; but after that fluid has remained for some time in a moist and warm atmosphere, lime separates a great quantity from it. Consequently ammonia is formed during the exposure of semen to the air.

When oxymuriatic acid is poured into semen, a number of white flakes precipitate, and the acid loses its peculiar odour. These flakes are in oluble in water, and even in acids. If the quantity of acid is sufficient, the semen acquires a yellow colour. Thus it appears that semen contains a mucilaginous substance analogous to that of the tears, which coagulates by absorbing oygen. M. Vauquelin obtained from 100 parts of semen six parts of this mucilage.

When semen is exposed to the air about the temperature of 60°, it becomes gradually covered with a transparent pellicle, and in three or four days deposits small transparent crystals, often crossing each other in such a manner as to represent the spokes of a wheel. These crystals, when viewed through a microscope, appear to be four-sided prisms, terminated by very long four-sided pyramids. They may be separated by diluting the liquid with water, and decanting it off. They have all the properties of phosphat of lime. If, after the appearance of these crystals, the semen is still allowed to remain exposed to the atmosphere, the pellicle on its surface gradually thickens, and a number of white round bodies appear on different parts of it. These bodies also are phosphat of lime, prevented from crystallizing regularly by the too rapid abstraction of moisture. M. Vauquelin found that 100 parts of semen contain three parts of phosphat of lime. If at this period of the evaporation the air becomes moist, other crystals appear in the semen, which have the properties of carbonat of soda. The evaporation does not go on to complete exsiccation, unless at the temperature of 77°, and when the air is very dry. When all the moisture is evaporated, the semen has lost 0.9 of its weight; the residuum is semitransparent like horn, and brittle.

When semen is kept in very moist air, at the temperature of about 77°, it acquires a yellow colour, like that of the yolk of an egg; its taste becomes acid, it exhales the odour of putrid fish, and its surface is covered with abundance of the byssus septica.

When dried semen is exposed to heat in a crucible, it melts, acquires a brown colour, and exhales a yellow fume, having the odour of burnt horn. When the heat is raised, the matter swells, becomes black, and gives out a strong odour of ammonia. When the odour of ammonia disappears, if the matter is lixiviated with water, an alkaline solution may be obtained, which, by evaporation, yields crystals of carbonat of soda. M. Vauquelin found that 100 parts of semen contain one part of soda. If the residuum is incinerated, there will remain only a quantity of white ashes, consisting of phosphat of lime.

Thus it appears that semen is composed of the following ingredients:

90	water
6	mucilage
3	phosphat of lime
1	soda
100.	

SEMEN, *seed.* See BOTANY; and PLANTS, *physiology of.* With respect to number, plants are either furnished with one seed, as sea-pink and bistort; two, as wood-roof, and the umbelliferous plants; three, as spurge four, as the lip-flowers of Tournefort, and rough-leaved plants of Ray; or many, as ranunculus, anemone, and poppy. The form of seeds is likewise extremely various, being either large or small, round, oval, heart-shaped, kidney-shaped, angular, prickly, rough, hairy, wrinkled, sleek, or shining, black, white, or brown. Most seeds have only one cell or internal cavity; those of lesser burdock, valerian, lamb's lettuce, carnelian cherry, and sebesten, have two. With respect to substance, seeds are either soft, membranaceous, or of a hard bony substance; as in gromwell, tamarind, and all the nuciferous plants. In point of magnitude, seeds are either very large, as in the cocoa-nut, or very small, as in campanula, ammannia, rampions, and throatwort.

With respect to situation, they are either dispersed promiscuously through the pulp (semina nidulentia), as in water-lily; affixed to a suture or joining of the valves of the seed-vessel, as in the cross-shaped and pea-bloom flowers; or placed upon a placenta or receptacle within the seed-vessel, as in tobacco and thornapple.

Seeds are said to be naked, (semina nuda) which are not contained in a cover or vessel. Such are those of the lip and compound flowers, the umbelliferous and rough-leaved plants; covered seeds (semina tecta) are contained in some vessel, whether of the capsule, pod, berry, apple, or cherry kind.

A simple seed is such as bears neither crown, wing, nor downy pappus; the varieties in seeds arising from these circumstances are particularly enumerated under their respective heads.

In assimilating the animal and vegetable kingdoms, Linnæus denominates seeds the eggs of plants. The fecundity of plants is frequently marvellous; from a single plant or stalk of Indian Turkey wheat, are produced, in one summer, 2000 seeds; of elecampane 3000; of sun-flower 4000; of poppy 32,000; of a spike of cat's-tail 10,000, and upwards; a single fruit, or seed-vessel, of tobacco, contains 1000 seeds; that of white poppy 8000. Mr. Ray relates, from experiments made by himself, that 1012 tobacco-seeds are equal in weight to one grain; and that the weight of the whole quantum of seeds in a single tobacco-plant is such as must, according to the above proportion, determine their number to be 360,000. The same author estimates the annual produce of a single stalk of spleenwort to be upwards of one million of seeds.

The dissemination of plants respects the different methods or vehicles by which nature has contrived to disperse their seeds for the purpose of increase. These by naturalists are generally reckoned four:

1. Rivers and running waters. 2. The wind. 3. Animals. 4. An elastic spring, peculiar to the seeds themselves.

1. The seeds which are carried along by rivers and torrents are frequently conveyed many hundreds of leagues from their native soil, and cast upon a very different climate, to which, however, by degrees they render themselves familiar.

2. Those which are carried by the wind are either winged, as in fir-tree, trumpet-flower, tulip-tree, birch, arbor-vitæ, meadow-rue, and jessamine, and some umbelliferous plants, furnished with a pappus, or downy crown, as in valerian, poplar, reed, succulent swallow-wort, cotton-tree, and many of the compound flowers, placed within a winged calyx or seed-vessel, as in scabious, sea-pink, dock, dioscorea, ash, maple, and elm-trees, logwood, and woad; or, lastly, contained within a swelled calyx or seed-vessel, as in winter-cherry, cucubalus, melilot, bladder-nut, fumitory, bladder-sena, heart-seed, and chick-peas.

3. Many birds swallow the seeds of vaneloe, juniper, misletoe, oats, millet, and other grasses, and void them entire. Squirrels, rats, parrots, and other animals, suffer many of the seeds which they devour to escape, and thus in effect disseminate them. Moles, ants, earthworms, and other insects, by ploughing up the earth, admit a free passage to those seeds which have been scattered upon its surface. Again, some seeds attach themselves to animals, by means of hooks, crotchets, or hairs: which are either affixed to the seeds themselves, as in hound's-tongue, mouse-ear, vervain, carrot, bastard-parsley, sanicle, water-hemp, agrimony, arctopus, and verbesina; to their calyx, as in burdock, agrimony, rhexia, small wild bugloss, dock, nettle, pellitory, and lead-wort; or to their fruit or seed-vessel, as in liquorice, enchanter's nightshade, cross-wort, clivers, French honeysuckle, and arrow-headed grass.

4. The seeds which disperse themselves by an elastic force, have that force resident either in their calyx, as in oats, and the great number of ferns; in their pappus, as in centaurea crupina; or in their capsule, as in geranium, herb-bennet, African spiræ, fraxinella, horse-tail, balsam, Malabar-nut, cucumber, elaterium, and male balsam-apple.

SEMI-CIRCLE, in geometry, half a circle, or that figure comprehended between the diameter of a circle and half the circumference.

SEMI-COLON, in grammar, one of the points or stops used to distinguish the several members of sentences from each other.

SEMI-CUBICAL parabola, in the higher geometry, a curve of the second order, wherein the cubes of the ordinates are as the squares of the abscisses. Its equation is $axx = y$.

SEMI-DIURNAL. Of any of those circles which the sun appears to perform each daily revolution, that portion which is above the horizon is called the diurnal arch, and that which is below the horizon is called the nocturnal arch, the halves of which are called the semi-diurnal and the semi-nocturnal arches.

SEMI-OPAL. See OPAL.

SEMI-PARABOLA, in geometry, a curve defined by the equation $ax^{m-1} = y^m$; as $ax^2 = y^3$, and $ax^3 = y^4$. See the article PARABOLA.

In semi-parabolas, $y^m : v^m :: ax^{m-1} : az^{m-1} = x^{m-1} : z^{m-1}$; or the powers of the semi-ordinates are, as the powers of the semi-abscisses, one degree lower: for instance, in cubical semi-parabolas the cubes of the ordinates are as the squares of the abscisses; that is, $^3y : v :: x^2 : z^2$.

SEMI-PELAGIANS, in church history, a branch of the pelagians, so called because they pretended to keep a medium between the pelagians and the orthodox.

SEMPERVIVUM, *house-leek,* a genus of plants belonging to the order of dodecagynia, and to the class of dodecandria, and in the natural method ranking under the 13th order, succulentæ. The calyx is divided into 12 parts; the petals are twelve; and the capsules twelve, containing many seeds. There are fourteen species; the arboreum, canariense, glutinosum, glandulosum, tectorum, globiferum, villosum, tortuosum, arachnoideum, montanum, fedeforme, menanthus, stellatum, and histum. The tectorum alone is a native of Britain. It is frequent on the tops of houses, and flowers in July.

SENATUS AUCTORITAS, a vote of the Roman senate, drawn up in the same form with a decree, but without its force, as having been hindered from passing into a decree by some of the tribunes of the people.

SENATUS CONSULTUM, a decree of the Roman senate, pronounced on some question or point of law, which, when passed, made a part of the Roman law. See CIVIL LAW.

SENECIO, *groundsel,* a genus belonging to the class of syngenesia, and to the order of polygamia superflua, and in the natural classification ranked under the 49th order, compositæ. The receptacle is naked; the pappus simple; the calyx cylindrical and calyculated. The scales are equal and contiguous, so as to seem entire; those at the base are few, and have their apices or points decayed. There are 75 species. Of these, seven are British; the vulgaris, viscosus, sylvaticus, crucifolius, jacobæa, paludosus, and saracenicus.

SENTENCE, in grammar, a period or set of words comprehending some perfect sense or sentiment of the mind.

SEPIA, the *cuttle-fish,* a genus belonging to the order of vermes mollusca. There are eight brachia interspersed on the interior side, with little round serrated cups, by the contraction of which the animal lays fast hold of any thing. Besides these eight arms, it has two tentacula longer than the arms, and frequently pedunculated. The mouth is situated in the centre of the arms, and is horny and hooked. The eyes are below the tentacula, towards the body of the animal. The body is fleshy, and received into a sheath as far as the breast. Their food are tunnies, sprats, lobsters and other shell-fish. With their arms and trunks they fasten themselves, to resist the motion of the waves. Their beak is like that of a parrot. The females are distinguished by two paps. They copulate as the polypi do, by a mutual embrace, and lay their eggs upon sea-weed and plants, in parcels like bunches of grapes. Immediately after they are laid they are white, and the males pass over and impregnate them with a black liquor, after which they grow larger. On opening the egg, the embryo cuttle is found alive. The males are very constant, accompany their females every where, face every danger in their defence, and rescue them intrepidly at the hazard of their own lives. The timorous females fly as soon as they see the males wounded. The noise of a cuttle-fish, on being dragged out of the water, resembles the grunting of a hog. When the male is pursued by the sea-wolf, or other ravenous fish, he shuns the danger by stratagem. He squirts his black liquor, sometimesto the quantity of a dram, by which the water becomes black as ink, under shelter of which he baffles the pursuit of his enemy. This ink, or black liquor, has been denominated by M. Le Cat æthiops animal, and is reserved in a particular gland. In its liquid state it resembles that of the choroïd in man, and would then communicate an indelible dye; when dry, it might be taken for the product of the black liquor in negroes dried, and made a precipitate by spirit of wine. This æthiops animal, in negroes as well as in the cuttle-fish, is more abundant after death than even during life. It may serve either for writing or printing; in the former of which ways the Romans used it. It is said to be an ingredient in the composition of Indian ink, mixed with rice. There are five species.

1. The loligo, or great cuttle, with short arms and long tentacula; the lower part of the body rhomboid and pinnated, the upper thick and cylindric. They inhabit all our seas, where having blackened the water by the effusion of their ink, they abscond, and with their tail leap out of the water. They are gregarious, and swift in their motions: they take their prey by means of their arms, and embracing it, bring it to their central mouth. They adhere to the rocks, when they wish to be quiescent, by means of the concave discs that are placed along their arms.

2. The octopodia, with eight arms, connected at their bottom by a membrane. This is the polypus of Pliny, which he distinguishes from the loligo and sepia by the want of the tail and tentacula. They inhabit our seas, but are most at home in the Mediterranean. In hot climates these are found of an enormous size. The Indians affirm that some have been seen two fathoms broad over their centre, and each arm nine fathoms long. When the Indians navigate their little boats, they go in dread of them; and lest these animals should fling their arms over and sink them, they never sail without an ax to cut them off. When used for food they are served up red from their own liquor, which from boiling with the addition of nitre becomes red. Barthol. says, upon cutting one of them open, so great a light broke forth, that at night, upon taking away the candle, the whole hou e seemed to be in a blaze.

3. The media, or middle cuttle, with a long, slender, cylindric body; tail finned, pointed, and carinated on each side; two long tentacula; the body almost transparent, green, but convertible into a dirty brown; confirming the remark of Pliny, that they change their colour through fear, adapting it, chameleon-like, to that of the place they are in. The eyes are large and smaragdine.

4. The sepiola, or small cuttle, with a short body, rounded at the bottom, has a round fin on each side and two tentacula. They are taken off Flintshire, but chiefly inhabit the Mediterranean.

5. The officinalis, or officinal cuttle, with an ovated body, has fins along the whole of the sides, almost meeting at the bottom, and two long tentacula. The body contains the bone, the cuttle-bone of the shops, which was formerly used as an absorbent. The bones are frequently flung on all our shores; the animal very rarely. The conger-eels bite off their arms, or feet, but they grow again, as does the lizard's tail. They are preyed upon by the plaise. This fish emits (in common with the other species), when frightened or pursued, the black liquor which the antients supposed, by darkening the circumambient wave, concealed it from the enemy; and which they sometimes made use of instead of ink.

This animal was esteemed a delicacy among them; and is eaten even at present by the Italians. Rondeletius gives us two receipts for the dressing, which may be continued to this day. Athenæus also leaves us the method of making an antique cuttle-fish sausage; and we learn from Aristotle, that those animals are in highest season when pregnant.

SEPIARIÆ, (from sepes, a hedge), the name of the 44th order of Linnæus's Fragments of a natural Method, consisting of a beautiful collection of woody plants, some of which, from their size and elegance, are very proper furniture for hedges. See Botany.

SEPTARIÆ, in natural history, a large class of fossils, commonly known by the names of ludus helmontii and waxen veins. They are defined to be fossils not inflammable, nor soluble in water; of a moderately firm texture and dusky hue, divided by several septa or thin partitions, and composed of a sparry matter greatly debased by earth; not giving fire with steel; fermenting with acids, and in great part dissolved by them; and calcining in a moderate fire. Of this class there are two distinct orders of bodies, and under those six genera. The septariæ of the first order are those which are usually found in large masses, of a simple uniform construction, but divided by large septa either into larger and more irregular proportions, or into smaller and more equal ones, called talc. The genera of this order are four: 1. Those divided by septa of spar, called secomiæ: 2. Those divided by septa of earthy matter, called gaiophragmia: 3. Those divided by septa of the matter of the pyrites, called pyritercia: and 4. Those divided by septa of spar, with an admixture of crystal, called diaugophragmia. Those of the second order are such as are usually found in smaller masses, of a crustated structure, formed by various incrustations round a central nucleus, and divided by very thin septa. Of this order there are only two genera: 1. Those with a short roundish nucleus, inclosed within the body of the mass: and, 2. Those with a long nucleus, standing out beyond the ends of the mass.

SEPTAS, a genus of plants belonging to the order of heptagynia, and the class of heptandria, and in the natural system ranged under the 13th order, succulentæ. The calyx is divided into seven parts; the petals are seven; the germens seven; the capsules are also seven, and contain many seeds. There is only one species, the capensis, which is a native of the Cape of Good Hope, is round-leaved, and flowers in August or September.

SEPTENTRIO, in astronomy, a constellation more usually called ursa minor. See Astronomy.

SEPTUM. See Anatomy.

SEQUESTRATION, is the separating or setting aside of a thing in controversy from the possession of both those who contend for it. And it is of two kinds, voluntary or necessary; voluntary is that which is done by consent of each party; necessary is that which the judge does of his authority, whether the parties will or not. It is used also for the act of the ordinary disposing of the goods and chattels of one deceased, whose estate no man will meddle with. A sequestration is also a kind of execution for debt, especially in the case of a beneficed clerk, of the profits of the benefices, to be paid over to him that had the judgment till the debt is satisfied.

Sequestration, in the civil law, is used in various senses; it is taken for the act of the ordinary in disposing of the goods of a deceased person, which nobody will meddle with. A widow is said to sequester, when she disclaims having any thing to do with the estate of her deceased husband. Sequestration is also used to signify the gathering up the fruits of a vacant benefice, for the use of the next incumbent of the church.

SEQUESTRO HABENDO, a writ judicial, for dissolving a sequestration of the fruits of a benefice made by a bishop at the king's command, thereby to compel the parson to appear at the suit of another; for the parson upon his appearance may have this writ for the discharge of the sequestration.

SERAPIAS, a genus of plants belonging to the order of diandria, and to the class of gynandria, and in the natural system arranged under the 7th order, orchideæ. The nectarium is egg-shaped and gibbous, with an egg-shaped lip. The species are 14, of which three are natives of Britain. 1. The latifolia, or broad-leaved helleborine. 2. The palustris, or marsh helleborine, grows in rough boggy pastures and marshes, and flowers in July. 3. The grandiflora, or white-flowered helleborine, grows in woods, and flowers in June.

SERGE, in commerce, a woollen stuff manufactured in a loom, of which there are various kinds, denominated either from their different qualities, or from the places where they are wrought; the most considerable of which is the London serge, which is highly valued abroad.

In the manufacture of London serges, the longest wool is chosen for the warp, and the shortest for the woof. But before either kind is used, it is first scoured, by putting it in a copper of liquor, somewhat more than lukewarm, composed of three parts of fair water, and one of urine. After it has staid in it long enough for the liquor to take off the grease, &c. it is stirred briskly about with a wooden peel, taken out, drained, washed in a running water, and dried in the shade; beaten with sticks on a wooden rack, to drive out the coarser dust and filth, and then picked clean with the hands. It is then greased with oil of olives; and the longest wool combed with large combs, heated in a little furnace, for that purpose: to clear it from the oil, it is put into a vessel of hot soap-water, whence being taken out, wrung, and dried, it is spun on the wheel. As to the shorter wool, intended for the woof, it is only carded on the knee, with small fine cords, and then spun on the wheel, without being scoured of its oil: and here it is to be observed, that the thread for the warp is always to be spun finer, and much better twisted, than that of the woof.

The wool both for the warp and woof being spun, and the thread reeled into skains, that of the woof is put on spools, fit for the cavity of the shuttle; and that for the warp is wound on a kind of wooden bobbins, to fit it for warping; and when warped, it is stiffened with a size, usually made of the shreds of parchments; and when dried, put into the loom, and mounted so as to be raised by four treadles, placed under the loom, which the workman makes to act transversely, equally, and alternately, one after another, with his feet; and as the threads are raised, throws the shuttle. See WEAVING.

The serge, on being taken from the loom, is carried to the fuller, who fulls or scours it, in the trough of his mill, with fuller's-earth; and after the first fulling, the knots, ends, straws, &c. sticking out on either side of the surface, are taken off with a kind of pliers or iron pincers, after which it is returned into the fulling-trough, where it is worked with warm water, in which soap has been dissolved; when quite cleared, it is taken out, the knots are again pulled off; it is then put on the tenter to dry; taking care, as fast as it dries, to stretch it out, both in length and breadth, till it is brought to its just dimensions; then being taken off the tenter, it is dyed, shorn, and pressed.

SERGEANT, or SERJEANT, at law, is the highest degree taken in that profession, as that of a doctor is in the civil law. To these serjeants, as men of great learning and experience, one court is set apart for them to plead in by themselves, which is the court of common pleas, where the common law of England is most strictly observed; yet though they have this court to themselves, they are not restrained from pleading in other courts, where the judges (who cannot be elevated to that dignity till they have taken the degree of serjeant at law) call them brothers, and hear them with great respect, next to the king's attorney and solicitor general. These are made by the king's mandate, or writ.

There are also serjeants at arms, whose office is to attend on the person of the king, to arrest persons of condition offending.

SERGEANT, or *Serjeant*, in war, is an inferior officer in a company of foot, or troop of dragoons, armed with a halberd, and appointed to see discipline observed, to teach the soldiers the exercise of their arms, and to order, straighten, and form, ranks, files, &c.

SERJEANTY, signifies in law a service that cannot be due from a tenant to any lord, but to the king only; and it is either grand serjeanty or petit serjeanty.

Grand serjeanty, is a tenure whereby a person holds his lands of the king by such services as he ought to do in person; as to carry the king's banner, or his lance, or to carry his sword before him at his coronation, or to do other like services; and it is called grand serjeanty, because it is a more worthy service than the service in the common tenure of escuage.

Petit serjeanty is where a person holds his land of the king, to furnish him yearly with some small thing towards his wars, as a bow, lance, &c. And such service is but socage in effect, because such tenant by his tenure ought not to go nor do any thing in his proper person.

SERIES, in general, denotes a continued succession of things in the same order, and having the same relation or connection with each other: in this sense we say, a series of emperors, kings, bishops, &c.

SERIES, in mathematics, is a number of terms, whether of numbers or quantities, increasing or decreasing in a given proportion, the doctrine of which has already been given under the article PROGRESSION.

SERIES, *infinite*, is a series consisting of an infinite number of terms, that is, to the end of which it is impossible ever to come; so that let the series be carried on to any assignable length, or number of terms, it can be carried yet farther, without end or limitation.

A number actually infinite (*i. e.* all whose units can be assigned, and yet is without limits) is a plain contradiction to all our ideas about numbers; for whatever number we can conceive, or have any proper idea of, is always determinate and finite; so that a greater after it may be assigned, and a greater after this; and so on, without a possibility of ever coming to an end of the addition or increase of numbers assignable: which inexhaustibility, or endless progression in the nature of numbers, is all we can distinctly understand by the infinity of number; and therefore to say that the number of any things is infinite, is not saying that we comprehend their number, but indeed the contrary; the only thing positive in this proposition being this, that the number of these things is greater than any number which we can actually conceive and assign. But then, whether in things that do really exist, it can be truly said that their number is greater than any assignable number; or, which is the same thing, that in the numeration of their units one after another, it is impossible ever to come to an end; this is a question about which there are different opinions, with which we have no business in this place: for all that we are concerned here to know is this certain truth; that after one determinate number we can conceive a greater, and after this a greater, and so on without end. And therefore, whether the number of any things that do or can really exist all at once, can be such that it exceeds any determinable number, or not, this is true; that of things which exist, or are produced successively one after another, the number may be greater than any assignable one; because, though the number of things thus produced that does actually exist at any time is finite, yet it may be increased without end. And this is the distinct and true notion of the infinity of a series; that is, of the infinity of the number of its terms, as it is expressed in the definition.

Hence it is plain, that we cannot apply to an infinite series the common notion of a sum, viz. a collection of several particular numbers that are joined and added together one after another, for this supposes that these particulars are all known and determined; whereas the terms of an infinite series cannot be all separately assigned, there being no end in the numeration of its parts, and therefore it can have no sum in sense. But again, if we consider that the idea of an infinite series consists of two parts, viz. the idea of something positive and determined, in so far as we conceive the series to be actually carried on; and the idea of an inexhaustible remainder still behind, or an endless addition of terms that can be made to it one after another, this is as different from the idea of a finite series as two things can be. Hence we may conceive it as a whole of its own kind, which therefore may be said to have a total value whether that is determinable or not. Now in some infinite series this value is finite or limited; that is, a number is assignable beyond which the sum of no assignable number of terms of the series can ever reach, nor indeed ever be equal to it, yet it may approach to it in such a manner as to want less than any assignable difference; and this we may call the value or sum of the series; not as being a number found by the common method of addition; but as being such a limitation of the value of the series, taken in all its infinite capacity, that if it were possible to add them all one after another, the sum would be equal to this number.

Again, in other series the value has no limitation; and we may express this, by saying the sum of the series is infinitely great; which indeed signifies no more than that it has no determinate and assignable value; and that the series may be carried such a length that its sum, so far, shall be greater than any given number. In short, in the first case we affirm there is a sum, yet not a sum taken in the common sense; in the other case we plainly deny a determinate sum to any sense.

Theorem I. In an infinite series of numbers, increasing by an equal difference or ratio (that is, an arithmetical or geometrical increasing progression) from a given number, a term may be found greater than any assignable number.

Hence, if the series increases by differences that continually increase, or by ratios that continually increase, comparing each term to the preceding, it is manifest that the same thing must be true, as if the differences or ratios continued equal.

Theorem II. In a series decreasing in infinitum in a given ratio, we can find a term less than any assignable fraction.

Hence, if the terms decrease, so as the ratios of each term to the preceding do also continually decrease, then the same thing is also true as when they continue equal.

Theor. III. The sum of an infinite series of numbers all equal, or increasing continually, by whatever differences or ratios, is infinitely great; that is, such a series has no determinate sum but grows so as to exceed any assignable number.

Demons. 1. If the terms are all equal, as $A : A : A$, &c. then the sum of any finite number of them is the product of A by that number, as An; but the greater n is, the greater is An; and we can take n greater than any assignable number, therefore An will be still greater than any assignable number.

Secondly, suppose the series increase continually (whether it does so infinitely or limitedly), then its sum must be infinitely great, because it would be so if the terms continued all equal, and therefore will be more so since they increase. But if we suppose the series increases infinitely, either by equal ratios or differences, or, by increasing differences or ratios of each term to the preceding; then the reason of the sums being infinite will appear from the first theorem; for in such a series, a term can be found greater than any assignable number, and much more therefore the sum of that and all the preceding.

Theor. IV. The sum of an infinite series of numbers decreasing in the same ratio is a finite number, equal to the quote arising from the division of the product of the ratio and first term, by the ratio less by unity; that is, the sum of no assignable number of terms of the series can ever be equal to that quote; and yet no number less than it is equal to the value of the series, or to what we can actually determine in it; so that we can carry the series so far, that the sum shall want of this quote less than any assignable difference.

Demonstration. To whatever assigned number of terms the series is carried, it is so far finite; and if the greatest term is l, the least A, and the ratio r, then the sum is $S = \frac{rl - \text{A}}{r-1}$. See Geometrical Progression.

Now, in a decreasing series from l, the more terms we actually raise, the last of them, A, becomes the lesser, and the lesser A be, $rl - \text{A}$ is the greater, and so also is $\frac{rl-\text{A}}{r-1}$: but rl—A being still less than rl, therefore $\frac{rl-\text{A}}{r-1}$ is still less than $\frac{rl}{r-1}$, that is, the sum of any assignable number of terms of the series is still less than the quote mentioned, which is, $\frac{rl}{r-1}$, and this is the first part of the theorem.

Again: The series may be actually continued so far, that $\frac{rl-\text{A}}{r-1}$ shall want of $\frac{rl}{r-1}$ less than any assignable difference; for, as the series goes on, A becomes less and less in a certain ratio, and so the series may be actually continued till A becomes less than any assignable number (by Theorem II.). Now $\frac{rl}{r-1} - \frac{rl-\text{A}}{r-1} = \frac{\text{A}}{r-1}$, and $\frac{\text{A}}{r-1}$ is less than A; therefore, let any number assigned be called N, we can carry the series so far till the last term A is less than N; and because $\frac{rl-\text{A}}{r-1}$ wants of $\frac{rl}{r-1}$, the difference $\frac{\text{A}}{r-1}$, which is less than A, which is also less than N, therefore the second part of the theorem is also true, and $\frac{rl}{r-1}$ is the true value of the series.

Scholium. The sense in which $\frac{rl}{r-1}$ is called the sum of the series, has been sufficiently explained; to which, however, we shall add this; that whatever consequences follow from the supposition of $\frac{rl}{r-1}$ being the true and adequate value of the series taken in all its infinite capacity, as if the whole were actually determined and added together, can never be the occasion of any assignable error in any operation or demonstration where it is used in that sense; because if it is said that it exceeds that adequate value, yet it is demonstrated that this excess must be less than any assignable difference, which is in effect no difference, and so the consequent error will be in effect no error: for if any error can happen from $\frac{rl}{r-1}$ being greater than it ought to be, to represent the complete value of the infinite series, that error depends upon the excess of $\frac{rl}{r-1}$ over that complete value; but this excess being unassignable, that consequent error must be so too; because still the less the excess is, the less will the error be that depends upon it. And for this reason we may justly enough look upon $\frac{rl}{r-1}$ as expressing the adequate value of the infinite series. But we are farther satisfied of the reasonableness of this, by finding in fact, that a finite quantity does actually convert into an infinite series, which happens in the case of infinite decimals. For example, $\frac{2}{3} = .6666$, &c. which is plainly a geometrical series from $\frac{6}{10}$ in the continual ratio of 10 to 1; for it is $\frac{6}{10} + \frac{6}{100} + \frac{6}{1000} + \frac{6}{10000}$, &c.

And reversely; if we take this series, and find its sum by the preceding theorem, it comes to the same $\frac{2}{3}$; for $l = \frac{6}{10}$, $r = 10$, therefore $rl = \frac{60}{10} = 6$; and $r - 1 = 9$; whence $\frac{rl}{r-1} = \frac{6}{9} = \frac{2}{3}$.

We have added here a table of all the varieties of determined problems of infinite, decreasing, geometrical progressions, which all depend upon these three things, viz. the greatest term l, the ratio r, and the sum S; by any two of which the remaining one may be found: to which we have added some other problems, wherein S — L is considered as a thing distinct by itself, that is, without considering S and L separately.

Given	Sought		Or supposing the ratio $\frac{a}{b}$ or the second term to be M, whereby the ratio is $\frac{l}{\text{M}}$, then is	Solutions.
rl	s,	$s = \frac{rl}{r-1}$		$s = \frac{a}{a-b}$ of $l = \frac{l^2}{l-\text{M}}$
rs	l,	$l = \frac{s \times \overline{r-1}}{r}$		$l = \frac{a-b}{a}$ of $s = \frac{\overline{l-\text{M}} \times s}{l}$
ls	r,	$r = \frac{s}{s-l}$ }		
lr	$s-l$,	$s - l = \frac{l}{r-1}$		$s - l = \frac{b}{a-b}$ of $l = \frac{\text{M}l}{l-\text{M}}$
sr	$s-l$,	$s - l = \frac{s}{r}$		$s - l = \frac{b}{a}$ of $s = \frac{\text{M}s}{l}$
$r.s-l$	s, l,	$\left\{ \begin{array}{l} s = \overline{s-l} \times r \\ l = \overline{s-l} \times \overline{r-1} \end{array} \right\}$		$s = \frac{a}{b}$ of $s - l = \frac{l \times \overline{s-1}}{\text{M}}$ $l = \frac{a-b}{b}$ of $s - l = \frac{\overline{l-\text{M}} \times \overline{s-l}}{\text{M}}$

Theorem V. In the arithmetical progression 1, 2, 3, 4, &c. the sum is to the product of the last term, by the number of terms, that is, to the square of the last term, in a ratio always greater than 1 : 2, but approaching infinitely near it. But if the arithmetical series begins with 0, thus, 0, 1, 2, 3, 4, &c then the sum is to the product of the last term, by the number of terms, exactly in every step as 1 to 2.

Theorem VI. Take the natural progression beginning with 0, thus, 0, 1, 2, 3, &c and take the squares of any the like powers of the former series; as the squares, 0, 1, 4, 9, &c. or cubes, 0, 1, 8, 27; and then again take the sum of the series of powers to any number of terms, and also multiply the last of the terms summed by the number of terms, (reckoning always 0 for the first term;) the ratio of that sum to that product is more than $\frac{1}{n \times 1}$, (n being the index of the powers) that is, in the series of squares it is more than $\frac{1}{3}$; in the cubes more than $\frac{1}{4}$ and so on. But the series going on *in infinitum*, we may take in more and more terms without end into the sum; and the more we take, the ratio of the sum to the product mentioned grows less and less; yet so as it never can actually be equal to $\frac{1}{n \times 1}$, but approaches infinitely near to it, or within less than any assignable difference.

SERIOLA, a genus of plants belonging to the order of polygamia æqualis, and to the class of syngenesia, and in the natural system ranged under the 49th order, compositæ. The receptacle is paleaceous; the calyx simple; and the pappus is somewhat plumose. There are four species: 1. The levigata: 2. Æthnensis: 3. Cretensis: 4. Urens. The first is a native of the island of Candia, and flowers in July and August; the second is a native of Italy; and the fourth is a native of the south of Europe.

SERIPHIUM, a genus of plants belonging to the order of monogamia, and to the class of syngenesia. The calyx is imbricated; the corolla is monopetalous and regular, with one oblong seed under it. There are four species, natives of the Cape of Good Hope.

SERPENS. See Astronomy.

SERPENTES, in natural history, an order of the amphibia class, the characteristics of which are, a mouth breathing by the lungs only; body tapering; neck not distinct; jaws dilatable, not articulate; no feet, fins, or ears: motion undulatory. They are cast naked upon the earth, without limbs, exposed to every injury, but frequently armed with a poison the most deadly and horrible, which is contained in tubular fangs resembling teeth, placed without the upper jaw, protruded or retracted at pleasure, and surrounded with a glandular vesicle, by which this fatal fluid is secreted. (See POISONS.) But lest this tribe should too much encroach upon the limits of other animals, the benevolent Author of Nature has armed only about a fifth in this dreadful manner. The jaws are dilatable and not articulate, and the œsophagus so lax, that they can swallow without mastication, an animal twice or thrice as large as the neck. There are seven genera, viz. the

Achrochordus	Coecilia
Amphisbæna	Coluber
Anguis	Crotalus.
Boa	

The distinction of species in this numerous tribe is often peculiarly difficult. Linnæus persuaded himself that an infallible criterion might be found in the number of scaly plates on the abdomen and beneath the tail; and accordingly attempted in the Systema Naturæ to discriminate the species by this mark alone. Experience, however, has sufficiently shown that, though often highly useful in the investigation of these animals, it is yet by much too uncertain and variable to be permitted to stand as an established specific test.

The distinction of serpents into poisonous and innoxious can only be known by an accurate examination of their teeth; the fangs or poisoning teeth being always of a tubular structure, and calculated for the conveyance or injection of the poisonous fluid from a peculiar reservoir communicating with the fangs on each side of the head: the fangs are always situated in the anterior and exterior part of the upper jaw, and are generally, but not always, of much larger size than the other teeth; they are also frequently accompanied by some smaller or subsidiary fangs, apparently destined to supply the principal ones when lost, either by age or accident. The fangs are situated in a peculiar bone, so articulated with the rest of the jaw as to elevate or depress them at the pleasure of the animal. In a quiescent state they are recumbent, with their points directed inwards or backwards; but when the animal is inclined to use them as weapons of offence, their position is altered by the peculiar mechanism of the above-mentioned bone in which they are rooted, and they become almost perpendicular.

A general rule for the determination of the existence or non-existence of these organs in any species of serpent is proposed in a paper relative to the amphibia by Dr. Gray, and published in the Philosophical Transactions for the year 1788. The fangs, according to Dr. Gray, may be distinguished with great ease, and, as he believes also, with great certainty, by the following simple method. When it is discovered that there is something like teeth in the anterior and exterior part of the upper jaw, which situation he considers as the only one in which venomous fangs are ever found, let a pin or other hard body be drawn from that part of the jaw to the angle of the mouth; (which operation may, for greater certainty, be tried on each side.) If no more teeth are felt in that line, it may, he thinks, be fairly concluded, that those first discovered are fangs, and that the serpent is consequently venomous: if, on the contrary, the teeth first discovered are observed not to stand alone, but to be only a part of a complete row, it may as certainly be concluded that the serpent is not venomous. This rule, however, like most others, may have its exceptions, and perhaps the most legitimate test of real fangs in a serpent is their tubular structure, which may always be easily detected by the assistance of a proper magnifier. It is to be observed, that all serpents, whether poisonous or not, have besides the teeth, (whether fangs or simple teeth) in the sides of the upper jaw, two additional or interior rows, which are generally much smaller than the rest, and frequently scarcely visible: the general rule, therefore, is, that all venomous serpents have only two rows of true or proper teeth in the upper jaw, and that all others have four.

A head entirely covered with small scales is in some degree a character, but by no means an universal one, of poisonous serpents; as are also carinated scales on the head and body, or such as are furnished with a prominent middle line.

All serpents are in the habit of casting their skin at certain periods; in temperate regions annually; in the warmer perhaps more frequently. The serpents of the temperate and cold climates also conceal themselves, during the winter, in cavities beneath the surface of the ground, or in any other convenient places of retirement, and pass the winter in a state more or less approaching, in the different species, to complete torpidity. It may be added, that some serpents are viviparous, as the rattlesnake, the viper, and many others of the poisonous kind, while the common snake, and probably the major part of the innoxious serpents, are oviparous, depositing their eggs in a kind of string or chain in any warm and close situation, where they are afterwards hatched.

The broad undivided laminæ or scaly plates on the bellies of serpents are termed scuta, and the smaller or divided plates beneath the tail are called squamæ subcaudales, or subcaudal scales; and from these different kinds of laminæ the Linnæan genera of serpents are chiefly instituted.

SERPENTARIUS. See ASTRONOMY.

SERPENTINE, a mineral found in amorphous masses, forming strata, and even entire mountains. Its fracture is splintery, sometimes conchoidal. Specific gravity 2.57 to 2.71; feels soft and almost greasy; generally emits an earthy smell when breathed on. Its colours are various shades of green, yellow, red, grey, brown, and blue: commonly one or two colours form the ground, and one or more appear in spots or veins. Before the blowpipe it hardens, but does not melt. According to Mr. Chenevix it contains

34.5	magnesia
28.0	silica
23.0	alumina
4.5	oxide of iron
0.5	lime
10.5	water
101.0	

SERPICULA, a genus of plants belonging to the class of monœcia, and to the order of tetrandria. The male calyx is quadridentate, and the corolla consists of four petals. The female calyx is divided into four parts, and the pericarpium is a tomentose nut. There are two species, the verticillata and repens.

SERPULA, a genus of insects of the order vermes testacea. The generic character is: animal a terebella; shell univalve, tubular generally adhering to other substances; often separated internally by divisions at uncertain distances. There are 48 species.

SERRATULA, *saw-wort*, a genus of plants belonging to the class of syngenesia, and to the order of polygamia æqualis. In the natural system it is ranged under the 49th order, compositæ. The calyx is subcylindrical, imbricated; the scales of it pointed, but not spinous. There are 20 species: 1. The tinctoria, grows in woods and wet pastures. It dyes cloth of an exceedingly fine yellow colour, which stands well when fixed with alum. Goats eat this plant; horses are not fond of it; cattle, swine, and sheep, leave it untouched. 2. The alpina, or mountain saw-wort, grows on high mountains, and flowers commonly in July or August. 3. The arvensis, corn saw-wort, or way-thistle, grows in cultivated grounds and by way-sides, and flowers in July or August. When burned, it yields good ashes for making glass or fixed alkali.

SERROPALPUS, a genus of insects of the order coleoptera: the generic character is, antennæ setaceous; feelers four, unequal; the anterior ones longer deeply serrate, composed of four joints, the last joint very large, truncate, compressed, potelliform; the posterior ones subclavate: thorax margined, concealing the head, with a prominent angle on each side; head deflected; feet formed for digging. There are two species: the striatus is found on old wooden buildings in the evening in autumn.

SERTULARIA, in natural history, a genus belonging to the class of vermes, and to the order of zoophyta. The stem is radicated, fibrous, naked, and jointed; the florets are hydræ, and there is one each joint. This genus comprehends 42 species of corallines.

SERVANT. See MASTER AND SERVANT

SERVICE, in law, is a duty which a tenant, on account of his fee, formerly owed to his lord.

SERUM, a thin transparent liquor, which makes a considerable part in the mass of blood.

The specific gravity of human blood is, at a medium, 1.0527. Mr. Fourcroy found the specific gravity of bullock's blood, at the temperature of 60°, to be 1.056. The blood does not uniformly retain the same consistence in the same animal, and its consistence in different animals is very various. It is easy to see that its specific gravity must be equally various.

When blood, after being drawn from an animal, is allowed to remain for some time at rest, it very soon coagulates into a solid mass of the consistence of curdled milk. This mass gradually separates into two parts; one of which is fluid, and is called serum; the other the coagulum, has been called cruor, because it alone retains the red colour which distinguishes blood. This separation is very similar to the separation of curdled milk into curds and whey.

The proportion between the cruor and serum of the blood varies much in different animals, and even in the same animal in different circumstances. The most common proportion is about one part of cruor to three parts of serum; but in many cases the cruor exceeds or falls short of this quantity; the limits of the ratios of these substances to each other appear, from a comparison of the conclusions of most of those who have written accurately on the subject, to be 1 : 1 and 1 : 4; but the first case must be very rare indeed.

The cause of this spontaneous decomposition of blood has not hitherto been ascertained. The coagulation takes place equally in close vessels and in the open air, whether the blood is allowed to cool, or is kept at the temperature at which it issues from the animal; neither is the coagulation prevented by diluting it with water.

1. The serum is of a light greenish-yellow colour; it has the taste, smell, and feel, of the blood, but its consistence is not so great. Its mean specific gravity is about 1.0287. It converts syrup of violets to a green, and therefore contains an alkali. On examination, Rouelle found that it owes this property to a portion of soda. When heated to the temperature of 156°, the serum coagulates, as Harvey first discovered. It coagulates also when boiling water is mixed with it; but if serum is mixed with six parts of cold water, it does not coagulate by heat. When thus coagulated, it has a greyish-white colour, and is not unlike the boiled white of an egg. If the coagulum is cut into small pieces, a muddy fluid may be squeezed from it, which has been termed the serosity. After the separation of this fluid, if the residuum is carefully washed in boiling water and examined, it will be found to possess all the properties of coagulated albumen. The serum, therefore, contains a considerable proportion of albumen. Hence its coagulation by heat, and the other phenomena which albumen usually exhibits.

If serum is diluted with six times its weight of water, and then boiled to coagulate the albumen, the liquid which remains after the separation of the coagulum, if it is gently evaporated till it becomes concentrated, and then is allowed to cool, assumes the form of a jelly, as was first observed by De Haen. Consequently it contains gelatine.

If the coagulated serum is heated in a silver vessel, the surface of the silver becomes black, being converted into a sulphuret. Hence it is evident that it contains sulphur; and Proust has ascertained that it is combined with ammonia in the state of a hydrosulphuret.

If serum is mixed with twice its weight of water, and after coagulation by heat, the albumen is separated by filtration, and the liquid slowly evaporated till it is considerably concentrated, a number of crystals are deposited when the liquid is left standing in a cool place. These crystals, first examined by Rouelle, consist of carbonat of soda, muriat of soda, besides phosphat of soda and phosphat of lime. The soda exists in the blood in a caustic state, and seems to be combined with the gelatine and albumen. The carbonic acid combines with it during evaporation.

Thus it appears that the serum of the blood contains albumen, gelatine, hydrosulphuret of ammonia, soda, muriat of soda, phosphat of soda, and phosphat of lime. These component parts account for the coagulation occasioned in the serum by acids and alcohol, and the precipitation produced by tan, acetat of lead, and other metallic salts.

With respect to the other part, the cruor, or clot, as it is sometimes called, is of a red colour, and possesses considerable consistence. Its mean specific gravity is about 1.245. If this cruor is washed carefully by letting a small jet of water fall upon it till the water runs off colourless, it is partly dissolved, and partly remains upon the searce. Thus it is separated into two portions, viz. (1.) A white, solid, elastic substance, which has all the properties of fibrina. 2. The portion held in solution by the water, which consists of the colouring matter, not however in a state of purity, for it is impossible to separate the cruor completely from the serum.

We are indebted to Bucquet for the first precise set of experiments on this last watery solution. It is of a red colour. Bucquet proved that it contained albumen and iron. Menghini had ascertained, that if blood is evaporated to dryness by a gentle heat, a quantity of iron may be separated from it by the magnet. The quantity which he obtained was considerable; according to him, the blood of a healthy man contains above two ounces of it. Now, as neither the serum nor the fibrina extracted from the cruor contains iron, it follows of course, that the water holding the colouring matter in solution must contain the whole of that metal.

This watery solution gives a green colour to syrup of violets. When exposed to the air, it gradually deposits flakes, which have the properties of albumen. When heated, a brown-coloured scum gathers on its surface. If it is evaporated to dryness, and then mixed with alcohol, a portion is dissolved; and the alcoholic solution yields by evaporation a residuum, which lathers like soap in water, and tinges vegetable blues green; the acids occasion a precipitate from its solution. This substance is a compound of albumen and soda. Thus we see that the watery solution contains albumen, iron, and soda.

Fourcroy and Vauquelin have ascertained that the iron is combined with phosphoric acid, and in the state of subphosphat of iron; thus confirming an opinion which had been maintained by Sage, and announced as a fact by Gren. If the residuum obtained by evaporating the watery solution of the colouring matter of blood to dryness is burnt in a crucible, there will remain a deep-red ferruginous substance, amounting to 0.045 of the blood employed. Nitric acid digested on this residuum dissolves a portion, which is phosphat of iron, and is precipitated white by ammonia, but assumes a red colour when treated with pure potass. When lime-water is poured into the potass employed, phosphat of lime precipitates. By this treatment they ascertained, that $\frac{19}{26}$ of the residuum consisted of subphosphat of iron. Now phosphat of iron is soluble in acids, but insoluble in water; when treated with pure alkalies, it loses a portion of its acid, assumes a red colour, and is converted into subphosphat. Hence it is evidently the soda of the blood which reduces it to that state, or at least maintains it in that state. Subphosphat of iron readily dissolves in albumen and in serum.

When new-drawn blood is stirred briskly round with a stick, or the hand, the whole of the fibrina collects together upon the stick, and in this manner may be separated altogether from the rest of the blood. The red globules, in this case, remain behind in the serum. It is in this manner that the blood is prepared for the different purposes to which it is put; as clarifying sugar, making puddings, &c. After the fibrina is thus separated, the blood no longer coagulates when allowed to remain at rest, but a spongy flaky matter separates from it, and swims on the surface.

When blood is dried by a gentle heat, water exhales from it, retaining a very small quantity of animal matter in solution, and consequently having the odour of blood. Blood dried in this manner being introduced into a retort and distilled, there comes over first a clear watery liquor, then carbonic acid gas, and carbonat of ammonia, which crystallizes in the neck of the retort; after these products there come over a fluid oil, carbonated hydrogen gas, and an oily substance of the consistence of butter. The watery liquor possesses the property of precipitating from sulphat of iron a green powder: muriatic acid dissolves part of this powder, and there remains behind a little Prussian blue. Consequently this watery liquor contains both an alkali and prussic acid.

9216 grains of dried blood being put into a large crucible, and gradually heated, at first became nearly fluid, and swelled up considerably, emitted a great many fetid fumes of a yellowish colour, and at last took fire and burned with a white flame, evidently owing to the presence of oil. After the flame and the fumes had disappeared, a light smoke was emitted, which affected the eyes and the nose; it had the odour of prussic acid, and reddened moist paper stained with vegetable blue. At the end of six hours, when the matter had lost five-sixths of its substance, it melted anew, exhibited a purple flame on its surface, and emitted a thick smoke. This smoke affected the eyes and nostrils, and reddened blue paper, but it had not the smell of prussic acid. When a quantity of it was collected and examined, it was found to possess the properties of phosphoric acid. The residuum amounted to 181 grains; it had a deep-black colour, and a metallic brilliancy; and its particles were attracted by the magnet. It contained no uncombined soda, though the blood itself, before combustion, contains it abundantly; but water extracted from it muriat of soda; part of the remainder was dissolved by muriatic acid, and of course was lime; there was besides a little silica, which had evidently been separated from the crucible. The iron had been reduced during the combustion.

Such are the properties of blood, as far as they have been hitherto ascertained by experiment. We have seen that it contains the following ingredients:

1. Water,
2. Fibrina,
3. Albumen,
4. Gelatine,
5. Hydrosulph. of ammonia,
6. Soda,
7. Subphosphat of iron,

8. Muriat of soda,
9. Phosphat of soda,
10. Phosphat of lime.

Besides benzoic acid, which has been detected by Proust.

But our knowledge of this singular fluid is by no means so complete as it ought to be; a more accurate analysis would probably discover the presence of other substances, and enable us to account for many of the properties of blood which at present are inexplicable.

SESAMUM, *oily grain*, a genus of plants belonging to the class of didynamia, and to the order of angiospermia, and in the natural system ranging under the 20th order, luridæ. The calyx is divided into five parts. The corolla is companulated, the tube of which is nearly the length of the calyx; the throat is inflated, and very large; the border is divided into five parts, four of which are spreading and nearly equal; the fifth is the lowest and largest. There are four filaments, and the rudiments of a fifth. The stigma is lanceolated, and the capsule has four cells. There are only three species, the orientale, indicum, and luteum. 1. The orientale has ovate, oblong, entire leaves. It is an annual, and grows naturally on the coast of Malabar and in the island of Ceylon; rising with an herbaceous four-cornered stalk, two feet high, sending out a few short side-branches. After the flowers are past, the germen turns to an oval acute-pointed capsule, with four cells, filled with oval compressed seeds, which ripen in autum. 2. The indicum, with trifid lower leaves, grows naturally in India: this is also an annual plant; the stalk rises taller than that of the former; the lower leaves are cut into three parts, which is the only difference between them. The first sort is frequently cultivated in all the eastern countries, and also in Africa, as a pulse; and of late years the seeds have been introduced into Carolina by the African negroes, where they succeed extremely well. The inhabitants of that country make an oil from the seed, which will keep good for many years, without having any rancid smell or taste, but in two years become quite mild; so that when the warm taste of the seed, which is in the oil when first drawn, is worn off, they use it as a sallad-oil, and for all the purposes of sweet oil. The seeds of this plant are also used by the negroes for food; which seeds they parch over the fire, and then mix them with water, and stew other ingredients with them, which makes a hearty food. Sometimes a sort of pudding is made of these seeds, in the same manner as with millet or rice, and is by some persons esteemed, but is rarely used for these purposes in Europe.

From nine pounds of this seed which came from Carolina, there were upwards of two quarts of oil drawn, which is as great a quantity as has been obtained from any vegetable whatever. This might occasion its being called the oily grain.

SESELI, *meadow-saxifrage*, a genus of plants belonging to the class of pentandria, and to the order of digynia, and in the natural system ranging under the 45th order, umbellatæ. The umbels are globular; the involucrum consists of one or two leaflets; the fruit is egg-shaped and streaked. There are fifteen species. The montanum grows naturally in France and Italy; the glaucum is a native of France; the ammoides and tortuosum grow in the south of Europe; and the hyppomarathrum is a native of Austria.

SESSION, in law, denotes a sitting of justices in court upon their commission: as the session of oyer and terminer, &c.

SESSIONS, *quarter*. The session of the peace is a court of record holden before two or more justices, whereof one is of the quorum, for the execution of the authority given them by the commission of the peace, and certain statutes and acts of parliament.

The justices shall keep their sessions in every quarter of the year at least, and for three days if need be; to wit, in the first week after the feast of St. Michael, in the first week after the Epiphany, in the first week after Easter, and in the first week after St. Thomas, and oftener if need be.

Any two justices, one whereof is of the quorum, by the words of the commission of the peace, may issue their precept to the sheriff to summon a session for the general execution of their authority; and such session, holden at any time within that quarter of a year, is a general quarter-session. 4 Burn, 181. And such precept should bear teste, or be dated, fifteen days before the return. Nels. Intr. 35.

The sheriff also shall cause a jury to appear at such days and places as the said justices, or such two or more of them as aforesaid, shall appoint.

There are many offences, which, by particular statutes, belong properly to this jurisdiction, and ought to be prosecuted in this court: as the smaller misdemeanors against the public or commonwealth, not amounting to felony; and especially offences relating to the game, highways, alehouses, bastard children, the settlement and provision of the poor, vagrants, servants' wages, apprentices, and popish recusants. Some of these are proceeded upon by indictment; and others in a summary way, by motion and order thereupon; which order may, for the most part, unless guarded against by any particular statute, be removed into the court of king's bench by certiorari, and be there either quashed or confirmed.

SESSIONS *for weights and measures*. In London, four justices from among the mayor, recorder, and aldermen, (of which the mayor or recorder to be one) may hold a session to enquire into offences of selling by false weights and measures, contrary to the statutes; and to receive indictments, punish the offenders, &c.

SESTERCE, a silver coin in use among the Romans. See COIN.

Some authors make two kinds of sesterces: the less, called sestertius, in the masculine gender; and the great one, called sestertium, in the neuter, the latter containing a thousand of the former.

Sesterce, or sestertius, was also used by the antients for a thing containing two wholes and a half of another, as *as* was taken for any whole or integer.

SESUVIUM, a genus of plants belonging to the class of icosandria, and to the order of trigynia. The calyx is coloured, and divided into five parts; there are no petals; the capsule is egg-shaped, three-celled, opening horizontally about the middle, and containing many seeds. There is only one species, the portulacastrum, purslane-leaved sesuvium, which is a native of the West Indies.

SET-OFF, is when the defendant acknowledges the justice of the plaintiff's demand on the one hand, but on the other sets up a demand of his own to counterbalance that of the plaintiff, either in the whole, or in part: as if the plaintiff sues for 10*l*. due on a note of hand, the defendant may set-off 9*l*. due to himself for merchandize sold to the plaintiff. 3 Black. 304.

The action in which a set-off is allowable upon the statutes 2 and 8 G. II. c. 22 and 24, are debt, covenant, and assumpsit, for the non-payment of money; and the demand intended to be set-off, must be such as might have been made the subject of one or other of these actions. A set-off, therefore, is never allowed in actions upon the case, trespass, replevin, &c. nor of a penalty, in debt on bond conditioned for the performance of covenants, &c. nor of general damages in covenant or assumpsit; but where a bond is conditioned for the payment of an annuity, a set-off may be allowed. A debt barred by the statute of limitations, cannot be set-off; and if it is pleaded in bar to the action, the plaintiff may reply the statute of limitations; or if given in evidence, on a notice of set-off, it may be objected to at the trial. Tidd's Pract. K. B.

SETON. See SURGERY.

SETTING, in the sea-language. To set the land or the sun by the compass, is to observe how the land bears on any point of the compass, or on what point of the compass the sun is. Also when two ships sail in sight of one another, to mark on what point the chased bears, is termed setting the chase by the compass.

SEVENTH, *septima*, in music. A dissonant interval called by the Greeks heptachordon, because it is formed of seven sounds, or six diatonic degrees. There are four kinds of sevenths. The minor seventh, composed of four tones (three majors and one minor), and two major semitones; the major seventh, composed diatonically of five tones (three majors and two minors), and a major semitone; the diminished seventh, consisting of three tones (two minors and one major), and three major semitones; and the superfluous seventh, containing five tones (three minors and two majors), a semitone major, and a semitone minor.

SEWER, a passage or gutter made to carry water into the sea or a river, whereby to preserve the land, &c. from inundations and other annoyances. The business of the commissioners of sewers, or their office in particular, is to repair sea-banks and walls, survey rivers, public streams, ditches, &c. and to make orders for that purpose.

These commissioners have likewise authority to make enquiry of all nuisances or offences committed by the stopping of rivers, erecting mills, not repairing banks, bridges, &c. and to tax persons chargeable for the amending of defaults that tend to the obstruction or hindrance of the free passage of the water through its antient courses. They may not only make a rate and assessment for repairs, but also may decree lands to be sold, in order to levy charges assessed, upon nonpayment thereof, &c. But the decrees of the commissioners are to be certified into chancery, and have the king's assent, to be bind-

4

ing, and their proceedings are subject to the jurisdiction of the king's bench. In the making of a rate or tax, the commissioners are to assess every owner or possessor of lands in danger of receiving any damage by the waters, equally according to the quality of their lands, rents, and numbers of acres, and their respective portions and profits, whether it is of pasture, fishing, &c. And where no persons or lands can be known that are liable to make repairs of banks and sewers, then the commissioners are to rate the whole level. The 3. Jac. I. ordains that all ditches, banks, bridges, and water-houses, within two miles of London, adjoining to, and falling into the Thames, shall be subject to the commissioners of sewers. Also the lord-mayor, &c. may appoint persons in that case to have the power of commissioners of sewers. Persons breaking down sea-banks, whereby lands are damaged, are adjudged to be guilty of felony; and removing piles, &c. forfeit twenty pounds by 6 and 10 Geo. II. c. 32.

SEXAGESIMALS, or SEXAGESIMAL FRACTIONS, fractions whose denominators proceed in a sexagecuple ratio; that is, a prime, or the first minute, $=\frac{1}{60}$; a second $=\frac{1}{3600}$; a third $=\frac{1}{216000}$.

Antiently there were no other than sexagesimals used in astronomy, and they are still retained in many cases, though decimal arithmetic begins to grow in use now in astronomical calculations. In these fractions, which some call astronomical fractions, the denominator being always sixty, or a multiple thereof, is usually omitted, and the numerator only written down, thus, 4°, 59′, 32″, 50‴, 16⁗, is to be read four degress, fifty-nine minutes, thirty-two seconds, fifty thirds, sixteen fourths, &c.

SEXANGLE, in geometry, a figure having six sides, and consequently six angles.

SEXTANS, a sixth part of certain things. The Romans having divided their *as* into twelve ounces, or unica, the sixth part of that, or two ounces, was the sextans.

Sextans was also a measure which contained two ounces of liquor, or two cyathi. See MEASURE.

SEXTANT, in mathematics, denotes the sixth part of a circle, or an arch comprehending sixty degrees.

The word sextant is more particularly used for an astronomical instrument made like a quadrant, excepting that its limb only comprehends sixty degrees. The use and application of the sextant is the same with that of the quadrant. See QUADRANT.

SEXTON, a church-officer, whose business is to take care of the vessels, vestments, &c. belonging to the church, and to attend the minister, churchwardens, &c. at church. He is usually chosen by the parson only.

SEXTUPLE, *sestuplo*, in music, denotes a mixed sort of triple which is beaten in double time, now called compound common time.

SHADOW, in optics, a privation or diminution of light, by the interposition of an opake body; or it is a plane where the light is either altogether obstructed, or greatly weakened, by the interposition of some opake body between it and the luminary. See OPTICS.

SHADOW. See GEOGRAPHY.

SHAFT *of a column*, in building, is the body thereof between the base and capital so called from its straightness.

SHAGREEN, or CHAGREEN, in commerce, a kind of grained leather, prepared, as is supposed, of the skin of a species of squalus, or hound-fish, called the shagree, or shagrain, and much used in covering cases, books, &c.

It is imported from Constantinople, Tauris, Tripoli, Algiers, and from some parts of Poland, where it is prepared in the following manner: the skin being stretched out is first covered over with mustard-seed, which is bruised upon it; and being thus exposed to the weather for some days, it is then tanned.

The best is of a brownish colour, as the white sort is the worst. It is extremely hard; yet, when steeped in water, it becomes soft and pliable; and being fashioned into case-covers, it readily takes any colour, as red, green, yellow, black, according to the fancy of the workman.

SHAKLES, in a ship, are the rings with which the ports are shut fast, by lashing the port-bar to them. There are also shakles put upon bilbow-bolts, for confining the men who have deserved corporal punishment.

SHAMBLES, among miners, a sort of niches, or landing-places, left at such distances in the adits of mines, that the shovelmen may conveniently throw up the ore from shamble to shamble, till it comes to the top of the mine.

SHAMMY, or CHAMOIS LEATHER, a kind of leather dressed either in oil or tanned, and much esteemed for its softness, pliancy, and being capable of bearing soap without hurt.

The real shammy is prepared of the skin of the chamois-goat.

The true chamois leather is counterfeited with common goat, kid, and even sheep-skin; the practice of which makes a particular profession, called by the French chamoisure. The last is the least esteemed, yet so popular, and such vast quantities prepared, especially about Orleans, Marseilles, and Tholouse, that it may not be amiss to give the method of preparation.

The manner of chamoising, or of preparing sheep, goat, or kid-skins in oil, in imitation of chamois:

The skins being washed, drained, and smeared over with quick-lime, on the fleshy side, are folded in two, lengthwise, the wool outwards, and laid on heaps, and so left to ferment eight days; or if they had been left to dry after flaying, for fifteen days.

Then they are washed out, drained, and half-dried, laid on a wooden leg or horse, the wool stripped off with a round staff for the purpose, and laid in a weak pit, the lime whereof had been used before, and had lost the greatest part of its force.

After twenty-four hours they are taken out, and left to drain twenty-four more; then put into another strong pit. This done, hey are taken out, drained, and put in again by turns; which begins to dispose them to take oil; and this practice they continue for six weeks in summer, or three months in winter; at the end whereof they are washed out, laid on the wooden leg, and the surface of the skin on the wool side peeled off, to render them the softer; then made into parcels, steeped a night in the river, in winter more; stretched six or seven over one another on the wooden leg; and the knife passed strongly on the fleshy side, to take off any thing superfluous, and render the skin smooth.

Then they are stretched as before in the river, and the same operation repeated on the wool side; then thrown into a tub of water with bran in it, which is brewed among the skins till the greatest part sticks to them; and then separated into distinct tubs, till they swell and rise of themselves above the water.

By this means, the remains of the lime are cleared out; they are then wrung out, hung up to dry on ropes, and sent to the mill, with the quantity of oil necessary to fill them: the best oil is that of stock-fish.

Here they are first thrown in bundles into the river for twelve hours, then laid in the mill-trough, and fulled without oil till they are well softened; then oiled with the hand, one by one, and thus formed into parcels of four skins each, which are milled and dried on cords a second time, then a third; then oiled again and dried.

This process is repeated as often as necessity requires; when done, if there is any moisture remaining, they are dried in a stove, and made up in parcels wrapped up in wool; after some time they are opened to the air, but wrapped up again as before, till such time as the oil seems to have lost all its force, which it ordinarily does in twenty-four hours.

The skins are then returned from the mill to the chamoiser to be scoured; which is done by putting them into a lixivium of wood-ashes, working and beating them in it with poles, and leaving them to steep till the lye has had its effect; then wrung out, steeped in another lixivium, wrung again, and this repeated till all the grease and oil is purged out. They are then half-dried, and passed over a sharp-edged iron instrument, placed perpendicular in a block, which opens, softens, and makes them gentle: lastly, they are thoroughly dried, and passed over the same instrument again, which finishes the preparation, and leaves them in form of chamois.

Kid and goat-skins are chamoised in the same manner as those of sheep, excepting that the hair is taken off without the use of any lime; and that when brought from the mill they undergo a particular preparation called ramalling, the most delicate and difficult of all the others.

It consists in this, that as soon as brought from the mill they are steeped in a fit lixivium; taken out, stretched on a round wooden leg, and the hair scraped off with the knife; this makes them smooth, and in working cast a fine nap. The difficulty is in scraping them evenly.

SHANKER, or CHANCRE. See MEDICINE.

SHARP, in music, a character, the power of which is to raise the note before which it is placed half a tone higher than it would be without such a preposition.

SHARPING-CORN, a customary gift of corn, said to be half a bushel for a plough-land, which the farmers pay in some parts of England to their smith, every Christmas, for sharping their plough-irons, harrow-tines, &c.

SHAWIA, a genus of the class and order syngenesia polygamia segregata. The calyx.

is intricate, with five or six seeds, three interior larger; corolla five-cleft; seed one, oblong. There is one species of New Zealand.

SHEATHING, in the sea language, is the casing that part of a ship which is to be under water, with fir-board of an inch thick; first laying hair and tar, mixed together, under the boards, and then nailing them on, in order to prevent worms from eating the ship's bottom.

SHEATS, in a ship, are ropes bent to the clews of the sails; serving, in the lower sails, to haul aft the clews of the sail; but, in top sails, they serve to haul home the clew of the sail close to the yard-arm.

SHEEP. See Ovis.

Sheep. Any person who shall feloniously drive away, or feloniously steal, any sheep or lamb; or wilfully kill any sheep or lamb, with a felonious intent to steal the carcase or any part thereof; or assist or aid in committing any of the said offences; shall be guilty of felony without benefit of clergy. 14 Geo. II. c. 6.

Any person who shall apprehend and prosecute to conviction any such offender, shall have a reward of 10*l.* for which purpose he shall have a certificate signed by the judge, before the end of the assizes, certifying such conviction, and where the offence was committed, and that the offender was apprehended and prosecuted by the person claiming the reward; and if more than one claim it, he shall therein appoint what share shall be paid to each claimant. And on tendering such certificate to the sheriff, he shall pay the same within a month, without deduction, or forfeit double, with treble costs; to be allowed in his accounts, or be repaid him out of the treasury.

And any person who shall in the night time, maliciously and willfully maim, wound, or otherwise hurt any sheep, whereby the same is not killed, shall forfeit to the party grieved treble damages, by action of trespass, or on the case.

And by 28 Geo. III. c. 38, every person who shall export any live sheep or lambs, shall forfeit 3*l.* for every sheep or lamb, and shall also suffer solitary imprisonment for three months, without bail, and until the forfeiture is paid; but not to exceed twelve months for such non-payment; and for every subsequent offence 5*l.* a piece, and imprisonment for six months, and until the forfeiture is paid; but not to exceed two years for the non-payment thereof. And all ships and vessels employed therein shall be forfeited.

SHEERING, or Shearing, in woollen manufacture, is the cutting off with large sheers the too long nap, in order to make the cloth more smooth and even. See the article Cloth.

Sheering, in the sea language, When a ship is not steered steadily, they say she sheers, or goes sheering; or, when at anchor, she goes in and out by means of the current of the tide, they also say she sheers.

SHEERS, in a ship, are two masts set across at the upper end of each other; a contrivance generally used for setting or taking out the masts of a ship, where there is no hulk to do that office.

SHEFFIELDIA, a genus of plants belonging to the class of pentandria, and to the order of monogynia. The corolla is bell-shaped; the filaments are ten, of which every second is barren; the capsule consists of one cell, which has four valves. There is only one species, the repens, of New Zealand.

SHEKEL, in Jewish antiquity, an antient coin, worth 2*s.* 3¼*d.* sterling. See the article Coin.

Some are of opinion that the Jews had two kinds of shekels, viz. the common one, already taken notice of, and the shekel of the sanctuary; which last they made double the former, and consequently equal to 4*s.* 6½*d.* But most authors make them the same; so that the shekel of the sanctuary, according to them, is only worth 2*s.* 3¼*d.*

SHELF, among miners, the same with what they otherwise call fast ground, or fast country; being that part of the internal structure of the earth, which they find lying even and in an orderly manner; and evidently having retained its primitive form and situation, unmoved by the waters of the general deluge, while the circumjacent and upper strata have plainly been removed and tossed about.

SHELLS, chemically examined, are found like bones to consist of calcareous salts united to a soft animal matter; but in them the lime is united chiefly to carbonic acid, whereas in bones it is united to phosphoric acid. In shells, the predominating ingredient is carbonat of lime; but in bones it is phosphat of lime. Mr. Hatchett has divided shells into two classes. The first are usually of compact texture, resembling porcelain, and have an enamelled surface, often finely variegated. These are denominated porcelaneous shells: to this class belong the various species of veluta, cypræa, &c. The second class consists of shells usually covered with a strong epidermis, below which lies the shell in layers, and composed entirely of the substance well known by the name of mother of pearl. They have been distinguished by the name of mother of pearl shells. The shell of the fresh-water muscle, the heliotis iris, the turbo olearius, are examples of such shells. The shells of the first class contain a very small portion of soft animal matter: those of the second contain a very large proportion. Hence the difference of their component parts.

Porcelaneous shells, when exposed to a red heat, crackle, and lose the colour of their enamalled surface. They emit no smoke nor smell; their figure continues unaltered; their colour becomes opaque white, tinged partially with pale grey. They dissolve when fresh with effervescence in acids, and without leaving any residue; but if they have been burnt there remains always a little charcoal. The solution is transparent, gives no precipitate with ammonia or acetat of lead; of course it contains no sensible portion of phosphat or sulphat of lime. Carbonat of ammonia throws down an abundant precipitate of carbonat of lime. Porcelaneous shells, then, consist of carbonat of lime cemented together with a small portion of animal matter, which is soluble in acids, and therefore resembles gelatine.

2. Mother of pearl shells when exposed to a red heat, crackle, blacken, and emit a strong fetid odour. They exfoliate, and become partly dark grey, partly a fine white. When immersed in acids they effervesce at first strongly; but gradually more and more feebly, till at last the emission of air-bubbles is scarcely perceptible. The acids take up only lime, and leave a number of their membranaceous substances which still retain the form of the shell.

The genera of shells are extremely numerous, and the species under many of them are also very much so. However, they may be divided into three series or orders; the first comprehending all shells formed only of one piece, called by authors simple or univalve shells; the second, all those shells composed of two parts or valves, under the name of bivalves; and the third, all shells composed of several parts or valves, under the name of multivalves.

This method takes in all the shells hitherto known; the land, as well as the sea-shells, being all comprehended under one or other of these divisions; indeed, all the recent land-shells are univalves, but the fossil shells belong to all the three series.

Shells, *fossil*, those found buried at great depths in earth, and often immersed in the hardest stones. These fossil shells, as well as those found lying on the sea-shore, make an excellent manure, especially for cold clayey lands.

Shells, in the military art. See Gunnery.

SHERARDIA, a genus of the monogynia order, in the tetrandia class of plants, and in the natural method ranking under the 47th order, stellatæ. The calyx is small, quadridentate; the corolla monopetalous, long, and funnel-shaped. The two seeds are naked, and crowned with the calyx. There are three species, viz. 1, arvensis; 2, muralis; 3, fruticosa.

SHERIFF. As keeper of the king's peace, the sheriff is the first man in the county, and superior in rank to any nobleman therein, during his office. He may apprehend and commit to prison all persons who break the peace, or attempt to break it, and may bind any one in a recognizance to keep the king's peace. He may, and is bound ex officio, to pursue and take all traitors, murderers, felons, and other misdoers, and commit them to gaol for safe custody. He is also to defend his county against any of the king's enemies, when they come into the land; and for this purpose, as well as for keeping the peace and pursuing felons, he may command all the people of his county to attend him; which is called the posse comitatus, or power of the county; which summons, every person above fifteen years of age, and under the degree of a peer, is bound to attend upon warning, on pain of fine and imprisonment. Yet he cannot exercise the office of a justice of the peace, for then this inconvenience would arise, that he should command himself to execute his own precepts. 1 Black. 343.

The sheriff has a jurisdiction both in criminal and civil cases; and therefore he has two courts: his torn for criminal cases, which is the king's court; the other is his county court, for civil causes, and this is the court of the sheriff himself. 3 Salk. 322.

When the new sheriff is appointed and sworn, he ought at or before the next county court, to deliver a writ of discharge to the old sheriff; who is to set over all the prisoners in the gaol, severally by their names, (together with all the writs,) precisely, by view and indenture between the two sheriffs, wherein must be comprehended all the actions which the old sheriff has against every prisoner, though the executions are of record. And till the delivery of the prisoners to the new sheriff, they remain in the custody of the old sheriff, notwithstanding the letters patent of appointment, the writ of discharge, and the writ of delivery. Neither is the new sheriff obliged to receive the prisoners, but at the gaol. But the office of the old sheriff ceases, when the writ of discharge is brought to him. Wood, b. 1. c. 7.

By 3 Geo. I. c. 15. it shall not be lawful for any person to buy, sell, let, or take to farm. the office of under-sheriff, or deputy-sheriff, or seal-keeper, county-clerk, shire-clerk, gaoler, bailiff, or any other office pertaining to the office of high sheriff, or to contract for any of the said offices, on forfeiture of 500*l.* one moiety to his majesty, the other to such as shall sue in any court at Westminster, within two years after the offence.

Provided that nothing in this act shall hinder any high sheriff from constituting an under-sheriff, or deputy-sheriff, as by law he may; nor to hinder the under-sheriff in any case of the high sheriff's death, when he acts as high sheriff, from constituting a deputy; nor to hinder such sheriff, or under-sheriff, from receiving the lawful perquisites of his office, or from taking security for the due answering the same; nor to hinder such sheriff, or under-sheriff, deputy-sheriff, seal-keeper, &c. from accounting to the high sheriff for all such lawful fees as shall be by them taken, nor from giving security so to do; or to hinder the high sheriff from allowing a salary to his under-sheriff, &c. or other officers.

And if any sheriff shall die before the expiration of his year, or before he is superseded, the under-sheriff shall nevertheless continue in his office, and execute the same in the name of the deceased, till another sheriff is appointed and sworn; and the under-sheriff shall be answerable for the execution of the office during such interval as the high sheriff would have been; and the security given by the under-sheriff and his pledges shall stand a security to the king, and all persons whatsoever, for the performing his office during such interval. Id.

SHIELD, an antient weapon of defence, in the form of a light buckler, borne on the arm, to turn off lances, darts, &c.

Shield, in heraldry, the escutcheon or field on which the bearings of coats of arms are placed.

SHILLING, an English silver coin. See the article Coin.

It is observed that there were no shillings or twelve-penny pieces in England till the year 1504, when they were first coined by Henry VIII.

SHINGLES, in building, small pieces of wood, or quartered oaken boards, sawn to a certain scantling, or, as is more usual, cleft to about an inch thick at one end, and made like wedges, four or five inches broad, and eight or nine inches long.

Shingles are also used instead of tiles or slates, especially for churches and steeples; however this covering is dear; yet where tiles are very scarce, and a light covering is required, it is preferable to thatch; and where they are made of good oak, cleft, and not sawed, and well seasoned in water and the sun, they make a sure, light, and durable covering. The building is first to be covered all over with boards, and the shingles nailed upon them.

SHIP, a general name for all large vessels, particularly those equipped with three masts and a bowsprit; the masts being composed of a lower-mast, top-mast, and top-gallant-mast: each of these being provided with yards, sails, &c. Ships, in general, are either employed for war or merchandize.

Ships *of war* are vessels properly equipped with artillery, ammunition, and all the necessary martial weapons and instruments for attack or defence. They are distinguished from each other by their several ranks or classes, called rates, as follows: ships of the first rate mount from 100 guns to 110 guns and upwards; second rate, from 90 to 98 guns; third rate, from 64 to 74 guns; fourth rate, from 50 to 60 guns; fifth rate, from 32 to 44 guns; and sixth rate, from 20 to 28 guns. Vessels carrying less than 20 guns are denominated sloops, cutters, fire-ships, and bombs.

In Plate I. Ship-building, fig. 1, is the representation of a first-rate, with rigging, &c. the several parts of which are as follow:

Parts of the hull.

A The cat head
B The fore chain wales or chains
C The main-chains
D The mizen-chains
E The entering port
F The hause-holes
G The poop-lantern
H The chess-trees
I The head
K The stern

1 The bowsprit
2 Yard and sail
3 Gammoning
4 Manrop
5 Bobstay
6 Spritsail sheets
7 Pendants
8 Braces and pendants
9 Halliards
10 Lifts
11 Clew-lines
12 Spritsail horses
13 Buntlines
14 Standing-lifts
15 Bowsprit-shroud
16 Jib-boom
17 Jibstay and sail
18 Halliards
19 Sheets
20 Horses
21 Jib-guy
22 Spritsail-topsail yard
23 Horses
24 Sheets
25 Lifts
26 Braces and pendants
27 Cap of bowsprit
28 Jack-staff
29 Truck
30 Jack flag
31 *Fore-mast*
32 Runner and tackle
33 Shrowds
34 Laniards
35 Stay and laniard
36 Preventer-stay and laniard
37 Woodling of the mast
38 Fore-yard and sail
39 Horses
40 Top
41 Crow-foot
42 Jeers
43 Yard-tackles
44 Lifts
45 Braces and pendants
46 Sheets
47 Foretacks
48 Bow-lines and bridles
49 Fore buntlines
50 Fore leech-lines
51 Preventer-brace
52 Futtock-shrouds
53 *Foretop-mast*
54 Shrouds and laniards
55 Fore-top-sail yard and sail
56 Stay and sail
57 Runner
58 Back-stays
59 Halliards
60 Lists
61 Braces and pendants
62 Horses
63 Clew-lines
64 Bow-lines and bridles
65 Reef-tackles
66 Sheets
67 Buntlines
68 Cross-trees
69 Cap
70 Foretop-gallant-mast
71 Shrouds
72 Yard and sail
73 Backstays
74 Stay
75 Lifts
76 Clew-lines
77 Braces and pendants
78 Bow-lines and bridles
79 Flag-staff
80 Truck
81 Flagstay-staff
82 Flag of the lord high admiral
83 *Mainmast*
84 Shrouds
85 Laniards
86 Runner and tackle
87 Futtock-shrouds
88 Top-lantern
89 Crank of ditto
90 Stay
91 Preventer stay
92 Stay-tackles
93 Woodling of the mast
94 Jeers
95 Yard-tackles
96 Lifts
97 Braces and pendants
98 Horses
99 Sheets
100 Tacks
101 Bowlines and bridles
102 Crow-foot
103 Cap
104 Top
105 Buntlines
106 Leech-lines
107 Yard and sail
108 *Main-topmast*
109 Shrouds and laniards
110 Yard and sail
111 Futtock shrouds
112 Backstays
113 Stay
114 Staysail and halliards
115 Tye
116 Halliards
117 Lifts
118 Clew-lines
119 Braces and pendants
120 Horses
121 Sheets
122 Bowlines and bridles
123 Buntlines
124 Reef-tackles
125 Cross-trees
126 Cap
127 *Maintop-gallant-mast*
128 Shrouds and laniards
129 Yard and sail
130 Backstay
131 Stay
132 Stay-sail and halliards
133 Lifts
134 Braces and pendants
135 Bowlines and bridles
136 Clew-lines
137 Flagstaff
138 Truck
139 Flagstaff-stay
140 Flag standard
141 *Mizen-mast*
142 Shrouds and laniards
143 Cap
144 Yard and sail
145 Block for signal halliards
146 Sheet
147 Pendant-lines
148 Peck-brails
149 Staysail
150 Stay
151 Derrick and span
152 Top
153 Cross-jack yards
154 Cross-jack lifts
155 Cross-jack braces
156 Cross-jack slings
157 *Mizen-top-mast*
158 Shrouds and laniards
159 Yard and sail
160 Backstays
161 Stay
162 Halliards
163 Lifts
164 Braces and pendants
165 Bowlines and bridles
166 Sheets
167 Clew-lines
168 Staysail
169 Cross-trees
170 Cap
171 Flagstaff
172 Flagstaff-stay
173 Truck
174 Flag, union
175 Ensign staff
176 Truck
177 Ensign
178 Stern ladder
179 Bower cable.

Ships of war are fitted out either at the expence of the state or by individuals. Those fitted out at the public expence are called king's ships, and are divided into ships of the line, frigates, sloops, &c. Ships of war fitted out by individuals are called privateers.

Ship, *hospital*, a vessel fitted up to attend on a fleet of men of war, and receive their sick or wounded; for which purpose her decks should be high, and her ports sufficiently large. Her cables ought also to run upon the upper deck, to the end that the beds or cradles may be more commodiously placed between decks, and admit a free passage of the air to disperse that which is offensive or corrupted.

SHIP, *merchant*, a vessel employed in commerce to carry commodities of various sorts from one port to another. The largest merchant-ships are those employed by the different companies of merchants who trade to the East Indies. They are in general larger than our 40-gun ships, and are commonly mounted with 20 guns on their upper deck, which are nine-pounders; and six on their quarter-deck, which are six-pounders.

SHIP, *store*, a vessel employed to carry artillery or naval stores for the use of a fleet, fortress, or garrison.

SHIP, *transport*, is generally used to conduct troops from one place to another. Besides the different kinds of ships above-mentioned, which are denominated from the purpose for which they are employed, vessels have also, in general, been named according to the different manner of rigging them. It would be an endless, and at the same time an unnecessary task, to enumerate all the different kinds of vessels with respect to their rigging; and therefore a few only are here taken notice of. Fig. 2 is a ship which would be converted into a bark by stripping the mizen-mast of its yards and the sails belonging to them. If each mast, its corresponding top-mast and top-gallant-mast, instead of being composed of separate pieces of wood, were all of one continued piece, then this vessel with very little alteration would be a polacre. Fig. 3, a brig; fig. 4, a ketch; fig. 5, a schooner; fig. 6, a sloop; fig. 7, a dogger; fig. 8, a galley under sail; fig. 9, ditto rowing.

Ships are also sometimes named according to the different modes of their construction. Thus we say, a cat-built ship, &c.

To ship, is either used actively, as to embark any person or put any thing aboard ship; or passively, to receive any thing into a ship; as, "we shipped a heavy sea at three o'clock in the morning."

To ship also implies to fix any thing in its place; as, to ship the oars, that is, to put them in their rowlocks; to ship the swivel guns, is to fix them in their sockets; to ship the handspokes, &c.

Management of ships at single anchor, is the method of taking care of a ship while riding at single anchor in a tide-way, by preventing her from fouling her anchor, &c. The following rules for this purpose will be found of the utmost consequence:

Riding in a tide-way, with a fresh of wind, the ship should have what is called a short or windward-service, say 45 or 50 fathoms of cable, and always sheered to windward, not always with the helm hard down, but more or less so according to the strength or weakness of the tide. It is a known fact, that many ships sheer their anchors home, drive on board of other ships, and on the sands near which they rode, before it has been discovered that the anchor had been moved from the place where it was let go.

When the wind is cross, or nearly cross, off shore, or in the opposite direction, ships will always back. This is done by the mizen-topsail, assisted, if needful, by the mizen-staysail; such as have no mizen-topsail commonly use the main topsail, or if it blows fresh, a top-gallant-sail, or any such sail at the gaff.

In backing, a ship should always wind with a tawt cable, that it may be certain the anchor is drawn round. In case there is not a sufficiency of wind for that purpose, the ship should be hove apeak.

Riding with the wind afore the beam, the yards should be braced forward; if abaft the beam, they are to be braced all aback.

If the wind is so far aft that the ship will not back (which should not be attempted if, when the tide eases, the ship forges ahead, and brings the buoy on the lee quarter), she must be set ahead: if the wind is far aft, and blows fresh, the utmost care and attention are necessary, as ships riding in this situation often break their sheers and come to windward of their anchors again. It should be observed, that when the ship lies in this ticklish situation, the after-yards must be braced forward, and the fore-yards the contrary way; she will lie safe, as the buoy can be kept on the lee quarter; or suppose the helm is aport, as long as the buoy is on the larboard quarter. With the helm thus, and the wind right aft, or nearly so, the starboard main and fore braces should be hauled in. This supposes the main braces to lead forward.

When the ship begins to tend to leeward, and the buoy comes on the weather-quarter, the first thing to be done is to brace about the fore-yard; and when the wind comes near the beam, set the fore-staysail, and keep it standing until it shakes; then brace all the yards sharp forward, especially if it is likely to blow strong.

If lying in the aforesaid position, and she breaks her sheer, brace about the main-yard immediately; if she recovers and brings the buoy on the lee or larboard-quarter, let the main-yard be again braced about; but if she comes to a sheer the other way, by bringing the buoy on the other quarter, change the helm and brace the fore-yard to.

Riding leeward tide with more cable than the windward service, and expecting the ship will go to windward of her anchor, begin as soon as the tide eases to shorten in the cable. This is often hard work: but it is necessary to be done, otherwise the anchor may be fouled by the great length of cable the ship has to draw round; but even if that could be done, the cable would be damaged against the bows or cut-water. It is to be observed, that when a ship rides windward tide the cable should be cackled from the short service towards the anchor, as far as will prevent the bare part touching the ship.

When the ship tends to windward and must be set ahead, hoist the fore-staysail as soon as it will stand; and when the buoy comes on the lee quarter, haul down the fore-staysail, brace to the fore-yard and put the helm alee; for till then the helm must be kept aweather and the yards full.

When the ship rides leeward tide, and the wind increases, care should be taken to give her more cable in time, otherwise the anchor may start, and probably it will be troublesome to get her brought up again; and this care is the more necessary when the ship rides in the hause of another ship. Previous to giving a long service it is usual to take a weather-bit, that is, a turn of the cable over the windlass end, so that in veering away the ship will be under command. The service ought to be greased, which will prevent its chafing in the hause.

If the gale continues to increase, the topmasts should be struck in time; but the fore-yard should seldom, if ever, be lowered down, that in case of parting the foresail may be ready to be set. At such times there should be more on deck than the common anchor-watch, that no accident may happen from inattention or falling asleep.

In a tide-way a second anchor should never be let go but when absolutely necessary; for a ship will sometimes ride easier and safer, especially if the sea runs high, with a very long scope of cable and one anchor, than with less length and two cables; however, it is advisable, as a preventive, when ships have not room to drive, and the night is dark, to let fall a second anchor under foot, with a range of cable along the deck. If this is not thought necessary to be done, the deep-sea lead should be thrown overboard, and the line frequently handed by the watch, that they may be assured she rides fast.

If at any time the anchor-watch, presuming on their own knowledge, should wind the ship, or suffer her to break her sheer without calling the mate, he should immediately, or the very first opportunity, oblige the crew to heave the anchor in sight; which will prevent the commission of the like fault again; for, besides the share of trouble the watch will have, the rest of the crew will blame them for neglecting their duty.

Prudent mates seldom lie a week in a road-stead without heaving their anchor in sight; even though they have not the least suspicion of its being foul. There are other reasons why the anchor should be looked at: sometimes the cable receives damage by sweeping wrecks or anchors that have been lost, or from rocks or stones; and it is often necessary to trip the anchor, in order to take a clearer birth, which should be done as often as any ship brings up too near.

SHIP-BUILDING may be defined, the manner of constructing ships, or the work itself, as distinguished from naval architecture, which may be considered as the theory or art of delineating ships on a plane.

Art of delineating ships on a plane.

All edifices, whether civil or military, are known to be erected in consequence of certain established plans, which have been previously altered or improved till they have arrived at their desired point of perfection. The construction of ships appears also to require at least as much correctness and precision as the buildings which are founded upon terra firma; it is therefore absolutely necessary that the mechanical skill of the shipwright should be assisted by plans and sections, which have been drawn with all possible exactness, examined by proper calculations, and submitted to the most accurate scrutiny.

Naval architecture may be distinguished

into three principal parts. 1. To give the ship such an exterior form as may be most suitable to the service for which she is designed. 2. To give the various pieces of a ship their proper figure; to assemble and unite them into a firm compact frame, so that by their combination and disposition they may form a solid fabric, sufficient to answer all the purposes for which it is intended. And, 3. To provide convenient accommodations for the officers and crew, as well as suitable apartments for the cargo, furniture, provisions, artillery, and ammunition.

The exterior figure of a ship may be divided into the bottom and upper works. The bottom, or quick-work, contains what is termed the hold, and which is under water when the ship is laden. The upper works, called also the dead-work, comprehend that part which is usually above the water when the ship is laden. The figure of the bottom is therefore determined by the qualities which are necessary for the vessel, and conformable to the service for which she is proposed.

The limits of our design will not admit of a minute description and enumeration of all the pieces of timber which enter into the construction of a ship, nor of a particular description of their assemblage and union, or the manner in which they reciprocally contribute to the solidity of those floating citadels.

It is usual among shipwrights to delineate three several draughts. 1. The whole length of the ship is represented according to a side view, perpendicular to the keel, and is termed the plane of elevation, or sheer draught. Plate II. fig. 10, 11, the ship is exhibited according to an end view, and stripped of her planks, so as to present the outlines of the principal timbers; and this is properly termed the plane of projection, or the vertical plane of the timbers (fig. 12), because it shows the projection of their frames relatively to each other. 3. It is not sufficient to have the vertical curves of the bottom in different places, for a distinct idea of the horizontal curves is also equally necessary and useful; this is obtained by means of water-lines, traced upon what is called the horizontal plane (fig. 11). In this draught the curves of the transoms, called the round-aft, are also marked, and sometimes the breadth and thickness of the timbers.

The plane of elevation (fig. 10), determines the length and depth of the keel; the difference of the draughts of water; the length and projection, or rake, of the stem and stern-post; the position of the midship-frame upon the keel, together with that of the principal frames afore and abaft; the load-water line; the wales; the dimensions and situations of the gun-ports; the projection of the rails of the head and stern-gallery; with the stations of the masts and channels.

This draught, however, conveys no idea of the vertical curve of the ribs or timbers; for as their projection will be only represented in a plane elevated upon the length of the keel, they will appear in this direction no otherwise than as straight lines. To perceive these curves accurately, they must be regarded in another point of view; which will represent their projection upon a vertical plane, supposed to cut the keel at right angles in the place where the ship is broadest. For, as all ships are broadest near the middle of their length than towards the extremities, it is evident that the timbers are more extended in proportion. The most capacious of these represents what is called the midship frame; and upon the area of this frame is delineated the projection of all the others.

Thus the plane of projection limits the different breadths of a ship in various points of her length, and exhibits the outline of the timbers respectively to each other as they are erected upon the keel. Accordingly, this draught ought to present a variety of sections of the ship in different places of her length, and always perpendicular to the surface of the water; so that the eye of the observer, when placed in what may be properly termed the axis of the ship, may perceive the several sections at one glance; that is to say, when looking full on the stem from before the ship, he shall discover the fore-timbers; and when looking from behind, directly to the stern, he shall perceive the form of the after-timbers.

To form a just idea of this plane, therefore, we ought to suppose a ship resting upon the stocks, in the same position as when afloat upon the water. Thus a variety of black vertical lines may be drawn at equal distances upon the bottom, which is white, to form different outlines of the ship corresponding to the timbers within. It is to be observed, that the fashion of the inferior timbers must conform to the figure of the midship frame, which is placed in the fullest part of the ship; and as the planes of all the other timbers diminish in a certain progression as they approach the stem and stern, they are properly delineated on the plane of the midship-frame, which also represents the depth of the keel and length of the midship-beam.

As the two sides of a ship ought to be exactly alike, it is judged sufficient to represent the sections of the fore-part of the ship on the left side, and those in the after-part on the right side, so as to perceive all the sections, as well afore as abaft, upon one plane. See the Plate, fig. 12.

However necessary it may be to understand precisely the vertical curves of the bottom, it is no less requisite to have a just idea of those which are horizontal.

The horizontal or floor-plane is that upon which the whole frame is erected, and will be more clearly understood by previously describing the water-lines and ribands of which it is composed.

When a ship floats upon the stream, it is evident that her upper works will be separated from the bottom by the surface of the water, which will accordingly describe an imaginary horizontal line upon the bottom from the stem to the stern-post.

The most elevated of those lines is termed the load water-line, which is supposed to be drawn by the surface of the water on the upper part of the bottom, when she is sufficiently laden for a sea-voyage. For if we suppose this surface a rule, and thereby describe a corresponding black line along the vessel's bottom, that line will be distinguished upon the bottom, which is white, and represent what is called the load water-line.

If the ship is lightened of any part of her lading, and preserves the same difference in her draught of water at the two ends; or, what is the same thing, if she is lightened so as to preserve the same equilibrium of the keel with regard to the surface of the water, it is evident that she will rise higher out of the water, so that the black line already described will be elevated above it; and another black line may be delineated upon the bottom, close to the surface of the water, which will exhibit a second water-line parallel to the first, but nearer the keel in proportion to the number of feet which the ship has risen.

Thus by lightening a ship gradually, and at the same time preserving the direction of her keel, or the angle which the keel makes with the surface of the water, a variety of water-lines may be drawn parallel to each other, and to the load water-line.

The ribands are likewise of great utility in ship-building; they are narrow and flexible planks placed on the bottom at different heights, so as to form a sort of mould for stationing the inferior timbers between the principal ones. They differ from the water-lines, inasmuch as the latter have only one curve, which is horizontal; whereas the ribands, besides their horizontal one, have a vertical curve. To convey a just idea of these curves, which cannot be represented on one draught at their full length without an oblique section of the ship's length, it will be necessary to have recourse to two planes; that of the elevation, which exhibits their vertical curve; and to the floor-plane, upon which the horizontal curve is expressed.

These different lines are extremely useful in exhibiting the various curves of a ship's bottom, that, as they are gradually diminished, their uniformity or irregularity may be discovered by the skilful artist.

The qualities required in a ship ought to determine the figure of the bottom. A ship of war, therefore, should be able to sail swiftly, and carry her lower tier of guns sufficiently out of the water; otherwise a small ship will have the advantage of a large one, inasmuch as the latter cannot open her lower battery in a fresh side-wind without being exposed to extreme danger by receiving a great quantity of water in at her ports between decks. A merchant-ship ought to contain a large cargo of merchant-goods, and be navigated with few hands; and both should be able to carry sail firmly, steer well, drive little to leeward, and sustain the shocks of the sea without being violently strained.

The first thing to be established in the draught of a ship, is her length; and as a ship of war, according to her rate, is furnished with a certain number of cannon, which are placed in battery on her decks, it is necessary that a sufficient distance should be left between their ports to work the guns with facility; and particularly to leave space enough between the foremost guns and the stem, and between the aftmost gun and the stern-post on each side, on account of the arching or inward curve of the ship toward her extremities.

When the length of a ship is determined, it is usual to fix her breadth by the dimensions of the midship-beam. On this occasion the shipwrights, for the most part, are conducted by rules founded on their own observation; for, having remarked, that some vessels, which by repeated experience have been found to answer all the purposes of navigation, have a certain breadth in proportion to their length, they have inferred that it would be improper to depart from this proportion; but as other ships have been constructed with different breadths, which were equally perfect, a variety of different general rules have been adopted by these artists, who are accordingly divided in their opinions about the breadth which ought to be assigned to a ship relatively with her length, whilst each one produces reasons and experience in support of his own standard. Those who would diminish the breadth, allege: 1. That a narrow vessel meets with less resistance in passing through the water. 2dly. That by increasing the length she will drive less to leeward. 3dly. That according to this principle, the water-lines will be more conveniently formed to divide the fluid. 4thly. That a long and narrow ship will require less sail to advance quickly; that her masts will be lower, and her rigging lighter; and, by consequence, the seamen less fatigued with managing the sails, &c. Those, on the contrary, who would enlarge the breadth, pretend, 1st. That this form is better fitted to preserve a good battery of guns. 2ndly. That there will be more room to work the guns conveniently. 3rdly. That by carrying more sail, the ship will be enabled to run faster; or, that this quality will at least overbalance the advantage which the others have of more easily dividing the fluid. 4thly. That being broader at the load water-line, or place where the surface of the water describes a line round the bottom, they will admit of being very narrow on the floor, particularly towards the extremities. And, 5thly. That a broad vessel will more readily rise upon the waves than a narrow one. From such opposite principles has resulted that variety of standards adopted by different shipwrights.

It has been remarked above, that a ship of war must carry her lower tier of cannon high enough above the water, otherwise a great ship which cannot open her lower battery, when sailing with a fresh side-wind, may be taken by a small one that can make use of her cannon.

A ship should be duly poised, so as not to dive or pitch heavily, but go smooth and easy through the water, rising to the waves when they run high, and the ship has reduced her sail to the storm; otherwise they will break aboard, and strain the decks or carry away the boats: the masts are likewise in great danger from the same cause.

A ship should sail well when large and before the wind, but chiefly close hauled, or with a side-wind, and her sails sharp-trimmed, and then not fall off to the leeward.

Now, the great difficulty lies in uniting so many different qualities in one ship, which seems to be nearly impossible; the whole art, therefore, consists in forming the body in such a manner that none of these qualities should be entirely destroyed, and in giving a preference to that which is chiefly required in the particular service for which the vessel is designed. We shall briefly show the possibility of uniting them all in one ship, that each of them may be easily discerned; when it happens otherwise, the fault must lie in the builder, who has not applied himself to study the fundamental rules and principles of his art.

To make a ship carry a good sail. A flat floor-timber, and somewhat long, or the lower futtock pretty round, a straight upper futtock, the top-timber to throw the breadth out aloft; at any rate, to carry her main breadth as high as the lower deck. Now, if the rigging is well adapted to such a body, and the upper works lightened as much as possible, so that they all concur to lower the centre of gravity, there will be no room to doubt of her carrying a good sail.

To make a ship steer well, and answer the helm quickly. If the fashion-pieces are well formed, the tuck, or spreading parts under the stern, carried pretty high, the midship-frame well forward, a considerable difference in the draught of water abaft more than afore, a great rake forward and none abaft, a snug quarter-deck and fore-castle; all these will make a ship steer well. A ship which sails well will certainly steer well.

To make a ship carry her guns well out of the water. A long floor-timber, and not of great rising; a very full midship-frame, and low tuck, with light upper works.

To make a ship go smoothly through the water without pitching hard. A long keel, a long floor, not to rise too high afore and abaft; but the area or space continued in the fore-body, according to the respective weights they are to carry; all these are necessary to make a ship go smoothly through the water.

To make a ship keep a good wind, and drive little to the leeward. A good length by the keel; not too broad, but pretty deep in the hold, which will occasion her to have a short floor-timber, and a great rising. As such a ship will meet with great resistance in the water going over the broadside, and little when going ahead, she will not fall much to the leeward.

Now, some builders imagine it is impossible to make a ship carry her guns well, bear a good sail, and be a prime sailer, because it would require a very full bottom to gain the first two qualities, whereas a sharp ship will answer better for the latter; but when it is considered that a full ship will carry a great deal more sail than a sharp one, a good artist may so form the body as to have all these three good qualities, and also steer well.

Without attempting to describe the pieces of which a ship is composed, and to explain the principal draughts used in the construction thereof, we observe that in vessels of war, the general dimensions are established by authority of officers appointed by the government to superintend the building of ships. In the merchant-service, the extreme breadth, length of the keel, depth in the hold, height between decks and in the waist, are agreed on by contract; and from these dimensions the shipwright is to form a draught suitable to the trade for which the ship is designed.

In projecting the draught of a vessel of war, the first article to be considered is her length. As all ships are much longer above than below, it is also necessary to distinguish the precise part of her height from which her length is taken: this is usually the lower gun deck, or the load water-line. It has been already observed, that water-lines are described longitudinally on a ship's bottom by the surface of the water in which she floats, and that the line which determines her depth under the water, is usually termed the load water-line. In this draught it will be particularly necessary to leave sufficient distance between the ports.

The next object is to establish the breadth by the midship-beam. Although there is great difference of opinion about proportioning the breadth to the length, yet it is most usual to conform to the dimensions of ships of the same rate. After the dimensions of the breadth and length are determined, the depth of the hold must be fixed, which is generally half the breadth; but the form of the body should be considered on this occasion; for a flat floor will require less depth in the hold than a sharp one. The distance between the decks must also be settled.

We may then proceed to fix the length of the keel, by which we shall be enabled to judge of the rake of the stem and stern-post. The rake is known to be the projection of the ship at the height of the stem and stern-post beyond the ends of the keel afore and abaft, or the angle by which the length is increased as the fabric rises. To these we may also add the height of the stem and wing-transom.

After these dimensions are settled, the timbers may be considered which form the sides of the ship. A frame of timbers, which appears to be one continued piece, is composed of one floor-timber, whose arms branch outward to both sides of the ship; two or three futtocks, and a top-timber. The futtocks are connected to the upper arms of the floor-timbers on each side of the ship, and serve to prolong the timber in a vertical direction; and the top-timbers are placed at the upper part of the futtocks for the same purpose; all these being united, and secured by cross-bars, or a circular inclosure, which is called a frame of timbers. And as a ship is much broader at the middle than at the extremities, the arms of the floor-timber will form a very obtuse angle at the extreme breadth; but this angle decreases in proportion to the distance of the timbers from the midship-frame, so that the foremost and aftmost ones will form a very acute angle. Floor-timbers of the latter sort are usually called crutches.

Shipwrights differ extremely in determining the station of the midship-frame; some placing it at the middle of the ship's length, others further forward. They who place it before the middle allege, that if a ship is full forwards, she will meet with no resistance after she has opened a column of water; and that the water so displaced will easily unite abaft, and by that means force the ship forward; besides having more power on the rudder, in proportion to its distance from the centre of gravity; this also comes nearer the form of fishes, which should seem the most advantageous for dividing the fluid.

When the rising of the midship floor-timber is decided, we may then proceed to describe the rising line of the floor, on the stern-post abaft, and on the stem afore.

The height of the lower-deck is the next thing to be considered: it is determined in the middle by the depth of the hold; and some builders make it no higher than the stem; but they raise it abaft as much above its height in the middle as the load water-mark, or draught of water abaft, exceeds that afore. With regard to the height between decks, it is altogether arbitrary, and must be determined by the rate of the ship and the service she is designed for.

It is also necessary to remember the sheer of the wales, and to give them a proper hanging; because the beauty and stateliness of a ship greatly depend upon their figure and curve, which, if properly drawn, will make her appear airy and graceful on the water.

We come now to consider the upper works, and all that is above water, called the dead-work: and here the ship must be narrower, so that all the weight lying above the load water-line, will thereby be brought nearer the middle of the breadth, and of course the ship will be less strained by the working of her guns, &c.

But although some advantages are acquired by diminishing the breadth, above water, we must be careful not to narrow her too much; as there must be sufficient room left on the upper deck for the guns to recoil. The security of the masts should likewise be remembered, which requires sufficient breadth to spread the shrouds. A deficiency of this sort may indeed be in some measure supplied by enlarging the breadth of the channels.

We come to explain the sheer-draught, or plane of elevation, of a sixty-gun ship.

AA, fig. 10. is the keel, whose upper edge is prolonged by the dotted line *p q*; upon the extremities of which are erected perpendiculars which determine the height of the wing-transom K, and the length of the gun deck KC. AB, the stern-post. AC, the stem. DD, the quarter gallery with its windows. EF, the quarter-pieces, which limit the stern on each side. F, the taffarel, or upper piece of the stern. FG, profile of the stern; with its galleries. H, the gun-ports. I, the channels, with their dead-eyes and chain-plates. K, the wing-transom. KG, the counter. LB, the deck-transom. MNO, the first, second, and third transoms, of which O *k* is the third or lowest. *m* OLP, the direction of the fashion-piece, having its breadth canted aft towards the stern. QR, the main skeeds, for hoisting in the boats clear of the ship's side. LQZ, the main wale, with its sheer afore and abaft. DRX, the channel-wales, parallel to the main-wale. SUS. the sheer rail parallel to the wales. T *t*, the rudder. A *t* F, the rake of the stern. VWV, the waist rail. P *i i*, the drift rails abaft; and *ia*, the drift rails forward. TUC, the water-line. XX, the rails of the head. Y, the knee of the head, or cutwater. ZZ, the cheeks of the head. *a a*, the cat head. M⊕C, The rising line of the floor. *k u* C, the cutting down line, which limits the thickness of all the floor-timbers, and likewise the height of the dead wood afore and abaft. ⊕ *u* UW, the midship-frame. *a, b, c, d, e, f, g, h*, the frames or timbers in the fore body of the ship, that is, before the midship-frame. 1, 2, 3, 4, 5, 6, 7, 8, 9, the timbers in the after-body, or which are erected abaft the midship-frame.

As the eye of a spectator is supposed in this projection to view the ship's side in a line perpendicular to the plane of elevation, it is evident that the convexity will vanish, like that of a cylinder or globe, when viewed at a great distance; and that the frames will consequently be represented by straight lines, except the fashion-piece abaft and the knuckle-timber forward.

It has been already observed, that the plane of projection may be defined a vertical delineation of the curves of the timbers upon the plane of the midship-frame, which is perpendicular to that of the elevation. It is necessary to observe here, that the various methods by which these curves are described, are equally mechanical and arbitrary. In the latter sense, they are calculated to make a ship fuller or narrower, according to the service for which she is designed; and in the former they are drawn according to those rules which the artist has been implicitly taught to follow, or which his fancy or judgment has esteemed the most accurate and convenient. They are generally composed of several arches of a circle, reconciled together by moulds framed for that purpose. The radii of those arches, therefore, are of different lengths, according to the breadth of the ship in the place where such arches are swept; and they are expressed on the plane of projection either by horizontal or perpendicular lines; the radii of the breadth-sweeps being always in the former, and the radii of the floor-sweeps in the latter direction. These two arches are joined by a third, which coincides with both without intersecting either. The curve of the top-timber is either formed by a mould which corresponds to the arch of the breadth-sweep, or by another sweep, whose centre and radius are without the plane of projection. The breadth of the ship at every top-timber, is limited by a horizontal line drawn on the floor-plane, called the half-breadth of the top timbers. The extreme breadth is also determined by another horizontal line on the floor-plane; and the lines of half-breadth are thus mutually transferable from the projection and floor-planes to each other.

The necessary data by which the curves of the timbers are delineated, then, are the perpendicular height from the keel; the main or principal breadth; and the top breadth; for as a ship is much broader near the middle of her length than towards the end, so she is broader in the middle of her height than above and below; and this latter difference of breadth is continued throughout every point of her length. The main breadth of each frame of timbers is therefore the ship's breadth nearly in the middle of her height in that part, and the top-timber breadth is the line of her breadth near the upper ends of each timber. It has been already observed, that as both sides of a ship are alike, the artificers only draw one side, from which both sides of the ship are built: therefore the timbers abaft the midship-frame are exhibited on one side of the plane of projection, and the timbers before it on the other.

Plane of projection.

Fig. 12. A, the keel. BC, the line which expresses the upper edge of the keel, from which the height of each timber and height of its different breadths are measured. BD, and CE, perpendiculars raised on the line BC, to limit the ship's extreme breadth and height amid-ships; or, in other words, to limit the breadth and height of the midship-frame. AF, a perpendicular erected from the middle of the keel to bisect the line of the ship's breadth in two equal parts. F 9, the half-breadth line of the aftmost top-timber; being the uppermost horizontal line in this figure.

Note. The seven lines parallel to and immediately under this, on the right side of the line AF, are all top-timber half-breadths, abaft the midship-frame; the lowest of which coincides with the horizontal line DE.

The parallel horizontal lines nearly opposite to these, on the left side of the line AF, represent the top-timber half-breadths in the fore body, or the half-breadths of the top-timbers before the midship-frame.

G, H, I, Q, R, S, T, the radii of the breadth-sweeps abaft the midship-frame; those of the breadth sweeps in the fore-body, or before the midship-frame, are directly opposite on the right side.

⊕, A, show the midship frame, from the extreme breadth downwards.

1, 2, 3, 4, 5, 6, 7, 8, 9, the outlines of the timbers abaft the midship-frame, in different parts of the height: *a, b, c, d, e, f, g, h*, the outlines of the timbers before the midship-frame, in different parts of their height, *h* being the foremost or knuckle-timber. K *i*, the wing-transom, whose ends rest upon the fashion-piece. L, the deck-transom, parallel to and under the wing-transom. MNO, the lower transoms, of which O *k* is the third and lowest. *m k* P, the dotted line, which expresses the figure of the fashion-piece without being canted aft. P, the upper part, or top-timber of the fashion-piece. *n, o, p, q, r, s*, the radii of the floor-sweeps, abaft the midship-frame; those before the midship-frame are on the opposite side of the line AF, to which they are all parallel.

1st R*d*, 2d R*d*, 3d R*d*, 4th R*d*, the diagonal ribands abaft the midship; *t, u, x, y*, the same ribands expressed in the fore-body.

It has been remarked above, that the horizontal plane is composed of water-lines and ribands; it also contains the main and top-timber-breadth lines, or longitudinal lines by which the main-breadth and top-timber-breadth are limited in every point of the ship's length. The horizontal curve of the transoms and harpins are also represented therein; together with the planes of the principal timbers, the cant of the fashion-piece, the length of the rake afore and abaft, the projection of the cat heads, and the curve of the upper rail of the head, to which the curves of the lower ones are usually parallel.

Horizontal Plane.

BAC, Fig. 11, the line of the ship's length, passing through the middle of the stem and stern-post. B, the upper end of the stern-post. C, the upper end of the stem. BF, the length of the rake abaft. DWX, the top-timber-breadth line, or the line which limits the breadth of each top-timber.

DF, the breadth of the aftmost timber at the taffarel. BK, the wing-transom. BLP, the horizontal curve of the deck-transom. MM, the horizontal curve, or round-aft, of the first transom. MN, the horizontal curve of the second transom: it is prolonged into a water-line, N 8 7. *k* O, the horizontal curve of the third transom, which is also prolonged into another water-line, O, *n*, U, *n*, Q. *m* OP, the plane of the fashion-piece, as canted aft. ⊕ WU, the plane of the midship-frame. *a, b, c, d, e, f, h,* the planes of the timbers before the midship-frame. 1, 2, 3, 4, 5, 6, 7, 8, 9, the plane of the timbers abaft the midship-frame. XX, the figure of the upper rail of the head. CY, the projection of the knee of the head.

The third horizontal riband is marked on the plate. *a, a,* the projection of the cat-head.

Thus we have endeavoured briefly to explain the nature and uses of the principal draughts used in the construction of a ship, which reciprocally correspond with each other in the dimensions of length, breadth, and depth. Thus the plane of elevation is exactly of the same length with the horizontal or floor-plane. The several breadths of the timbers in the floor-plane, and that of the projection, are mutually transferable; and the real height of the timbers in the projection exactly conforms to their height in the elevation. Thus, let it be required to transfer the height of the wing-transom from the elevation to the projection:

Extend the compasses from the point K, in the elevation, down to the dotted line prolonged from the upper edge of the keel, and setting the other foot in the point *p*, then shall the line K *p* be the perpendicular height in the wing-transom: transfer this from the middle of the line BAC, in the projection, to the point K in the perpendicular AF, then will AK be the height of the wing-transom in the plane of projection: and thus the height of all the transoms may be laid from the former upon the latter.

Again: Let it be required to transfer the main-breadth of the midship-frame from the projection to the horizontal plane: Set one foot of the compasses in the point ⊕ on the perpendicular CE, and extend the other along the main-breadth sweep ⊕ G, till it touches the perpendicular AP parallel to CE: lay this distance upon the horizontal plane from the point *u* in the line of the ship's length, BAC, along the plane of the midship-frame to the point ⊕; so shall the line ⊕ WU be the breadth of the midship-frame on the horizontal plane.

Thus also the top-timber-breadth, or the distance of each top-timber from the middle of the ship's breadth, may be in the same manner transferred, by extending the compasses from the line BAC, in the horizontal plane, to the top-timber-breadth line upon any particular timber, as 1, 2, 3, &c. which will give its proper dimensions thereon.

In the same manner the breadths of all the timbers may be laid from the projection to the horizontal plane, and, vice versa, from that to the projection. Thus the height of each timber may also be transferred from the elevation to the projection, &c.

The principal utility of these draughts, therefore, is to exhibit the various curves of the ship's body, and of the pieces of which it is framed, in different points of view, which are either transverse or longitudinal, and will accordingly present them in very different directions. Thus the horizontal curves of the transoms and water-lines are represented on the floor-plane, all of which are nearly straight lines in the elevation and projection; and thus the vertical curves of the timbers are all exhibited on the projection, although they appear as straight lines in the elevation and floor-plane.

Of constructing ships.

The pieces by which this complicated machine, a ship, is framed, are joined together in various places, by scarfing, rabitting, tenanting, and scoring.

During the construction of a ship, she is supported in the dock, or upon a wharf, by a number of solid blocks of timber placed at equal distance from, and parallel to, each other. She is then said to be on the stocks.

The first piece of timber laid upon the blocks is generally the keel: we say generally, because of late, a different method has been adopted in some of the royal dock-yards, by beginning with the floor timbers; the artists having found that the keel is often apt to rot during the long period of building a large ship of war. The pieces of the keel are scarfed together, and bolted, forming one entire piece, AA, which constitutes the length of the vessel below. At one extremity of the keel is erected the stem. It is a strong piece of timber incurvated nearly into a circular arch, or, according to the technical term, compassing, so as to project outwards at the upper-end, forming what is called the rake forward. In small vessels this is framed of one piece; but in large ships it is composed of several pieces scarfed and bolted together. At the other extremity of the keel is elevated the stern-post, which is always of one entire straight piece. The heel of it is let into a mortoise in the keel, and having its upper end to hang outwards, making an obtuse angle with the keel, like that of the stem: this projection is called the rake abaft. The stern-post, which ought to support the stern, contains the iron-work, or hinges of the rudder, which are called googings, and unites the lower part of the ship's sides abaft. See the connection of those pieces in the elevation, fig. 10.

Towards the upper-end of the stern-post, and at right angles with its length, is fixed the middle of the wing-transom, where it is firmly bolted. Under this is placed another piece parallel thereto, and called the deck-transom, upon which the after-end of the lower deck is supported. Parallel to the deck-transom, and at a proper distance under it, another piece is fixed to the stern-post called the first-transom; all of which serve to connect the stern-post to the fashion-pieces. Two more transoms, called second and third, are also placed under these, being likewise attached to the fashion-pieces, into which the extremities of all the transoms are let. The fashion-pieces are formed like the other timbers of the ship, and have their heels resting on the upper part of the kelson, at the after extremity of the floor-ribands.

All these pieces, viz. the transoms, the fashion-pieces, and their top-timbers being strongly united into one frame, are elevated upon the stern-post; and the whole forms the structure of the stern, upon which the galleries and windows, with their ornaments, are afterwards built.

The stem and stern-post being thus elevated upon the keel, to which they are securely connected by knees and arched pieces of timber bolted to both; and the keel being raised at its two extremities by pieces of dead wood, the midship floor-timber is placed across the keel, whereto it is bolted through the middle. The floor-timbers before and abaft the midship frame are then stationed in their proper places upon the keel; after which the kelson, which, like the keel, is composed of several pieces scarfed together, is fixed across the middle of the floor-timbers, to which it is attached by bolts driven through the keel, and clinched on the upper part of the kelson. The futtocks are then raised upon the floor-timbers, and the hawse-pieces erected upon the cant timbers in the fore part of the ship. The top-timbers on each side are next attached to the head of the futtocks, as already explained. The frames of the principal timbers being thus completed, are supported by ribands.

The ribs of the ship being now stationed, they proceed to fix on the planks, of which the wales are the principal, being much thicker and stronger than the rest. The harpins, which may be considered as a continuation of the wales at their fore-ends, are fixed across the hawse-pieces, and surround the fore part of the ship. The planks that inclose the ship's sides are then brought about the timbers; and the clamps, which are of equal thickness with the wales, fixed opposite to the wales within the ship: these are used to support the ends of the beams, and accordingly stretch from one end of the ship to the other. The thick-stuff, or strong planks of the bottom within-board, are then placed opposite to the several scarfs of the timbers, to reinforce them throughout the ship's length. The planks employed to line the ship, called the ceiling, or foot-waling, is next fixed in the intervals between the thick stuff of the hold. The beams are afterwards laid across the ship to support the decks, and are connected to the side by lodging and hanging knees.

The cable bits being next erected, the carlings, and ledges, are disposed between the beams to strengthen the deck. The water-ways are then laid on the ends of the beams throughout the ship's length, and the sprikett-ing fixed close above them. The upper deck is then planked, and the string placed under the gunnel or plansheer in the waist.

They proceed next to plank the quarter-deck and fore-castle, and to fix the partners of the masts and capsterns with the coamings of the hatches. The breast-hooks are then bolted across the stem and bow within-board; the step of the fore-mast placed on the kelson; and the riders fayed on the inside of the timbers, to reinforce the sides in different places of the ship's length. The pointers, if any, are afterwards fixed across the hold diagonally to support the beams; and the crotchets stationed in the after-hold to unite the half-timbers. The steps of the main-mast and capsterns are next placed; the planks of the lower-decks and orlop laid; the navel-hoods fayed on the hawse-holes; and the knee of the head, or cutwater, connected to the stem. The figure of the head is then erected, and the trail-board and cheeks are fixed on the sides of the knee.

The taffarel and quarter-pieces, which terminate the ship abaft, the former above and the latter on each side, are then disposed; and the stern and quarter galleries framed and supported by their brackets. The pumps, with their well, are next fixed in the hold; the limber-boards laid on each side of the kelson; and the garboard strake fixed on the ship's bottom next to the keel without.

The hull being thus fabricated, they proceed to separate the apartments by bulkheads, or partitions; to frame the portlids; to fix the cat-heads and chess-trees; to form the hatchways and scuttles, and fit them with proper covers or gratings. They next fix the ladders whereby to mount or descend the different hatchways; and build the manger on the lower deck, to carry off the water that runs in at the hawse-holes when the ship rides at anchor in a sea. The bread-room and magazines are then lined; and the gunnel, rails, and gangways, fixed on the upper part of the ship. The cleats, kevels, and rand ranges, by which the ropes are fastened, are afterwards bolted or nailed to the sides in different places.

The rudder, being fitted with its irons, is next hung to the stern-post; and the tiller, or bar, by which it is managed, let into a mortoise at its upper-end. The scuppers, or leaden tubes, that carry the water off from the decks, are then placed in holes cut through the ship's sides; and the standards bolted to the beams and sides above the decks to which they belong. The poop-lanthorns are last fixed upon their cranes over the stern; and the bilge-ways, or cradles, placed under the bottom, to conduct the ship steadily into the water whilst launching.

Stowing and trimming of ships, the method of disposing of the cargo in a proper and judicious manner in the hold of a ship. A ship's sailing, steering, and wearing, and being lively and comparatively easy at sea in a storm, depend greatly on the cargo, ballast, or other materials, being properly stowed, according to their weight and bulk, and the proportional dimensions of the built of the ship, which may be made too crank or too stiff to pass on the ocean with safety. These things render this branch of knowledge of such consequence, that rules for it ought to be endeavoured after, if but to prevent, as much as possible, the danger of a ship oversetting at sea, or being so laboursome as to roll away her masts, &c. by being improperly stowed, which is often the case.

When a ship is new, it is prudent to consult the builder, who may be supposed best acquainted with a ship of his own planning, and most likely to judge what her properties will be, to judge how the cargo of materials, according to the nature of them, ought to be disposed of to advantage, so as to put her in the best sailing trim; and at every favourable opportunity afterwards it will be proper to endeavour to find out her best trim by experiment.

Ships must differ in their form and proportional dimensions; and to make them answer their different purposes, they will require different management in the stowage, which ought not to be left to mere chance, or done at random, as goods or materials happen to come to hand, which is too often the cause that such improper stowage makes ships unfit for sea: therefore the stowage should be considered, planned, and contrived, according to the built and properties of the ship, which if they are not known should be inquired after. If she is narrow and high-built in proportion, so that she will not shift herself without a great weight in the hold, it is a certain sign such a ship will require a great part of heavy goods, ballast, or materials, laid low in the hold, to make her stiff enough to bear sufficient sail without being in danger of oversetting. But if a ship is built broad and low in proportion, so that she is stiff and will support herself without any weight in the hold, such a ship will require heavy goods, ballast, or materials, stowed higher up, to prevent her from being too stiff and laboursome at sea, so as to endanger her masts being rolled away, and the hull worked loose and made leaky.

In order to help a ship's sailing, that she should be lively and easy in her pitching and ascending motions, it should be contrived by the stowage, that the principal and weightiest part of the cargo or materials should lie as near the main body of the ship, and as far from the extreme ends, fore and aft, as things will admit of. For it should be considered, that the roomy part of our ships lengthwise, forms a sweep or curve near four times as long as they are broad; therefore those roomy parts at and above the water's edge, which are made by a full harping and a broad transom to support the ship steady and keep her from plunging into the sea, and also by the entrance and run of the ship having little or no bearing body under for the pressure of the water to support them, of course should not be stowed with heavy goods or materials, but all the necessary vacancies, broken stowage, or light goods, should be at these extreme ends fore and aft; and in proportion as they are kept lighter by the stowage, the ship will be more lively to fall and rise easy in great seas; and this will contribute greatly to her working and sailing, and to prevent her from straining and hogging; for which reason it is a wrong practice to leave such a large vacancy in the main hatchway as is usual, to coil and work the cables, which ought to be in the fore or aft hatchway, that the principal weight may be more easily stowed in the main body of the ship, above the flattest and lowest floorings, where the pressure of the water acts the more to support it. See NAVIGATION.

SHIPS, *masts of*. The mast of a ship is a long round piece of timber, elevated perpendicularly upon the keel of a ship, to which are attached the yards, the sails, and the rigging. A mast, with regard to its length, is either formed of one single piece, which is called a pole-mast, or composed of several pieces joined together, each of which retains the name of mast separately. The lowest of these is accordingly named the lower-mast; the next in height is the top-mast, which is erected at the head of the former; and the highest is the top-gallant mast, which is prolonged from the upper end of the top-mast. Thus the two last are no other than a continuation of the first upwards.

The lower-mast is fixed in the ship; the foot, or heel of it, rests on a block of timber called the step, which is fixed upon the kelson, and the top-mast is attached to the head of it by the cap and the trestle-trees. The latter of these are two strong bars of timber, supported by two prominences, which are as shoulders on the opposite sides of the mast, a little under its upper end: athwart these bars are fixed the cross-trees, upon which the frame of the top is supported. Between the lower-mast-head, and the foremost of the cross-trees, a square space remains vacant, the sides of which are bounded by the two trestle-trees. Perpendicularly above this is the foremost hole in the cap, whose after-hole is solidly fixed on the head of the lower-mast. The top-mast is erected by a tackle, whose effort is communicated from the head of the lower-mast to the foot of the top-mast; and the upper end of the latter is accordingly guided into and conveyed up through the holes between the trestle-trees and the cap.

Besides the parts already mentioned in the construction of masts, with respect to their length, the lower-masts of the largest ships are composed of several pieces united into one body. As these are generally the most substantial parts of various trees, a mast formed by this assemblage, is justly esteemed much stronger than one consisting of any single trunk, whose internal solidity may be very uncertain.

The whole is secured by several strong hoops of iron, driven on the outside of the mast, where they remain at proper distances.

Figs. 1, 2, and 3, Plate Masts, &c. represent one of Mr. George Smart's patent hollow masts. It is principally composed of four small beams ABDE, figs. 1 and 2, which are each quarters of one small tree; these are held at the proper distance apart by cross bars FF mortised into them. The spaces between these four beams are filled up by thick planks GG, which have grooves cut across them to receive one-half of the bars FF as shewn in fig. 3, and the whole is bound together by hoops HH. By this means a truss is formed in every direction; for in every strain, before the mast can give way, the beams and planks on the side nearest the strain must compress, and those on the opposite side must be torn asunder lengthwise.

There are several other methods of constructing these masts, as eight planks doweled together at the edges, or four planks tabled into each other with oak wedges at the end of the tables, to prevent the end wood from cutting into each other.

Masts on these principles can be made at one half the expence of the common ones, and of the same strength without any increase of the weight.

Figs. 4 and 5, represent a contrivance included in Mr. Smart's patent for masts, by which temporary yards for ships can be made when at sea, and of such spars as can conveniently be carried on board a ship. They are formed of two small spars, each half the length of the yard, which are sawn down lengthwise in two directions, so as to cut them into four branches, but left joined together at one end, A fig. 4: that end is then hooped so as to prevent splitting; the four pieces DEF, &c. are opened out as in the figure, and blocks of wood put in between them at GHIK to keep them apart; the two spars thus opened are joined together to make one yard at the block K formed of four pieces, one of which is shewn in fig. 5. It has a groove in it to receive the ends of one of the bars DEF in each spar and connect them; it has some small pieces put across in the angle of the groove, which are let into the ends of the pieces DEF, so that when they are kept in their places, by a broad hoop L, they cannot be drawn apart endways; the four pieces composing the block K are laid together, and put in between the bars, leaving a space between them to put in

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wedges which are drove in until the pieces fig. 5 are shoved out so as to fill the hoop and hold it all firmly.

Small yards may be made from one spar without joining; in that case the four pieces are left connected at each end, and the piece K is a plain block like the rest.

Yards on this construction can be considerably increased in their strength (if found too weak) by putting in larger blocks; which increases their diameter, and throws the four bars farther from each other without increasing their weight more than the extra weight of the blocks.

The principal articles to be considered in equipping a ship with masts are, 1st, the number; 2d, their situation in the vessel; and, 3d, their height above the water.

The masts being used to extend the sails by means of their yards, it is evident, that if their number was multiplied beyond what is necessary, the yards must be extremely short, that they may not entangle each other in working the ship, and by consequence their sails will be very narrow, and receive a small portion of wind. If, on the contrary, there is not a sufficient number of masts in the vessel, the yards will be too large and heavy, so as not to be managed without difficulty. There is a mean between these extremes, which experience and the general practice of the sea have determined; by which it appears, that in large ships every advantage of sailing is retained by three masts and a bowsprit.

The most advantageous position of the masts is undoubtedly that from whence there results an equilibrium between the resistance of the water on the body of the ship on one part, and of the direction of their effort on the other. By every other position this equilibrium is destroyed, and the greatest effort of the masts will operate to turn the ship horizontally about its direction; a circumstance which retards her velocity. It is counterbalanced indeed by the helm; but the same inconvenience still continues; for the force of the wind, having the resistance of the helm to overcome, is not entirely employed to push the vessel forward. The axis of the resistance of the water should then be previously determined, to discover the place of the main-mast, in order to suspend the efforts of the water equally, and place the other masts so that their particular direction will coincide with that of the main-mast. The whole of this would be capable of a solution if the figure of the vessel was regular, because the point, about which the resistance of the water would be in equilibrio, might be discovered by calculation.

The exact height of the masts, in proportion to the form and size of the ship, remains yet a problem to be determined. The more the masts are elevated above the centre of gravity, the greater will be the surface of sail which they are enabled to present to the wind; so far an additional height seems to have been advantageous. But this advantage is diminished by the circular movement of the mast, which operates to make the vessel stoop to its effort; and this inclination is increased in proportion to the additional height of the mast, an inconvenience which it is necessary to guard against. Thus what is gained upon one hand is lost upon the other. To reconcile these differences, it is certain, that the height of the mast ought to be determined by the inclination of the vessel, and that the point of her greatest inclination should be the term of this height above the centre of gravity.

In order to secure the masts, and counterbalance the strain they receive from the effort of the sails impressed by the wind, and the agitation of the ship at sea, they are sustained by several strong ropes, extended from their upper ends to the outside of the vessel, called shrouds. These are further supported by other ropes, stretched from their heads towards the fore-part of the vessel.

The mast, which is placed at the middle of the ship's length, is called the main-mast; that which is placed in the forepart, the foremast; and that which is towards the stern, is termed the mizen-mast.

SHISTUS. See SCHISTUS, and ROCKS *primitive*.

SHIVERS, or SHEEVERS, in the sea-language, names given to the little rollers or round wheels of pulleys. See PULLEY.

SHOE, a covering for the foot, usually made of leather, by the company of cordwainers.

SHOES, *horse*. See FARRIERY.

SHOE, *for an anchor*, in a ship, the place for the anchor to rest, and fitted to receive the stock, &c. so as to prevent the sheets, tacks, and other running-rigging, from galling, or being entangled with the flooks.

SHOOTING, in the military art. See ARTILLERY, GUNNERY, and PROJECTILES.

SHOOTING, in sportsmanship, the killing of game by the gun, with or without the help of dogs.

The first thing which the sportsman ought to attend to is the choice of his fowling-piece. Conveniency requires that the barrel should be as light as possible, at the same time it ought to possess that degree of strength which will make it not liable to burst. In a former article (GUN-SMITHERY, vol. i. p. 890) it was stated that very little was gained by extending the length of the barrel. It ought, however, to bear some proportion to the bore, and be of sufficient length to permit all the powder to inflame. The usual length is now from 26 to 30 inches.

It may appear as an objection to this, that a duck-gun which is five or six feet long kills at a greater distance than a fowling-piece; but this is not owing to its length, but to its greater weight and thickness, which give it such additional strength, that the shot may be increased, and the charge of powder doubled, trebled, and even quadrupled. More, indeed, will depend on the goodness of the powder, and using a proper charge (which must be learned by trying the gun at a mark), than on the length of the barrel.

The patent milled shot is now very generally used, and is reckoned superior to any other. The size of the shot must vary according to the particular species of game which is the object of the sportsman's pursuit, as well as be adapted to the season. In the first month of partridge-shooting, No. 4 is most proper.

As hares also sit closer, and are thinly covered with fur, at this season, they may easily be killed with this shot at 30 or 35 paces. No. 5, is proper for shooting quails; and No. 3, for snipes. About the beginning of October, when the partridges are stronger, and pheasant-shooting commences, No. 3 may be used.

In loading a piece, the powder ought to be slightly rammed down by only pressing the ramrod two or three times on the wadding, and not by drawing up the ramrod and then returning it into the barrel with a jerk of the arm several times. The shot ought to be rammed down with some force, since it is from the shot being loose in the gun, and a space being consequently left between it and the powder, that accidents most frequently happen by the bursting of guns. A sportsman ought never to carry his gun under his arm with the muzzle inclined downwards, for this practice loosens the wadding and charge too much.

Immediately after the piece is fired it ought to be re-loaded; for, while the barrel is still warm, there is no danger of any moisture lodging in it to hinder the powder from falling to the bottom. As it is found that the coldness of the barrel, and perhaps the moisture condensed in it, diminish the force of the powder in the first shot, it is proper to fire off a little powder before the piece is loaded. Some prime before loading, but this is not proper unless the touch-hole is very large. After every discharge the touch-hole ought to be pricked, or a small feather may be inserted to clear away any humidity or foulness that has been contracted.

The sportsman having loaded his piece, must next prepare to fire. For this purpose he ought to place his hand near the entrance of the ramrod, and at the same time grasp the barrel firmly. The muzzle should be a little elevated, for it is more usual to shoot low than high. This direction ought particularly to be attended to when the object is a little distant; because shot as well as ball only moves a certain distance point-blank, when it begins to describe the curve of the parabola.

Practice soon teaches the sportsman the proper distance at which he should shoot. The distance at which he ought infallibly to kill any kind of game with patent shot, provided the aim is well taken, is from 25 to 35 paces for the footed, and from 40 to 45 paces for the winged game. Beyond this distance even to 50 or 55 paces, both partridges and hares are sometimes killed; but in general the hares are only slightly wounded, and carry away the shot; and the partridges at that distance present so small a surface, that they frequently escape untouched between the spaces of the circle. Yet it does not follow that a partridge may not be killed at 60 and even 70 paces distance; but these shots are rare.

In shooting at a bird flying, or a hare running across, it is necessary to take aim at the fore part of the object. If a partridge flies across at the distance of 30 or 35 paces, it will be sufficient to aim at the head, or at most but a small space before it. Another thing to be attended to is, that the shooter ought not involuntarily to stop the motion of the arms at the moment of pulling the trigger; for the instant the hand stops in order to fire, however inconsiderable the time may be, the bird gets beyond the line of aim, and the shot will miss it. A sportsman ought therefore to accustom his hand while he is taking aim to follow the object. When a hare runs in a straight line from the shooter, he should take his aim between the ears, otherwise he will run the hazard either of missing, or at least not of killing dead, or, as it is sometimes called, clean.

A fowling-piece should not be fired more than 20 or 25 times without being washed; a barrel when foul neither shoots so ready, nor carries the shot so far, as when clean. The flint, pan, and hammer, should be well wiped after each shot; this contributes greatly to make the piece go off quick, but then it should be done with so much expedition, that the barrel may be reloaded whilst warm, for the reasons before advanced. The flint should be frequently changed, without waiting until it misses fire, before a new one is put in. Fifteen or eighteen shots, therefore, should only be fired with the same flint; the expence is too trifling to be regarded, and by changing it thus often much vexation will be prevented.

A gun also should never be fired with the prime of the preceding day; it may happen that an old priming will sometimes go off well, but it will more frequently contract moisture and fuze in the firing; then the object will most probably be missed, and that because the piece was not fresh primed.

For the information of the young sportsman we shall add a few more general directions. In warm weather he ought to seek for game in plains and open grounds; and in cold weather he may search little hills exposed to the sun, along hedges, among heath, in stubbles, and in pastures where there is much furze and fern. The morning is the best time of the day, before the dew is exhaled, and before the game has been disturbed. The colour of the shooter's dress ought to be the same with that of the fields and trees; in summer it ought to be green, in winter a dark grey. He ought to hunt as much as possible against the wind, not only to prevent the game perceiving the approach of him and his dog, but also to enable the dog to scent the game at a greater distance.

He should never be discouraged from hunting and ranging the same ground over and over again, especially in places covered with heath, brambles, high grass, or young coppice-wood. A hare or rabbit will frequently suffer him to pass several times within a few yards of its form without getting up. He should be still more patient when he has marked partridges into such places; for it often happens, that after the birds have been sprung many times, they lie so dead that they will suffer him almost to tread upon them before they will rise. Pheasants, quails, and woodcocks, do the same.

He ought to look carefully about him, never passing a bush, or tuft of grass, without examination; but he ought never to strike them with the muzzle of his gun, for it will loosen his wadding. He who patiently beats and ranges his ground over again, without being discouraged, will always kill the greatest quantity of game; and if he is shooting in company, he will find game where others have passed without discovering any.

When he has fired he should call in his dog, that he may not have the mortification to see game rise which he cannot shoot. When he has killed a bird, instead of being anxious about picking it up, he ought to follow the rest of the covey with his eye till he sees them settle.

Three species of dogs are capable of receiving the proper instructions and of being trained. These are the smooth pointer, the rough pointer, and the spaniel. The smooth pointer is active and lively enough in his range, but in general is proper only for an open country.

The greatest part of these dogs are afraid of water, brambles, and thickets; but the spaniel and the rough pointer are easily taught to take the water, even in cold weather, and to range the woods and rough places as well as the plain. Greater dependance may therefore be had on these two last species of dog than on the smooth pointer.

The education of a pointer may commence when he is only five or six months old. The only lessons which he can be taught at this time are, to fetch and carry any thing when desired; to come in when he runs far off, and to go behind when he returns; using, in the one case, the words here, come in, and in the other, back, or behind. It is also necessary at this period to accustom him to be tied up in the kennel or stable; but he ought not at first to be tied too long. He should be let loose in the morning, and fastened again in the evening. When a dog is not early accustomed to be chained, he disturbs every person in the neighbourhood by howling. It is also of importance that the person who is to train him should give him his food.

When the dog has attained the age of ten or twelve months, he may be carried into the field to be regularly trained. At first he may be allowed to follow his own inclination, and to run after every animal he sees. His indiscriminating eagerness will soon abate, and he will pursue only partridges and hares. He will soon become tired of following partridges in vain, and will content himself after having flushed them, to follow them with his eyes. It will be more difficult to prevent him from following hares.

All young dogs are apt to rake; that is, to hunt with their noses close to the ground, to follow birds rather by the track than by the wind. But partridges lie much better to dogs that wind them, than to those that follow them by the track. The dog that winds the scent approaches the birds by degrees, and without disturbing them; but they are immediately alarmed, when they see a dog tracing their footsteps. When you perceive that your dog is committing this fault, call to him in an angry tone, hold up; he will then grow uneasy and agitated, going first to the one side and then to the other, until the wind brings him the scent of the birds. After finding the game four or five times in this way, he will take the wind of himself, and hunt with his nose high. If it is difficult to correct this fault, it will be necessary to put the puzzle-peg upon him. This is of very simple construction, consisting only of a piece of oak or deal inch-board, one foot in length, and an inch and a half in breadth, tapering a little to one end; at the broader end are two holes running longitudinally, through which the collar of the dog is put, and the whole is buckled round his neck; the piece of wood being projected beyond his nose, is then fastened with a piece of leather thong to his under jaw. By this means the peg advancing seven or eight inches beyond his snout, the dog is prevented from putting his nose to the ground and raking.

As soon as the young dog knows his game, you must bring him under complete subjection. If he is tractable, this will be easy; but if he is stubborn, it will be necessary to use the trash cord, which is a rope or cord of 20 or 25 fathoms in length fastened to his collar. If he refuses to come back when called upon, you must check him smartly with the cord, which will often bring him upon his haunches. But be sure you never call to him except when you are within reach of the cord. After repeating this several times, he will not fail to come back when called; he ought then to be caressed, and a bit of bread should be given him. He ought now constantly to be tied up; and never unchained, except when you give him his food, and even then only when he has done something to deserve it.

The next step will be to throw down a piece of bread on the ground, at the same time taking hold of the dog by the collar, calling to him, "take heed,—softly." After having held him in this manner for some space of time, say to him "seize—lay hold." If he is impatient to lay hold of the piece of bread before the signal is given, correct him gently with a small whip. Repeat this lesson until he "takes heed" well, and no longer requires to be held fast to prevent him from laying hold of the bread. When he is well accustomed to this manege, turn the bread with a stick, holding it in the manner you do a fowling-piece, and having done so, cry seize. Never suffer the dog to eat either in the house or field, without having first made him take heed in this manner.

Then, in order to apply this lesson to the game, fry small pieces of bread in hog's lard, with the dung of partridge; take these in a linen bag into the fields, stubbles, ploughed grounds, and pastures, and there put the pieces in several different places, marking the spots with little cleft pickets of wood, which will be rendered more distinguishable by putting pieces of card in the nicks. This being done, cast off the dog and conduct him to these places, always hunting in the wind. After he has caught the scent of the bread, if he approaches too near, and seems eager to fall upon it, cry to him in a menacing tone, "take heed;" and if he does not stop immediately, correct him with the whip. He will soon comprehend what is required of him, and will stand.

At the next lesson, take your gun charged only with powder, walk gently round the piece of bread once or twice, and fire instead of crying seize. The next time of practising this lesson, walk round the bread four or five times, but in a greater circle than before, and continue to do this until the dog is conquered of his impatience, and will stand without moving until the signal is given him. When he keeps his point well, and stands steady in this lesson, you may carry him to the birds; if he runs in upon them, or barks when they spring up, you must correct him; and if he continues to do so, you must return to the fried bread; but this is seldom necessary.

When the dog has learned by this use of the bread to take heed, he may be carried to the fields with the trash-cord dragging on the ground. When he springs birds for the first time, if he runs after them or barks, check him by calling out to him, "take heed." If he points properly, caress him; but you ought never to hunt without the cord until he points staunch.

The principal objects of this sport are, 1. Partridges, which pair in the spring, and lay their eggs (generally from 15 to 20) during May and part of June. The young begin to fly about the end of June, and their plumage is complete in the beginning of October. The male has a conspicuous horse-shoe upon his breast, and an obtuse spur on the hinder part of the leg, which distinguishes him from the female. He is also rather larger.

When a sportsman is shooting in a country where the birds are thin, and he no longer chooses to range the field for the bare chance of meeting with them, the following method will show him where to find them on another day. In the evening, from sun-set to night-fall, he should post himself in a field, at the foot of a tree or a bush, and there wait until the partridges begin to call, or juck, which they always do at that time; not only for the purpose of drawing together when separated, but also when the birds composing the covey are not dispersed. After calling in this manner for some little space of time, the partridges will take to flight; then, if he marks the place where they alight, he may be assured they will lie there the whole night, unless disturbed.

2. The pheasant lays its eggs generally in the woods, the number of which is ten or twelve. Pheasants are accounted stupid birds; for when they are surprised they will frequently squat down like a rabbit, supposing themselves to be in safety as soon as their heads are concealed; and in this way they will sometimes suffer themselves to be killed with a stick. They love low and moist places, and haunt the edges of those pools which are found in woods, as well as the high grass of marshes that are near at hand; and above all, places where there are clumps of alders.

3. Grouse, or moor-game, are found in Wales, in the northern counties of England, and in great abundance in Scotland. They chiefly inhabit those mountains and moors which are covered with heath, and seldom descend to the low grounds. They fly in companies of four or five braces, and love to frequent mossy places, particularly in the middle of the day, or when the weather is warm. In pursuing this game, when the pointer sets, and the sportsman perceives the birds running with their heads erect, he must run after them as fast as he can, in the hope that he may get near enough to shoot when they rise upon the wing; for he may be pretty certain they will not lie well that day. As these birds are apt to grow soon putrid, they ought to be drawn carefully the instant they are shot, and stuffed with heath; and if the feathers happen to be wetted, they must be wiped dry.

4. The woodcock is a bird of passage; it commonly arrives about the end of October, and remains until the middle of March. Woodcocks are fattest in December and January, but from the end of February they are lean. At their arrival they drop any where, but afterwards take up their residence in copses of nine or ten years growth. They seldom, however, stay in one place longer than twelve or fifteen days. During the day they remain in those parts of the woods, where there are void spaces or glades, picking up earth-worms and grubs from the fallen leaves. In the evening they go to drink and wash their bills at pools and springs, after which they repair to the open fields and meadows for the night.

5. The snipe is a bird of passage as well as the woodcock. In the month of November they grow fat. Snipes frequent springs, bogs, and marshy places, and generally fly against the wind. The slant and cross shots are rather difficult, as the birds are small and fly very quickly. The sportsman ought to look for them in the direction of the wind; because then they will fly towards him, and present a fairer mark.

6. The wild duck also may in some measure be accounted a bird of passage, and arrives here in great flocks from the northern countries in the beginning of winter. Still, however, a great many remain in our marshes and fens during the whole year, and breed.

The wild duck differs little in plumage from the tame duck, but is easily distinguished by its size, which is less; by the neck, which is more slender; by the foot, which is smaller; by the nails, which are more black; and above all, by the web of the foot, which is much finer and softer to the touch.

In the summer season, when it is known that a team of young ducks are in a particular piece of water, and just beginning to fly, the sportsman is sure to find them early in the morning dabbling at the edges of the pool, and amongst the long grass, and then he may get very near to them: it is usual also to find them in those places at noon.

In the beginning of autumn almost every pool is frequented by teams of wild ducks, which remain there during the day, concealed in the rushes. If these pools are of small extent, two shooters, by going one on each side, making a noise and throwing stones into the rushes, will make them fly up; and they will in this way frequently get shots, especially if the pool is not broad, and contracts at one end. But the surest and most successful way, is to launch a small boat or trow on the pool, and to traverse the rushes by the openings which are found; at the same time making as little noise as possible. In this manner the ducks will suffer the sportsmen to come sufficiently near them to shoot flying; and it often happens that the ducks, after having flown up, only make a circuit, return in a little time, and again alight upon the pool. Then the sportsmen endeavour a second time to come near them. If several shooters are in company, they should divide; two should go in the boat, whilst the others spread themselves about the edge of the pool, in order to shoot the ducks in their flight. In pools which will not admit a trow, water-spaniels are absolutely necessary for this sport.

In winter they may be found on the margins of little pools; and when pools and rivers are frozen up, they must be watched for in places where there are springs and waters which do not freeze. The sport is then much more certain, because the ducks are confined to these places in order to procure aquatic herbs, which are almost their only food at this period.

SHORL. No word has been used by mineralogists with less limitation than shorl. It was first introduced into mineralogy by Cronstedt, to denote any stone of a columnar form, considerable hardness, and a specific gravity from 3 to 3.4. This description applied to a very great number of stones; and succeeding mineralogists, though they made the word more definite in its signification, left it still so general, that under the designation of shorl almost twenty distinct species of minerals were included. Mr. Werner first defined the word shorl precisely, and restricted it to one species of stones. It occurs commonly in granite, gneiss, and other similar rocks; often in mass, but very frequently crystallised. The primitive form of its crystals is an obtuse rhomboid, the solid angle at the summit of which is 139°, having rhombid faces, with angles of 114° 12′ and 65° 48′: but it usually occurs in 3, 6, 8, 9, or 12 sided prisms, terminated by four or five-sided summits, variously truncated.

SHORL, *black*. Colour black. Found in mass, disseminated and crystallized. Crystals three-sided prisms, having their lateral edges truncated. Sometimes terminating in a pyramid. Lateral faces of the prism striated. Vitreous. Fracture conchoidal. Opaque. Scratch grey. Feel cold. Specific gravity from 3 to 3. It becomes electric by heat. When heated to redness, its colour becomes brownish red; and at 127° Wedgewood, it is converted into a brownish compact enamel. According to Wiegleb, it is composed of

41.25	alumina
34.16	silica
20.00	iron
5.41	manganese
100.82.	

SHORL electric. This stone was first made known in Europe by specimens brought from Ceylon; but it is now found frequently forming a part of the composition of mountains. It is sometimes in amorphous pieces, but much more frequently crystallized in three or nine-sided prisms, with four-sided summits.

Colour usually green; sometimes brown, red, blue. Found in mass, in grains, and crystallized. Crystals three, six, or nine-sided prisms, variously truncated. Faces usually striated longitudinally. Its texture is foliated. Specific gravity 3. Colour brown, sometimes with a tint of green, blue, red, or yellow. When heated to 200° Fahrenheit, it becomes electric, one of the summits negatively and the other positively. It reddens when heated, and is fusible per se, with white intumescence, into a white or grey enamel. According to Vauquelin, it is composed of

40	silica
39	alumina
12	oxide of iron
4	lime
2.5	oxide of manganese
97.5	

SHORLITE, a stone which received its name from Mr. Klaproth, is generally found in oblong masses, which, when regular, are six-sided prisms, inserted in granite. Its

texture is foliated. Fracture uneven. Easily broken. Specific gravity 3.53. Colour greenish or yellowish white; sometimes sulphur yellow. Not altered by heat. According to the analysis of Klaproth, it is composed of 50 alumina
50 silica
———
100.

According to Vauquelin, of 52.6 alumina
36.8 silica
3.3 lime
1.5 water.
———
94.2

SHORT-HAND. See STENOGRAPHY.

SHOT, a denomination given to all sorts of balls for fire-arms; those for cannon being of iron, and those for guns, pistols, &c. of lead.

SHOT, *case*, formerly consisted of all kinds of old iron, nails, musket-balls, stones, &c. used as above.

SHOT *of a cable*, on ship-board, is the splicing of two cables together, that a ship may ride safe in deep waters and in great roads; for a ship will ride easier by one shot of a cable, than by three short cables out ahead.

SHOT, *grape*. See GRAPE-SHOT.

SHOT, *patent milled*, is thus made; sheets of lead, whose thickness corresponds with the size of the shot required, are cut into small pieces, or cubes, of the form of a die. A great quantity of these little cubes are put into a large hollow iron cylinder, which is mounted horizontally and turned by a winch; when by their friction against one another, and against the sides of the cylinder, they are rendered perfectly round and very smooth. The other patent-shot is cast in moulds, in the same way as bullets are.

SHOT, *common small*, or that used for fowling, should be well sized; for, should it be too great, then it flies thin and scatters too much; or if too small, then it has not weight and strength to penetrate far, and the bird is apt to fly away with it. In order, therefore, to have it suitable to the occasion, it not being always to be had in every place fit for the purpose, we shall set down the true method of making all sorts and sizes under the name of mould-shot, formerly made after the following process:

Take any quantity of lead you think fit, and melt it down in an iron vessel; and as it melts keep it stirring with an iron ladle, skimming off all impurities whatsoever that may arise at top; when it begins to look of a greenish colour, strew on it as much auripigmentum or yellow orpiment, finely powdered, as will lie on a shilling, to every twelve or fourteen pounds of lead; then stirring them together, the orpiment will flame. The ladle should have a notch on one side of the brim, for more easily pouring out the lead; the ladle must remain in the melted lead, that its heat may be the same with that of the lead, to prevent inconveniences which otherwise might happen by its being either too hot or too cold; then, to try your lead, drop a little of it into water, and if the drops prove round, then the lead is of a proper heat; if otherwise, and the shot have tails, then add more orpiment to increase the heat, till it is found sufficient.

Then take a plate of copper, about the size of a trencher, which must be made with a hollowness in the middle, about three inches compass, within which must be bored about 40 holes according to the size of the shot which you intend to cast; the hollow bottom should be thin; but the thicker the brim, the better it will retain the heat. Place this plate on a frame of iron, over a tube or vessel of water, about four inches from the water, and spread burning coals on the plate, to keep the lead melted upon it; then take some lead and pour it gently on the coals on the plate, and it will make its way through the holes into the water, and form itself into shot; do thus till all your lead is run through the holes of the plate, taking care, by keeping your coals alive, that the lead does not cool, and so stop up the holes.

While you are casting in this manner, another person with another ladle may catch some of the shot, placing the ladle four or five inches underneath the plate in the water, by which means you will see if they are defective, and rectify them. Your chief care is to keep the lead in a just degree of heat, that it shall be not so cold as to stop up the holes in your plate, nor so hot as to cause the shot to crack; to remedy the heat, you must refrain working till it is of a proper coolness; and to remedy the coolness of your lead and plate, you must blow your fire; observing, that the cooler your lead is, the larger will be your shot; as, the hotter it is, the smaller they will be.

After you have done casting, take them out of the water, and dry them over the fire with a gentle heat, stirring them continually that they do not melt; when dry, you are to separate the great shot from the small, by the help of a sieve made for that purpose, according to their several sizes. But those who would have very large shot, make the lead trickle with a stick out of the ladle into the water, without the plate. If it stops on the plate, and yet the plate is not too cool, give but the plate a little knock, and it will run again; care must be had that none of your implements are greasy, oily, or the like; and when the shot, being separated, are found too large or too small for your purpose, or otherwise imperfect, they will serve again at the next operation.

SHOT, *tin-case*, in artillery, is formed by putting a great quantity of small iron shot into a tin cylindrical box called a cannister, that just fits the bore of the gun. Leaden bullets are sometimes used in the same manner; and it must be observed, that whatever number or sizes of the shots are used, they must weigh with their cases nearly as much as the shot of the piece.

SHREW-MOUSE. See SOREX.

SHRIMP. See CANCER.

SHRINE, in ecclesiastical history, a case or box, to hold the relics of some saint.

SHROUDS. See SHROWDS.

SHROWDS, or SHROUDS, in a ship, are the great ropes which come down both sides of the masts, and are fastened below to the chains on the ship's side, and aloft to the top of the mast; being parcelled and served, in order to prevent the mast's galling them. The topmast shrowds are fastened to the puttock-plates, by dead-eyes and laniards, as the others are. Some of the terms relating to the shrowds are: ease the shrowds; that is, slacken them: and, set up the shrowds; that is, set them stiffer.

SHUTTLE, in the manufactures, an instrument much used by weavers, in the middle of which is an eye, or cavity, wherein is inclosed the spoul with the woof. See WEAVING.

SI, in music; a seventh note or sound, added by Le Maire to the six antient notes invented by Guido Aretine, viz. ut. re, mi, fa, sol, la, si.

SIBBALDIA, a genus of plants belonging to the class of pentandria, and to the order of pentagynia; and in the natural method ranking under the 35th order, senticosæ. The calyx is divided into ten segments. The petals are five, and are inserted into the calyx. The styles are attached to the side of the germens. The seeds are five. There are three species belonging to this genus, the procumbens, erecta, and altaica. The procumbens, or reclining sibbaldia, is a native of North Britain.

SIBTHORPIA, a genus of plants belonging to the class of didynamia, and to the order of angiospermia; and in the natural system classed with those the order of which is doubtful. The calyx is spreading, and divided into five parts, almost to the base. The corolla is divided into five parts in the same manner, which are rounded, equal, spreading, and of the length of the calyx. The stamina grow in pairs at a distance from each other. The capsule is compressed, orbicular, bilocular, the partition being transverse. There is one species; the Europæa, or bastard money-wort, a native of South Britain. It blossoms from July to September, and is found in Cornwall on the banks of rivulets.

SICE-ACE, a game with dice and tables, whereat five may play; each having six men, and the last out losing. At this game, they load one another with aces; sixes bear away; and doublets drinks, and throws again.

SICYOS, a genus of plants belonging to the class of monœcia, and to the order of syngenesia; and in the natural system arranged under the 34th order, cucurbitaceæ. The male flowers have their calyx quinquedentated, their corolla quinquepartite, and there are three filaments. The female flowers have their calyx and corolla similar; but their style is trifid, and their drupe monospermous. There are three species, the angulata, laciniata, and garcini, which are all foreign plants.

SIDA, yellow or Indian mallow: a genus of plants belonging to the class of monadelphia, and to the order of polyandria; and in the natural system ranking under the 37th order, columniferæ. The calyx is simple and angulated; the style is divided into many parts; there are several capsules, each containing one seed. There are 99 species, all natives of warm climates; and most of them are found in the East or West Indies. The Chinese make cords of the sida abutilon. This plant loves water, and may be advantageously planted in marshes and ditches, where nothing else will grow. The maceration of the smaller stalks is finished in about fifteen days; of the larger in a month. The strength and goodness of the thread appears to be in proportion to the perfection of the vegetation, and to the distance the plant is kept at from other plants. The fibres lie in strata, of which there are sometimes six; they are not quite straight, but preserve an undulating direction, so as to form a network in their natural positions. Their smell resembles that of hemp; the fibres are whiter, but more dry and harsh, than those of hemp. The harshness is owing to a greenish gluten which connects the fibres; and the white colour must always be obtained at the expence of having this kind of thread less supple; when of its natural hue, it is very soft and flexible.

SIDERIA, in natural history, the name of a genus of crystals, used to express those altered in their figure by particles of iron. These are of a rhomboidal figure, and composed only of six planes. Of this genus there are four known species: 1. A colourless, pellucid, and thin one; found in considerable quantities among the iron ores of the forest of Dean in Gloucestershire, and in several other places. 2. A dull, thick, and brown one, not uncommon in the same places with the former. And, 3. A black and very glossy kind, a fossil of great beauty; found in the same place with the others, as also in Leicestershire and Sussex.

SIDERITE, a substance discovered by Mr. Meyer, and by him supposed to be a new metal; but Messrs. Bergman and Kirwan discovered that it is nothing else than a natural combination of the phosphoric acid with iron. Mr. Klaproth of Berlin also came to the same conclusion, without any communication with Mr. Meyer. It is extremely difficult to separate this acid from the metal; however, he found the artificial compound of phosphoric acid and iron to agree in its properties with the calx sideri alba, obtained by Bergman and Meyer from the cold short iron extracted from the swampy or marshy ores.

SIDERITIS, Ironwort; a genus of plants belonging to the class of didynamia, and to the order of gymnospermia; and in the natural system ranging under the 42d order, verticillatæ. The stamina are within the tube of the corolla. There are two stigmas, one of which is cylindrical and concave; the other, which is lower, is membranous, shorter, and sheathing the other. The species are 19.

SIDEROXYLUM, Iron-wood: a genus of plants belonging to the class of pentandria, and to the order of monogynia; and in the natural system ranging under the 43d order, dumosæ. The corolla is cut into five parts, the laciniæ or segments being incurvated alternately; the stigma is simple; the berry contains five seeds. There are nine species; 1. Mite; 2. inerme, smooth iron-wood; 3. melanophleum, laurel-leaved iron-wood; 4. cymosum; 5. sericeum, silky iron-wood, native of New South Wales; 6. tomentosum; 7. tenax, silvery-leaved iron-wood, a native of Carolina; 8. lycioides, willow-leaved iron-wood, a native of North America; 9. decandrum. The wood of these trees being very close and solid, has given occasion for this name to be applied to them, it being so heavy as to sink in water. As they are natives of warm countries, they cannot be preserved in this country unless they are placed, the two former in a warm stove, the others in a green-house. They are propagated by seeds, when these can be procured from abroad.

SIEGE, in the art of war, the encampment of an army before a fortified place, with a design to take it.

SIENITE. See Rocks, *primitive*.

SIGESBECKIA, a genus of plants belonging to the class syngenesia, and to the order of polygamia superflua, and in the natural system ranging under the 49th order, compositæ. The receptacle is paleaceous; the pappus wanting; the exterior calyx is pentaphyllous, proper, and spreading; the radius is halved. There are three species: 1. The orientalis, which is a native of India and China. 2. The occidentalis, which is a native of Virginia. 3. The flosculosa, a native of Peru.

SIGHTS *of a quadrant*, &c. thin pieces of brass, raised perpendicularly on its side, or on the index of a theodolite, circumferentor, &c. They have each an aperture, or slit, up the middle, through which the visual rays pass to the eye, and distant objects are seen.

Sights *of a gun*. See Rifle.

SIGN, in astronomy, a constellation containing a twelfth part of the zodiac, or 30°. See Zodiac.

The names of the signs, in the order wherein they follow each other, are aries, taurus, gemini, cancer, leo, virgo, libra, scorpio, sagittarius, capricornus, aquarius, pisces. The three first of these signs are called the vernal, or spring-signs; the next three, cancer, leo, virgo, the æstival, or summer-signs; libra, scorpio, and sagittarius, the autumnal signs; and capricornus, aquarius, pisces, the brumal, or winter-signs. The vernal and æstival signs are also called the northern, and the autumnal and brumal the southern signs.

Sign-manual, in law, is used to signify a bill, or writing, signed by the king's own hand-writing.

SIGNALS, certain alarms or notices used to communicate intelligence to a distant observer. Signals are made by firing artillery, and displaying colours, lanterns, or fireworks; and these are combined by multiplication and repetition. Thus, like the words of a language, they become arbitrary expressions, to which we have previously annexed particular ideas; and hence they are the general sources of intelligence throughout a naval armament, &c.

Signals ought to be distinct, with simplicity. They are simple when every instruction is expressed by a particular token, in order to avoid any mistakes arising from the double purport of one signal. They are distinct when issued without precipitation, when sufficient time is allowed to observe and obey them, and when they are exposed in a conspicuous place, so as to be readily perceived at a distance.

All signals may be reduced into three different kinds, viz. those which are made by the sound of particular instruments, as the trumpet, horn, or fife; to which may be added, striking the bell, or beating the drum. Those which are made by displaying pendants, ensigns, and flags of different colours; or by lowering or altering the position of the sails; and, finally, those which are executed by rockets of different kinds; by firing cannon or small arms; by artificial fire-works; and by lanterns.

Firing of great guns will serve equally in the day or night, or in a fog, to make or confirm signals, or to raise the attention of the hearers to a future order. This method, however, is attended with some inconveniences, and should not be used indiscriminately. Too great a report of the cannon is apt to introduce mistakes and confusion, as well as to discover the track of the squadron. The report and flight of rockets is liable to the same objection, when at a short distance from the enemy.

It is then by the combination of signals, previously known, that the admiral conveys orders to his fleet; every squadron, every division, and every ship of which, has its particular signal. The instruction may therefore occasionally be given to the whole fleet, or to any of its squadrons; to any division of those squadrons, or to any ship of those divisions.

Hence the signal of command may at the same time be displayed for three divisions, and for three ships of each division; or for three ships in each squadron, and for only nine ships in the whole fleet. For, the general signal of the fleet being shown, if a particular pendant is also thrown out from some particular place on the same mast with the general signal, it will communicate intelligence to nine ships that wear the same pendant.

The preparatory signal given by the admiral to the whole or any part of his fleet, is immediately answered by those to whom it is directed; by showing the same signal, to testify that they are ready to put his orders in execution. Having observed their answer, he will show the signal which is to direct their operations: as, to chase, to form the line, to begin the engagement, to board, to double upon the enemy, to rally or return to action, to discontinue the fight, to retreat and save themselves. The dexterity of working the ships in a fleet depends on the precise moment of executing these orders, and on the general harmony of their movements; a circumstance which evinces the utility of a signal of preparation.

As the extent of the line of battle, and the fire and smoke of the action, or other circumstances in navigation, will frequently prevent the admiral's signals from being seen throughout the fleet, they are always repeated by the officers next in command, by ships appointed to repeat signals; and, finally, by the ship or ships for which they are intended.

The ships that repeat the signals, besides the chiefs of squadrons or divisions, are usually frigates lying to windward or to leeward of the line. They should be extremely vigilant to observe and repeat the signals, whether they are to transmit the orders of the commander in chief, or his seconds, to any part of the fleet; or to report the fortunate or distressful situation of any part thereof. By this means all the ships from the van to the rear will, unless disabled, be ready at a moment's warning to put the admiral's designs in execution.

To preserve order in the repetition of signals, and to favour their communication, without embarrassment, from the commander in chief to the ship for which they are calculated, the commanders of the squadrons repeat after the admiral; the chiefs of the divisions, according to their order of the line, after the commanders of the squadrons; and the particular ships after the chiefs of the divisions;

and those in return, after the particular ships, vice versa, when the object is to convey any intelligence from the latter to the admiral.

Besides the signals above-mentioned, there are others for different ranks of officers; as for captains, lieutenants, masters, &c. or for any of those officers of a peculiar ship.

SIGNALS *by the drum*, made use of, in the exercise of the army, instead of the word of command, viz.

SIGNALS.	*Operations.*
A short roll,	To caution.
A flam,	To perform any distinct thing.
To arms,	To form the line or battalion.
The march,	To advance, except when intended for a salute.
The quick march,	To advance quick.
The point of war,	To march and charge.
The retreat,	To retreat.
Drum ceasing,	To halt.
Two short rolls,	To perform the flank-firing.
The dragoon march,	To open the battalion.
The grenadier march,	To form the column.
The troop,	To double divisions.
The long roll,	To form the square.
The grenadier march,	To reduce the square to the column.
The preparative,	To make ready and fire.
The general,	To cease firing.
Two long rolls,	To bring or lodge the colours.

SIGNATURE, in printing, is a letter put at the bottom of the first page at least, in each sheet, as a direction to the binder, in folding, gathering, and collating them. The signatures consist of the capital letters of the alphabet, which change in every sheet: if there are more sheets than letters in the alphabet, to the capital letter is added a small one of the same sort, as Aa, Bb; which are repeated as often as necessary. In large volumes it is usual to distinguish the number of alphabets, after the first three or four, by placing a figure before the signature, as 5B, 6B, &c.

SIGNET, one of the king's seals, made use of in sealing his private letters, and all grants that pass by bill signed under his majesty's hand: it is always in the custody of the secretaries of state.

SIGNIFICAVIT, in law, a writ which issues out of the court of chancery, on a certificate given by the ordinary of a person's standing excommunicated forty days, in order to have him imprisoned till he submits to the authority of the church.

SILENE, *catchfly*, or *viscous campion*, a genus of plants belonging to the class of decandria, and order of trigynia; and in the natural system arranged under the 22d order, caryophylleæ. The calyx is ventricose; the petals are five in number, bifid and unguiculated, and crowned by a nectarium; the capsule is cylindrical, covered, and trilocular. There are 66 species, of which seven are natives of Britain and Ireland.

SILICA. There is a very hard white stone, known by the name of quartz, very common in almost every part of the world. Sometimes it is transparent and crystallized, and then is called rock crystal. Very frequently it is in the form of sand. As this stone, and several others which resemble it, as flint, agate, calcedony, &c. have the property of melting into a glass when heated along with fixed alkali, they were classed together by mineralogists under the name of vitrifiable stones. Mr. Pott, who first described their properties in 1746, gave them the name of siliceous stones, on the supposition that they were all chiefly composed of a peculiar earth called siliceous earth or silica. This earth was known to Glauber, who describes the method of obtaining it: but it was long before its properties were accurately ascertained. Geoffroy endeavoured to prove that it might be converted into lime, and Pott and Beaumé that it might be converted into alumina: but these assertions were refuted by Cartheuser, Scheele, and Bergman. To this last chemist we are indebted for the first accurate detail of the properties of silica.

1. Silica may be obtained pure by the following process: Mix together, in a crucible, one part of pounded flint or quartz, and three parts of potass, and apply a heat sufficient to melt the mixture completely. Dissolve the mass formed in water, saturate the potass with muriatic acid, and evaporate to dryness. Towards the end of the evaporation the liquid assumes the form of a jelly; and when all the moisture is evaporated, a white mass remains behind. This mass is to be washed in a large quantity of water, and dried; it is then silica in a state of purity.

2. Silica, thus obtained, is a fine white powder, without either taste or smell. Its particles have a harsh feel, as if they consisted of very minute grains of sand. Its specific gravity is 2.66.

It may be subjected to a very violent heat without undergoing any change. Lavoisier and Morveau exposed it to the action of a fire maintained by oxygen gas without any alteration. Saussure, indeed, has succeeded in fusing, by means of the blowpipe, a portion of it so extremely minute as scarcely to be perceptible without a glass. According to the calculation of this philosopher, the temperature necessary for producing this effect is equal to 4043° Wedgewood.

3. It is insoluble in water except when newly precipitated, and then one part of it is soluble in 1000 parts of water. It has no effect on vegetable colours.

It is capable of absorbing about one-fourth of its weight of water, without letting any drop from it; but on exposure to the air, the water evaporates very readily. When precipitated from potass by means of muriatic acid and slow evaporation, it retains a considerable portion of water, and forms with it a transparent jelly; but the moisture gradually evaporates on exposure to the air.

Silica may be formed into a paste with a small quantity of water: this paste has not the smallest ductility, and when dried forms a loose, friable, and incoherent mass.

Silica is capable of assuming a crystalline form. Crystals of it are found in many parts of the world. They are known by the name of rock crystal. When pure they are transparent and colourless like glass: they assume various forms; the most usual is a hexagonal prism, surmounted with hexagonal pyramids on one or both ends, the angles of the prism corresponding with those of the pyramids. Their hardness is very great, amounting to 11. Their specific gravity is 2.653.

4. Silica neither combines with oxygen, with the simple combustibles, nor with metals; but it combines with many of the metallic oxides by fusion, and forms various coloured glasses and enamels.

5. Azote has no action on silica, neither has muriatic acid when the silica is in a solid state; but when the silica is combined with an excess of alkali, muriatic acid dissolves the compound, and forms a permanent solution. By concentrating this solution, the silica separates from it in the form of a jelly.

6. There is a strong affinity between silica and fixed alkalies. It may be combined with them either by fusing them along with it in a crucible, or by boiling the liquid alkalies over it. When the potass exceeds the silica considerably, the compound is soluble in water, and constitutes what was formerly called liquor silicum, and now sometimes silicated potass or soda. When the silica exceeds, the compound is transparent and colourless like rock crystal, and is neither acted on by water, air, nor (excepting one) by acids. This is the substance so well known under the name of glass. See GLASS.

Silica is not acted on by ammonia, whether in the gaseous or liquid state.

7. There is a strong affinity between barytes and silica. When barytes water is poured into a solution of silica in potass, a precipitate appears, which is considered by Morveau as the two earths in a state of combination. Barytes and silica may be combined by means of heat. The compound is of a greenish colour, and coheres but imperfectly. The effect of heat on various mixtures of barytes and silica will appear from the following experiments of Mr. Kirwan:

Proportions.	Heat.	Effect.
80 Silica 20 Barytes	155° Wedg.	A white brittle mass.
75 Silica 20 Barytes	150	A brittle hard mass, semitransparent at the edges.
66 Silica 33 Barytes	150	Melted into a hard somewhat porous porcelain mass.

Proportions.	Heat.	Effect.
50 Silica 50 Barytes	148	A hard mass not melted.
20 Silica 80 Barytes	148	The edges were melted into a pale greenish matter between a porcelain and enamel.
25 Silica 75 Barytes	150	Melted into a somewhat porous porcelain.
33 Silica 66 Barytes	150	Melted into a yellowish and partly greenish white porous porcelain.

Strontian and silica combine with each other nearly in the same manner.

There is also an affinity between silica and lime. When lime-water is poured into a solution of silica in potass, a precipitate appears, as Stucke discovered. This precipitate is a compound of silica and lime. These two earths may be combined also by means of heat. They form a glass, provided the quantity of lime is not inferior to that of silica. The effect of heat upon these earths, mixed in various proportions, will appear from the following experiments of Mr. Kirwan:

Proportions.	Heat.	Effect.
50 Lime 50 Silica	150° Wedg.	Melted into a mass of a whitish colour, semi-transparent at the edges, and striking fire, though feebly, with steel: it was somewhat between porcelain and enamel.
80 Lime 20 Silica	156	A yellowish white loose powder.
20 Lime 80 Silica	156	Not melted, formed a brittle mass.

Equal parts of magnesia and silica melt with great difficulty into a white enamel when exposed to the most violent heat which can be produced. They are infusible in inferior heats, in whatever proportion they are mixed.

There is a strong affinity between alumina and silica. When equal portions of silicated and aluminated potass are mixed together, a brown zone immediately appears, which may be made, by agitation, to pass through the whole liquid. After standing about an hour, the mixture assumes the consistence of jelly. When formed into a paste with water, and dried, they cohere, and contract a considerable degree of hardness. When baked in the temperature of 160° Wedgewood, they become very hard, but do not fuse. Achard found them infusible in all proportions in a heat probably little inferior to 150° of Wedgewood. But when exposed to a very strong heat, they are converted into a kind of opaque glass, or rather enamel. Porcelain, stone ware, brick, tiles, and other similar substances, are composed chiefly of this compound. Mixtures of silica and alumina in various proportions constitute clays; but these are seldom uncontaminated with other ingredients.

It follows from the experiments of Achard, that equal parts of lime, magnesia, and silica, may be melted into a greenish-coloured glass, hard enough to strike fire with steel; that when the magnesia exceeds either of the other two, the mixture will not melt; that when the silica exceeds, the mixture seldom melts, only indeed with lime in the following proportions; three silica, two lime, one magnesia, which formed a porcelain; and that when the lime exceeds, the mixture is generally fusible.

A mixture of silica and alumina may also be combined with barytes or strontian by means of heat. The mixture melts readily into a greenish-coloured porcelain.

From the experiments of Achard and Kirwan, we learn that, in mixtures of lime, silica, and alumina, when the lime exceeds, the mixture is generally fusible either into a glass or a porcelain, according to the proportions. That if the silica exceeds, the mixture is frequently fusible into an enamel or porcelain, and perhaps a glass; and that when the alumina exceeds, a porcelain may often be attained, but not a glass.

As to mixtures of magnesia, silica, and alumina, when the magnesia exceeds, no fusion takes place at 150°. When the silica exceeds, a porcelain may often be attained; and three parts silica, two magnesia, and one alumina, form a glass. When the alumina exceeds, nothing more than a porcelain can be produced.

Achard found that equal parts of lime, magnesia, silica, and alumina, melted into a glass. They fused also in various other proportions, especially when the silica predominated.

Silica differs from all the other earths in not combining with any of the acids except the fluoric, phosphoric, and boracic; to which, perhaps, we may add the muriatic.

Silica is one of the most important of the earths. It is the chief ingredient of those stones which seem to constitute the basis of this terrestrial globe. It is an essential ingredient in mortar, in all kinds of stone ware, and in glass.

SILK, in natural history, is the production of different species of caterpillars. The phalæna, or bombyx mori, is most commonly propagated for that purpose in Europe; but the phalena atlas yields a greater quantity. See Bombyx, and Phalæna. A similar substance, indeed, is yielded by the greater number of the tribe of caterpillars. It is found inclosed in two small bags, from which it is protruded in fine threads to serve the insect for a covering during its chrysalis state. The webs of spiders are obviously of the same nature with silk; though their fibres, at least in this country, are finer and weaker. Reaumur and other naturalists ascertained, that the larger species of spiders spun webs sufficiently strong to be manufactured, and that the produce was neither inferior in beauty nor in strength to the silk of the silkworm. See Aranea.

The silkworm is a native of China, and feeds on the leaves of the white mulberry. That industrious nation was acquainted with the manufacture of silk from the most remote ages; but it was scarcely known in Europe before the time of Augustus. Its beauty attracted the attention of the luxurious Romans; and after the effeminate reign of Elagabulus, it became a common article of dress. It was brought from China at an enormous expence, manufactured again by the Phœnicians, and sold at Rome for its weight of gold. In the reign of Justinian this commerce was interrupted by the conquests of the Scythian tribes, and all attempts to procure it failed till two Persian monks had the address to convey some of the eggs of the insect from China to Constantinople, concealed in the hollow of a cane. They were hatched, and the breed carefully propagated. This happened in 555; and some years after we find that the Greeks understood the art of procuring and manufacturing silk as well as the Orientals. Roger, king of Sicily, brought the manufacture to that island in 1130, forcibly carrying off the weavers from Greece, and settling them in Sicily. From that island the art passed into Italy, and thence into France: and the revocation of the edict of Nantz established the manufactory of silk in Britain.

Silk, as spun by the animal, is in the state of fine threads, varying in colour from white to reddish yellow. It is very elastic, and has considerable strength, if we consider its small diameter. It is covered with a varnish, to which its elasticity is owing. This varnish is soluble in boiling water; but alcohol does not act upon it. Hence it has been compared to a gum, though it approaches much nearer to a gelatine; since Berthollet has shewn that it is precipitated by tan and by muriat of tin. It differs, however, from gelatine in several particulars. Alum throws it down of a dirty white, sulphat of copper of a dark brown, and sulphat of iron of a brown colour. When the water is evaporated, the varnish is obtained of a black colour, brittle, and of a shining fracture. Its weight is nearly one-third of the raw silk from which it was extracted. It may be separated from silk by soap as well as water, and the soap leys containing it soon putrefy.

Besides the varnish, silk contains another substance to which it owes its yellow colour. This substance possesses the properties of resin. It is yellow, soluble in alcohol, and in a mixture of alcohol and muriatic acid. Beaumé has ascertained, that by this last mixture it may be separated completely, and the silk deprived of it assumes a fine white colour.

The chemical properties of silk itself have been but imperfectly examined. It is not acted on by water or alcohol, has no taste, and is but imperfectly combustible; though fire rapidly blackens and decomposes it. When distilled, it yields, according to Neumann, an uncommonly great proportion of ammonia.

The fixed alkalies dissolve it by the assistance of heat; and it is not unlikely that they form with it an animal soap.

It is dissolved likewise by sulphuric and muriatic acids, and by nitric acid. By the action of this last acid, Berthollet obtained from silk some oxalic acid, and a fatty matter which swam on the surface of the solution. By a similar treatment, Welter obtained fine yellow crystals, very combustible, to which he gave the name of yellow bitter principle.

Silk is very little susceptible of putrefaction. Dr. Wilson, of Falkirk, says, that a ribbon was lately found in the churchyard of that town wrapt round the bone of the arm. It was uninjured, though it had lain eight years in the earth. We know, at the same time, that when silk is kept in a damp place it rots (to use the common language) in a much shorter time.

Silk, *manufacture, or preparation of.* When the silkworms have completed their balls or cocoons (see Phalæna, Vol. II. p. 389), they are collected, and put into little baskets; and thus exposed to the heat of an oven, to kill the insect, which, without this precaution, would not fail to open itself to go away and use those new wings abroad, it has acquired within.

Ordinarily, they only wind the more perfect balls; those that are double, or too weak, or too coarse, are laid aside, not as altogether useless, but that, being improper for winding, they are reserved to be drawn out into skains. The balls are of different colours; the most common are yellow, orange-colour, isabella, and flesh-colour; there are some also of a sea-green, others of a sulphur-colour, and others white; but there is no necessity for separating the colours and shades to wind them apart, as all the colours are to be lost in the future scouring and preparing of the silk.

The goodness of silk is best distinguished by its lightness. The organzine silk is the best of any made in the country of Piedmont, and two threads are equal in fineness, that is, in smoothness, thickness, and length, for the thread of the first twist. For the second, it matters not whether the single thread is strong before the two are joined, unless to see whether the first twist proves well. It is necessary that the silk be clean; and it is to be observed, that the straw-coloured is generally the lightest, and the white the heaviest of all. The skains should be even, and all of an equality, which shews that they were wrought together; otherwise we may with justice suspect that it is refuse silk, and cannot be equally drawn out and spun, for one thread will be shorter than the other, which is labour and loss. It will also be requisite to search the bale more than once, and take from out of the parcels a skain to make an essay; for unless it is known by trial, there is the greatest danger of being cheated in this commodity. To wind silk from off the balls, two machines are necessary; the one a furnace, with its copper; the other a reel, or frame, to draw the silk. The winder then, seated near the furnace, throws into the copper of water over the furnace (first heated and boiled to a certain degree, which custom alone can teach) a handful or two of balls, which have been first well purged of all their loose furry substance. She then stirs the whole very briskly about with birchen rods, bound and cut like brushes; and when the heat and agitation have detached the ends of the silks of the cocoons, which are apt to catch on the rods, she draws them forth, and joining ten or twelve, or even fourteen of them together, she forms them into threads, according to the size required to the works they are destined for: eight ends sufficing for ribands; and velvets, &c. requiring no less than fourteen. The ends, thus joined into two or three threads, are first passed into the holes of three iron rods, in the fore-part of the reel, then upon the bobbins or pulleys, and at last are drawn out to the reel itself, and there fastened; each to an end of an arm or branch of the reel. Thus disposed, the winder, giving motion to the reel, by turning the handle, guides the threads; substitutes new ones, when any of them break, or any of the balls are wound out; strengthens them, where necessary, by adding others; and takes away the balls wound out, or that, having been pierced, are full of water.

In this manner, two persons will spin and reel three pounds of silk in a day, which is done with greater dispatch than is made by the spinning-wheel or distaff. Indeed, all silks cannot be spun and reeled after this manner; either because the balls have been perforated by the silkworms themselves, or because they are double, or too weak to bear the water; or because they are coarse, &c. Of all these together, they make a particular kind of silk, called floretta; which being carded, or even spun on the distaff, or the wheel, in the condition it comes from the ball, makes a tolerable silk.

As to the balls, after opening them with scissars, and taking out the insects (which are of some use for the feeding of poultry), they are steeped three or four days in troughs, the water of which is changed every day to prevent their stinking. When they are well softened by this scouring, and cleared of that gummy matter the worm had lined the inside with, and which renders it impenetrable to the water, and even to air itself, they boil them half an hour in a lye of ashes, very clear and well strained: and after washing them out in the river, and drying them in the sun, they card and spin them on the wheel, &c. and thus make another kind of floretta, somewhat inferior to the former.

As to the spinning and reeling of raw silks off the balls, such as they are brought from Italy and the Levant, the first is chiefly performed on the spinning-wheel; and the latter, either on hand-reels, or on reels mounted on machines, which serve to reel several skains at the same time.

As to the milling, they use a mill composed of several pieces, which may mill two or three hundred bobbins at once, and make them into as many skains.

For the dyeing of silks, see Dyeing.

SILPHA, a genus of insects of the order coleoptera. The generic character is, antennæ thickening towards the tip; wing-sheaths margined; head prominent; thorax flattish, margined. The insects of the genus silpha, of which there are 35 species, are generally found among decaying animal or vegetable substances, frequenting dung-hills, carrion, &c. and deposit their eggs chiefly in the latter. The larvæ are of a lengthened shape, and of an unpleasant appearance, being generally roughened with minute spines and protuberances. The most remarkable of the European species, and which is by no means uncommon in our own country, is the silpha vespillo, distinguished by having the wing-sheaths considerably shorter than the abdomen, or as if cut off at the tips: they are also each marked by two waved, orange-coloured, transverse bars, the rest of the insect being black: the general length of the animal is about three quarters of an inch. This insect seeks out some decaying animal substance in which it may deposit its eggs, and in order to their greater security, contrives to bury it under ground. Three or four insects, working in concert, have been known to drag under the surface the body of so large an animal as a mole in the space of an hour, so that no trace of it has appeared above ground. The eggs deposited by the parent insects are white, and of an oval or rather subcylindric shape: from these are hatched the larvæ, which, when full-grown, are more than an inch in length, and of a yellowish-white colour, with a scaly orange-coloured shield or bar across the middle of each division of the body. Each of these larvæ forms for itself an oval cell in the ground, in which it changes to a yellowish chrysalis, resembling that of a beetle; out of which, in the space of about eighteen days, proceeds the perfect insect. This species possesses a considerable degree of elegance, but generally diffuses a very strong and unpleasant smell: it flies with considerable strength and rapidity, and is generally seen on the wing during the hottest part of the day. In many parts of North America is found a variety, differing merely in size, being far larger than the European kind, and measuring an inch and a half in length.

SILPHIUM, a genus of plants belonging to the class of syngenesia, and to the order of polygamia necessaria; and in the natural system arranged under the 49th order, compositæ. The receptacle is paleaceous; the pappus has a two-horned margin, and the calyx is squamose. There are eight species; the laciniatum, terebinthinum, perfoliatum, connatum, asteriscum, trifoliatum, arboreum, and trilobatum. The first six of these are natives of North America.

Several of the silphæ are of an entirely oval outline: of this kind is the S. thoracica, which is easily distinguishable by its red thorax, every other part of the animal being coal-black: it is about half an inch in length.

Silpha atrata is of similar size, but totally black, and has the wing-sheaths marked by three rising lines: its larva, which may be found in gardens, is of a lengthened shape and of a black colour. See Plate Nat. Hist., figs. 361 and 362.

SILVER, in natural history, is a metal of a fine white colour, without either taste or smell; and in point of brilliancy perhaps inferior to none of the metallic bodies, if we except polished steel. Its hardness is 7. When melted, its specific gravity is 10.478; when hammered, 10.609. In malleability, it is inferior to none of the metals, if we except gold, and perhaps also platinum. It may be beaten out into leaves only $\frac{1}{160000}$ inch thick. Its ductility is equally remarkable: it may be drawn out into wire much finer than a human hair; so fine, indeed, that a single grain of silver may be extended about 400 feet in length. Its tenacity is such, that a wire of silver 0.078 inch in diameter is capable of supporting a weight of 187.13lbs. avoirdupois without breaking.

Silver melts when it is heated completely red hot; and while melted, its brilliancy is much increased. According to the calculation of Bergman and Mortimer, its fusing point is 1000° of Fahrenheit. It continues melted at 28° Wedgewood, but requires a greater heat to bring it to fusion. If the heat is increased after the silver is melted, the liquid metal boils, and may be volatilized; but a very strong and long-continued heat is necessary.

When cooled slowly, its surface exhibits the appearance of crystals; and if the liquid part of the metal is poured out as soon as the surface congeals, pretty large crystals of silver may be obtained. By this method Tillet, and Mongez junior, obtained it in four-sided pyramids, both insulated and in groups.

Silver is not oxidated by exposure to the air: it gradually, indeed, loses its lustre, and becomes tarnished; but this is owing to a different cause. Neither is it altered by being kept under water. But if it is kept for a long time melted in an open vessel, it gradually attracts the oxygen from the atmosphere, and is converted into an oxide. Macquer, by exposing silver 20 times successively to the heat of a porcelain furnace, obtained a glass of an olive-green colour. Nay, if the heat is sufficient, the silver even takes fire and burns like other combustible bodies. Van Marum made electric sparks from his powerful Teylerian machine pass through a silver wire; the wire exhibited a greenish-white flame, and was dissipated into smoke. Before a stream of oxygen and hydrogen gas, it burns rapidly with a light-green flame.

The oxide of silver, obtained by means of heat, is of a greenish or yellowish grey colour; and is easily decomposed by the application of heat in close vessels, or even by exposing it to the light. When silver is dissolved in nitric acid, and precipitated by lime water, it falls to the bottom under the form of a powder, of a dark-greenish brown colour. From the experiments of Wenzel and Bergman it follows, that the greenish or yellowish grey oxide is composed of about 90 parts of silver and 10 of oxygen. When this oxide is exposed to the light, part of its oxygen is separated, as Scheele first ascertained; and is converted into a black powder, which contains but a very small portion of oxygen, and may be considered as silver reduced. By exposing the solution of silver in nitric acid to sunshine, the silver precipitates in the form of a flea-brown powder.

Neither carbon nor hydrogen has been combined with silver; but it combines readily with sulphur and phosphorus.

1. When thin plates of silver and sulphur are laid alternately above each other in a crucible, they melt readily in a low red heat, and form sulphuret of silver. It is of a black or very deep violet colour; brittle, but capable of being cut with a knife; often crystallized in small needles; and much more fusible than silver. If sufficient heat is applied, the sulphur is slowly volatilized, and the metal remains behind in a state of purity. It is very difficult to determine the proportion of the ingredients which enter into the composition of this substance, because there is an affinity between silver and its sulphuret, which disposes them to combine together. The greatest quantity of sulphur which a given quantity of silver is capable of taking up, is, according to Wenzel, $\frac{13}{100}$.

It is well known, that when silver is long exposed to the air, especially in frequented places, as churches, theatres, &c. it acquires a covering of a violet colour, which deprives it of its lustre and malleability. This covering, which forms a thin layer, can only be detached from the silver by bending it, or breaking it in pieces with a hammer. It was examined by Mr. Proust, and found to be sulphuret of silver.

2. Silver was first combined with phosphorus by Mr. Pelletier. If one ounce of silver, one ounce of phosphoric glass, and two drams of charcoal, are mixed together, and heated in a crucible, phosphuret of sulphur is formed. It is of a white colour, and appears granulated, or crystallized. It breaks under the hammer, but may be cut with a knife. It is composed of four parts of silver and one of phosphorus. Heat decomposes it by separating the phosphorus. Pelletier has observed, that silver in fusion is capable of combining with more phosphorus than solid silver: for when phosphuret of silver is formed by projecting phosphorus into melted silver, after the crucible is taken from the fire, a quantity of phosphorus is emitted the moment the metal congeals.

Silver does not combine with the simple incombustibles.

Silver combines readily with the greater number of metallic bodies.

1. When silver and gold are kept melted together, they combine, and form an alloy composed, as Homberg ascertained, of one part of silver, and five of gold. He kept equal parts of gold and silver in gentle fusion for a quarter of an hour, and found, on breaking the crucible, two masses, the uppermost of which was pure silver, the undermost the whole gold combined with $\frac{1}{6}$ of silver. Silver, however, may be melted with gold in almost any proportion; and if the proper precautions are employed, the two metals remain combined together.

The alloy of gold and silver is harder and more sonorous than gold. Its hardness is a maximum when the alloy contains two parts of gold and one of silver. The density of these metals is but little increased; but the colour of the gold is much altered, even when the proportion of the silver is small; one part of silver produces a sensible whiteness in twenty parts of gold. The colour is not only pale, but it has also a very sensible greenish tinge, as if the light reflected by the silver passed through a very thin covering of gold. This alloy being more fusible than gold, is employed to solder pieces of that metal together.

2. When silver and platinum are fused together (for which a very strong heat is necessary), they form a mixture, not so ductile as silver, but harder and less white. The two metals are separated by keeping them for some time in the state of fusion; the platinum sinking to the bottom from its weight. This circumstance would induce us to suppose that there is very little affinity between them.

The affinities of silver, and its oxides, are placed by Bergman in the following order:

Silver.	Oxide of Silver.
Lead,	Muriatic acid,
Copper,	Oxalic,
Mercury,	Sulphuric,
Bismuth,	Saclactic,
Tin,	Phosphoric,
Gold,	Sulphurous,
Antimony,	Nitric,
Iron,	Arsenic,
Manganese,	Fluoric,
Zinc,	Tartaric,
Arsenic,	Citric,
Nickel,	Lactic,
Platinum,	Acetic,
Sulphur,	Succinic,
Phosphorus.	Prussic,
	Carbonic.

Silver, *fulminating*. See Fulmination.

Silver-leaf, that beaten out into fine leaves for the use of the gilders, which is performed in the same manner as gold-leaf.

Silver-wire, that drawn out into fine wire; for the manner of doing which, see the articles Gold-wire, and Wire-drawing.

Silver, *shell*, is prepared of the shreds of silver-leaves, or of the leaves themselves, for the use of painters, after the same manner as shell-gold. See Gold.

Silvering. The art of silvering wood, paper, &c. is performed in the same manner as gilding, making use of silver instead of gold leaf.

To silver copper or brass, clean the metal with aqua fortis, by washing it lightly, and then throwing it in water; or by scouring it with salt and tartar with a wire brush. Dissolve some silver in aqua fortis, and put pieces of copper into the solution; this will throw down the silver in a state of metallic powder. Take 20 grains of this powder, and mix with it two drams of tartar, the same quantity of common salt, and half a drachm of alum; rub the articles with this composition till they are perfectly white, then brush it off, and polish them with leather.

To silver the dial-plates of clocks, scales of barometers, &c. Take half an ounce of silver lace, add to it an ounce of double-refined aqua fortis, put them into an earthen pot, and place them over a gentle fire till all is dissolved, which will happen in about five minutes; then take them off, and mix it in a pint of clear water, after which, pour it into another clean vessel, to free it from grit or sediment; then add a spoonful of common salt; and the acid, which has now a green tinge, will immediately let go the silver particles, which form themselves into a white curd; pour off the acid, and mix the curd with two ounces of salt of tartar, half an ounce of whiting, and a large spoonful of salt, more or less, according as you find it for strength. Mix it well up together, and it is ready for use.

Having well cleared the brass from scratches, rub it over with a piece of old hat and rottenstone, to clear it from all greasiness, and then rub it with salt and water with your hand: take a little of the beforementioned composition on your finger, and rub it over where the salt has touched, and it will adhere to the brass, and completely silver it. After which, wash it well with water, to take off what aqua fortis may remain in the composition; when dry, rub it with a clean rag, and give it one or two coats of varnish. This silvering is not durable, but may be improved by heating the article, and repeating the operation till the covering seems sufficiently thick.

Silver plating. The coat of silver applied to the surface of the copper by the means mentioned above, is very thin, and is not durable. A more substantial method of doing it is as follows: Form small pieces of silver and copper, and tie them together with wire, putting a little borax between. The proportion of silver may be to that of copper, as 1 to 12. Put them into a white heat, when the silver will be firmly fixed to the copper. The whole is now made to pass between rollers till it is of the required thickness for manufacturing the articles required.

SILURUS, a genus of fishes of the order abdominales. The generic character is, head large, depressed; mouth wide, bearded by long tentacula; body lengthened, naked; first ray of the pectoral fins, or of the first dorsal fin, toothed backwards. There are 28 species.

1. Silurus glaris, European silure. The great or common silure may perhaps be considered as the largest of all European river-fishes; growing to the length of eight, ten, or even fifteen feet, and to the weight of three hundred pounds. Its more general length, however, is from two to three or four feet. The head is broad and depressed; the body thick and of a lengthened form, with the abdomen very thick and short. It is a fish of a remarkably inert or sluggish disposition, being rarely observed in motion, and commonly lying half-imbedded in the soft bottom of the rivers it frequents, under the projecting roots of trees, rocks, logs, or other substances. In this situation it remains, with its wide mouth half-open, gently moving about the long cirri or tentacula situated on each side the jaws; which the smaller fishes mistaking for worms, and attempting to seize, become a ready prey to the sluggish silure. The usual colour of this species is dark olive, varied with irregular spots of black; the abdomen and lips being of a pale flesh colour, and the fins tinged with violet. It is an inhabitant of the larger rivers of Europe, as well as some parts of Asia and Africa; but appears to be most plentiful in the north of Europe. It is in no very high estimation as a food, the flesh being of a somewhat glutinous nature; but, from its cheapness, is in much request among the inferior ranks, and is eaten either fresh or salted: the skin also, which is smooth, and destitute of apparent scales, is dried and stretched, and after rubbing with oil, becomes of a horny transparency and strength, and is used in some of the northern regions instead of glass for windows. The silure is not a very prolific fish; depositing but a small quantity of spawn, consisting of large globules or ova: these, as well as the newly hatched young, are frequently the prey of other fishes, frogs, &c. and thus the great increase of the species is prevented. The ova, according to Dr. Bloch, usually hatch in the space of seven or nine days from their exclusion.

2. Silurus electricus, electric silure. Length about twenty inches; head and fore-parts very broad and depressed; on the upper lip two cirri; on the lower four; teeth small and numerous. Native of the African rivers; observed by Forskal in the Nile: possesses a degree of electric or galvanic power, but in a much slighter degree than the torpedo.

3. Silurus catus, cat silure. Length about two feet; form rounded and thick; colour dusky above, pale flesh-colour beneath; head round; mouth very large; on the upper jaw, beneath each eye, a very long beard; on the lower jaw four short beards; first dorsal fin small and conic; second, or adipose fin, without rays; rest of the fins small and red; tail forked. Inhabits the sea and rivers of North America, preying on all kinds of smaller fishes; and not sparing even those of its own kind: in taste resembles an eel, and is much esteemed by the Americans: is a fish of slow motion, like the European silure.

4. Silurus costatus is an inhabitant of South America and India. See Plate Nat. Hist. fig. 360.

SIMIA, ape, a genus of quadrupeds of the order primates. The Linnæan generic character is, front teeth in each jaw four, placed near together; canine teeth solitary, longer than the others, distant from the remaining teeth, or grinders; grinders obtuse. This numerous race may be properly divided into four sections, of which there are about 70 species, viz. 1. Apes, or such as are destitute of a tail. 2. Baboons, or such as have very muscular bodies, and whose tails are commonly short. 4. Monkeys, whose tails are, in general, long: and, lastly, sapajous, or monkeys, with what are termed prehensile tails, viz. such as can, at pleasure, be twisted round any object, so as to answer the purpose of an additional hand to the animal.

Of the whole genus, or the monkey tribe in general, it may be observed, that the baboons are commonly of a ferocious and sullen disposition. The larger apes are also of a malignant temper, except the oran otan and the gibbons. The monkeys, properly so called, are very various in their dispositions; some of the smaller species are lively, harmless, and entertaining; while others are as remarkable for the mischievous malignity of their temper, and the capricious uncertainty of their manners.

It may not be improper here to observe, that it is no easy task to determine with exact precision the several species of this extensive genus; since, exclusive of the varieties in point of colour, they are often so nearly allied as to make it difficult to give real distinctive characters. The most remarkable species are,

Apes.

1. Simia satyrus, oran otan. Of these singular animals, the species which has most excited the attention of mankind is, the oran otan, or, as it is sometimes called, the satyr, great ape, or man of the woods. It is a native of the warmer parts of Africa and India, as well as of some of the Indian islands, where it resides principally in woods, and is supposed to feed, like most others of this genus, on fruits. The oran otan appears to admit of considerable variety in point of colour, size, and proportions; and there is reason to believe, that, in reality, there may be two or three kinds, which, though nearly approximated as to general similitude, are yet specifically distinct. The specimens imported into Europe have rarely exceeded the height of two or three feet, and were supposed to be young animals; but it is said that the full-grown ones are, at least, six feet in height. The general colour seems to be dusky or brown; in some ferruginous or reddish brown, and in others coal-black, with the skin itself white. The face is bare; the ears, hands, and feet, nearly similar to the human, and the whole appearance such as to exhibit the most striking approximation to the human figure. The likeness, however, is only a general one; and the structure of the hands and feet, when examined with anatomical exactness, seems to prove, in the opinion of those most capable of judging with accuracy on the subject, that the animal was principally designed by nature for the quadrupedal manner of walking, and not for an upright posture, which is only occasionally assumed, and which, in those exhibited to the public, is, perhaps, rather owing to instruction than truly natural. The count de Buffon, indeed, makes it one of the distinctive characters of the real or proper apes (among which the oran otan is the chief), to walk erect on two legs only; and it must be granted, that these animals support an upright position much more easily and readily than most other quadrupeds, and may probably be very often seen in this attitude even in a state of nature.

The manners of the oran otan, when in captivity, are gentle, and perfectly void of that disgusting ferocity so conspicuous in some of the larger baboons and monkeys. It is docile, and may be taught to perform, with dexterity, a variety of actions in domestic life. Thus it has been seen to sit at table, and, in its manner of feeding and general behaviour, to imitate the company in which it is placed: to pour out tea, and drink it, without aukwardness or constraint; to prepare its bed with great exactness, and compose itself to sleep in a proper manner. Such are the actions recorded of one which was exhibited in London in the year 1738; and the count de Buffon relates nearly similar particulars of that which he saw at Paris. Dr. Tyson, who, about the close of the last century, gave a very exact description of a young oran otan, then exhibited in the metropolis, assures us, that, in many of its actions, it seemed to display a very high degree of sagacity. "The most gentle and loving creature that could be. Those that he knew a ship-board he would come and embrace with the greatest tenderness, opening their bosoms, and clasping his hands about them; and, as I was informed, though there were monkeys aboard, yet it was observed he would never associate with them, and, as if nothing akin to them, would always avoid their company."

But however docile and gentle when taken young, and instructed in its behaviour, it is said to be possessed of great ferocity in its native state, and is considered as a dangerous animal, capable of readily overpowering the strongest man. Its swiftness is equal to its strength, and for this reason it is rarely to be obtained in its full-grown state; the young alone being taken. A few years past, the hand of a supposed full-grown oran otan was brought from Sierra Leona, which, from its size, seemed to justify the idea of the stature to which this species is supposed to grow: it was of a black colour, and consequently belonged to the black variety of this species, or that described in a young state by Dr. Tyson.

M. Vosmaer's account of the manners of an oran otan brought into Holland in the year 1776, and presented to the prince of Orange's menagerie, is so curious and satisfactory, that we shall extract it from his accurate publication on that subject.

This animal was a female: its height was about two Rhenish feet and a half. It shewed no symptoms of fierceness or malignity, and was even of a somewhat melancholy appearance. It was fond of being in company, and shewed a preference to those who took daily care of it, of which it seemed to be sensible. Often when they retired it would throw itself on the ground, as if in despair, uttering lamentable cries, and tearing in pieces the linen within its reach. Its keeper having sometimes been accustomed to sit near it on the ground, it took the hay of its bed, and laid it by its side, and seemed, by every demonstration, to invite him to be seated near. Its usual manner of walking was on all-fours, like other apes; but it could also walk on its two hind feet only. One morning it got unchained, and we beheld it with wonderful agility ascend the beams and rafters of the building: it was not without some pains that it was retaken, and we then remarked an extraordinary muscular power in the animal; the assistance of four men being necessary, in order to hold it in such a manner as to be properly secured. During its state of liberty it had, amongst other things, taken the cork from a bottle containing some Malaga wine, which it drank to the last drop, and had set the bottle in its place again. It ate almost every thing which was given it; but its chief food was bread, roots, and especially carrots; all sorts of fruits, especially strawberries; and appeared extremely fond of aromatic plants, as parsley and its root. It also ate meat, both boiled and roasted, as well as fish. It was not observed to hunt for insects like other monkeys; it was fond of eggs, which it broke with its teeth and sucked completely; but fish and roast meat seemed its favourite food. It had been taught to eat with a spoon and a fork. When presented with strawberries on a plate, it was extremely pleasant to see the animal take them up, one by one, with a fork, and put them into its mouth, holding, at the same time, the plate in the other hand. Its common drink was water; but it also very willingly drank all sorts of wine, and particularly Malaga. After drinking it wiped its lips, and after eating, if presented with a tooth-pick, would use it in a proper manner. I was assured, that on shipboard it ran freely about the vessel, played with the sailors, and would go, like them, into the kitchen for its mess. At the approach of night it would lie down to sleep; and prepared its bed by shaking well the hay on which it slept, and putting it in proper order, and, lastly, covering itself warm with the coverlet. One day, seeing the padlock of its chain opened with a key, and shut again, it seized a little bit of stick, and put it into the key-hole, turning it about in all directions, endeavouring to see whether the padlock would open or not. This animal lived seven months in Holland. On its first arrival it had but very little hair, except on its back and arms: but on the approach of winter it became extremely well covered; the hair on the back being three inches in length. The whole animal then appeared of a chesnut-colour; the skin of the face, &c. was of a mouse-colour, but about the eyes and round the mouth of a dull flesh-colour.

It came from the island of Borneo, and was deposited in the museum of the prince of Orange.

Upon the whole, it appears clearly that there are two distinct species of this animal, viz. the pongo, or great black oran otan, which is a native of Africa, and the reddish brown or chesnut oran otan, called the jocko, which is a native of Borneo and some other Indian islands. This latter, as appears from a collation of most of the specimens which have been surveyed with the necessary degree of exactness, is distinguished by having no nails on the great toes; whereas in the pongo, or black species, they are conspicuous.

2. Simia lar, or long-armed ape. This is a species of a more deformed appearance than the oran otan, and is distinguished by the excessive length of its arms, which, when the animal stands upright, are capable of touching the ground with the fingers. It is a native of India and some of the Indian islands, and grows to the height of four feet or more. Its colour is black; but the face is commonly surrounded by a whitish beard.

Notwithstanding the apparent ferocity of the gibbon, and the deformity of its figure, it is of a more tractable and gentle nature than most of its tribe, and has even been celebrated for the decorum and modesty of its behaviour. Considered with respect to the rest of the genus it ranks among the genuine apes, or those which have not the least vestige of a tail; and like the oran otan, alarms the pride of mankind by too near an approach to the real primates of the creation. Nay, Linnæus, in his description, actually places it in the genus homo, under the title of homo lar.

3. Simia sylvanus, pigmy. This is the smallest of the genuine apes, or those destitute of tails. In its general appearance, as well as in colour, it extremely resembles the Barbary ape; but is not larger than a cat, and has a rounder or flatter face than the Barbary ape. This is supposed, by Mr. Pennant, to have been the pigmy of the antients, which was said to wage war, at certain seasons, with the cranes. It is a native of Ethiopia, where it is most common; but it is also found in other parts of Africa. It is easily tamed, and is much more docile and gentle than the former species.

BABOONS.

4. Simia sphinax, common baboon. This is a species of very considerable size, and when in a sitting posture, is from three to four feet in height. It is extremely strong and muscular in its upper parts, and slender towards the middle; but this is the general shape of all the true baboons; its colour is an uniform greyish-brown, paler beneath; the hairs on the upper parts, if narrowly inspected, appear as if mottled; the face is long, and of a tawny flesh-colour; the eyes appear as if sunk into the head, or very deeply seated, and are of a hazel colour. The hands and feet have strong blunt claws; but the thumbs of the hands have rounded nails. The tail is very short. It is ferocious in its manners, and its appearance is at once grotesque and formidable. The region surrounding the tail, to a considerable distance on each side, is perfectly bare and callous, and of a red colour. This is also common, in a greater or smaller degree, to the rest of this division. It is a native of the island of Borneo.

5. Simia mormon, variegated baboood. This is at least equal in size, if not superior, to the former, and, when in an upright posture, is about five feet high. It is the most remarkable of the whole genus for brilliancy and variety of colour. The general tinge is a rich and very deep yellowish-brown; the hairs, if viewed near, appearing speckled with yellow and black. The form of the face is long, with the snout ending somewhat abruptly; the whole length of the nose, down the middle, is of a deep blood-red; but the parts on each side are of a fine violet-blue, deeply marked by several oblique furrows. The remainder of the face is of a pale whitish-yellow. It is a native of the interior parts of Africa; but it is said to have been also brought from India.

The variegated baboon is of a fierce disposition, and extremely muscular and strong. Its voice somewhat resembles the slight roar of a lion: it is a rare species, and is not often imported into Europe.

6. Simia maimon, maimon. The synonyms between this species and the former are commonly confounded. It is described by the count de Buffon under the name of mandrill. It is an active animal, and seems far less indocile and malignant than the rest of the baboons. The general likeness which it bears to the former species is such as to give the idea of the same animal in a less advanced state of growth, and with less brilliant colours; the nose, instead of being red on its upper part, is merely flesh-coloured; but the sides are blue and furrowed, as in the former species. This baboon is not uncommon in exhibitions of animals. Its length from nose to tail is about two feet. Tail exactly as in the former.

The next division of the baboons consists of such as have long tails. Of these the chief is the

7. Simia hamadryas, dog-faced baboon. This species is of an elegant colour, composed of a mixture of grey and brown, the hair appearing as if speckled. It is a very large animal, at least equal, if not superior, in size to the common brown baboon and the mormon. It is remarkable for a vast quantity of flowing hair on each side the head, as well as round the shoulders, spreading in such a manner as to give the appearance of a short cloak or mantle. The whole face is naked, and of a flesh-colour, more or less deep in different individuals. The tail is almost the length of the body, aud is commonly a little tufted at the end. The nails on the hands or fore-feet are flat; those on the hind-feet resemble strong claws. This is a rare species in comparison with the common baboon, and is a native of the hottest parts of Africa and Asia, where it is said to reside in vast troops, and to be very fierce and dangerous. There is a wonderful degree of sagacity in the coun-

tenance of this animal, and a kind of solemn contemplative disposition seems to be strongly indicated in its looks, when calm and undisturbed; but when irritated, the most striking efforts of vindictive violence are immediately exhibited. It is also possessed of an uncommon degree of obstinate moroseness, surpassing most others of its tribe, and is, when in a state of confinement, of a disposition so rude and unquiet, and of manners so peculiarly indecorous, as generally to frustrate all attempts to civilize and reclaim it."

MONKEYS.

8. Simia leonina. Leonine monkey. This species was described from the living animal in the possession of the duc de Bouillon; and was in the royal menagerie at Versailles, in the year 1775. Its length was two feet from nose to tail, and it was eighteen inches high when standing on all-fours. The legs were long in proportion to the body; the face naked and quite black; the whole body and limbs of the same colour; the hair, though long, appearing short, on account of its lying smooth: around the face, according to Buffon's figure, is a fine long chevelure of grey-brown hair, and a large beard of fair grey. The chevelure or spreading hair round the face stretches upwards over the eyes and forehead, so as to encircle the whole head in a remarkable manner, as in the ouanderou or lion-tailed baboon, to which indeed, from the figure as well as description, it appears so extremely similar, that it might well pass for a variety of that animal.

9. S. Diana. Spotted monkey. Mr. Pennant describes this species as of a middling size, and of a reddish colour on the upper parts, as if singed, and marked with white specks; the belly and chin whitish; the tail very long. The Linnæan description differs. Linnæus says the animal is of the size of a large cat, and is black, spotted with white; the hind part of the back ferruginous; the face black; from the top of the nose a white line, passing over each eye to the ears in an arched direction; (this circumstance was probably the reason of the Linnæan name Diana, by which he has chosen to distinguish the animal) the beard pointed, black above, white beneath, and placed on a kind of fatty tumor; breast and throat white; from the rump across the thighs a white line; tail long, straight, and black; ears and feet of the same colour; canine teeth large. See Plate Nat. Hist. fig. 363.

10. Simia nasuta. Long-nosed monkey. Two remarkable monkeys are represented in Mr. Pennant's History of Quadrupeds, from drawings by a Mr. Paillou. The one is called the long-nosed monkey; it has a very long and slender nose, covered with a flesh-coloured skin; the hair on the forehead falls back; on the body and breast it is long; the colour of the head and upper parts is pale ferruginous mixed with black; of the breast and belly light ash-colour; tail very long; height when sitting down about two feet. Native country uncertain: probably Africa. Its face has very much the appearance of a long-nosed dog. See Plate Nat. Hist. fig. 364.

The other is called by Mr. Pennant the prude monkey; and of this he gives no particular description.

11. S. sinica. Chinese monkey. The Chinese monkey, so named from the unusual disposition of the hair on the top of the head, which spreads out in a circular direction, somewhat in the manner of a Chinese cap, is a native of Ceylon, and is about the size of a cat. Its general colour is a pale yellowish-brown, palest on the under parts. The face is commonly dusky, and sometimes the general tinge of the animal is dusky-ferruginous. This is a species easily distinguished when seen in a healthy state: the hair on the top of the head resembling that of a boy; as if parted in the middle, and lying smooth over the head. They are said to inhabit the woods in great troops, and to be very destructive to such gardens and plantations as lie within reach of their settlements. The tail in this species is very long: the nails of the thumbs are round; the rest long.

12. S. petaurista. Vaulting monkey. This is described by Mr. Allamand in his edition of Buffon's Natural History of Quadrupeds. It is said to be somewhat more than a foot high, and the tail about twenty inches long. The upper parts of the animal are of a dark olivaceous colour, owing to a mixture of olive-green and black hair; the face black, with a snow-white triangular spot on the nose; the chin, throat, breast, and belly, white; the under part of the tail and insides of the limbs of a blackish grey. It is a most extremely nimble and active animal, according to M. Allamand. The individual in his possession came from Guinea. It was perfectly familiar, playful, of a gentle disposition, and so rapid in its motions that it seemed to fly rather than leap.

13. Simia mona. Varied monkey. This is said to be the species which gives the name of monkey to the whole tribe: from the African word moane; or rather, as Mr. Pennant surmises, from its corruption monichus. It is one of the largest species, being about a foot and a half in length, with a tail nearly two feet long. The nose, mouth, and spaces round the eyes, are of a dull flesh-colour; the cheeks are bounded by long whitish hairs inclining to yellow; the forehead is grey, and above the eyes, from ear to ear, extends a black line. The upper part of the body is dusky and tawny; the breast, belly, and inside of the limbs, white; the outside of the thighs and arms black; hands and feet black and naked: the tail of a cinereous brown. On each side the base of the tail is commonly an oval white spot. This species inhabits Barbary, Æthiopia, and other parts of Africa.

14. Simia nasalis. Proboscis monkey. Amongst the whole tribe of monkeys this perhaps may be considered as the most singular in its aspect; the nose being of such a length and form as to present, especially in a profile view, an appearance the most grotesque imaginable; and indeed from an inspection of the figure alone, one would be apt to imagine that it must have been designed for a caricature of a monkey. The animal, however, is preserved in the royal cabinet at Paris, and was first described by Mons. D'Aubenton. It is a large species, measuring two feet from the tip of the nose to the tail, which is more than two feet long. The face has a kind of curved form, and is of a brown colour, and marked with blue and red; the ears broad, thin, naked, and hid within the hair. The form of the nose is most singular, being divided almost into two lobes at the tip; a longitudinal furrow running along the middle. It is said to be found chiefly in Cochinchina, and to grow to a very large size. It is sometimes seen in great troops, and is considered as of a ferocious disposition. It feeds only on fruits. Its native name is khî dôc, or great monkey.

15. Simia nemæus. Cochinchina monkey. The douc or Cochinchina monkey is a very large species, measuring at least two feet from the nose to the tail. The face is flattish and of a yellowish-bay colour, as are also the ears; across the forehead runs a narrow dusky band. The back, the under parts of the body, and sides, are of a yellowish grey; the lower part of the arms and tail are white; the feet dusky. It is a native of Cochinchina, and also of Madagascar. It is said that a bezoar is more frequently found in the stomach of this species than of almost any other. When in an upright posture this animal measures three and a half or four feet in height, being nearly of the size of a Barbary ape. This species seems considerably allied in its general form and colours to the preceding, but differs greatly in the form of the face. See Plate Nat. Hist. fig. 365.

16. Simia rosalia. Silky monkey. This species is so named from the appearance of its hair, which is very fine, soft, long, and of a bright-yellow colour, resembling yellow silk. Round the face the hair is much longer than in other parts, so as to form a large mane like that of a lion; near the face this mane is of a reddish colour, and grows paler as it recedes from the cheeks; the face itself is of a dusky purple; the ears round and naked; the hands and feet are also naked, and of the same dull purple colour as the face; the claws are small and sharp; the tail is very long, and rather bushy at the extremity. It is a native of Guiana, and is a lively, active species, and gentle in a state of confinement. See Plate Nat. Hist. fig. 366.

SEPAJOUS.

17. Simia beelzebul. Preacher monkey. This species is said to be of the size of a fox, and of a black colour, with smooth glossy hair; round beard beneath the chin and throat; the feet and end of the tail brown. It is a native of Brasil and Guiana, inhabiting the woods in vast numbers, and howls in a dreadful manner. Marcgrave assures us, that one sometimes mounts the top of a branch, and assembles a multitude below; he then sets up a howl so loud and horrible, that a person at a distance would imagine that a hundred joined in the cry; after a certain space he gives a signal with his hand, when the whole assembly join in chorus; but on another signal a sudden silence prevails and then the orator finishes his harangue. This howling faculty is owing to the conformation of the os hyoides, or throat-bone, which is dilated into a bottle-shaped concavity.

18. Simia paniscus. Four-fingered monkey. This animal is distinguished by the gracility of its body and limbs; its uniform black colour, except on the face, which is of a dark flesh-colour; and by the want of thumbs on the fore feet, instead of which are very small projections or appendices. It is one of the most active and lively of animals, and is besides of a gentle and tractable disposition in a state of confinement. It inhabits the woods of South America; associating in great multi-

tudes; assailing such travellers as pass through their haunts with an infinite number of sportive and mischievous gambols; chattering and throwing down dry sticks, swinging by their tails from the boughs, and endeavouring to intimidate the passengers by a variety of menacing gestures.

SIMILAR, in arithmetic and geometry, the same with like. In mathematics, similar parts have the same ratio to their wholes; and if the wholes have the same ratio to the parts, the parts are similar. Similar angles are also equal angles. In solid angles, when the planes under which they are contained are equal, both in number and magnitude, and are disposed in the same order, they are similar, and consequently equal. Similar arches of a circle are such as are like parts of their whole circumferences, and consequently equal. Similar plane numbers are those numbers which may be ranged into the form of similar rectangles, that is, into rectangles whose sides are proportional; such are 12 and 48, for the sides of 12 are 6 and 2, and the sides of 48 are 12 and 4; but 6 : 2 : : 12 : 4, and therefore those numbers are similar. Similar polygons are such as have their angles severally equal, and the sides about those angles proportional. Similar rectangles are those which have their sides about the equal angles proportional. Hence, 1. All squares are similar rectangles. 2. All similar rectangles are to each other as the squares of their homologous sides. Similar right-lined figures are such as have equal angles, and the sides about those equal angles proportional. Similar segments of a circle are such as contain equal angles. Similar curves: two segments of two curves are called similar, if, any right-lined figure being inscribed within one of them, we can inscribe always a similar right-lined figure in the other. Similar conic sections: two conic sections are said to be similar, when any segment being taken in the one, we can assign always a similar segment in the other. Similar diameters of two conic sections: the diameters in two conic sections are said to be similar, when they make the same angles with their ordinates. Similar solids are such as are contained under equal numbers of similar planes alike situated. Similar triangles are such as have their three angles respectively equal to one another. Hence, 1. All similar triangles have the sides about their angles proportional. 2. All similar triangles are to one another as the squares of their homologous sides.

SIMILAR FIGURES, in geometry, such as have their angles respectively equal, and the sides about the equal angles proportional.

SIMONIANS, in church history, a sect of antient christians, so called from their founder, Simon Magus, or the magician. The heresies of Simon Magus were principally his pretending to be the great power of God, and thinking that the gifts of the Holy Ghost were venal.

SIMONY, is the corrupt presentation of any one to an ecclesiastical benefice, for money, gift, reward, or benefit.

By one of the canons of 1603, every person before his admission to any ecclesiastical promotion, shall, before the ordinary, take an oath, that he has made no simoniacal contract, promise, or payment, directly or indirectly, by himself or any other, for the obtaining of the said promotion; and that he will not afterwards perform or satisfy any such kind of payment, contract, or promise, by any other without his knowledge or consent.

To purchase a presentation, the living being actually vacant, is open and notorious simony; this being expressly in the face of the statute. Moor. 914.

The sale of an advowson, during a vacancy, is not within the statute of simony, as the sale of the next presentation is; but it is void by the common law. 2 Black. 22.

A bond of resignation is a bond given by the person intended to be presented to a benefice, with condition to resign the same, and is special or general. The condition of a special one is to resign the benefice in favour of some certain person, as a son, kinsman, or friend of the patron, when he shall be capable of taking the same. By a general bond, the incumbent is bound to resign on the request of the patron. 4 Bac. Abr. 470.

A bond with condition to resign within three months after being requested, to the intent that the patron might present his son when he should be capable, was held good; and the judgment was affirmed in the exchequer-chamber; for a man may, without any colour of simony, bind himself for good reasons, as if he takes a second benefice, or if he is non-resident, or that the patron presents his son, to resign; but if the condition had been to let the patron have a lease of the glebe or tithes, or to pay a sum of money, it would have been simoniacal.

SIMOOM. A wind or haze was observed by Mr. Bruce, in the course of his travels to discover the sources of the Nile, which is supposed to be in some respects analogous to the sirocco. It is called by Mr. Bruce the simoom, and from its effects upon the lungs, we can entertain but little doubt, that it consists chiefly of carbonic acid gas in a very dense state, and perhaps mixed with some other noxious exhalations.

In the same desert Mr. Bruce observed the astonishing phenomenon of moving pillars of sand, which are probably the effects of a number of whirlwinds in those torrid regions. As the description of these pillars is in some degree blended with that of the simoom, we shall extract the passage. In relating the particulars of his journey across a certain part of the deserts of Africa, Mr. Bruce observes, "We were here at once surprised and terrified by a sight surely one of the most magnificent in the world. In that vast expanse of desert, from west and to the north-west of us, we saw a number of prodigious pillars of sand at different distances, at times moving with great celerity, and at others stalking on with a majestic slowness; at intervals we thought they were coming in a very few minutes to overwhelm us; and small quantities of sand did actually more than once reach us. Again they would retreat so as to be almost out of sight, their tops reaching to the very clouds. There the tops often separated from the bodies; and these, once disjoined, dispersed in the air, and did not appear more. Sometimes they were broken near the middle, as if struck with a large cannon-shot. About noon they began to advance with considerable swiftness upon us, the wind being very strong at north. Eleven of them ranged alongside of us about the distance of three miles. The greatest diameter of the largest appeared to me at that distance as if it would measure ten feet. They retired from us with a wind at south-east, leaving an impression upon my mind to which I can give no name, though surely one ingredient in it was fear, with a considerable deal of wonder and astonishment. It was in vain to think of flying; the swiftest horse, or fastest-sailing ship, could be of no use to carry us out of this danger; and the full persuasion of this rivetted me as if to the spot where I stood, and let the camels gain on me so much in my state of lameness, that it was with some difficulty I could overtake them."

SIMPLE, in music, a term applied to that counterpoint in which note is set against note, and which is called simple, in opposition to more elaborate composition, known by the name of figurative counterpoint. Simple fugue, or simple imitation, is that style of composition in which a single subject is adopted, or some partial echo preserved amongst the several parts. This word in the music of the last age is frequently used in contradistinction to double, applied to variations, as double 1, double 2, &c. and signifies the plain motivo, or subject, on which the variations are founded. Simple cadence is that in which the notes are equal through all the parts. Simple concords are those wherein we hear only two notes in consonance; and simple intervals are those in which no parts or divisions are supposed, and which the antients Greeks called diastems.

SIMPLE SOUND, a pure, unmixed, single sound. Some theorists will not allow that there is, musically speaking, any such sound in nature; but assert on the contrary that every sound which is produced is at least accompanied with its twelfth and seventeenth.

SIMPLE, in pharmacy, a general name given to all herbs or plants, as having each its particular virtue, whereby it becomes a simple remedy.

SIMPLE SUBSTANCES. See ELEMENTS.

SIMPLICITY, in composition, a natural unadorned melody, or incomplex combination of parts, in which the composer endeavours, rather by the force of his genius and feeling than the refinement of science, to awaken the softer passions, or rouse the mind to ardour. In performance, simplicity is that chaste, unaffected style, which, rejecting all vain and unmeaning flourish, only aims at conveying the ideas of the composer, without disturbing the purity of the text.

SINAPIS, *mustard*, a genus of plants belonging to the class of tetradynamia, and to the order of siliquosa, and in the natural system ranged under the 39th order, siliquosæ. The calyx consists of four expanding strap-shaped deciduous leaves; the ungues or bases of the petals are straight; two glandules between the shorter stamina and pistillum, also between the longer and the calyx. There are 19 species, three of them natives of Britain. 1. The alba, or white mustard, which is generally cultivated as a salad-herb for winter and spring use. 2. The nigra, or common mustard, which is frequently found growing naturally in many parts of Britain, but is also cultivated in fields for the seeds, of which the sauce called mustard is made. 3. The arvensis grows naturally on arable land in many parts of Britain. The seed of this is commonly sold under the title of Durham mustard seed. Of this there are two varieties, if not distinct species; the one with cut, the other with entire, leaves.

Mustard, by its pungency, stimulates the solids; and hence is recommended for exciting appetite, assisting digestion, promoting the fluid secretions, and for the other purposes of the acrid plants called antiscorbutic. It imparts its taste and smell in perfection to aqueous liquors, and by distillation with water yields an essential oil of great acrimony. To rectified spirit its seeds give out very little either of their smell or taste. Subjected to the press, they yield a considerable quantity of mild insipid oil, which is as free from acrimony as that of almonds. They are applied as an external stimulant to benumbed or paralytic limbs; to parts affected with fixed rheumatic pains, and to the soles of the feet, in the low stage of acute diseases, for raising the pulse: in this intention, a mixture of equal parts of the powdered seeds and crumb of bread, with the addition sometimes of a little bruised garlic, is made into a cataplasm with a sufficient quantity of vinegar.

SINAPISM. See PHARMACY.

SINCIPUT, in anatomy, the fore part of the head, reaching from the forehead to the coronal suture.

SINE, or *right sine of an arch*. See TRIGONOMETRY.

SINE-CURE, is where a rector of a parish has a vicar under him endowed and charged with the cure, so that the rector is not obliged either to do duty or residence.

SINE-DIE, *without day*, in law, a term frequently used in our proceedings at common law; as when judgment is given against the plaintiff, he is said to be in misericordia pro falso clamore suo; so when judgment passes for the defendant, it is entered eat inde sine die, being as much as to say, he is discharged, or dismissed the court.

SINISTER. See HERALDRY.

SINKING FUND, in political economy, a portion of the public revenue appropriated to the reduction or discharge of the public debts. As the funding system had been adopted in other countries long before it was resorted to in Great Britain, a provision of this kind had appeared necessary at a much earlier period, and had been established in Holland in 1655, and in the ecclesiastical state in 1685. These funds were both formed by reducing the interest payable on the public debts, and appropriating the annual sum thus saved to the gradual discharge of the principal.

In the reign of king William, when the mode of providing for extraordinary expences by incurring public debts, which has become so general, was first adopted in this country, the particular tax on which money was borrowed, generally produced much more than sufficient to pay the annual interest, and the surplus was applied in sinking or discharging the principal, which was generally effected in a few years. Had this plan been pursued, there never could have been any very great accumulation of public debts; but, as the expenditure increased, and the necessity of loans of still greater amount became more frequent, it was found sufficiently difficult to provide effectually for the yearly interest of the sums thus borrowed; and the repayment of the principal was either put off to a distant period, or left without any provision to the chance of more flourishing times.

Some of the effects of an accumulating public debt soon became evident in the discount at which all government securities sold, and in the difficulties experienced in providing for the annual expenditure; the propriety of reducing, and even of wholly discharging, the debt, was generally acknowledged; and the plan of a sinking fund very similar to that which was afterwards adopted, was recommended in a pamphlet published in 1701. In 1713 Mr. Archibald Hutcheson presented to George I. a plan for payment of the public debts. In 1715 different projects for this purpose were published by Edward Leigh, Mr. Asgill, and others. And in 1717 a plan for the gradual discharge of the debt was actually adopted, which was afterwards generally known by the appellation of the sinking fund.

The country had been engaged in an expensive war during nearly the whole of the reign of queen Anne; and it had been found impracticable to obtain the large sums required, without paying, in most instances, a very high interest; but upon the return of peace the current rate of interest lowered considerably, which proceeded in part from a real increase of the national capital, as well as from loans to government of any great amount being no longer necessary. It was therefore deemed a proper opportunity for effecting a reduction of the high interest payable to the public creditors, and of establishing an effectual plan for reducing by degrees the debts of the nation. Accordingly, on the 20th of May, 1717, general Stanhope, who was then first lord of the treasury, and chancellor of the exchequer, submitted to parliament the terms of a proposed agreement with the bank of England and the South Sea company, by which the interest was to be reduced from 6 to 5 per cent. on the capitals of these corporations, who were the principal public creditors, and who were likewise to furnish money, if it should be necessary, for paying off such individuals as should not agree to a similar reduction of the interest payable to them. The total annual interest saved to government by this transaction was no less than 328,560*l*. 13*s*. 7¼*d*.

The different funds on which most of the public debts had been charged were consolidated; and the produce of all the permanent taxes was distinguished into only three funds, called the aggregate fund, the South Sea fund, and the general fund. From these three funds the interest of all the public debts was payable; and the excess or overplus beyond the payments with which each fund was charged, was to be "appropriated, reserved, and applied, to and for discharging the principal and interest of such national debts and incumbrances, as were incurred before the 25th day of December 1716, and are declared to be national debts, and were provided for by act or acts of parliament, to be discharged therewith, or out of the same, and to or for none other use, intent, or purpose, whatsoever." This constituted the sinking fund; and as the plan originated while sir Robert Walpole was in office, he claimed much honour as the father of it; but it is evident that it required no invention, and but little judgment, to adopt a measure which had been found efficacious in other countries, which had been publicly recommended some years before, and the utility of which was so obvious, that not to have adopted it, when the reduction of interest rendered it so practicable, and when an example had been set in the establishment of the aggregate fund, would have been inexcusable. It was, in fact, nothing more than appropriating generally the surpluses of funds which were before established, to the uses to which the greater part had before been specifically appropriated.

For a few years the fund was strictly applied to the purposes for which it was established; and so well were its nature and importance then understood, that rather than encroach upon it, money was at the same time borrowed for extraordinary expences. This perseverance was however of no long duration; in 1722 it was made a collateral security for the interest of a million raised by exchequer bills, which prepared the way for more direct encroachments. In 1724 the sum of 15,144*l*. 19*s*. was taken from the fund, to make good the loss to the treasury from the reduction of the value of gold coin; and within twelve years from its establishment it was charged with the interest of new loans. In 1733 the gross sum of half a million was taken from it towards the supplies, at which time the medium annual produce of the fund for five years had been 1,212,000*l*. This amount, with its proper increase, would have been amply sufficient for the discharge of the debt which then existed, but the alienation of it was continued; and Dr. Price has shewn that no greater part of the public debt than about eight millions and a half was discharged by the fund from this period to the year 1786; when, in consequence of a new arrangement of the public accounts, the distinction of the different funds above-mentioned was abolished, and the produce of all the permanent taxes included under one general head, called the consolidated fund.

One of the objects of this arrangement was to lay the foundation of a new sinking fund, formed from the general surplus of the revenue, and consisting, like the old fund, in the application of the principle of compound interest. Among those whom Mr. Pitt consulted on this occasion, he particularly sought the advice and assistance of the late Dr. Price, who communicated three plans, which he conceived to be best adapted for carrying into execution a measure that he had so often urged in his different publications, particularly before the American war had swelled the public debts to what then appeared to be a hopeless magnitude: it was one of the plans thus communicated, which was afterwards adopted, but with some alterations which considerably affected its efficacy, and which it has since been found necessary to correct. By the act which was passed for carrying this scheme into execution, 26 Geo. 3. c. 31, the annual sum of 1,000,000*l*. was placed in the hands of commissioners, who are, the speaker of the house of commons, the chancellor of the exchequer, the master of the rolls, the accomptant-general of the court of chancery, and the governor and deputy-governor of the bank, for the time being respectively. This million was to be issued in four equal quarterly payments, and to be applied either in paying off such redeemable annuities as were at or above par, or in the purchase of annuities below par, at the market-price. The dividends on the sums redeemed or purchased, with the annuities for lives or terms that should fall in or expire, and the sums which might be saved by any reduction of interest, were to be added to the fund, which was thus to continue increasing till it amounted to four millions annually; this it was computed would be in about 26 years, when upwards of 56 millions of stock would have been redeemed, from which time the dividends on such capital as should afterwards be paid off or purchased by the commissioners, with such annuities as might fall in, were to be at the disposal of parliament.

On the 17th of February, 1792, Mr. Pitt proposed that the sum of 400,000*l.* should be issued in addition to the million, for the purpose of accelerating the operation of this fund; and stated, that in consequence of this and future intended additions, it might be expected that 25 millions of 3 per cents. would be paid off by the year 1800; and that in the year 1808, the fund would amount to four millions per annum, being the sum to which it was then restricted. But the most important improvement was a provision, that whenever, in future, any sums should be raised by loans on perpetual redeemable annuities, a sum equal to one per cent. on the stock created by such loans, should be issued out of the produce of the consolidated fund, quarterly, to be placed to the account of the commissioners, who were to keep a separate account of the stock redeemed by this new fund, which was not to affect the accumulation of the original fund. By these means the immediate progress of the fund was quickened, and future loans were put into a regular course of redemption.

The injudicious restriction of the fund to four millions per annum, was done away by an act passed in 1802, which directed that the produce of the two funds should continue to accumulate, without any limitation as to its amount, and be from time to time applied, according to the former provisions, in the redemption or purchase of stock, until the whole of the perpetual redeemable annuities, existing at the time of passing the act, shall have been completely redeemed or paid off. At the same time, the usual annual grant of 200,000*l.* in aid of the fund, was made a permanent charge, to be issued in quarterly payments from the consolidated fund, in the same manner as the original million per annum. In consequence of these improvements, the increase of the fund has been much greater than it was originally estimated; and its total amount, with the sources from which it arose, was on the 1st of February, 1806, as follows:

Annual charge, by act of 26 Geo. III.	£.1,000,000	0	0
Ditto, 42 Geo. III. -	200,000	0	0
Annuities for 99 and 96 years, expired 1792	54,880	14	6
Short annuities, expired 1787 - - -	25,000	0	0
Life annuities, unclaimed and expired - -	50,308	5	7
Dividend on 98,386,402*l.* at 3 per cent. -	2,951,592	1	2
Ditto on 2,617,400*l.* at 4 per cent. - -	104,696	0	0
Ditto on 142,000*l.* at 5 per cent. - -	7,100	0	0
One per cent. on capitals created since 1723	£.3,202,672	1	10
Total	£.7,596,249	3	1

This sum is exclusive of the fund for the reduction of the public debt of Ireland, funded in Great Britain, which at the above period amounted to 479,537*l.* 8*s.* and of the fund for reduction of the imperial debt, which amounted to 55,960*l.* 9*s.* 4*d.*

The commissioners are directed by the act to make their purchases "in equal portions, as nearly as may be, on every day (Saturdays and Mondays excepted) on which the same shall be transferable." So that they purchase on four days in every week in which there are no holidays. They are empowered to subscribe towards any public loan, to be raised by act of parliament, upon perpetual annuities, subject to redemption at par: and an account of the sums issued to them, and of the stock purchased to the 1st of February in every year, is to be annually laid before parliament on or before the 15th of February. The purchases, at first, were all made in the 3 per cents. probably with the view of redeeming the five per cents. if the state of the public funds should render such a measure practicable, or of inducing the proprietors to agree to a reduction of the interest at the time when they should become redeemable.

The progress of the fund from the commencement of its operation on 1st August 1786, to the 1st February 1806, will appear from the following statement of the total amount of the stock redeemed by the commissioners up to the latter period.

Consolidated 3 per cent. annuities - -	£.39,922,421
Reduced 3 per cent. annuities - -	51,493,981
Old South Sea annuities	3,492,000
New South Sea annuities	2,783,000
Three per cents. 1751 -	695,000
Consolidated 4 per cent. annuities - -	2,617,400
Navy 5 per cent. annuities	142,000
Total	£.101,145,802

The total sum which had been paid for this amount of stock, was 62,842,782*l.* 7*s.* 10*d.* the consolidated 3 per cents. having been bought up on an average at 61*l.* per cent. and the reduced at somewhat less.

The progress already made by the fund, and the important effect it has had in supporting the value of the government securities at a time when it has been necessary to borrow unprecedented sums in almost every year, sufficiently demonstrate the great utility of this measure. As its increase will be continually augmenting, it will, if steadily persevered in, and faithfully applied, become ultimately capable of discharging a debt of any amount which it is possible to suppose the country will ever be encumbered with.

It has been shewn that the fund, including the provision for the reduction of the debt in Ireland funded in Great Britain, and for the imperial loans, amounts at present to upwards of eight millions per annum; and as the stock has been bought up at little more than 60 per cent. the money has been improved at nearly 5 per cent. interest. It is neither desirable, nor to be expected, that it will always be possible to invest the produce of the fund at this rate of interest; but it will be shewn that if the fund is never diverted from its purpose, its effects will in time be almost omnipotent, particularly when it is considered that the following sums are money, and consequently much less than the nominal capital of stock that would be bought up at any of the current prices at which these securities have been for many years past:

Amount to which the present sinking fund of eight millions per annum will accumulate, if improved at 4 or 5 per cent. compound interest.

Years.	4 per cent. Millions.	5 per cent. Millions.
In 1810	33	34
1820	146	156
1830	312	356
1840	558	680
1850	923	1209
1860	1463	2070
1870	2261	3472
1880	3443	5757
1890	5193	9478
1900	7782	15540

SINNET, on board a ship, a line or string made of rope-yarn, consisting generally of two, six, or nine strings, which are divided into three parts, and are platted over one another, and then beaten smooth and flat with a wooden mallet. Its use is to save the ropes, or to keep them from galling.

SINOVIA. Within the capsular ligaments of the different joints of the body, there is contained a peculiar liquid, intended to lubricate the parts to facilitate their motion. The only analysis of sinovia is of that taken from oxen.

The sinovia of the ox, when it has just flowed from the joint, is a viscid semitransparent fluid, of a greenish-white colour, and a smell not unlike frog-spawn. It very soon acquires the consistence of a jelly; and this happens equally whether it is kept in a cold or a hot temperature, whether it is exposed to the air or excluded from it. This consistence does not continue long; the sinovia soon recovers again its fluidity, and at the same time deposits a thready-like matter.

Sinovia mixes readily with water, and imparts to that liquid a great deal of viscidity. The mixture froths when agitated; becomes milky when boiled, and deposits some pellicles on the sides of the dish; but its viscidity is not diminished.

When alcohol is poured into sinovia, a white substance precipitates, which has all the properties of albumen. One hundred parts of sinovia contain 4.52 of albumen. The liquid still continues as viscid as ever; but if acetic acid is poured into it, the viscidity disappears altogether, the liquid becomes transparent, and deposits a quantity of matter in white threads, which possesses the following properties: 1. It has the colour, smell, taste, and elasticity, of vegetable gluten. 2. It is soluble in concentrated acids and pure alkalies. 3. It is soluble in cold water; the solution froths. Acids and alcohol precipitate the fibrous matter in flakes. One hundred parts of sinovia contain 11.86 of this matter.

When the liquid, after these substances have been separated from it, is concentrated by evaporation, it deposits crystals of acetat of soda. Sinovia, therefore, contains soda. Margueron found that 100 parts of sinovia contained about 0.71 of soda.

When strong sulphuric, muriatic, nitric, acetic, or sulphurous acid, is poured into sinovia, a number of white flakes precipitate at first, but they are soon re-dissolved, and the viscidity of the liquid continues. When these acids are diluted with five times their weight of water, they diminish the transparency of sinovia, but not its viscidity; but when they are so much diluted that their acid taste is just perceptible, they precipitate the peculiar thready matter, and the viscidity of the sinovia disappears.

When sinovia is exposed to a dry atmosphere, it gradually evaporates, and a scaly residuum remains, in which cubic crystals and a white saline efflorescence are apparent. The cubic crystals are muriat of soda. One hundred parts of sinovia contain about 1.75 of this salt. The saline efflorescence is carbonat of soda.

Sinovia soon putrefies in a moist atmosphere, and during the putrefaction ammonia is exhaled. When it is distilled in a retort, there comes over, first water, which soon putrefies; then water containing ammonia; then empyreumatic oil and carbonat of ammonia. From the residuum muriat and carbonat of soda may be extracted by lixiviation. Sinovia is composed of

11.86	fibrous matter
4.52	albumen
1.75	muriat of soda
.71	soda
.70	phosphat of lime
80.13	water
100.00	

SINUATED LEAF. See BOTANY.

SINUS. See ANATOMY.

SINUS. See SURGERY.

SIPHON, or SYPHON. See HYDROSTATICS.

SIPHONATHUS, a genus of the tetrandria monogynia class and order. The corolla is one-petalled, very long, funnel-form, inferior; berries four, one-seeded. There are two species, herbs of South America.

SIPHONIA, a genus of the class and order monœcia monadelphia. The calyx is one-leaved; no corolla; male anthers five; fem. style none; stigmas three; caps. tricoccous; seed one. There is one species, a tree of Guaiana.

SIPUNCULUS, or *tube-worm*, a genus of insects of the order vermes intestina: the generic character is, body round, elongated; mouth cylindrical at the end, and narrower than the body; aperture at the side of the body, and verruciform. There are two species: the S. nudus, inhabits the European seas, under stones, and is eight inches long. The S. saccatus, body covered with a loose skin, and rounded at the lower end: inhabits the American and Indian seas.

SIREN, a genus of amphibia, of the order meantes, of which there are the following species:

1. Siren lacertina, or eel-shaped siren: This species stands eminently distinguished in the list of animals by the ambiguity of its characters, which are such as to have induced the great Linnæus to institute for it a new order of amphibia, under the title of meantes; an order, however, which does not stand among the rest of the amphibia in the Systema Naturæ, but is mentioned in a note at the end of the second part of the first volume of that work.

The genus with which the siren has the greatest possible affinity, is the lacerta or lizard. It even very much resembles the larva, or first state, of a lacerta; and it is still doubtful whether it may not really be such: yet it has never been observed in any other state, having two feet only, without any appearance of a hind pair; the feet are also furnished with claws, whereas the larvæ of all the lacertæ are observed to be without claws; or, in the Linnæan phrase, digitis muticis; the mouth has several rows of smallish teeth; the body is eel-shaped, but slightly flattened beneath, marked on the sides by several wrinkles, and slightly compressed towards the extremity of the tail, which is edged with a kind of soft skin or adipose fin; on each side the neck are three ramified branchial processes, resembling, on a larger scale, those belonging to the larva of water-newts, and at the base are the openings into the gills: the eyes are very small and blue. The general colour of the animal is a deep or blackish brown, scattered over, especially on the sides, with numerous minute whitish specks. Its size nearly equals that of an eel, being frequently found of the length of more than two feet. It is a native of North America, and more particularly of South Carolina, where it is not very uncommon in muddy and swampy places, living generally under water, but sometimes appearing on land. It has a kind of squeaking or singing voice, for which reason Linnæus distinguishes it by the title of siren. See Plate Nat. Hist. fig. 367.

It remains to be added, that the siren, if thrown on the ground with any degree of violence, has been observed to break in two or three places; in this particular resembling the anguis fragilis, or slow-worm. It is also proper to observe, that no lizard of which it may be supposed the larva, has ever yet been discovered in those parts of Carolina where it is most frequent. The species to which it seems most allied is the lacerta teguixin of Linnæus, which is a native of South America.

2. Siren anguina, anguine siren. This singular animal is found in as singular a situation, being an inhabitant of the celebrated and romantic lake called Lake Zirknitz, about six German miles from Labac, in the duchy of Carolina, in Austria. From this lake, which is somewhat more than a German mile in length, and half as much in breadth, the water regularly retires during the summer, by numerous subterraneous outlets or holes at the bottom; leaving the ground dry, and fit for pasture, the cultivation of millet, &c. &c. as well as for various kinds of hunting and other amusements; but in the month of October it again returns, with great force, springing out of the passages before mentioned from a vast depth till the lake is completely filled. It is situated in a hollow or valley, surrounded by rocky and woody mountains, in which are vast caverns, and is principally supplied by eight rivulets running into it from the adjoining mountainous region.

The species of siren at present to be described is extremely rare; and is found in the spring, and towards the decline of summer, in some particular parts of the above-mentioned lake; and commonly measures, when full-grown, from about ten to twelve or thirteen inches in length; the largest specimens being near three quarters of an inch in diameter. It is entirely of a pale rose or flesh-colour, or even nearly white, except the three pair of ramified branchial fins on each side the neck, which are of a bright red or carmine-colour. Its general shape is that of an eel; the body being cylindric, till towards the end of the tail, where it becomes flat, and is attenuated both above and below into a kind of fatty fin, scarcely distinguishable from the rest of the tail; the skin is every where smooth and even; the head of a somewhat depressed form; with a lengthened, obtuse, and widish snout, and has no external eyes; the mouth is moderately wide, and furnished with a row of very minute teeth; the legs are about $\frac{3}{4}$ of an inch in length, the fore legs being situated almost immediately behind the branchial fins, and the feet furnished with three toes, without any appearance of claws; the hind legs are situated at a great distance backwards, towards the commencement of the tail, and are of the same appearance with the fore legs; but the feet have only two toes, which, like those of the fore feet, are destitute of claws. The motions of the animal, when taken out of the water, are, in general, extremely slow and languid; as is also the case when kept in a vessel of water; but when in its native lake, it is sometimes observed to swim pretty briskly, waving its body in a serpentine direction in the manner of a leech.

3. Siren pisciformis, fish-formed siren. This animal in its natural size is supposed to be a native of Mexico, and though perhaps no other than the larva or tadpole of some large American lizard, scarcely seems a less singular and curious animal than the siren lacertina. In its general appearance it bears some resemblance to the larva of the rana paradoxa, but is furnished with gills, opening externally in the manner of a fish; the openings are very large, and the operculum or external flap is continued from the sides of the head across the throat beneath, so as completely to insulate the head from the breast; the gills themselves consist of four semicircular bony or cartilaginous arches, which are denticulated or serrated on their internal or concave part, like those of fishes; on the opercula or external flaps are situated three very large and elegant branchial fins or ramified parts, divided or subdivided into a vast number of slender or capillary processes. In these particulars it resembles the siren lacertina, except that in that animal the external opening to the gills is very small; the mouth is furnished in front with a row of extremely minute teeth; the tongue is large, smooth, and rounded at the tip: the rictus, or gape, when the mouth is closed, appears considerably wider than it really is, owing to a lateral sulcus proceeding from each corner to some distance; the feet are entirely destitute of webs, and the toes are furnished with weak

ish claws; the fore feet have four, and the hind feet five toes. Exclusive of the general colour of the animal, the whole skin, when minutely examined, appears to be scattered over with very minute white specks, resembling those on the surface of the siren lacertina. The sides of the body are marked by several strong rugæ or furrows, and an impressed lateral line or sulcus is continued from the gills to the tail.

SIREX, a genus of insects of the hymenoptera order. The generic character is, mouth with two strong jaws; feelers two, truncated; antennæ filiform, with more than twenty-four joints; piercer exserted, stiff, serrated; abdomen sessile, pointed; wings lanceolate, flat in all.

The larvæ of these insects are of a lengthened, cylindric appearance, living in the decayed parts of trees, on the substance of which they feed; the chrysalis, as in the tenthredo, exhibits the limbs of the perfect insect in a contracted state.

The largest species is the sirex gigas of Linnæus, which surpasses a hornet in size, and is principally observed in the neighbourhood of pines and other coniferous trees; it is of a black colour, with the eyes, the base, and lower half of the abdomen, bright orange-yellow; the thorax villose, and the wings of transparent yellowish brown; the sting or a terminal tube is very conspicuous. The larva, which measures about an inch and a quarter in length, is of a yellowish white colour, and inhabits decayed firs and pines; at first view it bears some resemblance to the larvæ of the beetle tribe, but is thinner in proportion, and furnished at the tip of the abdomen with a short black spine or process. It changes to a chrysalis in July, first enveloping itself in a slight silken web of a whitish colour. If the change to chrysalis takes place in summer, the fly proceeds from it in the space of about three weeks; but if at the close of autumn, the animal continues in chrysalis the whole winter, emerging in the following spring. The male insect is considerably smaller than the female, and may be farther distinguished by the want of the caudal tube or process so conspicuous in the female insect; the tip of the abdomen is also of a black colour. The eggs, which are deposited by the female in the decayed parts of the trees above mentioned, are very small, and of a lengthened oval shape with pointed extremities.

Sirex columba is an American species, and is distinguished by its black body, marked by testaceous bands.

Sirex pygmæus is one of the smallest of the European species, being, according to Linnæus, about the size of a gnat, with a black abdomen, marked by three yellow bands, the middle of which is interrupted. It is found in Sweden. There are seven species.

SIRIUS, the DOG-STAR. See ASTRONOMY.

SIRIUM, a genus of plants belonging to the class of tetrandria and order of monogynia. The calyx is quadrifid; there is no corolla; the nectarium is quadriphyllous, and crowning the throat of the calyx; the germen is below the corolla; the stigma is trifid, and the berry trilocular. There is only one species, the myrtifolium.

SIROCCO. The sirocco (so called by the Italians because it is supposed to blow from Syria, and in the south of France the Levant wind) resembles in some of its effects the harmattan, but differs from it in being extremely insalubrious. It sometimes blows for several days together, to the great annoyance of the whole vegetable and animal creation; its medium heat is calculated at one hundred and twelve degrees; it is fatal to vegetation and destructive to mankind, and especially to strangers; it depresses the spirits in an unusual degree; it suspends the powers of digestion, so that those who venture to eat a heavy supper while this wind prevails, are commonly found dead in their beds the next morning, of what is called an indigestion. The sick, at that afflicting period, commonly sink under the pressure of their diseases; and it is customary in the morning, after this wind has continued a whole night, to inquire who is dead.

We shall now insert an account of this baleful wind, from an interesting work on the present state of Sicily.

"The evil most to be dreaded in traversing these regions is, perhaps, the sirocco, or south wind, which it is imagined blows from the burning deserts of Africa, and is sometimes productive of dangerous consequences to those who are exposed to its fury. During the continuance of this wind all nature appears to languish, vegetation withers and dies, the beasts of the field droop, the animal spirits seem too much exhausted to admit of the least bodily exertion, and the spring and elasticity of the air appear to be lost. The heat exceeds that of the most fervid weather in Spain or Malta, and is felt with peculiar violence in the city and neighbourhood of Palermo.

"The sensation occasioned by the sirocco wind is very striking and wonderful. In a moment the air becomes heated to an excessive degree, and the whole atmosphere feels as if it was inflamed; the pores of the body seem at once opened, and all the fibres relaxed. During its continuance the inhabitants of Palermo shut their doors and windows to exclude the air; and where there are no window-shutters, wet blankets are hung on the inside of the window, and the servants are kept continually employed in sprinkling the apartments with water. No creature, whose necessities do not compel him to the exertion, is to be seen while this tremendous wind continues to blow, and the streets and avenues of the city appear to be nearly deserted.

"The sirocco generally continues so short a time in Sicily, that it seldom produces those complaints which are the consequence of its scorching heats in several parts of Italy, though its violence in those countries is much inferior to what is felt in this island. Here it seldom endures longer than thirty-six or forty hours; a time not sufficient to heat the ground, or the walls of the houses, in a very intense continued degree. It is commonly succeeded by the tramontane, or north wind, which in a short time restores the exhausted powers of animal and vegetable life, and nature soon assumes her former appearance. The cause of the sirocco wind has been frequently attempted to be explained, but the different hypotheses are perhaps more to be admired for their ingenuity and fancy than for being very satisfactorily explained. The superior intenseness of this scorching wind at Palermo, may perhaps be accounted for from the situation of that city, which is almost surrounded by lofty mountains, the ravines and valleys of which are parched and almost burnt up in summer. The numberless springs of warm water must also greatly increase the heat of the air; and the practice of burning brush-wood and heath on the neighbouring mountains, during the warm season, must undoubtedly tend to increase the heat of the wind in passing over the country of Sicily, though it had previously been disarmed of part of its violence by travelling over the sea which divides Sicily from Africa."

Whether the fatal effects of the sirocco depend entirely upon the degree of fever which is produced by the extreme heat which accompanies it, or whether it is really charged with any quantity of mephitic gas, we have never been sufficiently informed; but wish that any intelligent traveller would examine the state of the air by the eudiometer, and by other tests, during the prevalence of this wind. Should it be found loaded with carbonic gas, its ill effects might be easily obviated by suspending in the different apartments, cloths dipped in lime-water; but from the present state of the evidence we are disposed to think that all its evil consequences depend upon the sudden increase of the temperature only.

An extraordinary blasting wind is felt occasionally at Falkland's islands. Happily its duration is short; it seldom continues above twenty-four hours. It cuts the herbage down as if fires had been made under them; the leaves are parched up, and crumble into dust. Fowls are seized with cramps so as never to recover. Men are oppressed with a stopped perspiration, heaviness at the breast, and sore throat; but usually recover with care.

This account is extracted from the travels of Mr. Ives over land to the East Indies. Its fatal effects, if the statement is perfectly correct, evidently proceed from a certain portion of extremely putrid vapours with which it is charged, and we suspect it only happens when a strong wind chances to blow over some very putrid and stagnant lake which is not far distant; travellers, however, are on such occasions commonly in a state of too much alarm to note circumstances with accuracy, and too much of their accounts is collected upon hearsay evidence. This wind, after all, may only consist of a mephitic vapour which destroys life when inhaled; and the putridity which is said so rapidly to take place, may depend more upon the climate than the nature of the wind.

SISON, *bastard stone-parsley*: a genus of plants belonging to the class of pentandria, and to the order of digynia; and in the natural system arranged under the 45th order, umbellatæ. The fruit is egg-shaped and streaked; the involucra are subtetraphyllous. There are six species; the amomum, inundatum, segetum, salsum, canadense, and ammi. The three first are natives of Great Britain. 1. The amomum, common bastard parsley, or field stone-wort, is a biennial plant about three feet high, growing wild in many places of Britain. Its seeds are small, striated, of an oval figure and brown colour. Their taste is warm and aromatic. Their whole flavour is extracted by spirit of wine, which elevates very little of it in distillation; and hence the spirituous extract has the flavour in great perfection, while the watery extract has very little. A tincture drawn with pure spirit is of a green colour. The seeds have been esteemed aperient, diuretic, and carminative; but are little regarded in the present practice. 2. The inundatum, least water-parsnip; it grows in ditches and ponds. 3. Segetum, corn parsley or honey-wort: it grows in corn-fields and hedges.

SISYMBRIUM, *water-cresses*, a genus of plants belonging to the class of tetradynamia, and to the order of siliquosa; and in the natural system ranged under the 39th order, siliquosæ. The siliqua, or pod, opens with valves somewhat straight. The calyx and corolla are expanded. There are fifty-three species, of which eight are natives of Britain: the nasturtium, or common water-cress; sylvestre, water-rocket; amphibium, water-radish; terrestre, annual water-radish; monense; sophia, flixweed; irio, broad-leaved hedge-mustard.

SISYRINCHIUM, a genus of plants belonging to the class of monadelphia, and order of triandria; and in the natural system ranked under the 6th order, ensatæ. The spatha is diphyllous; there are six plane petals. The capsule is trilocular and inferior. There are ten species, natives of North America and the Cape.

SITTA, *nut-hatch*, a genus belonging to the class of aves, and order of picæ. It is thus characterized by Dr. Latham: The bill is for the most part straight; on the lower mandible there is a small angle; nostrils small, covered with bristles reflected over them; tongue short, horny at the end, and jagged; toes placed three forward and one backward, the middle toe joined closely at the base to both the outmost; back toe as large as the middle one. There are eleven species; the europæa, canadensis, carolinensis, jamaicensis, pusilla, major, nævia, surinamensis, cafra, longirosta, and chloris. The europæa, or nut-hatch, is in length near five inches three-quarters, in breadth nine inches; the bill is strong and straight, about three-quarters of an inch long; the crown of the head, back, and coverts of the wings, of a fine bluish grey; a black stroke passes over the eye from the mouth; the cheeks and chin are white; the breast and belly of a dull orange-colour. The female is like the male, but less in size, and weighs commonly five or at most six drams. The eggs are six or seven in number, of a dirty white, dotted with rufous; these are deposited in some hole of a tree, frequently one which has been deserted by a woodpecker, on the rotten wood mixed with a little moss, &c. If the entrance is too large, the bird nicely stops up part of it with clay, leaving only a small hole for itself to pass in and out by. While the hen is sitting, if any one puts a bit of stick into the hole, she hisses like a snake, and is so attached to her eggs, that she will sooner suffer any one to pluck off her feathers than fly away. During the time of incubation, the male supplies her with sustenance.

The bird runs up and down the bodies of trees, like the woodpecker tribe; and feeds not only on insects, but nuts, of which it lays up a considerable provision in the hollows of trees. Dr. Plott tells us, that this bird, by putting its bill into a crack in the bough of a tree, can make such a violent sound as if it was rending asunder, so that the noise may be heard at least twelvescore yards.

SIUM, *water parsnip*, a genus of plants belonging to the class of pentandria, and order of digynia, and in the natural system ranging under the 45th order, umbellatæ. The fruit is a little ovated, and streaked. The involucrum is polyphyllous, and the petals are heart-shaped. There are nineteen species; three are natives of Britain: 1. The latifolium, or great water-parsnip, which grows spontaneously in many places both of England and Scotland, on the sides of lakes, ponds, and rivulets. Cattle are said to have run mad by feeding upon this plant. 2. The angustifolium, or narrow-leaved water-parsnip, grows in ditches and rivulets, but is not common. 3. The nodiflorum, reclining water-parsnip, grows on the sides of rivulets.

The sium sisarium, or skirret, is a native of China, but has been for a long time cultivated in Europe, and particularly in Germany. The root is a bunch of fleshy fibres, each of which is about as thick as a finger, but very uneven, covered with a whitish rough bark, and has a hard core or pith running through the centre. Skirrets come nearest to parsnips of any of the esculent roots, both for flavour and nutritive qualities. They are rather sweeter than the parsnip, and therefore to some few palates are not altogether so agreeable. Mr. Margraaf extracted from half a pound of skirret-root an ounce and a half of pure sugar.

SIXTH, in music, an interval formed of six sounds, or five diatonic degrees. There are four kinds of sixths, two consonant and two dissonant. The consonant sixths, are first, the minor sixth, composed of three tones and two semitones major. Secondly, the major sixth, composed of four tones and a major semitone. The dissonant sixths are, first the diminished sixth, composed of two tones and three major semitones. Secondly, the superfluous sixth, composed of four tones, a major semitone, and a minor semitone.

SIZE, the name of an instrument used to find the bigness of fine round pearls. It consists of thin pieces or leaves, about two inches long and half an inch broad, fastened together at one end by a rivet. In each of these are round holes drilled of different diameters. Those in the first leaf serve for measuring pearls from half a grain to seven grains; those of the second, for pearls from eight grains or two carats, to five carats, &c.; and those of the third, for pearls from six carats and a half to eight carats and a half.

SIZE. See GELATINA.

SKAITE. See RAIA.

SKELETON. See ANATOMY.

SKIMMIA, a genus of the monogynia order, in the tetrandria class of plants, and in the natural method ranking under the 40th order, personatæ. The calyx is quadripartite; the corolla consists of four concave petals; and the berry contains four seeds. There is only one species, viz. the japonica.

SKIN. See CUTIS.

SKINNER, one who works in skins. Skinners, or fellmongers, shall not retain any journeyman, &c. to work in their trade, except they themselves have served seven years as apprentices thereto, on pain of forfeiting double the value of the wares wrought by such persons.

SKULL, cranium et calvaria. See ANATOMY.

SLAB, an outside sappy plank or board sawed off from the sides of a timber-tree; the word is also used for a flat piece of marble.

SLATE. This stone constitutes a part of many mountains. Its structure is slaty. Its texture foliated. Fracture splintery. Fragments often tabular. Lustre most commonly silky. Specific gravity from 2.67 to 2.88. Does not adhere to the tongue. Gives a clear sound when struck. Streak white or grey. Colour most commonly grey, with a shade of blue, green, or black; sometimes purplish, yellowish, mountain-green, brown, bluish-black; sometimes striped or spotted with a darker colour than the ground.

It is composed, according to Kirwan, of silica, alumina, magnesia, lime, oxide of iron. In some varieties the lime is wanting. Several varieties contain a considerable quantity of carbonaceous matter.

SLAVERY. The law of England abhors, and will not endure, the existence of slavery within this nation. A slave or negro, the moment he lands in England, falls under the protection of the laws, and becomes a free man.

SLEDGE, a kind of carriage without wheels, for the conveyance of very weighty things, as huge stones, &c.

This is also the name of a large smith's hammer, to be used with both hands. Of this there are two sorts; the up-hand sledge, which is used by under-workmen, when the work is not of the larger sort; it is used with both the hands before, and they seldom raise it higher than their head: but the other, which is called the about-sledge, and which is used for battering or drawing out the largest work, is held by the handle with both hands, and swung round over their heads at their arm's end, to strike as hard a blow as they can.

SLEEP. See PHYSIOLOGY.

SLEEPERS, in a ship, timbers lying before and aft, in the bottom of the ship, as the rung-heads do; the lowermost of them is bolted to the rung-heads, and the uppermost to the futtocks and rungs.

SLINGING, is used variously at sea, but chiefly for the hoisting up casks, or other heavy things, with slings; *i.e.* contrivances of ropes spliced into themselves, at either end, with one eye big enough to receive the cask, or other thing, to be slung.

SLOANEA, a genus of plants belonging to the class of polyandria, and order of monogynia; and in the natural system ranking under the 50th order, amentaceæ. There is no corolla; the calyx is monophyllous; the stigma is perforated; the berry is corticose, echinated. There are three species, large trees of South America and the West Indies.

SLOATH, or SLOTH. See BRADYPUS.

SLOE, prunus sylvestris, the English name for the wild plum. See PRUNUS.

SLOOP, a sort of small ship or vessel, usually with one mast, otherwise called shallop. In our navy, sloops are tenders on the men of war, and are usually of about sixty tons, and carry about thirty men.

SLOW-WORM. See ANGUIS.

SLUICE, in hydraulics, a frame of timber, stone, earth, &c. serving to retain and raise the water of the sea, a river, &c. and on occasion to let it pass; such is the sluice of a mill, which stops and collects the water of a rivulet, &c. in order to discharge it at length, in greater plenty, upon the mill-wheel; such also are those used in drains, to discharge water off lands; and such are the sluices of Flanders, &c. which serve to prevent the waters of the sea overflowing the lower lands, except when there is occasion to drown them. See CANAL.

Construction of sluices. The construction of sluices ought to be conducted by an able engineer, who is well acquainted with the action of fluids in general; and particularly with the situation of the place, the nature of the soil, &c. where the sluice is to be erected; if on the sea-shore, he ought to be perfectly well acquainted with the effects of the sea on that coast, and the seasons when it is calm or stormy, that he may be able to prevent the fatal accidents thence arising; and if in a river, it is necessary to know whether it usually overflows its banks, and at what seasons of the year its waters are highest and lowest. The machines for driving the piles should be placed about forty yards from the side of the sluice, above and below it. As to the depth of sluices, it must be regulated by the uses for which they are designed; thus, if a sluice is to be erected at the entrance of a bason for shipping, its depth must correspond with the draught of water of the largest ship that may, at any time, have occasion to enter by it. The rule usually observed, is to make the surface of the bottom of the canal on a level with the low-water mark; but if the bottom of the harbour or canal is such as to be capable of becoming deeper by the action of the water, Belidor very justly observes, that the bottom of the sluice-work should be made deeper than either.

When a sluice is to be placed at the bottom of a harbour, in order to wash away the filth that may gather in it, by means of the waters of a river or canal; in this case the bottom of the sluice-work should be two feet or eighteen inches higher than the bottom of the harbour, that the water may run with the greater violence.

An engineer ought always to have in his view, that the faults committed in the construction of sluices are almost always irreparable. We shall therefore lay down some rules, from Belidor, for avoiding any oversights of this kind: 1. In order to adjust the level of the sluice-work with the utmost exactness, the engineer ought to determine how much deeper it must be than a fixed point; and this he should mark down in his draught, in the most precise terms possible. 2. When the proper depth is settled, the foundation is next to be examined; and here the engineer cannot be too cautious, lest the apparent goodness of the soil deceive him; if the foundation is judged bad, or insufficient to bear the superstructure, it must be secured by driving piles, or a grate-work of carpentry. 3. There should be engines enough provided for draining the water; and these should be entirely under the direction of the engineer, who is to take care that they are so placed as not to be an obstacle to the work; and also cause proper trenches to be cut, to convey the water clear off from the foundation. 4. When the sluice is to be built in a place where the workmen will be unavoidably incommoded by the waters of the sea, &c. all the stones for the mason-work, as well as the timbers for that of carpentry, should be prepared beforehand; so that when a proper season offers for beginning the work, there remains nothing to be done, but to fix every thing in its place.

Sluices are made different ways, according to the uses they are intended for; when they serve for navigation, they are shut with two gates, presenting an angle towards the stream; but when made near the sea, there are two pair of gates, one to keep the water out, and the other to keep it in, as occasion requires; the pair of gates next the sea present an angle that way, and the other pair the contrary way; the space inclosed by these gates is called a chamber.

When sluices are designed to detain the water in some parts of the ditch of a fortress, they are made with shutters to slide up and down in grooves; and when they are made to cause an inundation, they are then shut by means of square timbers let down into cullises, so as to lie close and firm.

SMALT, a kind of glass of a dark-blue colour, which, when levigated, appears of a most beautiful colour; and if it could be made sufficiently fine, would be an excellent succedaneum for ultramarine, as not only resisting all kinds of weather, but even the most violent fires. It is prepared by melting one part of oxide of cobalt with two of flint-powder, and one of potass. At the bottoms of the crucibles in which the smalt is manufactured, we generally find a regulus of a whitish colour inclining to red, and extremely brittle. This is melted afresh, and when cold, separates into two parts; that at the bottom is the cobaltic regulus, which is employed to make more of the smalt; the other is bismuth.

SMARAGDITE, in mineralogy. This stone was called smaragdite by M. Saussure, from some resemblance which it has to the emerald. Never crystallized. Its texture is foliated. Easily divided into plates. The laminæ are inflexible. Fracture even. Specific gravity 3. Colour in some cases fine green; in others it has the grey colour and metallic lustre of mica; it assumes all the shades of colour between these two extremes.

According to the analysis of Vauquelin, it is composed of

50.0	silica
13.0	lime
11.0	alumina
7.5	oxide of chromium
6.0	magnesia
5.5	oxide of iron
1.5	oxide of copper
94.5	

SMELT. See SALMO.

SMELTING, in metallurgy, the fusion or melting of the ores of metals, in order to separate the metalline part from the earthy, stony, and other parts.

SMELTING, or the art of fusing the ores after roasting, is the principal and most important of metallurgic operations, all the other being preliminary or preparative to this. The whole attention of the miner is directed towards this process; to this all his efforts are applied, because it affords the truly useful product to which his hopes are directed. Though it consists in general in fusing the roasted ore to extract the metal, and in this point of view it seems to present a simple and uniform operation, there is, nevertheless, no operation which differs so much in its circumstances, according to the nature of the metal and the ore required to be treated, and according to the furnaces made use of, the nature and quantity of the combustible employed, the energy, duration, and administration of the fire, the addition of an appropriate flux, the heat being applied in the midst of the coal or in crucibles, the period, the length of time, and the mode of casting the fused metal; every thing, even the form of the metal which flows out, varies, and presents to the observer very remarkable differences.

When the ore is smelted, and the metal obtained, the whole process is not yet finished. This metal is scarcely ever pure. It is either altered by certain substances foreign to its metallic nature; or it contains a portion of another metal, which alters the properties of this which is desired in a pure state; or else it contains a portion of a metal more valuable than all the rest of the mass, which it is necessary therefore to extract; or, lastly, it is an alloy, in large proportions of several metals, which are required to be separated from each other. All the operations subsequent to the smelting, are comprehended under the general name of refining, because the effect is always to obtain a pure metal. See METALLURGY.

SMILAX, *rough bindweed*; a genus of plants belonging to the class of diœcia and order of hexandria; and in the natural system ranging under the 11th order, sarmentaceæ. The male calyx is hexaphyllous, and there is no corolla; the female calyx is also hexaphyllous, without any corolla; there are three styles, a trilocular berry, and two seeds. There are 22 species; of these, the smilax sarsaparilla, which affords the sarsaparilla root, is the most valuable. This is well described in the London Medical Journal by Dr. Wright, who, during a long residence in Jamaica, made botany his peculiar study.

"This species (says he) has stems of the thickness of a man's finger; they are jointed, triangular, and beset with crooked spines. The leaves are alternate, smooth and shining on the upper side: on the other side are three nerves or costæ, with sundry small crooked spines. The flower is yellow, mixed with red. The fruit is a black berry, containing several brown seeds.

"Sarsaparilla delights in low moist grounds and near the banks of rivers. The roots run superficially under the surface of the ground. The gatherers have only to loosen the soil a little, and to draw out the long fibres with a wooden hook. In this manner they proceed till the whole root is got out. It is then cleared of the mud, dried, and made into bundles.

"The sensible qualities of sarsaparilla are mucilaginous and farinaceous, with a slight degree of acrimony. The latter, however, is so slight as not to be perceived by many; and I am apt to believe that its medicinal powers may fairly be ascribed to its demulcent and farinaceous qualities."

The china, or oriental species of China

root, has roundish, prickly stalks and red berries, and is a native of China and Japan. The pseudo-china, or occidental species, has rounder smooth stalks and black berries, grows wild in Jamaica and Virginia, and bears the colds of our own climate. At present the China root is very rarely made use of, having for some time given place to sarsaparilla, which is supposed to be more effectual. Prosper Alpinus informs us, that this root is in great esteem among the Egyptian women for procuring fatness and plumpness.

SMITHERY, or SMITHING, a manual art, by which an irregular lump of iron is wrought into an intended shape.

SMITHIA, a genus of the decandria order, in the diadelphia class of plants; and in the natural method ranking under the 32nd order, papilionaceæ. The calyx is monophyllous and bilabiated; the corolla winged; the legumen inclosed in the calyx, with three or four joints, and containing as many seeds, which are smooth, compressed, and kidney-shaped. There is only one species, viz. the sensitiva, an annual of the East Indies.

SMOKE. See EVAPORATION, Vol. I. p. 687.

SMOKE-JACK. See JACK.

SMUT. See HUSBANDRY.

SMYRNIUM, ALEXANDERS; a genus of plants belonging to the class of pentandria, and to the order of digynia; and in the natural system ranging under the 45th order, umbellatæ. The fruit is oblong and striated: the petals have a sharp point, and are keel-shaped. There are seven species: 1. The perfoliatum, or perfoliate alexanders, which is a native of Candia and Italy; 2. The Ægyptiacum; 3. The aureum, or golden alexanders, which is a native of North America; 4. The integerrimum; 5. The olusatrum, common alexanders, a native of Britain; the leaves of which are cauline, ternate, petiolated, and serrated. It grows on the sea-coast at Dunglass on the borders of Berwickshire, North Britain. Since the introduction of celery into the garden, the alexanders is almost forgotten. It was formerly cultivated for salading, and the young shoots or stalks blanched were eaten either raw or stewed. The leaves too were boiled in broths and soups. It is a warm comfortable plant to a cold weak stomach, and was in much esteem among the monks, as may be inferred by its still being found in great plenty by old abbey-walls. 6. Laterale. 7. Apiifolium.

SNAIL. See HELIX, and LIMAX.

SNAKE. See ANGUIS.

SNIPE. See SCOLOPAX.

SOAL-FISH. See PLEURONECTES.

SNOW. See METEOROLOGY.

SNOWDROP. See GALANTHUS.

SNOWDROP-TREE. See CHIONANTHUS.

SNUFF, a powder chiefly made of tobacco, the use of which is too well known to need any description here. See NICOTIANA.

SNAPDRAGON, in botany. See ANTIRRHINUM.

SOAP. The fixed oils have the property of combining with alkalies, earths, and metallic oxides, and of forming with these bodies a class of compounds which have received the name of soaps. As these soaps differ from each other very materially, according as their base is an alkali, an earth, or an oxide, it will be proper to consider each set separately.

SOAPS, *alkaline*. As there are a great number of fixed oils, all or most of which are capable of combining with alkalies, earths, and oxides, it is natural to suppose that there are as many genera of alkaline soaps as there are oils. That there are differences in the nature of soaps corresponding to the oil which enters into their composition, is certain; but these differences are not of sufficient importance to require a particular description. It will be sufficient, therefore, to divide the alkaline soaps into as many species as there are alkalies, and to consider those soaps which have the same alkaline base, but differ in their oil, as varieties of the same species.

Soap of soda, or hard soap. The word soap (sapo σαπων) first occurs in the works of Pliny and Galen, and is evidently derived from the old German word, sepe. Pliny informs us that soap was first discovered by the Gauls; that it was composed of tallow and ashes; and that the German soap was reckoned the best.

Soap may be prepared by the following process: a quantity of the soda of commerce is pounded, and mixed in a wooden vessel, with about a fifth part of its weight of lime, which has been slacked and passed through a sieve immediately before. Upon this mixture a quantity of water is poured, considerably more than what is sufficient to cover it, and allowed to remain on it for several hours. The lime attracts the carbonic acid from the soda, and the water becomes strongly impregnated with the pure alkali, which in that state is caustic. This water is then drawn off by means of a stop-cock, and called the first ley. Its specific gravity should be about 1.200.

Another quantity of water is then to be poured upon the soda, which, after standing two or three hours, is also to be drawn off by means of the stop-cock, and called the second ley.

Another portion of water is poured on; and after standing a sufficient time, is drawn off like the other two, and called the third ley.

Another portion of water may still be poured on, in order to be certain that the whole of the soda is dissolved; and this weak ley may be put aside, and employed afterwards in forming the first ley in subsequent operations.

A quantity of oil, equal to six times the weight of the soda used, is then to be put into the boiler, together with a portion of the third or weakest ley; and the mixture must be kept boiling and agitated constantly by means of a wooden instrument. The whole of the third ley is to be added at intervals to the mixture; and after it is consumed, the second ley must be added in the same manner. The oil becomes milky, combines with the alkali, and after some hours it begins to acquire consistence. A little of the first ley is then to be added, not forgetting to agitate the mixture constantly. Portions of the first ley are to be added at intervals; the soapy substance acquires gradually greater consistency, and at last it begins to separate from the watery part of the mixture. A quantity of common salt is then to be added, which renders the separation much more complete. The boiling is to be continued still for two hours, and then the fire must be withdrawn, and the liquor must be no longer agitated. After some hours repose, the soap separates completely from the watery part, and swims upon the surface of the liquor. The watery part is then to be drawn off; and as it contains a quantity of carbonat of soda, it ought to be reserved for future use.

The fire is then to be kindled again; and, in order to facilitate the melting of the soap, a little water, or rather weak ley, is to be added to it. As soon as it boils, the remainder of the first ley is to be added to it at intervals. When the soap has been brought to the proper consistence, which is judged of by taking out small portions of it and allowing it to cool, it is to be withdrawn from the fire, and the watery part separated from it as before. It is then to be heated again, and a little water mixed with it, that it may form a proper paste. After this let it be poured into the vessels proper for cooling it; in the bottom of which there ought to be a little chalk in powder, to prevent the soap from adhering. In a few days, the soap will have acquired sufficient consistence to be taken out, and formed into proper cakes.

The use of the common salt in the above process is, to separate the water from the soap; for common salt has a stronger affinity for water than soap has.

Olive-oil has been found to answer best for making soap, and next to it perhaps tallow may be placed; but a great variety of other oils may be employed for that purpose, as appears from the experiments of the French chemists. They found, however, that linseed-oil and whale-oil were not proper for making hard soaps, though they might be employed with advantage in the manufacture of soft soaps. Whale-oil has been long used by the Dutch for this last purpose.

Soap may also be made without the assistance of heat; but in that case a much longer time and a larger proportion of alkali are necessary.

Manufacturers have contrived various methods of sophisticating soap, or of adding ingredients which increase its weight without increasing its value. The most common substance used for that purpose is water; which may be added in considerable quantities, especially to soap made with tallow (the ingredient used in this country), without diminishing its consistency. This fraud may be easily detected, by allowing the soap to lie for some time exposed to the air. The water will evaporate from it, and its quantity will be discovered by the diminution of the weight of the soap. As soap sophisticated in this manner would lose its water by being kept, manufacturers, in order to prevent that, keep their soap in saturated solutions of common salt; which do not dissolve the soap, and at the same time, by preventing all evaporation, preserve, or rather increase, the weight of the soap. Messrs. Darcet, Lelievre, and Pelletier, took two pieces equal in weight of soap sophisticated in this manner, and placed the one in a dry place in the open air, and the other in a saturated solution of common salt. After a month the first had lost 0.56 of its weight, the other had gained about 0.10 parts. Various other methods have been fallen upon to sophisticate soap; but as they are not generally known, it would be doing an injury to the public to describe them here.

Different chemists have analysed soap, in order to ascertain the proportions of its ingredients; but the result of their experiments is various, because they used soap containing various quantities of water. From the experiments of Darcet, Lelievre, and Pelletier, it appears that soap newly made and exposed to sale contains

60.94	oil
8.56	alkali
30.50	water
100.00	

Soap is soluble both in water and in alcohol. Its properties as a detergent are too well known to require any description.

Soap made with tallow and soda has a white colour, and is therefore known by the name of white soap; but it is usual for soap-makers, in order to lower the price of the article, to mix a considerable portion of rosin with the tallow; this mixture forms the common yellow or turpentine soap of this country.

Soap of potass, or soft soap. Potass may be substituted for soda in making soap, and in that case precisely the same process is to be followed. It is remarkable, that when potass is used, the soap does not assume a solid form; its consistence is never greater than that of hog's lard. This is what in this country is called soft soap. Its properties as a detergent do not differ materially from those of hard soap, but it is not nearly so convenient for use. The alkali employed by the antient Gauls and Germans in the formation of soap was potass; hence we see the reason that it is described by the Romans as an unguent. The oil employed for making soft soap in this country is whale-oil. A little tallow is also added, which, by peculiar management, is dispersed through the soap in fine white spots.

Some persons have affirmed that they knew a method of making hard soap with potass. Their method is this: After forming the soap in the manner above described, they add to it a large quantity of common salt, boil it for some time, and the soap becomes solid when cooled in the usual way. That this method may be practised with success, has been ascertained by Messrs. Darcet, Lelievre, and Pelletier; but then the hard soap thus formed does not contain potass but soda; for when the common salt (muriat of soda) is added, the potass of the soap decomposes it, and combines with its muriatic acid, while at the same time the soda of the salt combines with the oil, and forms hard soap; and the muriat of potass formed by this double decomposition is dissolved in water, and drawn off along with it.

Chaptal has lately proposed to substitute wool in place of oil in the making of soap. The ley is formed in the usual manner, and made boiling hot, and shreds of woollen cloth of any kind are gradually thrown into it; they are soon dissolved. New portions are to be added sparingly, and the mixture is to be constantly agitated. When no more cloth can be dissolved, the soap is made. This soap is said to have been tried with success. It might doubtless be substituted for soap with advantage in several manufactures, provided it can be obtained at a cheaper rate than the soaps at present employed.

Some time ago a proposal was made to substitute the muscles of fish instead of tallow or oil in the manufacture of soap; but the experiments of Mr. Jamieson have demonstrated that they do not answer the purpose.

Soap of ammonia. This soap was first particularly attended to by Mr. Berthollet. It may be formed by pouring carbonat of ammonia on soap of lime. A double decomposition takes place, and the soap of ammonia swims upon the surface of the liquor in the form of an oil; or it may be formed with still greater ease by pouring a solution of muriat of ammonia into common soap dissolved in water.

It has a more pungent taste than common soap. Water dissolves a very small quantity of it; but it is easily dissolved in alcohol. When exposed to the air, it is gradually decomposed. The substance called volatile linament, which is employed as an external application in rheumatisms, colds, &c. may be considered as scarcely any thing else than this soap.

All the alkaline soaps agree in the properties of solubility in water and alcohol, and in being powerful detergents.

Soaps, *earthy.* The earthy soaps differ essentially from the alkaline in their properties. They are insoluble in water, and incapable of being employed as detergents. They may be formed very readily by mixing common soap with a solution of an earthy salt; the alkali of the soap combines with the acid of the salt, while the earth and oil unite together and form an earthy soap. Hence the reason that all waters holding an earthy salt are unfit for washing. They decompose common soap, and form an earthy soap insoluble in water. These waters are well known by the name of hard waters. Hitherto the earthy soaps have been examined by Mr. Berthollet only.

Soap of lime. This soap may be formed by pouring lime-water into a solution of common soap. It is insoluble both in water and alcohol. Carbonat of fixed alkali decomposes it by compound affinity. It melts with difficulty, and requires a strong heat.

Soap of barytes and of strontian resemble almost exactly the soap of lime.

Soap of magnesia may be formed by mixing together solution of common soap and sulphat of magnesia. It is exceedingly white. It is unctuous, dries with difficulty, and preserves its whiteness after desiccation. It is insoluble in boiling water. Alcohol and fixed oil dissolve it in considerable quantity. Water renders its solution in alcohol milky. A moderate heat melts it; a transparent mass is formed, slightly yellow, and very brittle.

Soap of alumina may be formed by mixing together solutions of alum and of common soap. It is a flexible soft substance, which retains its suppleness and tenacity when dry. It is insoluble in alcohol, water, and oil. Heat easily melts it, and reduces it to a beautiful transparent yellowish mass.

Metallic oxides are capable of combining with oils by two different processes: 1. By mixing together a solution of common soap with a metallic salt. 2. By uniting the metallic oxide with the oil directly, either cold or by the assistance of heat. The first of these combinations is called a metallic soap; the second a plaster. See Plaster.

Soaps, *metallic.* These soaps have been examined by Mr. Berthollet; who has proposed some of them as paints, and others as varnishes; but it does not appear that any of them has been hitherto applied to these purposes.

1. Soap of mercury may be formed by mixing together a solution of common soap and of corrosive muriat of mercury. The liquor becomes milky, and the soap of mercury is gradually precipitated. This soap is viscid, not easily dried, loses its white colour when exposed to the air, and acquires a slate-colour, which gradually becomes deeper, especially if exposed to the sun or to heat. It dissolves very well in oil, but sparingly in alcohol. It readily becomes soft and fluid when heated.

2. Soap of zinc may be formed by mixing together a solution of sulphat of zinc and of soap. It is of a white colour, inclining to yellow. It dries speedily, and becomes friable.

3. Soap of cobalt, made by mixing nitrat of cobalt and common soap, is of a dull leaden colour, and dries with difficulty, though its parts are not conducted.

Mr. Berthollet observed, that towards the end of the precipitation there fell down some green coagula, much more consistent than soap of cobalt. These he supposed to be a soap of nickel, which is generally mixed with cobalt.

4. Soap of tin may be formed by mixing common soap with a solution of tin in nitro-muriatic acid. It is white. Heat does not fuse it like other metallic soaps, but decomposes it.

5. Soap of iron may be formed by means of sulphat of iron. It is of a reddish-brown colour, tenacious, and easily fusible. When spread upon wool, it sinks in and dries. It is easily soluble in oil, especially of turpentine. Berthollet proposes it as a varnish.

6. Soap of copper may be formed by means of sulphat of copper. It is of a green colour, has the feel of a resin, and becomes dry and brittle. Hot alcohol renders its colour deeper, but scarcely dissolves it. Ether dissolves it, liquefies it, and renders its colour deeper and more beautiful. It is very soluble in oils, and gives them a pleasant green colour.

7. Soap of lead may be formed by means of acetite of lead. It is white, tenacious, and very adhesive when heated. When fused it is transparent, and becomes somewhat yellow if the heat is increased.

8. Soap of silver may be formed by means of nitrat of silver. It is at first white, but becomes reddish by exposure to the air. When fused, its surface becomes covered with a brilliant iris; beneath the surface it is black.

9. Soap of gold is formed by means of muriat of gold. It is at first white, and of the consistence of cream. It gradually assumes a dirty purple colour, and adheres to the skin.

10. Soap of manganese is formed of sulphat of manganese. It is at first white, and then by absorbing oxygen it becomes red.

SOCAGE, an antient tenure, by which lands were held on condition of ploughing the lord's lands, and doing the operations of husbandry, at their own charges.

SOCCUS, in antiquity, a kind of high shoe, reaching above the ancle, worn by comedians, as the cothurnus was by tragedians.

SOCIETY. See ACADEMY.

SOCINIANS, in church history, a sect of christians, so called from their founder Faustus Socinus, a native of Sienna, in Italy. He, about the year 1574, began openly to declare against the catholic faith, and taught, 1. That the eternal father was the one only God; that the Word was no more than an expression of the godhead, and had not existed from all eternity; and that Jesus Christ was God no otherwise than by his superiority above all creatures, who were put in subjection to him by the Father. 2. That Jesus Christ was not a mediator between God and men, but sent into the world to serve as a pattern of their conduct; and that he ascended up to heaven only to take a journey thither. 3. That the punishment of hell will last but for a certain time, after which the body and soul will be destroyed. And 4. That it is not lawful for princes to make war. These four tenets were what Socinus defended with the greatest zeal. In other matters, he was a lutheran or a calvinist; and the truth is, that he did but refine upon the errors of all the antitrinitarians that went before him. The socinians spread extremely in Poland, Lithuania, and Transylvania.

SOCMEN. See SOCAGE.

SOCOME, is taken for a custom of grinding corn at the lord's mill; whence came the name or term of bond socome, by which the tenants were bound to it; and also love socome, where they did it voluntarily out of love to their lord.

SODA, called also fossil or mineral alkali, because it was thought peculiar to the mineral kingdom, was known to the antients (though not in a state of purity) under the names of νιτρον and nitrum.

It is found in large quantities combined with carbonic acid in different parts of the earth, especially in Egypt; and common salt is a compound of soda and muriatic acid. But the soda of commerce is obtained from the ashes of different species of the salsola, a genus of plants which grow upon the seashore, especially from the salsola soda, from which the alkali has obtained its name. The soda of commerce is also called barilla, because the plant from which it is obtained bears that name in Spain. Almost all the algæ, especially the fuci, contain also a considerable quantity of soda. The ashes of these plants are known in this country by the name of kelp; in France they are called varec.

The soda, or barilla of commerce, is far from being pure; besides carbonic acid it contains common salt, and several other foreign ingredients; but it may be obtained perfectly pure by the processes for purifying potass. (See that article.)

Soda and potass resemble each other so nearly, that they were confounded together till Du Hamel published his dissertation on common salt in the Memoirs of the French Academy for 1736. He first proved that the base of common salt is soda, and that soda is different from potass. His conclusions were objected to by Pott, but finally confirmed by Margraff in 1758.

Soda is of a greyish-white colour, and agrees exactly with potass in its taste, smell, and action upon animal bodies; but its specific gravity is only 1.336.

Heat produces on it exactly the same effects as upon potass. When exposed to the air, it absorbs moisture and carbonic acid, and is soon reduced to the consistence of paste; but it does not liquefy like potass; in a few days it becomes dry again, and crumbles into powder.

It has a strong affinity for water, dissolves in it like potass, and may also be obtained in crystals by evaporating its aqueous solution. It is not altered by light; nor does it combine with oxygen, hydrogen, azote, carbon, charcoal, or metals. Its action upon phosphorus and sulphur is the same with that of potass. The sulphuret and hydrogenated sulphuret of soda possess the properties of the sulphuret and hydrogenated sulphuret of potass, and are formed in the same manner. In its action on metals, metallic oxides, and in its affinities, it also agrees with potass. In short, the two fixed alkalies, in a state of purity, resemble each other very nearly in almost every particular. Its importance in manufactures is not inferior to that of potass. For several purposes, as for soap and glass, it answers even better than potass.

SOFFITA, or SOFFIT, in architecture, any plafond or ceiling formed of cross beams of flying cornices, the square compartments or pannels of which are enriched with sculpture, painting, or gilding.

SOFI, or SOPHI. See SOPHI.

SOFTENING. See PAINTING.

SOIL. See HUSBANDRY.

SOIT FAIT COMME IL EST DESIRE', *be it done as it is desired*, a form used when the king gives the royal assent to a private bill preferred in parliament.

SOL, in music, the fifth note of the gamut, ut, re, mi, fa, sol, la. See GAMUT.

SOL, or SOU, a French coin made up of copper mixed with a little silver, value the 23d part of our shilling.

SOL, the *sun*, in astronomy.

SOL, in the old chemistry, is gold.

SOLANDRA, a genus of plants belonging to the class of pentandria, and to the order monogynia. The calyx is bursting; the corolla elevate, funnel-formed, very large; berry four-celled, many-seeded. The only species is grandiflora. This genus was first named solandra in honour of Dr. Solander, by Murray, in the 14th edition of the Systema Vegetabilium. In Jamaica it is called the peach-coloured trumpet-flower.

SOLANUM, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 28th order, luridæ. The calyx is inferior; the corolla is rotate and monophyllous; the fruit a berry, bilocular, and containing many small and flat seeds. Of this genus there are 93 species, most of them natives of the East and West Indies, the most remarkable of which are the following:

1. The dulcamora, woody nightshade a native of Britain and of Africa, is a slender climbing plant, rising to six or more feet in height. The leaves are generally oval, pointed, and of a deep-green colour; the flowers hang in loose clusters, of a purple colour, and divided into five pointed segments. The calyx is purple, persistent, and divided into five; the berry, when ripe, is red, and contains many flat yellowish seeds. It grows in hedges well supplied with water, and flowers about the end of June. On chewing the roots, we first feel a bitter, then a sweet taste: hence the name. The berries are said to be poisonous, and may easily be mistaken by children for currants. The stipites or younger branches are directed for use, and may be employed either fresh or dried; they should be gathered in the autumn. This plant is generally given in decoction or infusion. Several authors take notice, that the dulcamara partakes of the milder powers of the nightshade, joined to a resolvent and saponaceous quality; hence it promotes the secretions of urine, sweat, the menses, and lochia. It is recommended in a variety of disorders; but particularly in rheumatism, obstructed menses, and lochia; also in some obstinate cutaneous diseases.

2. The nigrum, garden nightshade, common in many places in Britain about dunghills and waste places. It rises to about two feet in height. The stalk herbaceous; the leaves alternate, irregularly oval, indented, and clothed with soft hairs. The flowers are white; the berries black and shining. It appears to possess the deleterious qualities of the other nightshades in a very high degree, and even the smell of the plant is said to cause sleep. The berries are equally poisonous with the leaves, causing cardialgia and delirium, and violent distortions of the limbs in children. Mr. Getaker, in 1757, recommended its internal use in old sores, in scrofulous and cancerous ulcers, cutaneous eruptions, and in dropsies. He says, that one grain infused in an ounce of water, sometimes produced a considerable effect; that in the dose of two or three grains it seldom failed to evacuate the first passages, to increase very sensibly the discharges by the skin and kidneys, and sometimes to occasion head-ache, drowsiness, giddiness, and dimness of sight. Mr. Broomfield declares, that in cases in which he tried the solanum they were much aggravated by it; and that in one case in the dose of one grain it proved mortal to one of his patients; therefore he contends its use is prejudicial. This opinion seems tacitly to be confirmed, as it is now never given internally. In antient times it was employed externally as a discutient and anodyne in some cutaneous affections, tumefactions of the glands, ulcers, and disorders of the eyes. The solanum nigrum ε rubrum, a native of the West Indies, is called guma by the negroes. It is so far from having any deleterious quality, that it is daily served up at table as greens or spinach. It has an agreeable bitter taste.

3. Lycopersicum, the love-apple, or tomato, cultivated in gardens in the warmer parts of Europe, and in all tropical countries. The stalk is herbaceous; the leaves pinnated, oval, pointed, and deeply divided. The flowers are on simple racemi; they are small and yellow. The berry is of the size of a plum; they are smooth, shining, soft; and are either of a yellow or reddish colour. The tomato is in daly use; being either boiled in soups or broths, or served up boiled as garnishes to flesh-meat.

4. Melongena, the egg plant, or vegetable egg. This is also cultivated in gardens, particularly in Jamaica. It seldom rises above a foot in height. The fruit is as big as, and

very like, the egg of a goose. It is often used boiled as a vegetable along with animal food or butter, and supposed to be aphrodisiac and to cure sterility.

5. Longum. This plant is also herbaceous, but grows much ranker than the foregoing. The flowers are blue: and the fruit is six or eight inches long, and proportionally thick. It is boiled and eaten at table as the egg-plant.

6. Tuberosum, the common potatoe. It was introduced by sir Walter Raleigh, and first cultivated in Ireland about the year 1600. Large fortunes have been made by the culture of potatoes at Westham in Essex.

SOLDANELLA, in botany, a genus of plants of the class of pentandria, and order of monogynia, and in the natural system arranged under the 21st order, preciæ. The corolla is campanulated; the border being very finely cut into a great many segments. The capsule is unilocular, and its apex polydentate. There is one species.

SOLDER, SODDER, or SODER, a metallic or mineral composition used in soldering or joining other metals. Solders are made of gold, silver, copper, tin, bismuth, and lead; usually observing, that in the composition there shall be some of the metal that is to be soldered mixed with some higher and finer metals. Goldsmiths usually make four kinds of solder, viz. solder of eight, where to seven parts of silver there is one of brass or copper; solder of six, where only a sixth part is copper; solder of four, and solder of three. It is the mixture of copper in the solder that makes raised plate come always cheaper than flat.

As mixtures of gold with a little copper are found to melt with less heat than pure gold itself, these mixtures serve as solders for gold: two pieces of fine gold are soldered by gold that has a small admixture of copper; and gold alloyed with copper is soldered by such as is alloyed with more copper. The workmen add a little silver as well as copper, and vary the proportions of the two to one another, so as to make the colour of the solder correspond as nearly as may be to that of the piece. A mixture of gold and copper is also a solder for fine copper as well as for fine gold. Gold being particularly disposed to unite with iron, proves an excellent solder for the finer kinds of iron and steel instruments.

The solder used by plumbers is made of two pounds of lead to one of block-tin. Its goodness is tried by melting it, and pouring the size of a crown piece on a table; for, if good, there will arise little bright shining stars in it. The solder for copper, is made like that of the plumbers; only with copper and tin; and for very nice works, instead of tin, they sometimes use a quantity of silver. Solder for tin is made of two-thirds of tin and one of lead, or of equal parts of each; but where the work is any thing delicate, as in organ-pipes, where the juncture is scarcely discernible, it is made of one part of bismuth and three parts of pewter. The pewterers use a kind of solder made with two parts of tin and one of bismuth; this composition melts with the least heat of any of the solders.

Silver solder is that which is made of two parts of silver and one of brass, and used in soldering those metals. Spelter solder is made of one part of brass and two of spelter or zinc, and is used by the braziers and coppersmiths for soldering brass, copper, and iron. This solder is improved by adding to each ounce of it one pennyweight of silver; but as it does not melt without a considerable degree of heat, it cannot be used when it is inconvenient to heat the work red-hot; in which case copper and brass are soldered with silver.

Though spelter solder is much cheaper than silver solder, yet workmen in many cases prefer the latter. And Mr. Boyle informs us, that he has found it to run with so moderate a heat, as not much to endanger the melting of the delicate parts of the work to be soldered; and if well made, this silver solder will lie even upon the ordinary kind itself; and so fill up those little cavities that may chance to be left in the first operation, which is not easily done without a solder more easily fusible than the first made use of.

SOLDERING, the joining and fastening together of two pieces of the same metal, or of two different metals, by the fusion and application of some metallic composition on the extremities of the metals to be joined. To solder upon silver, brass, or iron: take silver, five pennyweights; brass, four pennyweights; melt them together for soft solder, which runs soonest. Take silver, five pennyweights; copper, three pennyweights; melt them together for hard solder. Beat the solder thin, and lay it on the place to be soldered, which must be first fitted and bound togerher with wire as occasion requires; then take borax in powder, and temper it like pap, and lay it upon the solder, letting it dry; then cover it with live coals, and blow, and it will run immediately.; take it presently out of the fire, and it is done. It is to be observed, that if any thing is to be soldered in two places, which cannot well be done at one time, you must first solder with the harder solder, and then with the soft; for, if it is first done with the soft, it will unsolder again before the other is softened. Let it be observed, that if you would not have your solder run about the piece that is to be soldered, you must rub such places over with chalk. In the soldering either of gold, silver, copper, or either of the metals above mentioned, there is generally used borax in powder, and sometimes rosin. As to iron, it is sufficient that it be heated red-hot, and the two extremities thus hammered together, by which means they will become incorporated with each other. For the finer kinds of iron and steel instruments, however, gold proves an excellent solder. This metal will dissolve twice or thrice its weight of iron in a degree of heat very far less than that in which iron itself melts; hence if a small plate of gold is wrapped round the parts to be joined, and afterwards melted by a blowpipe, it strongly unites the pieces together without any injury to the instrument, however delicate.

SOLEÆ, among the Romans, a kind of sandals or slippers which covered only the sole of the feet, and were bound on with thongs of leather, instead of which the women and the effeminate ones of the other sex tied them on with purple-coloured ribbons, or such as were variously adorned with gold and silver.

SOLECISM, *soloecismus*, in grammar, a false manner of speaking contrary to the use of language and the rules of grammar, either in respect of declension, conjugation, or syntax.

SOLEN, *razor sheath*, or *knife-handle shell*, a genus belonging to the class of vermes, and order of testacea. The animal is an ascidia. The shell is bivalve, oblong, and opening at both sides; the hinge has a tooth shaped like an awl, bent back, often double, not inserted into the opposite shell; the rim at the sides somewhat worn away, and has a horny cartilaginous hinge. There are 23 species; three of them, viz. the siliqua, vagina, and ensis, are found on the British coasts, and lurk in the sand near the low-water mark in a perpendicular direction. When in want of food they elevate one end a little above the surface, and protrude their bodies far out of the shell. On the approach of danger they dart deep into the sand, sometimes two feet at least. Their place is known by a small dimple on the surface. Sometimes they are dug out with a shovel; at other times they are taken by striking a barbed dart suddenly into them. When the sea is down, these fish usually run deep into the sand; and to bring them up, the common custom is to throw a little salt into the holes, on which the fish raises itself, and in a few minutes appears at the mouth of its hole. When half the shell is discovered, the fisherman has nothing more to do than to take hold of it with his fingers and draw it out; but he must be cautious not to lose the occasion, for the creature does not continue a moment in that state; and if by any means the fisherman has touched it, and let it slip away, it is gone for ever; for it will not be decoyed again out of its hole by salt; so that there is then no way of getting it but by digging under it, and throwing it up with the sand. The fish has two pipes, each composed of four or five rings or portions of a hollow cylinder, of unequal lengths, joined one to another; and the places where they join are marked by a number of fine streaks or rays. The reason why the salt causes these creatures to come up out of their holes, is, that it gives them violent pain, and even corrodes these pipes. This is somewhat strange, as the creature is nourished by means of salt water; but it is very evident, that if a little salt is strewed upon these pipes in a fish taken out of its habitation, it will corrode the joinings of the rings, and often make one or more joints drop off; the creature, to avoid this mischief, arises out of its hole, and throws off the salt, and then retires back again. The use of these pipes to the animal is the same with that of many other pipes of a like kind in other shell-fish; they all serve to take in water: they are only a continuation of the outer membrane of the fish, and serve indifferently for taking in and throwing out the water, one receiving and the other discharging it, and either answering equally well to their purpose.

This fish was used as food by the antients; and Athenæus, from Sophron, speaks of it as a great delicacy, and particularly grateful to widows. It is often used as food at present, and is brought up to table fried in eggs.

SOLFAING, or SOLMIZATION, the art of sounding the notes, together with the corresponding syllables of the gamut. This preparatory exercise, so necessary to sight-singing, and which, by uniting in the mind of the practitioner the ideas of the different syllables with those of the intervals, facilitates the recollection of the several sounds, was of very antient adoption.

Guido having substituted his hexachord in place of the antient tetrachord, adopted at the same time for his solmization six other syllables, ut, re, mi, fa, sol, la, taken from the hymn of St. John the Baptist.

Of the seven notes in the French scale, only four were for a while used by us, as mi, fa, sol, la; but now we, as well as the Italians, employ the first six, with the exception of changing ut for do, as a softer and more vocal syllable. By applying these syllables to the several notes, the practitioner not only utters the sound with more fulness, ease, and freedom, but, by the association of ideas, attains a ready recollection of the places of the tones and semitones, and by feeling the relation between the syllabic and the musical sounds, acquires the power of expressing them with truth and certainty.

SOLICITOR, a person employed to take care of, and manage, suits depending in the courts of equity, and those of the lower sort are too often made use of to the damage of the people, and the increase of champerty and maintenance.

Solicitors are within the statute to be sworn and admitted by the judges, before they are allowed to practise in our courts, in like manner as attorneys.

SOLID. Geometricians define a solid to be the third species of magnitude, or that which has three dimensions, viz. length, breadth, and thickness or depth.

A solid may be conceived to be formed by the revolution, or direct motion, of a superficies of any figure whatever, and is always terminated or contained under one or more planes or surfaces, as a surface is under one or more lines.

Solids are commonly divided into regular and irregular. The regular solids are those terminated by regular and equal planes, and are only five in number, viz. the tetrahedron, which consists of four equal triangles; the cube, or hexahedron, of six equal squares; the octahedron, of eight equal triangles; the dodecahedron, of twelve; and the icosihedron, of twenty equal triangles. See TETRAHEDRON, CUBE, &c.

SOLID *of least resistance*. Sir Isaac Newton, in his Principia, shews that if there is a curve figure, as DNFG, (Plate Miscel. fig. 218.) of such a nature, that from any point, as N, taken in its circumference, a perpendicular NM is let fall on the axis AB; and if from a given point, as G, there is drawn the right line GR, parallel to a tangent to the curve in the point N, cutting the axis produced in R, and the proportion then is, as $NM : GR :: GR^3 : 4 BG \times GR$; the solid generated by the revolution of this curve about its axis AB, when moved swiftly in a rare and elastic medium, will meet with less resistance from the medium, than any other circular solid whatever, of the same length and breadth.

SOLID ANGLE, is that formed by three or more planes meeting in a point, like the point of a diamond well cut.

SOLID NUMBERS, are those which arise from the multiplication of a plane number, by any other whatever; as 18 is a solid number made of 6 (which is plane), multiplied by 3; or of 9 multiplied by 2.

SOLID PROBLEM, in mathematics, is one which cannot be geometrically solved unless by the intersection of a circle and a conic section; or by the intersection of two other conic sections, besides the circle.

As to describe an isosceles triangle on a given right line, whose angle at the base shall be triple to that at the vertex.

This will help to inscribe a regular heptagon in a given circle; and may be resolved by the intersection of a parabola and a circle.

This problem also helps to inscribe a nonagon in a circle; and may be solved by the intersection of a parabola, and an hyperbola between its asymptotes, viz.

To describe an isosceles triangle, whose angle at the base shall be quadruple of that at the vertex.

And such a problem as this has four solutions, and no more; because two conic sections can cut one another but in four points.

SOLIDAGO, *golden rod*, a genus of plants of the class of syngenesia, and the order of polygamia superflua, and in the natural system ranging under the 49th order, compositæ. The receptacle is naked; the pappus simple; the radii are commonly five; the scales of the calyx are imbricated, and curved inward. There are 30 species. Among these there is only one which is a native of Britain; the virgaurea, or common golden rod, which grows frequently in rough mountainous pastures and woods. There is a variety of this species called cambrica, to be found on rocks, from six inches to a foot high.

SOLIDITY is that property of matter, by which it excludes all other bodies from the place which itself possesses.

SOLITARIES, a denomination of nuns of St. Peter of Alacantara, instituted in 1676, the design of which is to imitate the severe penitent life of that saint: thus they are to keep a continual silence, never to open their mouths to any body; employ their time wholly in spiritual exercises, and leave the temporal concerns to a number of maids, who have a particular superior in a separate part of the monastery; they always go barefooted, without sandals; gird themselves with a thick cord, and wear no linen.

SOLO, in music, a term used in pieces consisting of several parts, to mark those that are to perform alone: it is sometimes denoted by S.

When two or three parts play, or sing, separately from the grand chorus, they are called a dio soli, a tre soli, &c.

SOLSTICE. See ASTRONOMY.

SOLUTION, in chemistry, denotes an intimate mixture, or perfect union, of solid bodies with fluids, so as seemingly to form one homogeneous liquor. The dissolving fluid is termed the solvent or menstruum.

A solution is distinguished from a mixture by being perfectly clear, though not always colourless, and from the parts not separating when set at rest. See CHEMISTRY.

SOLUTION, in algebra and geometry, is the answering a question, or the resolving any problem proposed.

SOLUTION *of continuity*, in surgery, is the separation of the natural cohesion of the solid parts of the body, by a wound.

SOMMETI, a mineral named from the mountain Somma, where it was first found. It is usually mixed with volcanic productions. It crystallizes in prisms, sometimes terminated by pyramids. Colour white, and somewhat transparent. It cuts glass. The specific gravity is 3.27. Infusible by the blowpipe; and according to Vauquelin, it is composed of

49	alumina
46	silica
2	lime
1	oxide of iron
98.	

SONATA, in music, a piece, or composition, intended to be performed by instruments only; in which sense it stands opposed to cantata, or a piece designed for the voice.

There are several kinds of sonatas. The Italians, however, reduce them principally to two: the sonata da camera, or chamber sonata; and the sonata da chiesa, or church sonata. The sonata, of whatever kind, generally opens with an adagio; and after two or three movements of various descriptions, concludes with an allegro, or a presto. This definition of a sonata, however, rather belongs to what is called the antient than to the modern music, in which the sonata is chiefly composed as a lesson or exercise for a single instrument.

SONCHUS, *sow-thistle*, a genus of plants belonging to the class of syngenesia, and to the order of polygamia æqualis, and in the natural system ranged under the 49th order, compositæ. The receptacle is naked; the calyx is imbricated, bellying, and conical; the down of the seed is simple, sessile, and very soft; the seed is oval and pointed. There are 19 species; four of these are natives of Britain: 1. Palustris, marsh sow-thistle. 2. Arvensis, corn sow-thistle. 3. Oleraceus, common sow-thistle. 4. Alpinus, blue-flowered sow-thistle. All of them nefarious weeds.

SONG, in poetry, a little composition, consisting of easy and natural verses, set to a tune in order to be sung. See POETRY.

SONG, in music, is applied in general to a single piece of music, whether contrived for the voice or an instrument.

SONG *of birds*, is defined by the honourable Daines Barrington to be a succession of three or more different notes, which are continued without interruption, during the same interval, with a musical bar of four crotchets in an adagio movement, or whilst a pendulum swings four seconds. It is affirmed by this author that the notes of birds are no more innate than language in man, and that they depend upon imitation, as far as their organs will enable them to imitate the sounds which they have frequent opportunities of hearing; and their adhering so steadily, even in a wild state, to the same song, is owing to the nestlings attending only to the instruction of the parent bird, whilst they disregard the notes of all others that may perhaps be singing round them.

Birds in a wild state do not commonly sing above 10 weeks in the year; whereas birds that have plenty of food in a cage, sing the greatest part of the year; and we may add, that the female of no species of birds ever sings. This is a wise provision of nature, because her song would discover her nest. In the same manner, we may rationally account for her inferiority in plumage. The faculty of singing is confined to the cock birds; and accordingly Mr. Hunter, in dissecting birds of several species, found the muscles of the larynx to be stronger in the nightingale than in any other bird of the same size; and in all those instances where he dissected both cock and hen, the same muscles were stronger in the cock.

Some have ascribed the singing of the cock bird in the spring solely to the motive of pleasing his mate during incubation; others, who allow that it is partly for this end, believe it is partly owing also to another cause, viz. the great abundance of plants and insects in the spring, which, as well as seeds, are the proper food of singing birds at that time of the year.

Mr. Barrington remarks, that there is no instance of any singing bird which exceeds our blackbird in size; and this, he supposes, may arise from the difficulty of its concealing itself. if it called the attention of its enemies, not only by its bulk, but by the proportionable loudness of its notes. This writer further observes, that some passages of the song in a few kinds of birds, correspond with the intervals of our musical scale, of which the cuckoo is a striking and known instance: but the greater part of their song cannot be reduced to a musical scale; partly, because the rapidity is often so great, and it is also so uncertain when they may stop, that we cannot reduce the passages to form a musical bar in any time whatsoever; partly, also, because the pitch of most birds is considerably higher than the most shrill notes of those instruments which have the greatest compass; and principally, because the intervals used by birds are commonly so minute, that we cannot judge of them from the more gross intervals into which we divide our musical octave. This writer apprehends that all birds sing in the same key.

Most people, who have not attended to the notes of birds, suppose that every species sing exactly the same notes and passages; but this is by no means true, though it is admitted that there is a general resemblance. Thus the London bird-catchers prefer the song of the Kentish goldfinches, and Essex chaffinches; and some of the nightingale-fanciers prefer Surry birds to those of Middlesex.

Of all singing birds, the song of the nightingale has been most universally admired; and its superiority (deduced from a caged bird) consists in the following particulars: its tone is much more mellow than that of any other bird; though at the same time, by a proper exertion of its musical powers, it can be very brilliant. Another point of superiority is its continuance of song without a pause, which is sometimes no less than 20 seconds; and when respiration becomes necessary, it takes it with as much judgment as an opera-singer. The sky-lark in this particular, as well as in compass and variety, is only second to the nightingale. The nightingale also sings (if the expression may be allowed) with superior judgment and taste.

Mr. Barrington has observed, that his nightingale, which was a very capital bird, began softly like the antient orators; reserving its breath to swell certain notes, which by these means had a most astonishing effect. This writer adds, that the notes of birds, which are annually imported from Asia, Africa, and America, both singly and in concert, are not to be compared to those of European birds.

The following table, formed by Mr. Barrington, agreeably to the idea of M. de Piles, in estimating the merits of painters, is designed to exhibit the comparative merit of the British singing birds; in which 20 is supposed to be the point of absolute perfection.

	Mellowness of tone.	Sprightly notes	Plaintive notes.	Compass.	Execution.
Nightingale - -	19	14	19	19	19
Sky-lark - - -	4	19	4	18	18
Wood-lark - -	18	4	17	12	8
Tit-lark - - -	12	12	12	12	12
Linnet - - -	12	16	12	16	18
Goldfinch - -	4	19	4	12	12
Chaffinch - -	4	12	4	8	8
Greenfinch - -	4	4	4	4	6
Hedge-sparrow -	6	0	6	4	4
Aberdavine, or siskin	2	4	0	4	4
Red-poll - -	0	4	0	4	4
Thrush - - -	4	4	4	4	4
Blackbird - -	4	4	0	2	2
Robin - - -	6	16	12	12	12
Wren - - -	0	12	0	4	4
Reed sparrow -	0	4	0	2	2
Black-cap, or Norfolk mock-nightingale	14	12	12	14	14

SONNERATIA, a genus of plants belonging to the class of icosandria, and to the order of monogynia. The calyx is cut into six segments; the petals are six; the capsule is multilocular and succulent; and the cells contain many seeds. The only species is the acida, a tree of New Guinea.

SONNET. See POETRY.

SOOT, a substance deposited from the flame of burning vegetables. It consists chiefly of carbon, which, for want of complete contact with the air, could not be consumed, and is partly carried off mechanically with the smoke, and partly precipitated.

SOPHORA, a genus of plants belonging to the decandria monogynia class, with a papilionaceous flower: its fruit is a very long and slender unilocular pod, containing a great many roundish seeds. It agrees in every thing with the diadelphia and papilionaceous plants, except that its stamina are distinct and separate. There are 25 species, all foreign shrubs.

SORBUS, *service-tree*, a genus of plants belonging to the class icosandria, and to the order of trigynia. The calyx is quinquefid; the petals are five; the berry is below the flower, soft, and containing three seeds. There are three species; the aucuparia, domestica, and hebrida.

1. The aucuparia, mountain-ash, quicken-tree, quick-beam, or roan-tree, rises with a straight upright stem and regular branching head, 20 or 30 feet high or more, covered with a smooth greyish-brown bark; pinnated leaves, and large umbellate clusters of white flowers at the sides and ends of the branches, succeeded by clusters of fine red berries, ripe in autumn and winter. There is a variety with yellow-striped leaves. This species grows wild in many parts of this island, in mountainous places, woods, and hedge-rows, often growing to the size of timber; and is admitted into most ornamental plantations, for the beauty of its growth, foliage, flowers, and fruit..

2. The domestica, or cultivated service-tree, with eatable fruit, grows with an upright stem, branching 30 or 40 feet high, or more, having a brownish bark, and the young shoots in summer covered with a mealy down: pinnated leaves of eight or ten pair. This tree is a native of the southern warm parts of Europe, where its fruit is used at table as a dessert; and it is cultivated here in many of our gardens as a fruit-tree, and as an ornament to diversify hardy plantations.

3. The hebrida, or mongrel service-tree of Gothland, grows 20 or 30 feet high; it has half pinnated leaves, very downy underneath; and clusters of white flowers, succeeded by bunches of round reddish berries in autumn.

SOREX, *shrew*, a genus of quadrupeds of the order feræ. The generic character is, front teeth in the upper jaw two, long, bifid; in the lower, two or four, the intermediate ones shorter; canine teeth, several on each side; grinders cuspidated.

The genus sorex, of which there are 17 species, in its general appearance bears a great resemblance to the mouse tribe; but the structure, number, and situation of the teeth, prove it to constitute a very different set of animals, which are evidently rather carnivorous than frugivorous. It is more closely allied to the genus talpa; insomuch that these two genera may be considered as linked to each other by intermediate species, which in habit resemble the one genus, and in teeth the other. It is owing to this circumstance that Linnæus, in the twelfth edition of the Systema Naturæ, has placed one or two genuine species of talpa in the genus sorex. The most common species of sorex in this country is the S. araneus, commonly known by the name of the shrew-mouse.

1. Sorex araneus. This little animal, which is perhaps the smallest of the European quadrupeds, is a very common inhabitant of our fields and gardens, and measures about two inches and a half, and the tail one and a half. Its colour is nearly similar to that of a mouse, but of a somewhat more ferruginous tinge; and the animal is readily distinguished by its long and sharp snout; the eyes are small, and almost hid in the fur. It feeds on roots, grain, insects, and almost any kind of neglected animal substance. It has a very strong and unpleasant smell; and it is remarkable that cats will kill but not eat it. Mr. Pennant observes that there seems to be an annual mortality among these little animals every autumn; numbers of them being found dead at that season by paths and in the fields. It inhabits most parts of Europe, and is also said to be found in Siberia and Kamtschatka. It breeds in holes, under banks, among moss, &c. and is said to produce several young at a time.

2. Sorex moschatus, musk-shrew. This is a very singular species, which, though ex-

tremely common in some of the northern parts of Europe and Asia, does not seem to have been very distinctly understood by modern naturalists.

According to Dr. Pallas, it chiefly inhabits the river Wolga and the adjacent lakes, from Novogorod to Saratof; and is not found in Russia, nor does its existence in Lapland seem well ascertained. It is said to be very seldom seen on land; confining itself to lakes and rivers, in the banks of which it occasionally burrows to a great distance. The general length of the animal is about seven inches from nose to tail, and of the tail eight inches: but it is sometimes found of a larger size. The tail, except at its base, is perfectly naked, marked out into scaly divisions, and is of a brown colour; it is also of a laterally compressed form, and gradually tapers to the extremity; near the base of the tail are situated several small follicles, or glandular receptacles, in which is secreted a yellowish fluid, resembling in smell the strongest civet; of this substance about the quantity of a scruple may, it is said, be obtained from each animal.

These creatures are said sometimes to be seen swimming about in considerable numbers on the surface of lakes and rivers, and may often be heard to snap their mouths with a sound not unlike that of a duck; feeding on worms, leeches, water-insects, &c. as well as occasionally on vegetable substances.

In some particulars this animal makes a distant approach to that most singular of quadrupeds, the platypus.

The musk-shrew is a slow-paced animal, and easily taken, if accidentally found on land. The skins are said to be sold in Russia to put into chests in order to drive away moths; and so common is the animal in the neighbourhood of Nizney Novogorod, that the peasants are said to bring five hundred apiece to market, where they are sold for a ruble per hundred.

In the twelfth edition of the Systema Naturæ this animal is placed in the genus castor or beaver, under the title of castor moschatus. See Plate Nat. Hist. fig. 368.

3. Sorex radiatus, Canada shrew. This animal may with great propriety be termed sorex radiatus, since the snout, which is long and slender, has a dilated cartilaginous extremity, furnished with a circular series of sharp-pointed processes or soft tendrils, disposed in the manner of the rays in a spur. The whole animal is of a long form, and its habit immediately pronounces it to belong to the genus sorex, and not to that of talpa. Its body is longish, and covered with black coarsish hair; the feet far less than those of a mole; the eyes hid under the skin; the snout edged on each side with upright vibrissæ; the radiated tentacula at the end of the nose are of a bright rose-colour, and moveable at the pleasure of the animal, so as either to be brought together into a tubular form, or expanded in the form of a star.

It is said to inhabit Canada, but not to be very common there. It occasionally burrows somewhat in the manner of a mole, but far less strongly, or more slowly, and is said to pass a considerable portion of its life beneath the surface of the snow.

4. Sorex cærulescens, perfuming shrew, measures from nose to tail near eight inches; and the tail is about three inches and a half long. This animal diffuses a musky smell, so extremely powerful as to penetrate almost every substance which it touches. It inhabits fields, but is said sometimes to come into houses. It is found in the East Indian islands, as well as in India, occurring in Java, &c. &c. and is said to feed chiefly on rice.

5. Sorex minutus, minute shrew, is an extremely small animal, which inhabits moist places in Siberia, and makes its nest of lichens and mosses under the roots of trees, living on grains and seeds, &c. It is of a subferruginous brown colour above, and whitish below; the head is large; the snout very long and slender, and beset with a row of long whiskers on each side, reaching as far as the eyes. It has no tail; the eyes are small, and the ears short and naked. It is said to run swiftly, and to have a voice like that of a bat. It weighs about a dram.

SORITES, in logic, a species of reasoning in which a great number of propositions are so linked together, that the predicate of the one becomes continually the subject of the next following, till at last a conclusion is formed by bringing together the subject of the first proposition and the predicate of the last: such is the following argument: "God is omnipotent; an omnipotent being can do every thing possible; a being that can do every thing possible, can do whatever involves not a contradiction; therefore, God can do whatever involves not a contradiction."

SORREL. See Rumex.

SOUND is produced by a vibrating motion, excited in a sonorous body by a blow or a shock from another body; and the same motion is communicated by this sonorous body to the air which surrounds it, and transmitted by this fluid to the ear, which is an organ admirably adapted to receive its impression.

From this definition it follows, that sound should be considered in three different views; first, with respect to the sonorous body; which produces it; secondly, as to the medium which transmits it; and, thirdly, as to the organ which receives the impression.

Those bodies are properly called sonorous which afford a sound distinct, and of some duration; such as bells, the strings of a violin, &c. and not those which cause only a confused noise, such as a stone produces when it falls upon a pavement. When bodies are, strictly speaking, sonorous, they are necessarily elastic, as will be afterwards proved; and their sound, as to its force and duration, is proportionate to their vibrations.

Suppose, for example, the bell of a clock to be struck by any solid body, a kind of undulating or tremulous motion is imparted to the minute particles; and this motion may be even perceived by the hand or fingers when applied to the bell.

To understand this more completely, let us conceive that a bell is composed of a series of circular zones, decreasing in diameter all the way to its top, each of which may be considered as a flat ring, composed of as many concentric circles as its thickness will admit of. If this ring is struck at the point *a* (Plate Miscel. fig. 219), the part so struck tends towards *g*, and at the same time the parts *b* and *d* tend towards *i* and *m*, and this action in these parts necessarily causes the point *c* to approach towards *e*. By their elastic power, however, these parts presently regain the position in which they were before the bell was struck; but as they return with an accelerated force, they generally go beyond the point where they ought to rest. The part *a*, therefore, after having returned from *g* to *a*, tends towards *f*, the part *c* towards *h*, and the parts *b* and *d* towards *k* and *l*; whence it happens that the bell, at first of a circular form, really becomes alternately elliptical in two different directions; it follows then, that in those parts where the curvature is the greatest, their exterior points depart from each other.

The same circumstance happens to the musical chord of a harp, or other stringed instrument, when it is touched: for, in order to become angular, as BCD or BED (fig. 220) it is necessary that the string be stretched or lengthened, and consequently its particles be in some measure removed from the point of contact.

There are then two vibrations which take place in sonorous bodies: the general vibration, which changes the form of the body; and the particular vibration, which affects the minute particles, in consequence of the former. M. de la Hire has proved, that the sound is not owing to the general vibration, but rather to the vibration of the particles: for whenever the two vibrations can be separated, it is found that the former produces no sound; but when the general vibration is accompanied with a vibration of the particles, it is the latter that regulates the duration, the force, and the modulation of the sound; if, on the contrary, these vibrations are stopped or interrupted by touching the sonorous body, the sound immediately ceases. On this account clock-makers attach to the hammer which strikes the bell of the clock a small spring, which elevates it again the moment it has struck, and prevents it from remaining upon the bell, which would considerably deaden or destroy the sound.

Acute sounds are produced, when the vibrations of the sounding body are more frequent; grave or deep sounds, when they are less so; no medium between acute and grave sounds can be found. Sonorous bodies are said to be in unison when they vibrate with the same frequency; when one vibrates twice as fast as the other, they differ by an octave; and other ratios, with respect to the quickness of vibration, are distinguished by other names. Chords which are short and tightly stretched, produce acute sounds; those which are long and lax, grave sounds.

The motion or vibration of bodies at a distance from us would not affect our sense of hearing without the medium of some other body, which receives an impulse from this motion, and communicates the vibration to our organs. Thus a hard blow upon an anvil or upon a bell could not be heard by us, even at a very small distance, if there was not a medium between those objects and us capable of transmitting the vibrations to our auditory nerves. Elastic fluids are the most effective mediums for this purpose, and consequently the air is the most common vehicle of sound; which is very easily proved by ringing a bell under the receiver of an air-pump, the sound it affords being found gradually to diminish as the air becomes exhausted, till at length it ceases to be heard at all. That the air is capable of being agitated with great force, appears from the violent concussions produced by explosions of gunpowder, as well as from the power, which some persons are known to possess, of breaking drinking-glasses, by means of their voice, when sounded in unison with the note which the glass would have produced when struck. The tremulous motion excited in the air by sounding bodies, has been supposed analogous to the successive rings which are produced by disturbing the surface of the water. This hypothesis, however, was disproved by the observation that sounds, whether weak or loud, always travel with the same velocity, which does not hold true with respect to the rings on the surface of water, since these move faster or slower according to the force of the cause which excited them.

Every sound is rendered stronger or weaker, and may be heard at a greater or less distance, according to the density or rarity of that elastic fluid by which it is propagated. According to Mr. Hauksbee, who has made deep researches into this branch of philosophy, when air has acquired twice its common density it transmits sound twice as far as common air; whence he reasonably concludes, that sound increases, not only in direct proportion to the density of the air, but in proportion to the square of this density.

If sound was propagated in an elastic fluid more dense than the air, it would be carried proportionably farther. I have proved this, says M. Brisson, by putting a sonorous body into carbonic acid gas or fixable air, the density of which is about one-third more than that of atmospherical air; the consequence was, that at that time, and in that situation, the sound was very considerably increased. For the same reason, the dryness of the air, which increases its density, has a considerable effect in rendering sound louder and more audible. Sound is also much increased by the reverberation of the pulses of the air from those surrounding bodies against which they strike, whence it happens that music is so much louder in a close apartment than in the open air.

Elastic fluids are, however, not the only medium through which sound may be transmitted; for it may be propagated by means of water and other liquors, which may be proved by immersing a sonorous body in water; but it must be observed, that in this case the sound will be less perceptible, and will not extend to so great a distance; the cause of this diminution is, because mediums for the transmission of sound should be elastic, and that is a property which water and other liquors possess only in a very restricted degree.

Sound is also transmitted by solid bodies, provided they possess a sufficient degree of elasticity to produce this effect.

Light, we have already seen, is projected or reflected with incredible velocity; but sound is transmitted much more slowly, and its progression is very perceptible to our senses. The flash from a cannon, or even a musket, may be seen some seconds before the sound reaches our ears. As the motion of light, therefore, is instantaneous with respect to any moderate distance, this has been the common means employed for ascertaining the progress of sound. Sir Isaac Newton observes that "all sounding bodies propagate their motions on all sides by successive condensations and relaxations; that is, by an alternate progression and return of the particles;" and these vibrations, when communicated to the air, are termed pulses of sound.

All pulses move equally fast. This is proved by experiment; and it is found that they pass about one thousand one hundred and forty-two feet in a second, whether the sound is loud or low, grave or acute.

Some curious experiments were made, relative to the propagation of sound, by Messieurs De Thury, Maraldi, and De la Caille, upon a line fourteen thousand six hundred and thirty-six fathoms in length, having the tower of mount Lhéri at one end, and the pyramid of Montmartre at the other extremity of that distance: their observatory was placed between those two objects. The results of their observations were these: 1st. That sound moves one hundred and seventy-three fathoms, French, in a second, when the air is calm. 2d. That sound moves with the same degree of swiftness whether it is strong or weak; for these gentlemen observed, that the discharge of a box of half a pound of gunpowder exploded at Montmartre was heard at mount Lhéri in the same space of time as the report of a great gun charged with nearly six pounds of powder. 3d. That the motion of sound is uniform; that its velocity neither accelerates nor diminishes through all the intervals of its progress, as is the case with almost every other species of motion. 4th. That the velocity of sound is the same, whether a cannon is placed towards the person who hears its report, or turned a contrary way; in other words, a great gun fired from the Tower of London eastward, would be heard at Westminster in the same interval of time as if it was discharged towards the latter place. And if the gun was discharged in a direction perpendicular to the horizon, it would be heard as soon as if discharged in a right line towards the hearer. By other experiments, however, the progress of sound appears to be impeded by a strong wind, so that it travels at the rate of about one mile slower in a minute against a strong wind than with it.

A knowledge of the progression of sound is not an article of mere sterile curiosity, but in several instances useful; for by this we are enabled to determine the distance of ships or other moving bodies. Suppose, for example, a vessel fires a gun, the sound of which is heard five seconds after the flash is seen; as sound moves 1142 English feet in one second, this number multiplied by 5, gives the distance of 5710 feet. The same principle has been applied to storms of lightning and thunder, as to calculating the distance of it from us. See Electricity.

The waves or pulses of sound being reflexible in their course when they meet with an extended solid body of a regular surface, an ear placed in the passage of these reflected waves will perceive a sound similar to the original sound, but which will seem to proceed from a body situated in a similar position and distance behind the plane of reflection, as the real sounding body is before it. This reflected sound is commonly called an echo, which, however, cannot take place at less than fifty-five feet; because it is necessary that the distance should be such, and the reverberated or reflected sound so long in arriving, that the ear may distinguish clearly between that and the original sound.

Reflected sound may be magnified by much the same contrivances as are used in optics respecting light: hence it follows, that sounds uttered in one focus of an elliptical cavity are heard much magnified in the other focus. The whispering-gallery at St. Paul's cathedral in London, is of this description; a whisper uttered at one side of the dome is reflected to the other, and may be very distinctly heard. The speaking and ear trumpets are constructed on this principle. The best form for these instruments is a hollow parabolic conoid, with a small orifice at the top or apex, to which the mouth is applied when the sound is to be magnified, or the ear when the hearing is to be facilitated.

The structure of the ear is one of the most complicated and difficult subjects of physiology; and the reader is, therefore, referred to that article for what concerns this branch of acoustics.

Sound, *musical.* Sounds of such qualities and dispositions as to produce that agreeable and appreciable effect upon the ear which we call melody, or harmony. We shall at present confine our observations to that affection of sound by which it becomes distinguished into acute and grave

This difference has hitherto appeared to have no other causes than the different velocities of the vibrations of the sounding bodies. In fact, the tone or pitch of a sound seems to have been discovered, by an abundance of experiments, to depend on the nature of those vibrations, whose difference we can conceive no otherwise than as having different velocities; and since it is proved, that all the vibrations of the same chord are performed in equal time; and that the tone of a sound, which continues for some time after the stroke, is the same from first to last; it follows, that the tone is necessarily connected with a certain quantity of time in making each vibration: and it is from this principle that all the phenomena of tune are deduced.

If the vibrations are isochronous, the sound is called musical; and is said to be acuter, or higher, than any other sound whose vibrations are slower and graver, or lower than any other sound whose vibrations are quicker.

From the same principle arise what we call concords, &c. which are resolvable into the frequent unions and coincidences of the vibrations of two sonorous bodies, and consequently of the undulations of the air which they occasion. On the contrary, the result of less frequent coincidences of those vibrations is what we call discord.

Another considerable distinction of musical sounds is, that by which they are denominated long and short; not with regard to the sonorous body's retaining a motion, once received, a longer or lesser time, but to the continuation of the impulse of the efficient cause on the sonorous body for a longer or shorter time; as in the notes of a violin, &c. which are made longer or shorter by strokes of different length or quickness.

This continuity is, properly, a succession of several sounds, or the effect of several distinct strokes, or repeated impulses, on the sonorous body, so quick that we may judge it one continued sound, especially if it is continued in the same degree of strength; and hence arises the doctrine of measure and time.

Sounds again are distinguished by musicians into simple and compound.

A simple sound is the single product of one voice, or one instrument.

A compound sound consists of the sounds of several distinct voices or instruments, all united in the same individual time and measure of duration, that is, all striking the ear together, whatever may be their other differences. But in this sense there is a twofold compound, natural and artificial.

The natural compound is that proceeding from the manifold reflections of the first sound from adjacent bodies, when the reflections are not so sudden as to occasion echoes, but are all given at the same moment, as well as in the same tone, or pitch, with the first note.

The artificial compound, which alone comes under the musician's province, is that mixture of several different sounds, which being produced by art, the ingredient sounds are separable, and distinguishable from one another. In this sense the distinct sounds of several voices or instruments, or several notes of the same instrument, are called simple sounds, in contradistinction to the compound ones, in which, to answer the purposes of music, the simples must have such an agreement in all relations, chiefly as to acuteness and gravity, as that the ear may receive the mixture with pleasure.

Sound, in geography, denotes in general any streight, or inlet, of the sea, between the two headlands.

Sound-board, in an organ, is a reservoir into which the wind, drawn in by the bellows, is conducted by a port-vent, and hence distributed into the pipes placed over holes in its upper part; this wind enters them by valves, which open by pressing upon the stops or keys; after drawing the registers, which prevent the air from entering any of the pipes, except those it is required in.

SOUNDING, in navigation, the act of trying the depth of the water, and the quality of the bottom, by a line and plummet, or other artifice.

At sea there are two plummets used for this purpose, both shaped like the frustum of a cone or pyramid. One of these is called the hand-lead, weighing about eight or nine pound; and the other the deep-sea lead, weighing from 25 to 30 pounds. The former is used in shallow waters, and the latter at a great distance from the shore. The line of the hand-lead is about 25 fathoms in length, and marked at every two or three fathoms, in this manner, viz. at two and three fathoms from the lead there are marks of black leather; at five fathoms a white rag, at seven a red rag, at ten and at thirteen black leather, at fifteen a white rag, and at seventeen a red one.

Sounding with the hand-lead, which the seamen call heaving the lead, is generally performed by a man who stands in the main-chains to windward. Having the line all ready to run out, without interruption, he holds it nearly at the distance of a fathom from the plummet: and having swung the latter backwards and forwards three or four times, in order to acquire the greater velocity, he swings it round his head, and thence as far forward as is necessary; so that, by the lead's sinking whilst the ship advances, the line may be almost perpendicular when it reaches the bottom. The person sounding then proclaims the depth of the water in a kind of song resembling the cries of hawkers in a city; thus, if the mark of 5 is close to the surface of the water, he calls, "by the mark five," and as there is no mark at 4, 6, 8, &c. he estimates those numbers, and calls, "by the dip four," &c. If he judges it to be a quarter or a half more than any particular, number he calls, "and a quarter five," "and a half four," &c. If he conceives the depth to be three quarters more than a particular number, he calls it a quarter less than the next; thus, at four fathoms $\frac{3}{4}$, he calls, "a quarter less 5," and so on.

The deep-sea lead-line is marked with two knots at 20 fathoms, three at 30, four at 40, &c. to the end. It is also marked with a single knot at the middle of each interval, as at 25, 35, 45 fathoms, &c. To use this lead more effectually at sea, or in deep water on the sea-coast, it is usual previously to bring-to the ship, in order to retard her course; the lead is then thrown as far as possible from the ship on the line of her drift, so that, as it sinks, the ship drives more perpendicularly over it. The pilot feeling the lead strike the bottom, readily discovers the depth of the water by the mark on the line nearest its surface. The bottom of the lead, which is a little hollowed there for the purpose, being also well rubbed over with tallow, retains the distinguishing marks of the bottom, as shells, ooze, gravel, &c. which naturally adhere to it.

The depth of the water, and the nature of the ground, which are called the soundings, are carefully marked in the log-book, as well to determine the distance of the place from the shore, as to correct the observations of former pilots.

SOUTHERNWOOD. See Artemisia.

SOW, in the iron-works, the name of the block or lump of metal they work at once in the iron-furnace. The size of these sows of iron is very different, even from the same workmen, and the same furnace. These furnaces having sand-stones for their hearths and sides up to the height of a yard, and the rest being made of brick, the hearth by the force of the fire is continually growing wider, so that if it at first contains as much metal as will make a sow of six or seven hundred weight, it will at last contain as much as will make a sow of 2000 weight.

SOWANS. See Starch.

SOWNE, a term used in the exchequer, where estreats that sowne not, are such as the sheriff by his care and diligence cannot levy, wherefore they are not regarded; and the estreats that sowne, are such as he may levy.

SPA. See Waters, *mineral*.

SPACE, in geometry, denotes the area of any figure, or that which fills the interval or distance between the lines that terminate it.

Space, in mechanics, the line a moveable body, considered as a point, is conceived to describe by its motion.

SPAN, a measure taken from the space between the thumb's end and the tip of the little finger, when both are stretched out. The span is estimated at 3 hand's-breadths, or 9 inches. See Measure.

SPANIEL. See Canis.

SPAR. See Fluat *of lime*.

Spar, in mineralogy, a name given to those earths which break easily into rhomboidal, cubical, or laminated fragments with polished surfaces. As the term spar is thus applied to stones of different kinds, without any regard to the ingredients of which they are composed, some additional term must be used to express the constituent parts as well as the figure; for instance, calcareous spar, gypseous spar, &c. The spars found in Britain and Ireland are of four different species, opaque, refracting, diaphanous, and stalactitical. 1. The opaque spar is rhomboidal, hexangular, and triangular, of various colours, and is found in mines in Wales, Derbyshire, &c. and at Ovens near Cork. 2. The refracting spar is rhomboidal, shows objects seen through it double, and sometimes 8, 12, or 16 images at once. It is frequent in the lead-mines of Derbyshire, Yorkshire, &c. 3. Diaphanous spar is rhomboidal, triangular, hexangular, pyramidal or columnar; and is found in mines, quarries, and caverns, in many different places. 4. Stalactitical spar, icicle, or drop-stone, is formed by the running or dropping of water, containing a large proportion of calcareous earth. It is opaque, generally laminated, but from accidental circumstances assumes various forms. It occurs at Knaresborough in Yorkshire, and at Ovens near Cork.

A new species of spar has lately been found in the East Indies, which, from its extreme hardness, approaching to that of a diamond, is called adamantine spar. It was discovered by Dr. Black of Edinburgh to be a distinct species. Happening one day to visit a lapidary, it was shown to him among other specimens as a stone that was used in the East Indies for polishing gems, and grinding other hard substances. Dr. Black immediately singled out a specimen, which he sent to Mr. Greville, who requested M. Klaproth to analyse it.

There are two varieties of this spar; one of them comes from China, and crystallizes in hexagonal prisms without pyramids, the length of the sides varying from six to twelve lines; their breadth being about nine, of a grey colour with different shades. Though the entire pieces are opaque, the thin laminæ are transparent, and when broken, its surface appears slightly striated. Its crystals are covered with a very fine and strongly-adhering crust, composed of scales of silvery mica, mixed with particles of red feld-spar. Sometimes the surface has martial pyrites or yellow sulphuret of iron adhering to it. Its hardness is so great, that it not only cuts glass as easily as the diamond, but even scratches rock crystal and other very hard stones. Its specific gravity is to that of water as 3710 to 1000. Sometimes it contains crystallized grains of magnetic oxyd of iron, which may be separated from the stone when pulverized by means of the loadstone.

The other kind found in Hindostan is of a white colour, and of a more laminated texture than the former: the grains of iron contained in it are likewise of a smaller size than those of the former; they are not diffused through the substance, but only adhere to its surface. This spar is exceedingly difficult to analyse.

SPARGANIUM, *bur-reed*, a genus of plants belonging to the class of monœcia, and to the order of triandria, and in the natural system ranged under the 3d order, calamariæ. The amentum of the male flower is roundish, the calyx is triphyllous, and there is no corolla. The amentum of the female flower resembles that of the male. The stigma is bifid; the fruit is a dry berry containing one seed. There are three species, all of them natives of Great Britain and Ireland, and growing in pools and lakes.

SPARMANNIA, a genus of plants belonging to the class of polyandria, and to the order of monogynia. The corolla consists of four petals, and is bent back; the nectaria are numerous, and swell a little; the calyx is quadriphyllous; the capsule is angulated, quinquelocular and echinated. There is only one species, the africana, a shrub of the Cape.

SPARROW. See Fringilla.

Sparrow-hawk. See Falco.

SPARTIUM, *broom*, a genus of plants belonging to the class of diadelphia, and order of decandria, and in the natural system arranged under the 32d order, papilionaceæ. The stigma is longitudinal and woolly above, the filaments adhere to the germen. The calyx is produced downwards. There are 27 species. All these, except the scoparium, are exotics, chiefly from Spain, Portugal, Italy, &c. The scoparium, or common broom, is used for a variety of purposes. It has been a great benefit sometimes in dropsical complaints. The manner in which Dr. Cullen administered it was this: he ordered half an ounce of fresh broom-tops to be boiled in a pound of water till one-half of the water was evaporated. He then gave two table-spoonfuls of the decoction every hour till it operated both by stool and urine. By repeating these doses every day, or every second day, he says some dropsies have been cured. Dr. Mead relates, that a dropsical patient, who had taken the usual remedies, and been tapped three times without effect, was cured by taking half a pint of the decoction of queen-broom tops, with a spoonful of whole mustard-seed, every morning and evening. "An infusion of the seeds drunk freely (says Mr. Withering) has been known to produce similar happy effects; but whoever expects these effects to follow in every dropsical case will be greatly deceived. I knew them succeed in one case that was truly deplorable; but out of a great number of cases in which the medicine had a fair trial, this proved a single instance."

The flower-buds are in some countries pickled, and eaten as capers; and the seeds have been used as a bad substitute for coffee. The branches are used for making besoms, and tanning leather. They are also used instead of thatch to cover houses. The old wood furnishes the cabinet-maker with beautiful materials for veneering. The tender branches are in some places mixed with hops for brewing, and the macerated bark may be manufactured into cloth.

SPARGELSTEIN, a mineral found in Spain, where it forms whole mountains, in different parts of Germany, and in Cornwall. It is sometime amorphous, and sometimes crystallized. The primitive form of its crystals is a regular six-sided prism. Its integrant molecule is a regular triangular prism, whose height is to a side of its base, as 1 to $\sqrt{2}$. Sometimes the edges of the primitive hexagonal prism are wanting, and small faces in their place; sometimes there are small faces instead of the edges, which terminate the prism; sometimes these two varieties are united.

SPARUS, a genus of fishes of the order thoracici: the generic character is, the teeth strong; front teeth in some species disposed in a single row, in others in a double, triple, or quadruple row: grinders (in most species) convex, smooth, and disposed in ranges, forming a kind of pavement in the mouth: lips thick; gill-covers unarmed, smooth, scaly. The genus sparus is extremely numerous, there being more than 40 species, and as the greater number are exotic, very little is known of their history; a general survey is therefore all that can be expected; it may be observed that they are much allied to the labri, and that the distinction between these two genera is not, in all cases, so clear as might be wished: in the Systema Naturæ of Linnæus an evident confusion takes place with respect to the characters of both.

Sparus aurata. Gilt-head sparus. General length about fifteen inches, but occasionally found of far larger size; body broad and thin, the back rising into a carina: native of the Mediterranean, Atlantic, and Indian seas, and held in considerable esteem as a food; much admired by the antient Greeks and Romans, and by the former nation consecrated to Venus.

SPATHELIA, a genus of plants belonging to the class of pentandria, and to the order of trigynia. The calyx is pentaphyllous; the petals are five; the capsule is three-edged and trilocular; the seeds solitary. There is only one species, the simplex, which is a native of Jamaica, and was introduced into the botanic gardens of this country in 1778 by Dr. Wright, late of Jamaica.

SPASM. See Medicine.

SPATULA, an instrument used by surgeons and apothecaries for spreading plasters, &c.

SPECIES, in algebra, the characters or symbols made use of to represent quantities.

SPECIFIC, in medicine, a remedy whose virtue and effect is peculiarly adapted to some certain disease, is adequate thereto, and exerts its whole force immediately thereon.

Specific, in philosophy, that which is peculiar to any thing, and distinguishes it from all others.

SPECIOUS ARITHMETIC, the same with algebra.

SPECULARIS LAPIS, in natural history, a genus of talcs, composed of large plates visibly separate, and of extreme thinness; and each fissile again separated into a number of plates still finer. (See Talc.) Of this genus there are three species: 1. The white shining specularis, with large and broad leaves, commonly called isinglass and Muscovy glass; its lamellæ, or leaves, are extremely thin, elastic, and transparent; it makes sometimes not the least effervescence with aquafortis, and is not easily calcined in the fire. It is imported in great quantities; the miniature-painters cover their pictures with it; the lantern-makers use it instead of horn; and minute objects are usually preserved between two plates of it, for examination by the microscope. 2. The bright-brown specularis, with broad leaves; a very valuable species, though inferior to the former. 3. The purple bright specularis, with broad leaves, the most elegant of all the talcs, and as beautifully transparent as the first kind.

SPECULUM, a *looking-glass* or *mirror*, capable of reflecting the rays of the sun, &c. See Optics: see also Foliating *of looking-glasses*, vol. i. p. 758.

Speculum, in surgery, an instrument for dilating a wound, or the like, in order to examine it attentively.

Speculum for reflecting telescopes, is made of a kind of white copper consisting of 32 parts of fine red copper, one of brass, fifteen of grain-tin, and three of white arsenic. The process given by the late J. Edwards, who was rewarded by the board of longitude for disclosing it to the public, was published in the Nautical Almanack for 1787, and is as follows: Melt the copper in a large crucible, employing some black flux, composed of two parts of tartar and one of nitre; when melted, add to it the brass and the silver. Let the pure tin be melted into another crucible, also with some black flux. Take them both from the fire, and pour the melted tin into the fused mass in the large crucible. Stir the whole well with a dry spatula of birch; and pour off the fused metal immediately into a large quantity of cold water. The sudden chill of the water will cause the fluid metal to divide into an infinite number of small particles, which will cool instantly. 2. If the copper is completely saturated, the fracture of one piece of this mixed metal will appear bright, and of a glossy look, resembling the face of pure quicksilver. But if it is a brown reddish-colour, it wants a little more tin. To ascertain the required proportion, melt a small quantity, known by weight, of the mixed metal, with a known very small part of tin; and, if necessary, repeat the trial with different doses, till the fracture of the new mixture looks as already described. Having now ascertained the necessary addition of tin that is required, proceed to the last melting of the whole metal, together with the additional proportional dose of tin; fuse the whole, observing the same cautions as before, and you will find that the mixture will melt with a much less heat than that for the first fusion. Have ready as many ounces of white arsenic in coarse powder as there are pounds in the weight of metal; wrap up the arsenic in a small paper, and put it, with a pair of tongs, into the crucible; stir it well with the spatula, retaining the breath to avoid the arsenical fumes or vapours (which however are not found to be hurtful to the lungs) till they disappear; take the crucible off the fire, clear away the dross from the top of the metal; pour in about one ounce of powdered rosin, with as much nitre, in order to give the metal a clean surface, and pour out the metal into the moulded flasks. 3. The speculum should be moulded with the concave surface downwards, and many small holes should be made through the sand upwards, to discharge the air. The moulding-sand from Highgate near London, used by the founders, is as good as any for casting these metallic mirrors. The cast metal should be taken out from the sand of the flasks whilst it is hot, or else it may happen to crack if left to cool within.

SPEEDWELL. See Veronica.

SPELTER. See Zinc.

SPENT, in the sea-language, signifies the same as broken.

SPERGULA, *spurrey*, a genus of plants belonging to the class of decandria, and the order of pentagynia, and in the natural system arranged under the 22nd order, caryophyllеæ. The calyx is pentaphyllous; the petals five, and undivided; the capsule oval, unilocular, and containing five valves. There are seven species, five of which are British: 1. The arvensis, corn-spurrey, has linear furrowed leaves, from eight to twenty in a whorl. The flowers are small, white, and terminal. It is frequent in corn-fields. In Holland it is cultivated as food for cattle, and has the advantage of growing on the very poorest soils, but does not afford a great deal of food. Poultry are fond of the seeds; and the inhabitants of Finland and Norway make bread of them when their crops of corn fail. Horses, sheep, goats, and swine, eat it. Cows refuse it. 2. The nodosa, knotted spurrey. 3. Pentandra, small spurrey. 4. Laricina, larch-leaved spurrey. 5. Saginoides, pearlwort spurrey.

SPERMACETI. This peculiar oily substance is found in the cranium of the physeter mocrocephalus, or spermaceti-whale. It is obtained also from some other species. At first it is mixed with some liquid oil, which is separated by means of a woollen bag. The last portions are removed by an alkaline ley, and the spermaceti is afterwards purified by fusion. Thus obtained it is a beautiful white substance, usually in small scales, very brittle, has scarcely any taste, and but little smell. It is distinguished from all other fatty bodies by the crystalline appearance which it always assumes. It melts, according to the experiments of Bostock, at the temperature of 112°. When sufficiently heated it may be distilled over without much alteration; but when distilled repeatedly, it loses its solid form, and becomes a liquid oil. It is soluble in boiling alcohol, but separates again as the solution cools. About 150 parts of alcohol are necessary to dissolve it. Ether dissolves it cold, and very rapidly when hot: on cooling it concretes into a solid mass. It dissolves also in hot oil of turpentine, but precipitates again as the liquor cools.

The acids have hardly any action upon it, but it unites with the pure alkalies. With hot ammonia it forms an emulsion which is not decomposed by cooling nor by water. It dissolves sulphur, and is dissolved by the fixed oils.

SPERMACOCE, *button-wood*, a genus of plants belonging to the class of tetrandria, and order of monogynia, and in the natural system arranged under the 47th order, stellatæ. The corolla is monopetalous and funnel-shaped, and there are two bidentate seeds. The species are 20, all stove plants from warm climates.

SPHACELUS. See SURGERY.

SPHÆRANTHUS, a genus of plants belonging to the class of syngenesia, and to the order of polygamia segregata; and in the natural system arranged under the 49th order, compositæ. Each partial calyx contains eight florets; the florets are tubulated, the female being scarcely distinguishable. The receptacle is scaly; and there is no pappus. The species are four, the indicus, the africanus, the chinensis, and another.

SPHÆRIA, a genus of the class and order cryptogamia fungi. The fructifications are mostly spherical, opening at the top; while young filled with jelly, when old with blackish powder. They grow on the bark or wood of other plants. There are 29 species.

SPHÆROCARPUS, a genus of the cryptogamia class of plants, and order algæ, consisting of foliaceous matter, expanded on the ground, and producing very large and obvious fructifications. Dr. Hill thinks it probable, that the male flowers are produced on separate plants from the female, and have not been discovered to belong to the same species: no male parts of fructification are described to us; the female parts consist of a tubulated and inflated vagina, within which is contained a large globular capsule, containing a great number of small loose seeds.

SPHAGNUM, *bog-moss*, a genus of plants belonging to the class of cryptogamia and order of musci. The antheræ are globose; the mouth entire, and closed by an operculum; the calyptra is wanting. There are three species, the palustre, alpinum, and arboreum. 1. The palustre, common bog-moss, grows on our bogs in wide patches, so as frequently to cover a large portion of their surface. The stalks are from two inches to two feet long, irregularly surrounded with numerous, conical, pendant branches, and terminated with a rotaceous cluster of erect short ones. It is generally believed, that the roots and decayed stalks of this moss constitute a principal part of that useful bituminous substance called peat, which is the chief fuel of the northern regions. The Lapland matrons are well acquainted with this moss. They dry and lay it in their cradle, to supply the place of bed, bolster, and every covering; and, being changed night and morning, it keeps the infant remarkably clean, dry, and warm. It is sufficiently soft of itself; but the tender mother, not satisfied with this, frequently covers the moss with the downy hairs of the rein-deer; and by that means makes a most delicate nest for the young babe. 2. The alpinum, green bog-moss. Its branches are subulate and erect; the antheræ are oval. It grows in mountain bogs in South Britain. 3. The arboreum, creeping bog-moss, is branched; the antheræ are numerous, sessile, hairy, and grow along the branches chiefly on one side. It is found on the trunks of trees.

SPHENOIDAL SUTURE. See ANATOMY.

SPHENOIDES. See ANATOMY.

SPHERE, is a solid contained under one uniform round surface, such as would be formed by the revolution of a circle about a diameter thereof as an axis. See GEOMETRY.

SPHERE, *properties of the*, are as follow:

1. A sphere may be considered as made up of an infinite number of pyramids, whose common altitude is equal to the radius of the sphere, and all their bases form the surface of the sphere. And therefore the solid content of the sphere is equal to that of a pyramid whose altitude is the radius, and its base is equal to the surface of the sphere, that is, the solid content is equal to $\frac{1}{3}$ of the product of its radius and surface.

2. A sphere is equal to $\frac{2}{3}$ of its circumscribing cylinder, or of the cylinder of the same height and diameter, and therefore equal to the cube of the diameter multiplied by .5236, or $\frac{2}{3}$ of .7854; or equal to double a cone of the same base and height. Hence all different spheres are to one another as the cubes of their diameters, and their surfaces as the squares of the same diameters.

3. The surface or superficies of any sphere, is equal to four times the area of its great circle, or of a circle of the same diameter as the sphere. Or,

4. The surface of the whole sphere is equal to the area of a circle whose radius is equal to the diameter of the sphere. And, in like manner, the curve surface of any segment, whether greater or less than a hemisphere, is equal to a circle whose radius is the chord line drawn from the vertex of the segment to the circumference of its base, or the chord of half its arc.

5. The curve surface of any segment or zone of a sphere, is also equal to the curve surface of a cylinder of the same height with that portion, and of the same diameter with the sphere. Also the surface of the whole sphere, or of a hemisphere, is equal to the curve surface of its circumscribing cylinder. And the curve surfaces of their corresponding parts are equal, that are contained between any two places parallel to the base. And consequently the surface of any segment or zone of a sphere, is as its height or altitude.

Most of these properties are contained in Archimedes's treatise on the sphere and cylinder. And many other rules for the surfaces and solidities of spheres, their segments, zones, frustums, &c. may be seen in Bonnycastle's Mensuration.

Hence, if d denotes the diameter or axis of a sphere, s its curve surface, c its solid content, and $a = .7854$ the area of a circle whose diam. is 1; then we shall, from the foregoing properties, have these following general values or equations, viz.

$$s = 4ad^2 = \frac{6c}{d} = 6\sqrt[3]{\tfrac{2}{3}ac^2}.$$

$$s = \tfrac{1}{6}ds = \tfrac{2}{3}ad^3 = \tfrac{1}{12}\sqrt{\frac{s^3}{a}}.$$

$$d = \frac{6c}{s} = \sqrt{\frac{s}{4a}} = \sqrt[3]{\frac{3c}{2a}}.$$

SPHERE, in astronomy, that concave orb, or expanse, which invests our globe, and in which the heavenly bodies appear to be fixed, and at an equal distance from the eye.

SPHERE, *armillary*. See ARMILLARY SPHERE.

SPHERICS, the doctrine of the sphere, particularly of the several circles described on its surface, with the method of projecting the same on a plane. See PROJECTION *of the sphere*.

A circle of the sphere is that which is made by a plane cutting it. If the plane passes through the centre, it is a great circle: if not, it is a little circle.

The pole of a circle, is a point on the surface of the sphere, equidistant from every point of the circumference of the circle. Hence every circle has two poles, which are diametrically opposite to each other; and all circles that are parallel to each other have the same poles.

Properties of the circles of the sphere. 1. If a sphere is cut in any manner by a plane, the section will be a circle; and a great circle when the section passes through the centre, otherwise it is a little circle. Hence all great circles are equal to each other: and the line of section of two great circles of the sphere, is a diameter of the sphere: and therefore two great circles intersect each other in points diametrically opposite; and make equal angles at those points; and divide each other into two equal parts; also any great circle divides the whole sphere into two equal parts.

2. If a great circle is perpendicular to any other circle, it passes through its poles. And if a great circle passes through the pole of any other circle, it cuts it at right angles, and into two equal parts.

3. The distance between the poles of two circles is equal to the angle of their inclination.

4. Two great circles passing through the poles of another great circle, cut all the parallels to this latter into similar arcs. Hence, an angle made by two great circles of the sphere, is equal to the angle of inclination of the planes of these great circles. And hence also the lengths of those parallels are to one another as the sines of their distances from their common pole, or as the cosines of their distances from their parallel great circle. Consequently, as radius is to the cosine of the latitude of any point on the globe, so is the length of a degree at the equator, to the length of a degree in that latitude.

5. If a great circle passes through the poles of another, this latter also passes through the poles of the former; and the two cut each other perpendicularly.

6. If two or more great circles intersect each other in the poles of another great circle; this latter will pass through the poles of all the former.

7. All circles of the sphere that are equally distant from the centre, are equal; and the farther they are distant from the centre, the less they are.

8. The shortest distance on the surface of a sphere, between any two points on that surface, is the arc of a great circle passing through those points. And the smaller the circle is that passes through the same points, the longer is the arc of distance between them. Hence the proper measure, or distance, of two places on the surface of the globe, is an arc of a great circle intercepted between the same. See Theodosius, and other writers on spherics.

SPHEROID, a solid body approaching to the figure of a sphere, though not exactly round, but having one of its diameters longer than the other.

This solid is usually considered as generated by the rotation of an oval plane figure about one of its axes. If that is the longer or transverse axis, the solid so generated is called an oblong spheroid, and sometimes prolate, which resembles an egg, or a lemon; but if the oval revolves about its shorter axis, the solid will be an oblate spheroid, which resembles an orange, and in this shape also is the figure of the earth, and of the other planets.

The axis about which the oval revolves, is called the fixed axis, and the other is the revolving axis, whichever of them happens to be the longer.

When the revolving oval is a perfect ellipse, the solid generated by the revolution is properly called an ellipsoid; as distinguished from the spheroid, which is generated from the revolution of any oval whatever, whether it is an ellipse or not. But generally speaking, in common acceptation, the term spheroid is used for an ellipsoid; and therefore, in what follows, they are considered as one and the same thing.

Any section of a spheroid by a plane, is an ellipse (except the sections perpendicular to the fixed axis, which are circles); and all parallel sections are similar ellipses, or having their transverse and conjugate axes in the same constant ratio; and the sections parallel to the fixed axis are similar to the ellipse from which the solid was generated.

For the surface of the spheroid, whether it is oblong or oblate:

Let f denote the fixed axis,
r the revolving axis,
$a = .7854$, and $q = \frac{ff \backsim rr}{ff}$; then will

the surface s be expressed by the following series, using the upper signs for the oblong spheroid, and the under signs for the oblate one; viz.

$$s = 4arf \times (1 \mp \frac{1}{2.3} q - \frac{1}{2.4.5} q^2 \mp \frac{3}{2.4.6.7} q^3$$

&c.; where the signs of the terms, after the first, are all negative for the oblong spheroid, but alternately positive and negative for the oblate one.

Hence, because the actor $4\,arf$ is equal to 4 times the area of the generating ellipse, it appears that the surface of the oblong spheroid is less than 4 times the generating ellipse: but the surface of the oblate spheroid is greater than 4 times the same; while the surface of the sphere falls in between the two, being just equal to 4 times its generating circle.

Huygens has given two elegant constructions for describing a circle equal to the superficies of an oblong and an ovate spheroid, which he says he found out towards the latter end of the year 1657.

Of the solidity of a spheroid. Every spheroid, whether oblong or oblate, is, like a sphere, exactly equal to two-thirds of its circumscribing cylinder. So that, if f denotes the fixed axis, r the revolving axis, and $a =$ 7854; then $\frac{2}{3}\,afr^2$ denotes the solid content of either spheroid. Or, which comes to the same thing, if t denotes the transverse, and c the conjugate axis of the generating ellipse;

then $\frac{2}{3}ac^2t$ is the content of the oblong spheroid,

and $\frac{2}{3}ac^2t$ is the content of the oblate spheroid.

Consequently, the proportion of the former solid to the latter, is as c to t, or as the less axis to the greater.

Farther, if about the two axes of an ellipse are generated two spheres and two spheroids, the four solids will be continued proportionals, and the common ratio will be that of the two axes of the ellipse; that is, as the greater sphere, or the sphere upon the greater axis, is to the oblate spheroid, so is the oblate spheroid to the oblong spheroid, and so is the oblong spheroid to the less sphere, and so is the transverse axis to the conjugate.

SPHEROID, *universal*, a name given to the solid generated by the rotation of an ellipse about some other diameter, which is neither the transverse nor conjugate axis.

SPHEX, a genus of insects of the order hymenoptera. The generic character is, mouth with jaws, without tongue; antennæ of ten joints; wings flat-incumbent (not pleated) in each sex; sting concealed. As the insects of the genus ichneumon deposit their eggs in the bodies of other living insects, so those of the genus sphex deposit theirs in dead ones, in order that the young larvæ, when hatched, may find their proper food. 1. Thus the sphex figulus of Linnæus, having found some convenient cavity for the purpose, seizes on a spider, and having killed it, deposits it at the bottom: then laying her egg in it, she closes up the orifice of the cavity with clay: the larva, which resembles the maggot of a bee, having devoured the spider, spins itself up in a dusky silken web, and changes into a chrysalis, out of which, within a certain number of days, proceeds the complete insect, which is of a black colour, with a slightly foot-stalked abdomen, the edges of the several segments being of a brighter appearance than the rest of the body. It should be added, that the female of this species prepares several separate holes or nests as abovementioned, in each of which she places a dead insect and an egg: each cell costing her the labour of about two days.

2. The sphex viatica of Linnæus, which is of a black colour and slightly hairy, with brown wings, and the fore part of the abdomen ferruginous with black bands, seizes caterpillars in a similar manner, burying one in every cell, in which she deposits an egg, and then closes up the cell.

3. Sphex sabulosa Lin. is a black and hairy species, with the second and third joints of the abdomen ferruginous. It inhabits sandy and gravelly places, in which the female digs holes with her fore-feet, working in the manner of a dog, in order to form the cavity, in which she places either a spider or a caterpillar; after which she closes up the cavity, having first laid her egg in the dead insect. Linnæus, in his description of this insect, contradicts the generic character, since he observes that it has a retractile snout containing the tongue.

Many of the extra-European spheges are insects of a very considerable size. The whole genus is very much allied to those of vespa and apis. There are 38 species. See Plate Nat. Hist. fig. 369.

SPHINCTER. See ANATOMY.

SPHINX, the hawk moth, a genus of insects of the order lepidoptera. The generic character is, antennæ thickest in the middle, subprismatic, and attenuated at each extremity; wings deflected; flight strong, and commonly in the evening or morning. The insects of this genus have in general a large thorax and thick body, commonly tapering towards the extremity. The name sphinx is applied to the genus on account of the posture assumed by the larvæ of several of the larger species, which are often seen in an attitude much resembling that of the Egyptian sphinx, viz. with the fore parts elevated, and the rest of the body applied flat to the surface.

1. One of the most elegant insects of this genus is the sphinx ligustri, or privet hawkmoth. It is a large insect, measuring nearly four inches and a half from wing's end to wing's end: the upper wings of a brown colour, most elegantly varied or shaded with deeper and lighter streaks and patches; the under wings

and body are of a fine rose-colour, barred with transverse black stripes. The caterpillar, which is very large, is smooth, and of a fine green, with seven oblique purple and white stripes along each side: at the extremity of the body, or top of the last joint, is a horn or process pointing backwards. This beautiful caterpillar is often found in the months of July and August feeding on the privet, the lilac, the poplar, and some other trees, and generally changes to a chrysalis in August or September, retiring for that purpose to a considerable depth beneath the surface of the ground, and, after casting its skin, continuing during the whole winter in a dormant state, the sphinx emerging from it in the succeeding June.

2. The sphinx ocellata is perhaps still more beautiful: it is rather a smaller insect than the preceding, and has the upper wings and body brown, the former finely clouded with different shades, while the lower wings are of a bright rose-colour, each marked with a large ocellated black spot with a blue interior circle and a black centre. This insect proceeds from a green caterpillar of a rough or shagreen-like surface, marked on each side by seven oblique yellowish-white streaks, and furnished, like the preceding, with a horn at the tail. It is principally found on the willow; retires under ground, in order to undergo its change into the chrysalis state, in the month of August or September; and in the following June appears the complete insect.

3. But the largest and most remarkable, if not the most beautiful European insect of this genus, is the sphinx atropos of Linnæus, see Plate Nat. Hist. fig. 370, which very considerably exceeds in size both the species already mentioned. The upper wings are of a fine dark-grey colour, with a few slight variegations of dull orange and white: the under wings are of a bright orange-colour, marked by a hair of transverse black bands; the body is also orange-coloured, with the sides marked by black bars, while along the top of the back, from the thorax to the tail, runs a broad blue-grey stripe: on the top of the thorax is a very large patch of a most singular appearance, exactly representing the usual figure of a skull or death's-head, and of a pale grey, varied with dull ochre-colour and black. When in the least disturbed or irritated, this insect emits a stridulous sound, something like the squeaking of a bat or mouse; and from this circumstance, as well as from the mark above-mentioned on the thorax, is held in much dread by the vulgar in several parts of Europe, its appearance being regarded as a kind of ill omen, or harbinger of approaching fate. We are informed by the celebrated Reaumur, that the members of a female convent in France were thrown into great consternation at the appearance of one of these insects, which happened to fly in during the evening at one of the windows of the dormitory. The caterpillar from which this curious sphinx proceeds is in the highest degree beautiful, and far surpasses in size every other European insect of the kind; measuring sometimes near five inches in length, and being of a very considerable thickness: its colour is a bright yellow, the sides marked by a row of seven most elegant broad stripes or bands, of a mixed violet and sky-blue colour. This caterpillar is principally found on the potatoe and the jessamine, those plants being its favourite food. It usually changes into a chrysalis in the month of September, retiring for that purpose pretty deep under the surface of the earth; the complete insect emerging in the following June or July. The sphinx atropos is generally considered as a very rare insect; and as the caterpillar feeds chiefly by night, concealing itself during the day under leaves, &c. it is not often detected.

We shall not conclude the survey of the genus sphinx without observing, that it contains some species of a smaller size, and of a somewhat different habit from the kinds above described. Among these is the beautiful sphinx fillipendulæ, or dropwort sphinx, common in meadows towards the decline of summer, and which is distinguished by having the upper wings of an oblong-oval shape and of a dark shining green colour, with blood-red spots, and the lower wings red with a dark green edging: the caterpillars of a pale yellow, with rows of squarish black spots, and often seen feeding on various meadow-plants and grasses: it does not undergo its change under ground, but encloses itself in an oval shining yellow web of silk, attached to the stem of some grass, &c. In this it changes into a chrysalis, out of which in about the space of three weeks emerges the complete insect. See Plate Nat. Hist. fig. 371.

Others of the smaller sphinges are remarkable for having the wings in a considerable degree transparent: of this kind is the sphinx apiformis, which is of an aspect at first sight more resembling that of a wasp or hornet than of a sphinx, the wings being transparent with merely a slight edging of brown, and the thorax and abdomen varied with black and yellow. The caterpillar inhabits the hollows of poplar, sallow, willow, and lime trees, feeding on the substance of the bark; changing to a chrysalis in April, and the fly appearing in the month of June.

Sphinx crabroniformis is so much like the former as scarcely to be distinguished from it, and inhabits the hollows of the sallow and other willows, feeding on the wood: it changes to a chrysalis in May, and the fly appears in July.

SPICA VIRGINIS, a star of the first magnitude, in the constellation Virgo.

SPIDER. See ARANEA.

SPIDER'S WEB. See SILK.

SPIDER'S VENOM. See POISONS.

SPIELMANNIA, a genus of the didynamia angiospermia class and order. The calyx is five-cleft; corolla bearded at the throat, with five-cleft border; drupe with a two-celled, two-seeded nut. There is one species, a shrub of the Cape.

SPIES, in war, are persons employed to give intelligence of what the enemy is doing. By making a proper use of the necessary creatures, the most secret designs of an enemy may be discovered, the positions his army are to take, the stations of his fleets, and even the manner in which the former is to be secured by masked batteries, or the latter be kept firm with chain-moorings, as was the case off Boulogne in 1800. If they are apprehended, they immediately suffer death.

SPIGELIA, *worm grass*, a genus of plants belonging to the class of pentandria, and order of monogynia; and in the natural system arranged under the 47th order, stellatæ. The corolla is funnel-shaped; the capsule is didymous, bilocular, and polyspermous. There are two species, the anthelmia and marilandica. 1. The anthelmia, see Plate Nat. Hist., fig. 372, has an herbaceous stem, and its highest leaves are fourfold. This plant is generally found in low dry lands, after they have been turned up some months, and after great rains; its taste is herbaceous, and somewhat clammy; its growth is soft and sudden; its stalk hollow, smooth, and roundish. Its medical qualities are highly spoken of by Dr. Browne. 2. The marilandica, perennial worm-grass, or Indian pink. Its stem is four-cornered; all the leaves opposite. Dr. Garden gave it in what he calls continued or remitting low worm-fevers, and found its efficacy promoted by the addition of rad. serpentar. virg.

SPIKING *up the ordnance*, a sea-phrase, used for fastening a quoin with spikes to the deck close to the breech of the carriages of great guns, that they may keep close and firm to the ship's sides, and not get loose when the ship rolls, and by that means endanger the breaking out of a butt-head of a plank.

SPILANTHUS, a genus of plants belonging to the class of syngenesia, and to the order of polygamia æqualis. The common calyx is erect; the leaflets numerous, subequal, and oblong, the two exterior being longer than the rest. The calyx is almost equal; down two-toothed, rectangular, conical, chaffy. There are nine species, annuals of hot climates.

SPINACIA, *spinage*, a genus of plants belonging to the class of diœcia, and to the order of pentandria; and in the natural system arranged under the 12th order, holoraceæ. The male calyx is quinquepartite; there is no corolla: the female calyx is quadrifid; no corolla; there are four styles, and one seed within the indurated calyx. There are only two species, the oleracea and fera. 1. The oleracea, common spinage, has sessile fruits and sagittated leaves. It has been cultivated in Britain since 1568, but it is not known from what country it was originally brought. When intended for winter use, it should be sown on an open spot of ground in the latter end of July; observing to do it, if possible, when the weather is rainy. The way of gathering it to advantage is only to take off the longest leaves, leaving those in the centre to grow bigger; and at this rate a bed of spinage will furnish the table for a whole winter, till the spinage sown in spring is become fit for use, which is commonly in April. 2. The fera, wild spinage, produces its fruit on footstalks.

SPINÆ. See BOTANY.

SPINALIS. See ANATOMY.

SPINDLE, in the sea language, is the smallest part of a ship's capstan, which is betwixt the two decks. The spindle of the jeer-capstan has whelps to heave the viol. The axis of the wheel of a watch or clock is also called the spindle. Among miners, the spindle is a piece of wood fastened into either stow-blade.

SPINDLE-SHELL. See BUCCINUM.

SPINE, *spina dorsi*. See ANATOMY.

SPINEL. This stone, which comes from the island of Ceylon, is usually crystallized. The form of its integrant particles is the tetrahedron. The primitive form of its crystals is a regular octahedron, composed of two four-sided pyramids applied base to base, each of the sides of which is an equilateral triangle. In some cases two opposite sides of the pyramids are broader than the other two; and sometimes the edges of the octahedron are wanting, and narrow faces in their place. For figures and descriptions of these, and other varieties of these crystals, the reader is referred to Romé de Lisle and the abbé Estner. It occurs also in tetrahedrons, in rhomboids whose faces have angles of 120° and 60°, in rhomboidal dodecahedrons, and in four-sided prisms terminated by four-sided pyramids.

The texture of the spinel is foliated. Fracture conchoidal. Its lustre is 3. Transparency 2 to 4. It causes a single refraction. Hardness 13. Specific gravity 3.570 to 3.625. Colour red, of various shades; sometimes also blue, green, and yellow. The constituents of the spinel are, according to

Vauquelin,		Klaproth,	
86.00	alumina	76	alumina
8.50	magnesia	16	silica
5.25	chromic acid	8	magnesia
		1.5	oxide of iron
99.76		101.5	

SPINET, or Spinnet, a musical instrument ranked in the second or third place among harmonious instruments. The harpsichord is a kind of spinet, only with another disposition of the keys.

SPINIFEX, a genus of plants belonging to the class of polygamia and order of dioecia. The hermaphrodite flowers have a calyx with bivalved biflorous glumes, the valvelets being parallel to the rachis; the corolla is bivalved and awnless; there are three stamina and two styles. In the male flowers the calyx is common with the hermaphrodite; the corolla and stamina are similar. There is only one species, the squarrosus, a grass of the East Indies.

SPINNING, the act of reducing silk, flax, hemp, hair, wool, or other matter, into thread. Spinning is either performed on the wheel, or with a distaff and spindle, or with other machines proper for the several kinds of working. Hemp, flax, nettle-thread, and other like vegetable matters, are to be wetted in spinning: silks, wools, &c. are spun dry, at least they do not stand in need of water: there is, however, a way of spinning or reeling silk as it comes off the cases or balls, where hot, and even boiling, water is to be used. The vast variety, and importance of these branches of our manufactures, which are produced from cotton, wool, and flax, spun into yarn, together with the cheapness of provisions, and the low price of labour, in many foreign countries, which are the rivals of our trade, have occasioned many attempts at home to render spinning more easy, cheap, and expeditious. Mr. Arkwright has carried the invention to a high degree of perfection. He not only contrived methods for spinning cotton, but obtained a patent for making cotton, flax, and wool, into yarn.

SPINSTER, in law, an addition usually given to all unmarried women from a viscount's daughter downwards.

SPIO, a genus of vermes of the order mollusca. The generic character is, body projecting from a tube, jointed, and furnished with dorsal fibres; peduncles or feet rough with bristles, and placed towards the back; feelers two, long, simple; eyes two, oblong. There are two species, viz. 1. The seticornis, which inhabits the ocean where there is a clayey bottom, is about three inches long: the tube is composed of agglutinated particles of earth, thin, erect, and thrice as long as the body. From this the animal projects its capillary white feelers, in search of food, which consists of marine worms. 2. Filicornis, that inhabits the Greenland seas: tube fragile, erect, greenish, from which it projects its feelers in search of planariæ and other small marine worms.

SPIRACULA, in entomology, holes or pores on each side of every segment of the abdomen, through which insects breathe.

SPIRÆA, a genus of plants belonging to the class of icosandria, and to the order of pentagynia; and in the natural system arranged under the 26th order, pomaceæ. The calyx is quinquefid; petals five; capsule polyspermous. There are 22 species; of which two only are British, the filipendula and ulmaria.

SPIRAL, in geometry, a curve line of the circular kind, which, in its progress, recedes from its centre.

A spiral, according to Archimedes, its inventor, is thus generated: If a right line, as AB (Plate Miscel. fig. 222), having one end fixed at B, is equally moved round, so as with the other end A to describe the periphery of a circle; and, at the same time, a point is conceived to move forward equally from B towards A, in the right line BA, so that the point describes that line, while the line generates the circle: then will the point, with its two motions, describe the curve-line B 1, 2, 3, 4, 5, &c. which is called the helix or spiral line; and the plane space, contained between the spiral line and the right line BA, is called the spiral space.

If also you conceive the point B to move twice as slow as the line AB, so that it shall get but half-way along the line BA when that line shall have formed the circle; and if then you imagine a new revolution to be made of the line carrying the point, so that they shall end their motion at last together; there will be formed a double spiral line, and the two spiral spaces, as you see in the figure. From the genesis of this curve, the following corollaries may be easily drawn. 1. The lines B 12, B 11, B 10, &c. making equal angles with the first and second spirals (as also B 12, B 10, B 8, &c.), are in arithmetical proportion. 2. The lines B 7, B 10, &c. drawn any how to the first spiral, are to one another as the arches of the circle intercepted betwixt BA and those lines. 3. Any lines drawn from B to the second spiral, as B 18, B 22, &c. are to each other as the aforesaid arches, together with the whole periphery added on both sides. 4. The first spiral space is to the first circle as 1 to 3. And, 5. The first spiral line is equal to half the periphery of the first circle; for the radii of the sectors, and consequently the arches, are in a simple arithmetic progression, while the periphery of the circle contains as many arches equal to the greatest; wherefore the periphery to all those arches is to the spiral lines as 2 to 1.

Spiral, in architecture and sculpture, implies a curve that ascends, winding about a cone or spire, so that all the points thereof continually approach the axis. It is distinguished from the helix, by its winding round a cone, whereas the helix winds in the same manner round a cylinder.

Spirals, *proportional*, are such spiral lines as the rhumb-lines on the terrestrial globe; which, because they make equal angles with every meridian, must also make equal angles with the meridians in the stereographic projection on the plane of the equator; and therefore will be, as Dr. Halley observes, proportional spirals about the polar point. See Rhumb.

SPIRITS, ardent. See Alcohol.

SPIRITUALITIES *of a bishop*, are the profits that he receives as a bishop, and not as a baron of parliament; such are the duties of his visitation, presentation-money, what arises from the ordination and institution of priests, the income of his jurisdiction, &c.

SPIT-INSECT, or Cuckow Spit. See Cicada.

SPLACHNUM, a genus of plants belonging to the class of cryptogamia, and order of musci. The antheræ are cylindrical, and grow on a large coloured apophysis or umbraculum. The calyptra is caducous. The female star grows on a separate stem. There are six species, the rubrum, luteum, sphæricum, ampullaceum, vasculosum, angustatum.

SPITTLE. See Saliva.

SPLEEN. See Anatomy.

SPLICING, in the sea-language, is the untwisting the ends of two cables or ropes, and working the several strands into one another by a fidd, so that they become as strong as if they were but one rope, &c.

SPONDEE, *spondæus*, in antient poetry, a foot consisting of two long syllables, as omnes. Some give the appellation spondaic to verses composed wholly of spondees, or at least that end with two spondees; as,

Constitit, atque oculis Phrygia agmina circumspexit.

SPONDIAS, *hog-plum*, a genus of the decandria pentagynia class of plants, the flower of which consists of five ovated, plane, and patent petals; and its fruit is an oval berry, containing four nuts in each cell. It is called monbin by Plumier. There are four species, trees of the West Indies.

SPONDYLUS, a genus of vermes testacea. The generic character is, animal a tethys; shell hard, solid, with unequal valves; one of the valves convex, the other rather flat; hinge with two recurved teeth, separated by a small hollow. There are four species. The gœderopus, which has a shell slightly eared and spinous, inhabits the Indian and other seas, and is found in infinite varieties as to size, thickness, and colours; sometimes entirely purple, orange, white, or bloom-colour; sometimes marked with various streaks. See Plate Nat. Hist., fig. 373.

SPONGIA, *sponge*, in natural history; a genus of animals belonging to the class of vermes, and order of zoophyta. It is fixed, flexible, and very torpid, growing in a variety of forms, composed either of reticulated fibres, or masses of small spines interwoven together, and clothed with a living gelatinous flesh, full of small mouths or holes on its surface, by which it sucks in and throws out the water.

Fifty species have already been discovered, of which 10 belong to the British coasts. 1. Oculata, see Plate Nat. Hist. fig. 374, or branched sponge, is delicately soft and very much branched; the branches are a little compressed, grow erect, and often united together. They have rows of cells on each margin, that project a little. This species is of a pale yellow colour, from five to ten inches high. The fibres are reticulated; and the flesh of the gelatinous part is so tender, that when it is taken out of the water it soon dries away. It is very common round the sea-coast of Britain and Ireland. This description will be better understood by observing that along the edges, and on the surface of the branches, are rows of small papillary holes, through which the animal receives its nourishment. 2. Cristata, or cock's-comb sponge, is flat, erect, and soft, growing in the shape of cock's combs, with rows of little holes along the tops, which project a little. It abounds on the rocks to the eastward of Hastings in Sussex, where it may be seen at low water. It is commonly about three inches long, and two inches high, and of a pale yellowish colour. When put into a glass of sea-water, it has been observed to suck in and squirt out the water through little mouths along the tops, giving evident signs of life. 3. Stuposa, tow-sponge, or downy branched sponge, is soft like tow, with round branches, and covered with fine pointed hairs. It is of a pale yellow colour, and about three inches high. It is frequently thrown on the shore at Hastings in Sussex. This sponge is so closely covered with a fine down, that the numerous small holes in its surface are not discernible. 4. Dichotoma, dichotomous or forked sponge, is stiff, branched with round, upright, elastic branches, covered with minute hairs. It is found on the coast of Norway, and also, according to Berkenhout, on the Cornish and Yorkshire coasts. It is of a pale yellow colour; and full of very minute pores, guarded by minute spines. 5. Urens or tomentosa, stinging sponge, or crumb-of-bread sponge, is of many forms, full of pores, very brittle and soft, and interwoven with very minute spines. It is full of small protuberances, with a hole in each, by which it sucks in and throws out the water. It is very common on the British coast, and is frequently seen surrounding fucuses. It is found also on the shores of North America, Africa, and in the East Indies. When newly taken out of the sea, it is of a bright orange-colour, full of gelatinous flesh; but when dry it becomes whitish, and when broken has the appearance of crumb of bread. If rubbed on the hand it will raise blisters; and if dried in an oven, its power of stinging is much increased, especially that variety of it which is found on the sea-coast of North America. 6. Palmata, palmated sponge, is like a hand with fingers a little divided at the top. The mouths are a little prominent, and irregularly disposed on the surface. It is found on the beach at Brighthelmstone. It is of a reddish colour, inclining to yellow, and of the same soft woolly texture with the spongia oculata. 7. Coronata, coronet sponge, is very small consisting of a single tube surrounded at the top by a crown of little spines. The tube is open at the top. The rays that compose the little crown are of a bright shining pearl-colour; the body is of a pale yellow. It has been found in the harbour of Emsworth, between Sussex and Hampshire. 8. Botryoides, grape sponge, is very tender and branched, as if in bunches: the bunches are hollow, and are made up of oblong oval figures having the appearance of grapes; and each bunch is open at top. This species is of a bright shining colour. The openings at the top are evidently the mouths by which the animal imbibes and discharges moisture. When the surface is very much magnified, it appears covered with little masses of triple, equidistant, shining spines. 9. Lacustris, creeping sponge, has erect, cylindrical, and obtuse branches. It is found in lakes in Sweden and England. 10. Fluviatilis, river sponge, is green, erect, brittle, and irregularly disposed in numerous branches. It abounds in many parts of Europe, in the fresh rivers of Russia and England, but particularly in the river Thames. It scarcely exhibits any symptoms of life, and is of a fishy smell: its pores or mouths are sometimes filled with green gelatinous globules. It differs very little from the lacustris.

So early as the days of Aristotle, sponges were supposed to possess animal life; the persons employed in collecting them having observed them shrink when torn from the rocks, thus exhibiting symptoms of sensation. The same opinion prevailed in the time of Pliny; but no attention was paid to this subject till count Marsigli examined them, and declared them vegetables. Dr. Peysonell, in a paper which he sent to the Royal Society in the year 1752, and in a second in 1757, affirmed they were not vegetables, but the production of animals; and has accordingly described the animals, and the process which they performed in making the sponges. Mr. Ellis, in the year 1762, was at great pains to discover these animals. For this purpose he dissected the spongia urens, and was surprised to find a great number of small worms of the genus of nereis or sea scolopendra, which had pierced their way through the soft substance of the sponge in quest of a safe retreat. That this was really the case, he was fully assured of, by inspecting a number of specimens of the same sort of sponge, just fresh from the sea. He put them into a glass filled with sea-water; and then, instead of seeing any of the little animals which Dr. Peysonell described, he observed the papillæ or small holes with which the papillæ are surrounded contract and dilate themselves. He examined another variety of the same species of sponge, and plainly perceived the small tubes inspire and expire the water. He therefore concluded, that the sponge is an animal, and that the ends or openings of the branched tubes are the mouths by which it receives its nourishment, and discharges its excrement.

SPONGIOSE, in anatomy, an appellation given to several parts of the body.

SPONSORS. See GODFATHERS.

SPONTANEOUS, or EQUIVOCAL, GENERATION. See EQUIVOCAL GENERATION.

SPONTOON, is a weapon much like a halberd, formerly used instead of a half-pike, by the officers of foot. When the spontoon was planted, the regiment halted; when pointed forwards, the regiment marched; and when pointed backwards, the regiment retreated.

SPOONBILL. See PLATALEA.

SPOONING, in the sea-language, is said of a ship, which being under sail in a storm at sea, is unable to bear it, and consequently forced to put right before the wind.

SPOTS, in astronomy. See MACULÆ.

SPOUT. See WATER-SPOUT.

SPRAT. See CLUPEA.

SPRING, in natural history, a fountain or source of water, rising out of the ground. See WATER.

Origin of springs. The water which falls on the surface of the earth, in rain, snow, &c. penetrates its substance till it meets with a stratum of clay, stone, or some other matter, which stops its descent; it then glides laterally on the stratum which sustains it, and in the direction to which it leans, till meeting with an aperture, it appears on the surface of the earth in the form of a spring. As water, like other matter, obeys the force of gravity, and therefore has a tendency to descend, springs are always lower than the source from which they are supplied. Springs are most common on the sides and at the bottom of mountains; they are seldom found quite at the summit of a mountain, and are rare where a country is every where level to a considerable distance, because there the strata are parallel, and do not conduct the water to any particular point. In order to obtain water, therefore, in flat countries, it is generally necessary to dig into the earth, when it is found to flow copiously from the sides of the opening, at no great distance from the surface. When wells are dug in elevated situations, water is seldom met with till we have dug to a considerable depth, and got below the general level of the country.

A curious circumstance occurs in the making of wells at Modena and Stiria in Italy. The workmen begin by digging through several strata or soils, till they come to a very hard kind of earth much resembling chalk; here they begin their mason-work, and build a well, which they carry on at their leisure till they have finished without being interrupted with one drop of water, and without any apprehension of not finding it when they come to make the experiment. The well being finished, they bore through the hard bed of chalk, upon which the well is built, with a long auger, but take care to get out of the well before they draw it out again; which when they have done, the water springs up into the well, and in a little time rises to the brim, nay sometimes overflows the neighbouring grounds. Now there can be little doubt, that these waters flow from reservoirs which are collected within the Appenine mountains, not far from Modena, and taking their course through subterraneous passages, endeavour to force their ascent to the same height from which they descend, wherever they can find a vent.

As all the water which falls in rain has undergone a natural distillation, it is much more pure when it first falls, than after it has passed through different strata of the earth and rises in springs. Spring water is always found to contain some foreign admixture; if this should be only an earthy salt, the water is called hard; if it contains other substances, it then receives the denomination of mineral water. See SOAP.

For intermitting springs, see HYDROSTATICS, Vol. I. p. 953.

Hot springs. There is no phenomenon which has more completely baffled the efforts of modern philosophy than this. The most probable hypothesis (though not satisfactory) is, that the same causes operate to produce these which produce volcanoes; but that their permanent temperature arises from the inflammatory matter being confined by an immense pressure, while the heat may be continued to a considerable degree in the earth, without exhibiting to our affrighted senses the formidable phenomenon of a volcanic fire. It must be acknowledged that it is in volcanic regions, that tepid waters are found in the greatest quantity; and it is in these that they display the most striking phenomena. At Laugervarm, a small lake, two days journey from mount Hecla, in Iceland, there are hot spouting springs, one of which throws up a column of water to the height of twenty-four feet. A piece of mutton and some salmon-trout were almost boiled to pieces, in six minutes, in one of these springs. At Geyser in the same island, there are forty or fifty spouting springs within the compass of three miles; in some the water is impregnated with clay, and white in its appearance; in some, where it passes through a fine ochre, it is as red as scarlet; in some it spouts forth in a continued stream; in others, at intervals like an artificial jet-d'eau. The largest which Von Troil observed had an aperture nineteen feet in diameter, through which the water spouted, at intervals, nine or ten times a day; round the top of it is a bason, which, together with the pipe, is in the form of a cauldron; the margin of the bason is nine feet higher than the conduit, and its diameter fifty-six feet. The water was thrown up in an immense column, at different times, to the height of from thirty to sixty feet, and at one time to the height of ninety-two feet. Previously to this explosion the earth began to tremble in three different places, and a noise was heard like a battery of cannon.

Another writer states, that at Geyser, in Iceland, there springs up a hot water, which upon cooling, deposits siliceous earth; and that of this very matter it has formed for itself a crater, in which columns of water, of a stupendous bulk, after they have been thrown to the height of ninety feet and upwards, fall, and are again received. The heat of the water during the explosion cannot be measured; but after it has risen and fallen through a stratum of air ninety feet thick, it raises the thermometer to 212°, which evinces that the heat in the bowels of the earth must be much more intense; and at this we shall cease to wonder when we consider, that in this case the subterraneous fire acts upon the water in caverns closed up by very thick strata of stones, an apparatus far more effective than Papin's digester. The crater was at first undoubtedly formed, and is daily strengthened, by siliceous earth, which quits the menstruum on its being cooled, falls down, and, being in somewhat like a soft state, concretes.

About sixty yards from the shore of the island of Ischia, at a place called St. Angelo, a column of boiling water bubbles on the surface of the sea with great force, and communicates its heat to the water of the sea near it. It boils winter and summer, and is of great use to the inhabitants in bending their planks for ship-building, &c. The fishermen also frequently employ this curious cauldron to boil their fish. Near the shore of this island sir William Hamilton found, when bathing in the sea, many spots where the sand was so intensely hot under his feet as to oblige him hastily to retire.

There is also a boiling spring near Viterbo, in the Roman state, called the Bullicame. It is a circular pool of about sixty feet in diameter, and exceedingly deep, the water of which is constantly boiling. It is situated in a plain surrounded by volcanic mountains. A stony concretion floats on the surface of the pool, which being carried off by the superfluous water, is deposited, and is constantly forming a labes or tufa, of which the soil all around the pool is composed.

These fountains are best accounted for by supposing the pipe or conduit to communicate with a large reservoir of water, which being subject to the heat of a volcanic fire, the steam generated in the reservoir by the boiling of the water acts forcibly on the water in the shaft or pipe, and ejects it by its elastic force in the form of a fountain, which will act with more or less vigour according to the degree of heat, and according to the resistance which the water encounters in its passage.

The most singular circumstance is the number of these springs which are found in almost every country; and even in those countries which have long ceased to be volcanic. England itself has its tepid springs, and those of Bath, Buxton, &c. are well known. Camden mentions, a well near Wigan, in Lancashire, which was called the burning well. If a candle was applied to its surface, he says, a flame was excited like that of ardent spirits set on fire, and the heat and inflammation thus excited would continue sometimes for the space of a whole day, and were sufficient to boil eggs, and even meat. Camden however mentions the well as having lost its inflammable property in his time; but he notices two others of a similar description, one in the same neighbourhood, and another in Shropshire. Should, then, the fact be as it is related by Camden, the philosophic reader will not find it difficult to explain the cause. The country where the well is, or was situated, abounds in coals. The well is therefore impregnated with naphta, or some bituminous vapour; this, upon the application of an ignited body, is capable of inflammation, and can even communicate a considerable portion of heat to the water of the well itself. There is no proof, however, that the Bath or Buxton waters are impregnated with any bituminous matter, though coals are plentiful in the neighbourhood; and as these waters contain a small portion of iron, there is reason to suppose them connected with beds of pyrites, or possibly with a latent subterraneous fire. On the whole we are not sufficiently acquainted with the internal parts of the earth to account satisfactorily for these and other phenomena of a similar kind; and whatever is advanced in the way of theory on these topics should be advanced with becoming diffidence, and rather with a view of exciting the attention and curiosity of others, than for the purpose of establishing a system unsanctioned by experiment, or building a reputation on the fallible basis of mere hypothesis. See WATERS, *Mineral.*

SPRING, in mechanics, denotes a thin piece of tempered steel, or other elastic substance; which, being wound up, serves to put several machines in motion by its elasticity, or endeavour to unbend itself: such is the spring of a clock, watch, &c.

The spring of a lock, gun, or pistol, is a piece of steel, violently bent; which, being set at liberty, beats back the bolt of the lock, or strikes down the cock.

SPRINGING *of a mast*, in the sea language, is when it cracks, but is not broken in any part of it; as the partners, hounds, &c.

SPRUCE-BEER, a cheap and wholesome liquor, which is thus made: Take of water sixteen gallons, and boil the half of it. Put the water thus boiled, while in full heat, to the cold part, which should be previously put into a barrel, or other vessel; then add sixteen pounds of treacle or molasses, with a few table-spoonfuls of the essence of spruce, stirring the whole well together; add half a pint of yeast, and keep it in a temperate situation, with the bung-hole open, for two days, till the fermentation is abated. Then close it up, or bottle it off, and it will be fit for being drunk in a few days afterwards. In North America, and perhaps in other countries, where the black and white spruce-firs abound, instead of adding the essence of the spruce at the same time with the molasses, they make a decoction of the leaves and small branches of these trees, and find the liquor equally good. It is a powerful antiscorbutic, and may prove very useful in long sea-voyages.

SPUNGE. See SPONGIA.

SPUNGING, in gunnery, the cleaning a gun's inside with a spunge, in order to prevent any sparks of fire from remaining in it, which would endanger the life of him who should load it.

SQUALUS, the *shark*, a genus of fishes of the order nantes. The generic character is; mouth situated beneath the anterior part of the head, with numerous teeth disposed in rows. Spiracles on each side the neck, in most species five in number, of a semilunar shape. Body oblong, somewhat cylindric. The animals of this genus are said to be much rarer in the Baltic than in any other sea: they are viviparous, and are observed to produce more young at a time than the rays, but each included, as in those fishes, in a quadrangular capsule or involucrum, each extremity of which is extended into a long, contorted, cartilaginous thread of great length. Many of the sharks are said to emit a phosphoric light during the night: they are chiefly of a solitary nature, and, in general, devour with indiscriminating voracity, almost every animal substance, whether living or dead; some few species however are observed to feed chiefly on fuci and other marine vegetables. There are 34 species, the most remarkable of which are,

1. Squalus carcharias. White shark. The great or white shark, so remarkable for its vast size and its powers of destruction, is an inhabitant of most parts of the globe, though much more frequently seen in the warmer than the colder latitudes: it is said to reside principally in the depths of the ocean, whence it rises at intervals in order to prowl for prey, and is considered as the most voracious of all the inhabitants of the deep. It arrives at the length of more than thirty feet, and is of a somewhat thicker or broader form than most of the genus: the head is of a depressed shape, and broad; terminating in front in an obtusely pointed snout: the mouth is of vast width, and furnished on the margin of each jaw with from three to six rows of strong flat, triangular, sharp-pointed, and finely serrated teeth, which are so imbedded in their investing cartilage as to be either raised or depressed at pleasure: the tongue is broad, thick, and

cartilaginous, and the throat extremely wide: the eyes, as in most of the genus, of a blueish or greenish cast, rather small, and half overhung by their skinny veil: the pectoral fins are large, strong, broad, and pointed: the first dorsal fin moderately large, somewhat falcated behind, and pointed: the second is situated very low on the back, near the origin of the tail, which is slightly lengthened, and of a bilobate shape, the upper lobe or division slightly pointed, and the lower or terminal lobe rather rounded: so great is the strength of this part, that even a young shark of about six feet in length is able by a stroke of its tail to break a man's leg; it is usual therefore with sailors to cut off the tail the instant they drag a shark on board: the anal fin is placed somewhat beyond the middle of the abdomen, and is of moderate size, and of a somewhat square outline: the general colour of the whole animal is a pale or whitish ash, darker or browner on the upper parts: the mouth is situated considerably beneath the front, for which reason the animal is said, like most others of this genus, to be obliged to turn on its back, or rather side, in order to seize its prey.

"Sharks (says Mr. Pennant) are the dread of sailors in all hot climates, where they constantly attend the ships, in expectation of what may drop overboard: a man that has that misfortune perishes without redemption: they have been seen to dart at him like gudgeons to a worm." They are said to attack negroes in preference to Europeans, and are observed in particular to attend with unremitting assiduity the passage of the slave-ships from the coasts of Africa to the West Indian islands, and, as Cepede very happily and justly observes, may be considered as forming a proper escort to the cruel conductors of those most accursed vessels. "A master of a Guinea-ship (says Pennant) informed me that a rage of suicide prevailed among his new-bought slaves, from a notion the unhappy creatures had, that after death they should be restored again to their families, friends, and country. To convince them that at least they should not reanimate their bodies, he ordered one of their corpses to be tied by the heels to a rope, and lowered into the sea; and though it was drawn up again as fast as the united force of the crew could be exerted, yet in that short space the sharks had devoured every part but the feet, which were secured at the end of the cord." The shark does not spare even its own species. A Laplander, according to Leems, had taken a shark, and fastened it to his canoe; but soon missed it, without being able to guess how: in a short time afterwards he caught a second of much larger size, in which, when opened, he found the one he had lost.

The internal parts of the shark present many remarkable particulars: the brain is small: the heart furnished with one ventricle and one auricle, which latter is of very large size, and receives the vena cava. In the stomach and intestines, according to Commerson, are usually found a great many tæniæ or tape-worms, which not only infest the cavities of these parts, but even penetrate into and lodge themselves between the interior coats: these animals, therefore, by their vellication and motions, must be supposed to aggravate the natural voracity of the shark, and to impel it to engorge a large quantity of food, in order to allay the sensations excited by these internal enemies: the milt, in the male fish, is disposed into two portions, and equals the length of about a third of the whole animal; and in the female the ovaries are of similar length. During the breeding-season, which takes place at different periods in different climates, the sharks are observed to approach the shores, in order to deposit their young in the most favourable situations: these are discharged, to the number of two or three at a time, still adhering to the capsule in which they had been before inclosed, and are excluded before the young animal has had time to break from it: the length of the newly-hatched shark does not exceed that of a few inches.

2. Squalus maximus, basking shark. This is a very large species, scarcely, if at all, inferior in size to the white shark; its length, according to Mr. Pennant, being from three to twelve yards, and even sometimes more. Great numbers of this species of shark were observed to visit the bays of Caernarvonshire and Anglesea in the summers of 1756 and a few succeeding years; continuing there only during the hot months, and quitting the coast about Michaelmas. They appear in the firth of Clyde, and among the Hebrides, in the month of June, in small shoals of seven or eight, but more frequently in pairs; and depart again in July. "They had nothing (says Mr. Pennant), of the fierce and voracious nature of other sharks, and were so tame as to suffer themselves to be stroked: they generally lay motionless on the surface, commonly on their bellies, but sometimes, like tired swimmers, on their backs: their food seemed to consist entirely of sea-plants, no remains of fish being ever discovered in the stomachs of numbers that were cut up, but the half-digested parts of algæ, &c." Linnæus says they feed on medusæ.

Mr. Pennant adds, that a shoal of this species will permit a boat to follow them without accelerating their motion till almost within contact, when it is usual for the harpooner to strike his weapon into them as near the gills as possible; but that they are often so insensible as not to move till the united strength of two men has forced in the harpoon deeper. As soon as they perceive themselves wounded, they fling up their tail, and plunge headlong to the bottom, and frequently coil the rope round them in their agonies, attempting to disengage the harpoon from them by rolling on the ground, for it is often found greatly bent. As soon as they discover that their efforts are in vain, they swim away with amazing rapidity, and with such violence, that there has been an instance of a vessel of seventy tons having been towed away against a fresh gale: they sometimes run off with two hundred fathom of line, and with two harpoons in them, and will employ the fishers for twelve, and sometimes for twenty-four hours, before they are subdued: when killed, they are either hawled on shore, or, if at a distance from land, to the vessel's side: the liver (the only useful part) is taken out, and marked out, and melted into oil in kettles provided for the purpose. A large fish will yield eight barrels of oil, and two of useless sediment. The fishers observed on these sharks a sort of leech, of a reddish colour, and about two feet long, but which fell off when the fish was brought to the surface of the water, and left a white mark on the skin.

3. Squalus catulus. Spotted shark. Lesser spotted dog-fish. Habit rather slender: length from two to three feet; head large; snout prominent, and slightly pointed; skin rough; body cylindric; colour pale brick-red, marked with very numerous, small, rounded, blackish, or dusky spots; abdomen whitish; both the dorsal fins placed much nearer to the tail than the head; ventral fins connate, large, and of a slightly pointed form; anal fin small; tail long, bilobate, with the lower lobe continued to a considerable distance beneath. Native of the European seas: a very voracious animal, preying on the smaller fishes, crabs, &c. According to Pennant it breeds from nine to thirteen young at a time, is very numerous on our own coasts, and very injurious to the fisheries: the liver is said to be highly noxious, causing long-continued stupor, succeeded by an universal itching, with a total desquamation of the cuticle.

4. Squalus stellaris. Rock shark, or greater spotted dog-fish. The general colour of this animal is a reddish grey, with round, unequal, blackish spots scattered over the whole body. The male and female are said to differ as to the disposition of spots. Native of the European seas, generally frequenting rocky places, and preying on various mollusca and crustacea. Its skin is used in commerce for the same purposes as those of other small sharks, and the flesh is esteemed somewhat more eatable than that of the former species. In Edwards's figure of the young of this fish, the body is represented as barred across the back with several broad brown bands.

5. Squalus ocellatus. Ocellated shark. Length about two feet and a half: colour ash-brown, with a few scattered dusky spots; back crossed by a few dusky bands; abdomen greenish-grey: teeth numerous, small, sharp, compressed, and dilated at the base: pectoral fins rounded, and of a dusky or blackish colour, edged with white; first dorsal fin situated beyond the ventral, marked at its anterior edge with two black spots, and emarginated behind; second of similar shape, but smaller: anal fin placed very near the tail, which is slightly sublobate. Native of the southern Pacific: observed about the coasts of New Holland during the first voyage of sir Joseph Banks.

6. Squalus zygæna. Hammer-headed shark. Perhaps the most deformed of all the marine animals. Length from five to fifteen or seventeen feet: habit rather slender; body subcylindric: head dilated on each side to a great extent; the eyes, which are very large, being placed at each extremity; mouth beneath, as in other sharks; teeth sharp, denticulated on each side, and disposed in three rows in each jaw; first dorsal fin rather large, of a somewhat falcated shape, and placed towards the upper part of the back; the second much smaller, and situated near the tail, which is rather short than long, and lobed beneath, the fin running on nearly as far as the vent; colour brown above, paler or whitish beneath. Native of the Mediterranean and Indian seas, where it is scarcely less voracious and formidable than even the white shark itself; attacking such as are accidentally exposed to its fury, or are incautiously bathing or swimming in its neighbourhood. It is observed about the coasts of the southern islands, and particularly of Otaheite, where the natives, trusting to their dexterity in swimming, appear to

hold it in but little dread, since they bathe without apprehension in places known to be infested by it. This fish is said to produce about ten or fourteen young at a birth. See Plate Nat. Hist. fig. 375.

7. Squalus pristis. Saw-snouted shark. The saw-fish is a large species of shark, growing to the length of fifteen feet or more: the head is slightly flattened at the top, and is produced in front into a very long, flat, straight, and slightly tapering bony snout, covered, like the rest of the animal, by minute scales: along the edges project a great number of very strong, large, slightly flattened, and very sharp-pointed toothlike processes: the mouth, as in other sharks, is placed beneath, and is furnished on the edges of the jaws with several rows of small and somewhat blunt teeth, paving the lips, as in some of the rays. The habit of the fish is rather slender; the body convex above, and somewhat flattened beneath; the dorsal fins placed as in the squalus acanthias and several others. The saw-fish is an inhabitant of the Mediterranean and northern seas, and was known to the ancient writers by the title of pristis. In the embryo animal the edges of the snout are observed to be nearly smooth, or but slightly undulated by the projection of the incipient teeth or processes, which are supposed to be of very quick growth.

SQUARE. See GEOMETRY.

SQUARE NUMBER, the product of a number multiplied into itself.

SQUARE, *in the military art*, a particular formation into which troops are thrown on critical occasions; particularly to resist the charge of cavalry.

SQUARE, *solid*, is a body of foot, where both ranks and files are equal. It was formerly held in great esteem; but when the prince of Nassau introduced the hollow square, this was soon neglected.

SQUARE, *hollow*, is a body of foot drawn up, with an empty space in the centre, for the colours, drums, and baggage, facing every way to resist the charge of the horse.

SQUARE, *oblong*, a square which is not at right angles, but represents the figure of an oblong, whose sides are unequal. Thus as eight companies of equal numbers would form a perfect square, ten make an oblong.

SQUARE, *perfect*, a square whose sides are equal and at right angles. The perfect square, in the formation of troops, seems best calculated for military movements and arrangements. Battalions, for instance, which are composed of eight companies, with one hundred rank and file in each, are equal to every species of disposition. It is upon this principle, we presume, that the French have distributed their infantry. British regiments, on the contrary, consist of ten companies, and are so composed that no square of this kind can be formed. This is manifestly a defect in our system. It is indeed remedied by the grenadier and light infantry companies being occasionally detached, or cast into separate battalions; so that the remaining companies, by being told off, are brought to eight equal parts.

SQUARE ROOT. See ALGEBRA, and ARITHMETIC.

SQUIRREL. See SCIURUS.

STACHYS, a genus of plants belonging to the class of didynamia, and order of gymnospermia; and in the natural system arranged under the 42d order, verticillatæ. The upper lip of the corolla is arched, the lower lip reflexed, and the larger intermediate lacinia is marginated. The stamina, after shedding the farina, are bent towards the sides. There are 24 species. Four only are natives of Britain; viz. 1. Sylvatica, hedge-nettle. The plant is hairy all over, erect, a yard high, and branched. The whole plant has a strong fetid smell. It grows commonly in woods and shady places, and flowers in July or August. It will dye yellow. 2. Palustris, clown's all-heal. The roots are white and tuberous. The stalk is branched at the bottom, and two or three feet high. The flowers are red or purple. This plant has a fetid smell and bitter taste, and is reckoned a good vulnerary. It grows on the sides of rivers and lakes, in low moist grounds, and sometimes in corn-fields. 3. Germanica, base horehound. The stem is downy, and about two feet high. The leaves are white, downy, wrinkled, and indented. The flowers are white, purplish within, and grow in multiflorous whorls. It grows in England. 4. Arvensis, corn-stachys, petty ironwort, or all-heal. The stalk is ten or twelve inches high, square, branched, and hairy. It is frequent in corn-fields, and grows from June to August.

STADIUM, an antient Greek long measure, about a furlong.

STÆHELINA, a genus of plants belonging to the class of syngenesia, and order of polygamia æqualis; and in the natural system arranged under the 49th order, compositæ. The receptacle is paleaceous, the chaff being very short; the pappus is branchy, and the antheræ caudated. There are 10 species, the gnaphaloides, dubia, arborescens, fruticosa, ilicifolia, corymbosa, chamæpeuce, imbricata, spinosa, and hastila.

STAG. See CERVUS.

STAG-BEETLE. See LUCANUS.

STALACTITÆ, or STALACTAGNIA, stony concretions resembling icicles, in natural history, or crystalline spars formed into oblong, conical, round, or irregular bodies, composed of various crusts, and usually found hanging in form of icicles from the roofs of grottoes, &c. See SPAR.

Of this class there are various species: as the hard, white stalactitæ; the white, shattery stalactitæ; and the yellow, shattery, crystalline stalactitæ. See Plate Nat. Hist. fig. 384.

STALAGMITIS, a genus of the monœcia order, in the polygamia class of plants; and in the natural method ranking under the 38th order, tricoccæ. The calyx is either quadriphyllous or hexaphyllous; the corolla consists of four or of six petals; the receptacle is fleshy, and somewhat square-shaped; the filaments about 30. In the hermaphrodite flower the stylus is short, thick, and erect; the fruit is a berry of a globular shape, unilocular, and browned with the stylus and stigma: they contain three oblong jointed triangular seeds. Of this there is only one species, viz. the cambogioides, a native of the East Indies and of the warmer parts of America. From this plant is obtained the gutta cambogia, or gum gamboge of the shops. See GUM RESINS, and GAMBOGE.

Till very lately botanists were at a loss for the true nature of the plant which yields this gum. Koenig, a native of Ireland, and an excellent botanist, travelled over a great part of India, and collected a great number of new plants, and among the rest the stalagmitis. These he bequeathed to sir Joseph Banks.

STALK. See BOTANY.

STAMINA. See BOTANY.

STAMINA, in the animal body, are defined to be those simple original parts, which existed first in the embryo. See PHYSIOLOGY.

STAMP DUTIES, a branch of the public revenue, raised by requiring, that all deeds or documents, in order to be valid, shall be written on paper or parchment bearing a public mark or seal, for which a tax is paid.

Stamp-duties are said to have originated in Holland, and were introduced into England in 1671, by "an act for laying impositions on proceedings at law:" these duties were very numerous, and were at first granted for nine years; they were afterwards continued for three years from 1680, when, in consequence of the unfortunate jealousies between the crown and parliament, they were suffered to expire. It was not long, however, before the necessities of the government caused this mode of taxation to be again resorted to as a source of revenue more to be depended on than some of the taxes which then existed: an act was accordingly passed in 1694, for imposing several duties upon vellum, parchment, and paper, which may be considered as the commencement of the present stamp-office, as a particular set of commissioners were then appointed for managing the duties; and about four years after, several new duties were granted, to continue for ever, to which numerous additions have at different times been since made.

The total gross produce of the stamp-duties, in the year 1713, was 107,779*l.*, the charges of management of which amounted to 14,296*l.*, leaving a nett produce of only 93,483*l.* In 1723, the nett produce had increased to 130,409*l.*; and it seldom exceeded this amount till 1757, when some new stamp-duties were imposed, by which the total nett amount of this revenue was increased to 267,725*l.*: in 1766 it amounted to 285,266*l.*; and no material additions were made till towards the conclusion of the American war. In 1782, a duty was imposed on fire-insurances, which, though not actually collected by means of stamps, was classed with the stamp-duties. In 1784, additional duties were laid on gold and silver plate. In 1785, duties were laid on post-horses, quack medicines, game-licences, attorneys' licences, and pawnbrokers; all of which were deemed stamp-duties, and considerably augmented the annual amount. But a far greater increase took place in the course of the war which began in 1793, during which new stamp-duties were imposed on receipts, bills of exchange, attorneys' articles, sea-insurances, licences to wear hair-powder, horse-dealers' licences, legacies, hats, stage-coaches, deeds, armorial bearings, small notes, medicines, and several other articles, which soon increased this branch of the revenue to more than double its former amount; and it is a mode of taxation which it is in general so difficult to evade, and is attended with such a comparatively small expence in collecting, that there can be little doubt that it will be extended as far as possible.

Total gross produce of the stamp-duties of

Great Britain, in the year ending 5th January 1806:

England and Wales	£3,931,616	8	$6\frac{3}{4}$
Scotland - -	262,669	4	$3\frac{1}{2}$
	£4,194,285	12	$10\frac{1}{4}$

This amount is subject to various deductions, as, the charges of management, discounts, and other parliamentary allowances, the cost of parchment and paper for the country distributors, an allowance to the two universities on almanacks, and many incidental expences, which reduced the actual nett produce paid into the exchequer to the following sums:

England and Wales	£3,672,793	5	2
Scotland - -	246,170	17	2
	3,918,964	2	4

The expence of collection amounted to 3*l*. 5*s*. per cent. on the gross revenue, or 3*l*. 9*s*. 5*d*. per cent. on the nett produce, which is considerably less than the management of this branch of the public income amounted to a few years back.

The total gross produce of the stamp-duties of Ireland for the year ending 5th January 1806, was 501,943*l*. 9*s*. $10\frac{1}{4}$*d*., and the nett sum paid into the exchequer 456,535*l*. 11*s*. $4\frac{1}{4}$*d*.; the expence of collection amounted to 5*l*. 0*s*. 1*d*. per cent. on the gross produce, or 5*l*. 7*s*. $6\frac{1}{4}$*d*. per cent. on the nett produce.

The following are the stamp-duties at present in force:

Actions, entry of, in inferior courts, for 40*s*. and upwards, 1*s*. 6*d*. 12 Geo. c. 22.

Acts. See Notarial Acts.

Adjudications, apprisings, charter, resignation, clare-constat, cognition of heirs, heritable right, confirmation, novodamus, principal and original instrument of surrender, retour, sasine, and service in Scotland, 9*s*. 6*d*. 37 Geo. III. c. 90.

Administration. See Probate.

Admiralty, or cinque-ports. Any answer exhibited in these courts, 7*s*. 41 Geo. III. c. 86.

Any libel, allegation, deposition, or inventory, exhibited in the courts of admiralty or cinque-ports, 5*s*. 37 Geo. III. c. 90.

Any copy of any citation, monition, or answer, made in the courts of admiralty or cinque-ports, 5*s*. 37 Geo. III. c. 90.

Any copy of any libel, allegation, deposition, or inventory, exhibited in the courts of admiralty or cinque-ports, 5*s*. 37 Geo. III. c. 90.

Any personal decree, warrant, or monition, in any court of admiralty, or the cinque-ports, or any copy thereof, 10*s*. 27 Geo. III. c. 90.

Any sentence given in the courts of admiralty or cinque-ports, or any attachment made out by the same, or relaxation thereof, 1*l*. 37 Geo. III. c. 90.

Any sentence or final decree exhibited in the courts of admiralty or cinque-ports, or any copy thereof, 4*s*. 37 Geo. III. c. 90.

Admission into corporations or companies, 8*s*. 37 Geo. III. c. 90.

Admission into any inn of chancery, 4*l*. 2*s*. 37 Geo. III. c. 90.

Admission into any of the four inns of court, 16*l*. 4*s*. 37 Geo. III. c. 90.

Admittance of fellow of college of physicians, attorney, clerk, advocate, proctor, notary, or other officer of any court whatsoever in Great Britain, except under 10*l*. per annum, 16*l*. 37 Geo. III. c. 50.

Advertisement in newspapers, 3*s*. 37 Geo. III. c. 50.

Advertisement in periodical pamphlets, 3*s*. 29 Geo. III. c. 50.

Advocate. See Admittance.

Affidavit in any court of law or equity, at Westminster, or in any court of great session for the counties in Wales, or in the court of the county palatine of Chester, or copies thereof, 2*s*. 35 Geo. III. c. 30.

Affidavits in inferior courts, 1*s*. 35 Geo. III. c. 30.

Agreements (except where the matter of agreement shall not exceed twenty pounds, and also except those for lease at rack rent) of messuages under five pounds, those for hire of labourers, artificers, manufacturers or menial servants, and those relating to sale of goods, &c. 10*s*. 37 Geo. III. c. 90.

No memorandum or agreement written upon an unstamped paper shall be deemed void, in case it is stamped at the head office and the duty paid within 21 days after the same shall have been entered into.

Allegation. See Citation.

Almanack, book or sheet, 8*d*. 37 Geo. III. c. 90.

Answer in court of equity. See Bills, copy.

Answer, sentence, and final decree, in ecclesiastical courts, and copies thereof, and copies of citation or monition, 2*s*. 23 Geo. III. c. 58.

Appeal, writ of. See Certiorari.

Appeal from the admiralty, arches, or prerogative courts of Canterbury or York, 12*l*. 37 Geo. III. c. 90.

Appearance on common bail, in the courts at Westminster, great sessions, or counties palatine, 1*s*. 6*d*. 32 Geo. II. c. 35. In all other courts, 1*s*.

Appearance on special bail, 2*s*. 10 W. III. c. 25.

Apprentices. The stamps upon apprentices' indentures amount to 25*s*. for each indenture, except parish-apprentices, or charity-children, for whom a sixpenny stamp is sufficient. Also where the fee given with the apprentice does not amount to 10*l*., each indenture is subject to a stamp of 15*s*. only. See Deeds.

And if a fee is given with an apprentice, clerk, or servant, bound or articled for a term of years, the following duty must be paid in respect of such fee:

From 1*l*. to 50*l*. sixpence for every pound.

All above 50*l*. and upwards, 1*s*. for every pound; to be paid by the master or mistress.

The full sum given must be set down in the indentures, or forfeit double the amount if the deception can be discovered.

And the indentures must be brought to the stamp-office: if executed within the bills of mortality, within one month; or if executed in the country, to their agents within two months after binding, and the duty paid, or the indentures become void, and forfeit 50*l*. besides.

Apprisings. See Adjudication.

Articles of clerkship. See Attorneys' clerks.

Assignments. See Deeds.

Assignments of bail-bonds, 1*s*. 10 W. III. c. 25.

Assurance of houses and policy. See Insurance.

Attachment in admiralty or cinque-ports, 1*l*. 37 Geo. III. c. 90.

Attested copies. See Copy.

Attorney, letter of. See Deeds.

Attorney, admittance of. See Admittance.

Every solicitor, attorney, notary, proctor, agent, or procurator, practising in any of the courts at Westminster, ecclesiastical, admiralty, or cinque-port courts, in his majesty's courts in Scotland, the great sessions in Wales, the courts in the counties palatine, or any other courts holding pleas to the amount of 40*s*. or more, shall take out certificates annually, upon which there shall be charged, if the solicitor, &c. reside in any of the inns of courts or in London, Westminster, Southwark, St. Pancras, St. Mary-le-bone, or within the bills of mortality, a stamp-duty of 5*l*.; in any other part of Great Britain, 3*l*. 25 Geo. III. c. 80.

And every solicitor, attorney, notary, proctor, agent, or procurator, in any court in England, holding pleas of 40*s*., shall annually, between November 1. and the end of Michaelmas term, deliver at the head office for stamps, a note containing his name and place of abode; and thereupon, and upon payment of the duties in respect of his abode, every such person shall be entitled to his certificate, to be issued by the commissioners of stamps, or their proper officer. 37 Geo. III. c. 90.

And every such certificate so obtained, shall be entered with the proper officer of the court where the party shall practise, who shall be paid 1*s*. for the entry, and the books of such entry may be inspected by all persons gratis.

And every such certificate shall bear date the 2d day of November, and shall cease on the 1st day of November next following.

Persons who shall, from and after the 1st day of November, 1797, act without obtaining a certificate, or without entering the same as aforesaid, or shall deliver in to any person at the stamp-office any account of a residence with intent to evade the higher duties, shall forfeit 50*l*. and be incapable of suing for any fees.

And every person admitted, sworn, inrolled, or registered in any of the courts, who shall neglect to obtain his certificate in manner aforesaid for the space of one whole year, shall from thenceforth be incapable of practising in his own name, or in the name of any other; but the courts may re-admit him on payment of the duty accrued since the expiration of his last certificate, and such further sum as the court shall order by way of penalty.

And by 39 and 40 Geo. III. c. 72. from and after November 1., 1800, every person who shall act as a public notary, or use or exercise the office of a notary in any manner, or do any notarial act whatsoever, without having been duly admitted in the court where notaries are usually admitted, and without having delivered in his name and usual place of residence, and taken out such certificate as is directed by the acts, shall forfeit 50*l*. and be incapable to do any act as a notary-public, or recover any fee.

Attorneys' clerks. By 34 Geo. III. c. 14, there shall be paid for every contract in writing, whereby any person shall become bound to serve as a clerk, in order to his admission as a solicitor or attorney, the additional duties following, viz. For every piece of vellum, parchment, or paper, upon which shall be written any such contract, whereby any person shall become bound to serve as a clerk as aforesaid, in order to his admission as a solicitor or attorney in any of the courts at Westminster, there shall be charged a stamp-duty of 100*l.*

And in order to his admission as a solicitor or attorney in any of the courts of great session in Wales, or in the counties palatine of Chester, Lancaster, or Durham, or in any court of record in England, holding pleas to the amount of 40*s.* and not in any of the said courts at Westminster, there shall be charged a stamp-duty of 50*l.*

Award, 10*s.* 37 Geo. III. c. 90.

Bail-bonds, and assignments thereof, 1*s.* 10 W. III. c. 25.

Beneficial warrant under sign manual (except for navy, army, or ordnance), 1*l.* 5*s.* 37 Geo. III. c. 90.

Bill of exchange, promissory or other note, draft, or order, where the sum amounts to 40*s.* and does not exceed 5*l.* 5*s.*, 6*d.* 41 Geo. III. c. 10.

Above 5*l.* 5*s.*, and not exceeding 30*l.*, 1*s.* 41 Geo. III. c. 10.

Above 30*l.*, and not exceeding 50*l.*, 1*s.* 6*d.* 41 Geo. III. c. 10.

Above 50*l.*, and not exceeding 100*l.*, 2*s.* 41 Geo. III. c. 10.

Above 100*l.*, and not exceeding 200*l.*, 3*s.* 41 Geo. III. c. 10.

Bills and notes not exceeding 200*l.* value, and for every bill of exchange, promissory or other note, draft or order, payable on demand, or otherwise, where the sum shall exceed 200*l.*, there shall be charged 4*s.* 41 Geo. III. c. 10.

Foreign bills of exchange, drawn in sets according to the custom of merchants, where the sum shall not exceed 100*l.*, 1*s.* 1*d.* 41 Geo. III. c. 10.

Above 100*l.*, and not exceeding 200*l.*, 1*s.* 6*d.* 41 Geo. III. c. 10.

And exceeding 200*l.* 2*s.* 41 Geo. III. c. 10.

Bill of lading, 2*s.* 37 Geo. III. c. 90.

Bill of Middlesex. See Original Writ.

Bills, answers, replications, rejoinders, demurrers, interrogatories, depositions taken by commissions, and other proceedings in courts of equity, 2*s.* 6*d.* 23 Geo. III. c. 58.

Bonds (except such as are given as security for money), 15*s.* 41 Geo. III. c. 86.

Coast bonds, and bonds on wills or administrations not exceeding 20*l.*, and bonds given by the widow of any soldier or sailor, are exempt from the duty imposed by 37 Geo. III. c. 90.

Bonds given as security for payment of money, if not above 100*l.*, 15*s.* 41 Geo. III. c. 86.

Above 100*l.*, and under 500*l.*, 1*l.* 37 Geo. III. c. 90.

If of 500*l.* or upwards, 1*l.* 10*s.* 37 Geo. III. c. 90.

When the amount shall be of the value of 100*l.* or upwards, 2*l.* 37 Geo. III. c. 90.

When the amount shall be of the value of 200*l.* or upwards, 3*l.* 37 Geo. III. c. 90.

When the amount shall be of the value of 5000*l.* or upwards, 5*l.* 37 Geo. III. c. 90.

Briefs for collecting charitable benevolence, &c. 4*l.* 23 Geo. III. c. 58.

Capias writ. See Original Writ.

Cards per pack, 2*s.* 6*d.* 41 Geo. III. c. 86.

Catalogue. See Inventory.

Certificate of barrister in any of the inns of court, 28*l.* 37 Geo. III. c. 90.

Certificate or debenture for drawback, 4*s.* 37 Geo. III. c. 90.

Certificate of marriage, except of seamen's widows, 5*s.* 5 W. III. c. 21.

Certificate. See Register, Registry, Sacrament.

Certiorari, writ of error, or writ of appeal, except to delegates, 10*s.*

Certificate to kill game, 3*l.* 3*s.* See Game.

Certificate of appointment of game-keeper, 10*s.* 6*d.*

Certificate for wearing hair-powder, 1*l.* 1*s.* 41 Geo. III. c. 69.

Certificate for attorneys. See Attorney.

Charter. See Adjudication.

Charter-party. See Deeds.

Charity-children's indenture. See Apprentice.

Citation or monition, libel or allegation, deposition or inventory, exhibited in any ecclesiastical court, and all copies thereof (except copies of citation or monition, for which see Answer), 2*s.* 6*d.* 23 Geo. III. c. 58.

Clare-constat. See Adjudication.

Clerk. See Admittance.

Clerks to attorneys. See Attorneys' Clerks.

Cognition of heirs. See Adjudication.

Collation, donation, or presentation to any ecclesiastical dignity, promotion, or benefice, of the yearly value of 10*l.* and upwards in the king's books, 12*l.* 37 Geo. III. c. 90.

And to any other benefice, dignity, or spiritual or ecclesiastical promotion, 6*l.* 37 Geo. III. c. 90.

Commission, ecclesiastical, 5*s.* 10 W. III. c. 25.

Common bail in the courts at Westminster, great sessions, or county palatine, 1*s.* 6*d.* 32 Geo. II. c. 35.

Confirmation. See Adjudication.

Contract. See Deed.

Conveyance, surrender, or grants of offices, release, or other deed inrolled in any court of record, or by any custos rotulorum, or clerk of the peace, 1*l.* 37 Geo. III. c. 90.

Copy of court-roll. See Surrender.

Copy of depositions in chancery, or other court of equity at Westminster, copy of any bill, answer, plea, demurrer, replication, rejoinder, interrogatories, or other proceedings whatsoever, in such courts of equity, 3*d.* 19 Geo. III. c. 66.

Copies of wills, 6*d.* 37 Geo. III. c. 90.

Any copy purporting to be a true copy, or attested to be a true copy, of any indenture, lease, or other deed, or any part thereof, for the security or use of any person, being a party to the same deed, and not having the custody of the original, or where such copy shall not be made in lieu of such original, 6*s.* 8*d.* 40 Geo. III. c. 72.

And the number of stamps required to be used for such copies of deeds is, one for every ten common law sheets of 72 words: but if after a calculation of that number, there shall remain a number of words less in quantity than ten common law-sheets, no further stamp is required for the excess.

And by 39 and 40 Geo. III. c. 72. from August 1, 1800, in lieu of the stamp-duty o 6*s.* 8*d.* upon the copy of any deed, when it is for the use of any person, other than any of the parties to the same deed, and who shall not have the custody of the original, or where such copy shall not be made in lieu of such original, there shall be paid a stamp-duty of 6*d.* on every piece of vellum or parchment, or sheet or piece of paper, on which any such copy shall be written.

And the number of stamps to be put upon every copy, is to be calculated according to the last act.

And by 39 and 40 Geo. III. c. 84. copies of indentures or other deeds, liable to the duties granted by 37 Geo. c. 90., may be stamped within sixty days after date of the attestation, on payment of the duty only.

Copy of any surrender of, and admittance to, any custom-right estate, not being copyhold, which shall pass by surrender and admittance only, and which shall not pass by deed, within England, Wales, and town of Berwick upon Tweed, 12*s.* 41 Geo. III. c. 86.

Copyhold estate. See Surrender.

Covenant, writ of. See Writ of Covenant.

Debenture for drawbacks. See Certificate.

Declaration, plea, replication, rejoinder, demurrer, or other pleading whatsoever, in any court of law at Westminster, or in any of the courts of the principality of Wales, or in any of the counties palatine of Chester, Lancaster, or Durham, and copies thereof, 3*d.* 32 Geo. II. c. 35.

Declaration, plea, replication, rejoinder, demurrer, or other pleading whatsoever, in any inferior court of law, and copies thereof, 2*d.* 10 W. III. c. 15.

Decree, personal. See Warrant.

Dedimus potestatem. See Original Writ.

Deeds. Any indenture (except parish-indentures), lease or deed-poll; and any charter-party, release, contract, or other obligatory instrument; or any procuration of letters of attorney; for every 15 common law-sheets, of 72 words each, 15*s.* 41 Geo. III. c. 86.

And moreover, by 37 Geo. III. there shall be paid upon every deed which shall be made after August 1, 1797, an additional stamp-duty of 10*s.* over and above all duties now payable on the vellum or paper whereon such deed shall be engrossed (but this is upon the first skin only), the provisions of this act being as follow:

It shall not extend to any bond or letter of attorney, bearing date before Aug. 1, 1797.

Also it shall not extend to any indenture of apprenticeship, where a sum not exceeding 10*l.* shall be given; nor to any lease for not exceeding twenty-one years, the full and improved value whereof, and rent reserved thereby, shall not be more than 10*l.* nor to any lease for lives, or years determinable on lives, where the fine shall not exceed 20*l.* nor the rent reserved 40*l.*

But by 39 and 40 Geo. III. c. 42, the above duties shall extend to every deed, which by lease may form, or is intended to form, a part of any conveyance of lands or tenements, whereby a greater interest in the same shall be conveyed than a term of twenty-one years, whatever may be the value thereof.

Nor shall any deed be subject to the payment of any greater duty than the sum before mentioned, or to be stamped on more than one skin, with the additional stamp; or to be stamped with more than one such stamp.

Nor shall the duty by this act imposed, be liable to the regulations respecting the stamping of parchment and paper, according to the number of common law-sheets engrossed thereon.

Upon payment, within sixty days after the date of the deed, of the duty hereby imposed, the stamp-officers may stamp any vellum, parchment, or paper, to which any deed shall have been engrossed, or on which any deed shall be intended to be engrossed with the additional stamp.

And if the duty shall not be paid within sixty days, then it shall be lawful to send the deed to the head office, and on payment of the duty, and the further sum of 10*l.* by way of penalty, the same may be stamped.

But grants, conveyances, and assurances, under the seal of the duchy of Lancaster, according to 19 Geo. III. c. 45. where the consideration does not exceed 10*l.* are exempted by that act, and 39 and 40 Geo. III. c. 72. from all duty.

The number of stamps required to be used on deeds, is, one for every fifteen common law-sheets (of seventy-two words each) contained in the deed, or in any schedule or instrument annexed thereto, or any indorsement thereon.

Deeds to be inrolled. See Conveyance.

Degrees in universities. See Register.

Demurrer at law. See Declaration.

Demurrer in equity. See Bills, copy.

Depositions in courts of equity. See Bills.

Depositions in ecclesiastical courts. See Citation.

Dice, per pair, and all other things used for any game of chance, 17*s.* 6*d.* 41 Geo. III. c. 86.

Dispensation to hold two ecclesiastical dignities, or benefices, or other dispensation from the archbishop of Canterbury, 20*l.* 37 Geo. 3. c. 90.

Donation. See Collation.

Draft for money. See Bill of Exchange.

Drawbacks. See Certificate.

Ecclesiastical commission. See Commission.

Entry, writ of. See Writ of Covenants.

Error, writ of. See Certiorari.

Exemplifications under the seal of any court, 2*l.* 37 Geo. 3. c. 90.

Faculty from the archbishop of Canterbury, or master of the faculty, 20*l.* 37 Geo. 3. c. 90.

Fellow of the college of physicians. See Admittance.

Final decree. See Answer.

Grant, or letters patent. Any grant or letters patent, under the great seal, or the seal of the duchy of Lancaster, of any honour, dignity, promotion, franchise, liberty, or privilege, or the exemplification thereof, 16*l.*. 37 Geo. 3. c. 90.

Grant from his majesty of money exceeding 100*l.*, which shall pass the great seal or privy seal, 12*l.* 37 Geo. 3. c. 90.

Grant of land in fee, lease for years, or other profits, not particularly charged under the great seal, seal of exchequer, duchy or county palatine of Lancaster, or privy seal, 10*l.* 37 Geo. 3. c. 90.

Grant of office or employment above 50*l.* a year, 6*l.* 12 Anne c. 9.

If above 100*l.* (to be calculated on the salary, fees, and perquisites), 12*l.* 37 G.3.c. 90.

Habeas corpus, 5*s.* 5 W. 3. c. 21.

Hats. Duty on every hat of 4*s.* or under, 3*d.* 36 G. 3. c. 12.

Above 4*s.* and not exceeding 7*s.*, 6*d.* 36 G. 3. c. 12.

Above 7*s.* and not exceeding 12*s.*, one shilling. 36 G. 3. c. 12.

Above 12*s.* and upwards, 2*s.* 36 Geo. 3. c. 12.

Heritable right. See Adjudication.

Horses. See Race-horses.

Indenture. See Deed.

Indentures, parish or charity. See Apprentices.

Institution, or licence ecclesiastical, in England, Wales, or Berwick upon Tweed (except licences of any ecclesiastical court or ordinary, appointing any stipendiary curate, in which the annual amount of the stipend shall be inserted), 1*l.* 10*s.* 37 G. 3. c. 90.

Instrument obligatory. See Deed.

Insurance of houses or goods from fire, 2*s.* per cent. 37 G. 3. c. 90.

Insurance upon any ship, goods, or merchandize, when the sum shall amount to 100*l.* five shillings, 41 G. 3. c. 10. and so progressively for every sum of 100*l.* insured.

And where the sum to be insured shall not amount to 100*l.* a like duty of five shillings. 41 G. 3. c. 10.

And where the sum to be insured shall exceed 100*l.* or any progressive sums of 100*l.* each, by any fractional part of 100*l.*, a like duty for each fractional part of 100*l.*, five shillings. 41 G. 3. c. 10.

And upon every insurance where the premium shall not exceed the rate of 20*s.* there shall be paid where the sum shall amount to 100*l.* a duty of 2*s.* 6*d.*: and so progressively for every sum of 100*l.* so insured. 41 G. 3. c. 10.

And where the sum to be insured shall not amount to 100*l.* a like duty of 2*s.* 6*d.*

And where the sum to be insured shall exceed 100*l.* or any progressive sums of 100*l.* each, by any fractional part of 100*l.* a like duty of 2*s.* 6*d.* 41 G. 3. c. 10.

Which duties shall be payable by the assured.

This does not extend to any insurance of houses, furniture, goods, wares, merchandizes, or other property, from loss by fire, already subject to duty, nor any insurance on lives. 41 G. 3. c. 10.

Interrogatories. See Bills, copy.

Inventories or catalogue of furniture with reference to any agreement, 5*s.* 37 Geo. 3. c. 90.

Inventory in ecclesiastical courts. See Citation.

Judgment. See Record.

Lading. See Bill of Lading.

Latitat. See Original Writ.

Lease of land, house, &c. See Deed.

Lease for years, or other profits, not particularly charged, under the great seal, seal of exchequer, duchy or county palatine of Lancaster, or privy seal, 10*l.* 37 G. 3. c. 90.

Lease by copy of court roll. See Surrender.

Legacies, wives, children, and grandchildren, to pay for a legacy or share of a personal estate.

Of the value of 20*l.* or under, 2*s.* 6*d.* 20 G. 3. c. 28.

Above 20*l.* and under 100*l.*, five shillings. 20 G. 3. c. 28.

For 100*l.* and upwards, 1*l.* 20 G. 3. c. 28.

Any other lineal descendant, or the father, mother, and other lineal ascendant, or the husband of the deceased, to pay for a legacy or share of a personal estate.

Of the value of 20*l.* or under, 5*s.* 23 G. 3. c. 58.

Above 20*l.* and under 100*l.* ten shillings. 23 G. 3. c. 58.

For 100*l.* two pounds. 23 G. 3. c. 58.

For 200*l.* three pounds. 23 G. 3. c. 58.

For 300*l.* four pounds. 23 G. 3. c. 58.

And for every further sum of 100*l.* two pounds. 29 G. 3. c. 51.

All collateral relations, and strangers, to pay for a legacy or share of a personal estate, under the value of 20*l.* five shillings. 23 G. 3. c. 58.

Letter of attorney for transfer or disposal of stock, or any other purpose, fiteen shillings. 41 G. 3. c. 86.

Letters of administration. See Probate.

Letters of mart. See Mart.

Letters patent. See Grant.

Libel. See Citation.

Licence ecclesiastical. See Institution.

Licence to pawnbrokers within the bills of mortality, 10*l.* per annum.

Out of the bills, 5*l.* per ann. 25 G. 3. c. 48.

Licence for marriage, 5*s.* 5 W. 3. c. 21.

Licence for selling quack medicines. See Medicines.

Licence for retailing beer and ale, 2*l.* 2*s.*

Licences for spirituous liquors, sweets, and wines, to be taken out annually at the excise-office.

Licence for a mad-house, 5*s.*

Licence to keep lying-in hospitals, 5*s.*

Licence to keep lottery-office, in London, Edinburgh, or Dublin, 50*l.*, elsewhere 10*l.*

Mandate. See Original Writ.

Marine Insurance. See Insurance.

Marriage licence. See Licence.

Mart, letters of, 1*l.* 10*s.* 37 G. 3. c. 90.

Matriculation in the universities, 8*s.* 37 G. 3. c. 90.

Medicines. See Quack Medicines.

Middlesex, bill of. See Original.

Monition. See Citation, Warrant.

Newgate, and general circuit pardon, 4*l.* 23 G. 3. c. 58.

Newspapers. Every newspaper, or paper containing public news, intelligence, or occurrences, contained in half a sheet or less, 3½*d.* 37 G. 3. c. 90.

Being larger than half a sheet, and not exceeding a whole sheet, 4*d.* 37 G. 3. c. 90.

Nisi prius. See Record.

Notary. See Admittance, and Attorney.

Notarial acts. Any protest or notarial act whatever, 4*s.* 37 G. 3. c. 90.

Note, promissory. See Bills of Exchange.

Novodamus. See Adjudication.

Obligatory instrument. See Bond.

Officer of any court. See Admittance.

Order for payment of money. See Bills of Exchange.

Order in any court of Westminster, and copy, 1*s.* 6*d.* 32 G. 2. c. 35.

Original Writ (unless præ capias), subpœna, bill of Middlesex, latitat, writ of capias, quo minus, writ of dedimus potestatem, every other writ, process, or mandate, for 40*s.* or upwards, 3*s.* 6*d.* 35 G. 3. c. 30.

Pamphlets of half a sheet, or less, ½*d.*

——— of one sheet, 1*d.*

——— per sheet, for every sheet in one copy of every pamphlet not exceeding six sheets in octavo, or a less size, twelve sheets in quarto, and twenty in folio, 2*s.*

Pardon of corporal punishment, crime, forfeiture, offence, or money above 100*l.* twelve pounds. 37 G. 3. c. 90.

Pardon. See Newgate Pardon.

Parish, charity indentures. See Apprentice.

Passports, 2*s.* 37 Geo. 3. c. 90.

Patents. See Grant.

Personal decree. See Warrant.

Plate. All gold plate made or wrought in Great Britain, except watch-cases, per oz. troy, 16*s.* 37 Geo. 3. c. 90.

And for every ounce troy of all silver plate, 1*s.* 37 Geo. 3. c. 90.

Plea at law. See Declaration.

Plea in equity. See Copy.

Pleadings in superior courts. See Bills, Copy, Declaration.

Pleadings in inferior courts. See Declaration.

Policy of assurance, on house, goods, or life, on any sum not exceeding 1000*l.* 6*s.* 25 Geo. 3. c. 58.

If above 1000*l.* eleven shillings. 17 Geo. 3. c. 50.

But by stat. 37 Geo. 3. c. 90. the above duties on policies, so far as the same relate to policies for insuring houses, furniture, goods, wares, merchandize, or other property, from loss by fire, are repealed from and after July 5, 1797, and from that period there shall be paid in lieu thereof:

For every policy of insurance, where the sum insured shall not amount to 1000*l.* the sum of 3*s.*

And where it shall amount to 1000*l.* or upwards, 6*s.* These policies are exempted from the additional ten shillings duty on deeds.

Policy of assurance upon ships. See Insurance.

Postea. See Record.

Presentation to any ecclesiastical dignity, promotion, or benefice, of the yearly value of 10*l.* and upwards in the king's books; 12*l.* 37 Geo. 3. c. 90.

And to any other benefice, dignity, or spiritual or ecclesiastical promotion, 6*l.* 37 Geo. 3. c. 90.

Probate of wills, or letters of administration, of any estate above 24*l.* and under 100*l.* ten shillings.

If the estate is of the value of 100*l.* and under 300*l.* two pounds ten shillings.

If the estate is of the value of 300*l.* and under 600*l.* eight pounds. 37 Geo. 3. c. 90.

If the estate is of the value of 600*l.* and under 1000*l.* fifteen pounds. 41 Geo. 3. c. 86.

If the estate is of the value of 1000*l.* and under 2000*l.* thirty pounds. 41 Geo. 3. c. 86.

If the estate is of the value of 2000*l.* and under 5000*l.* fifty pounds. 41 Geo. 3. c. 86.

If the estate is of the value of 5000*l.* and under 10,000*l.* seventy-five pounds. 41 Geo. 3. c. 86.

If the estate is of the value of 10,000*l.* and under 15,000*l.* one hundred and ten pounds. 41 Geo. 3. c. 86.

If the estate is of the value of 15,000*l.* and under 20,000*l.* one hundred and sixty pounds. 41 Geo. 3. c. 86.

If the estate is of the value of 20,000*l.* and under 30,000*l.* two hundred and ten pounds. 41 Geo. 3. c. 86.

If the estate is of the value of 30,000*l.* and under 40,000*l.* three hundred and ten pounds. 41 Geo. 3. c. 86.

If the estate is of the value of 40,000*l.* and under 50,000*l.* four hundred and ten pounds. 41 Geo. 3. c. 86.

If the estate is of the value of 50,000*l.* and under 60,000*l.* five hundred and ten pounds. 41 Geo. 3. c. 86.

If the estate is of the value of 60,000*l.* and under 70,000*l.* six hundred and ten pounds. 41 Geo. 3. c. 86.

If the estate is of the value of 70,000*l.* and under 80,000*l.* seven hundred and ten pounds. 41 Geo. 3. c. 86.

If the estate is of the value of 80,000*l.* and under 90,000*l.* eight hundred and ten pounds. 41 Geo. 3. c. 86.

If the estate is of the value of 90,000*l.* and under 100,000*l.* nine hundred and ten pounds. 41 Geo. 3. c. 86.

If the estate is of the value of 100,000*l.* and upwards, 1000*l.* 41 Geo. 3. c. 86.

And if any person shall administer any personal estate, without proving the will, or taking out letters of administration, within six months after the death of the party, such person shall forfeit 50*l.* to be recovered by action or information. 37 Geo. 3. c. 90.

Proctor. See Admittance.

Quack medicines, by 25 Geo. 3. c. 79. For every packet, box, bottle, pot, phial, or other inclosure, containing drugs, herbs, pills, waters, essences, tinctures, powders, or other preparation or composition whatsoever, used or applied externally, or internally, as medicines, or medicaments, for the prevention, cure, or relief, of any disorder or complaint, incident to, or in any wise affecting, the human body, which shall be uttered or vended in Great Britain, there shall be charged a stamp duty, after the rates following, viz.

Where the contents of any such packet, box, &c. shall not exceed the price of 1*s.* there shall be charged a stamp duty of 1½*d.*

Above 1*s.* and not exceeding			2*s.* 6*d.*,	3*d.*
2*s.* 6*d.*	-		4*s.*	6*d.*
4*s.*	-		10*s.*	1*s.*
10*s.*	-	-	20*s.*	2*s.*
20*s.*	-	-	30*s.*	3*s.*
30*s.*	-	-	50*s.*	10*s.*

And above 50*s.*, 20*s.*

Quó minus. See Original Writ.

Race-horses. For every horse entered to start or run for any plate, prize, sum of money, or any thing whatsoever, 2*l.* 2*s.*

Receipts. By 31 Geo. 3. c. 25, the following stamp duties shall be paid upon receipts:

For every piece of paper, &c. upon which shall be written, &c. any receipt, discharge, or acquittance for money, amounting to 40*s.* and not amounting to 10*l.*, two-pence.

Amounting to

10*l.* and not exceeding			20*l.*	4*d.*
20*l.*	-	-	50*l.*	8*d.*
50*l.*	-	-	100*l.*	1*s.*
100*l.*	-	-	200*l.*	2*s.*
200*l.*	-	-	500*l.*	3*s.*

Amounting to 500*l.* or upwards, 5*s.*

Receipt or discharge for legacies. See Legacies.

Recognizances and entries thereof, statute staple, or statute merchant, 1*l.* 37 Geo. 3. c. 90.

Record of nisi prius and postea, 5*s.* 10 W. 3. c. 25.

Register, entry, testimonial, or certificate of degree in any inn or court, 28*l.* 37 Geo. 3. c. 90.

Rejoinder at law. See Declaration.

Rejoinder at equity. See Bills, Copy.

Release. See Deed.

Release, enrolled. See Conveyance.

Replication at law. See Declaration.

Replication in equity. See Bills, Copy.

Reprieve, 12*l.* 37 Geo. 3. c. 90.

Resignation. See Adjudication.

Retour. See Adjudication.

Rule or order in any of the courts of Westminster, and copies thereof, 1*s.* 6*d.* 32 Geo. 2. c. 35.

Running horses. See Race-horses.

Sacrament certificate, 1*s.*

Sasine and service. See Adjudication.

Sentence. See Answer.

Sentence in the admiralty. See Admiralty.

Significavit pro corporis deliberatione, 10*s.* 10 W. 3. c. 25.

Special bail, and appearance therein. See Appearance.

Statute merchant. See Recognizance.

Statute staple. See Recognizance.

Subpœna. See Original Writ.

Surrender of, or admittance to, any copyhold land or tenement in England, Wales, or Berwick upon Tweed; or grant, or lease, by copy of court-roll, or any other copy of court-roll, of any honour or manor, within the same parts, except the original surrender to the use of a will, and the court book or roll itself, 10*s.* 37 Geo. 3. c. 90.

And for every copyhold tenement of 20*s.* per annum mentioned in any surrender, for which a several fine shall be due, a distinct stamp duty shall be charged, if the tenements mentioned in the surrender shall, before June 22, 1797, have been surrendered by the different surrenders, and from and after 28 June, 1798, shall be added to any other tenement, or mentioned therewith, to be surrendered by the same surrender, 38 Geo. 3. c. 85.; and if any officer of a copyhold or customary court, shall receive a fine for any surrender without demanding the duty for each distinct tenement, he shall forfeit 20*l.* and if he shall receive the duties, and neglect to purchase the proper stamps for three months, he shall forfeit 5*l.* and double duty. 37 Geo. 3. c. 90.

Surrender, copy of. See Copy.

Surrender of grants or offices. See Conveyance.

Surrender, principal and original instrument of. See Adjudication.

Testimonial. See Register, and Registry.

Transfer of stock, in any company, society, or corporation, except the bank of England, or South-sea company, 1*l.* 37 Geo. 3. c. 90.

Transfers at the bank of England, 7*s.* 9*d.* 23 Geo. 3. c. 58.

Universities, degrees in. See Register.

Warrant, beneficial. See Beneficial Warrant.

Warrant, mandate, or authority, given to an attorney or solicitor, to carry on or defend a suit, &c. in any of the courts at Westminster, ecclesiastical, admiralty, or cinque port courts, or in his majesty's courts in Scotland, the grand session in Wales, or courts in the counties palatine, wherein the debt shall amount to 40*s.* or more, 2*s.* 6*d.* to be paid by the attorney, and not charged to the client. 25 Geo. 3. c. 80.

Warrant of attorney, to enter up judgment. See Letter of Attorney.

Wills. See Copy.

Wills, probate of. See Probate.

Writ. See Original Writ.

Writ of covenant for levying fines, 1*l.* 10*s.* 37 Geo. 3. c. 90.

Writ of entry, 1*l.* 10*s.*

Writ of error. See Certiorari.

Writ of habeas corpus, 5*s.*

STANDARD, in commerce, the original of a weight, measure, or coin, committed to the keeping of a magistrate, or deposited in some public place, to regulate, adjust, and try, the weights used by particular persons in traffic. The standards of weights and measures in England are appointed by Magna Charta to be kept in the exchequer, by a special officer, called the clerk or comptroller of the market.

The standard of gold coin is twenty-two carats of fine gold and two carats of alloy in the pound-weight troy; and the French, Spanish, and Flemish gold, is nearly of the same fineness. The pound-weight is cut into forty-four parts and a half, each current for twenty-one shillings. The standard of silver is eleven ounces and two pennyweights of silver, and eighteen pennyweights of alloy of copper. Whether gold or silver is above or below standard, is found by assaying, and the hydrostatical balance.

Standard, in military affairs, a measure by which men enlisted into his majesty's service, have the regulated height ascertained.

According to the regulations and orders published in 1799, the standard for men raised for the heavy cavalry shall be five feet seven inches, and for the light cavalry and infantry five feet five inches; but no recruits are to be taken, even of those sizes, who exceed thirty-five years of age, or who are not stout and well made. Lads between sixteen and eighteen years of age, who are well limbed, and likely to grow, may be taken as low as five feet six inches for the heavy cavalry, and as low as five feet four inches for the light cavalry and infantry. In those regiments which are specially authorised to enlist boys, healthy lads, under sixteen years of age, who are likely to grow, may be taken as low as five feet one inch. It will be recollected, that this standard is for men enlisted during a war; when regiments are put upon a peace establishment, a higher standard is resorted to. Thus by a letter, dated 28th January, 1802, it is directed, that the standard for the infantry of the line shall be five feet seven inches; that no man shall be enlisted who is above twenty-five years of age; but growing lads from seventeen to nineteen years of age, shall be taken as low as five feet five inches.

Standard, in war, a sort of banner or flag, borne as a signal for the joining together of the several troops belonging to the same body.

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The standard is usually a piece of silk one and a half feet square, on which are embroidered the arms, device, or cypher, of the prince or colonel. It is fixed on a lance eight or nine feet long, and carried in the centre of the first rank of a squadron of horse, by the cornet.

Standards, belonging to the cavalry. Standards are posted in the following manner:

The king's, with the right squadron; the second with the left; and the third with the centre.

In advancing to the front on foot, the advanced standards and their serjeants must not slacken their pace, or deviate from right to left, as the lieutenant-colonel or leading officer may happen to do; but if he is in their way, they must call to him, because they alone regulate the march.

The standards must always be brought to the parade by a troop, viz. by that which has its private parade nearest to head-quarters. They must be accompanied by as many trumpeters as can conveniently assemble with that troop. Swords must be drawn, and the march sounded. The cornets parade, of course, with that troop to receive the standards. The standards are received by the regiment or squadron at open ranks, with swords drawn, officers saluting, and the march sounding by the remaining trumpeters. They must march off from head-quarters, and be lodged with the same form.

STANDING, in the sea-language. Standing part of the sheet, is that part of it which is made fast to a ring at the ship's quarter. Standing part of a tackle, is the end of the rope where the block is fastened. Standing ropes, are those which do not run in any block, but are set tawt or let slack, as occasion serves; as the sheet-stays, back-stays, &c.

STANGENSPATH, a sulphat of barytes, in bars: colour white; sometimes grey, red, green; always crystallized. The crystals are four-sided prisms, terminated by two-sided or four-sided summits, or six-sided prisms terminated by two-sided summits. Crystals very long and small, united in clusters. Longitudinal fracture, radiated cross, fracture even; brittle.

STANNARIES, the mines and works where tin is dug and purified, as in Cornwall, Devonshire, &c. There are four courts of the stannaries in Devonshire, and as many in Cornwall, and great liberties were granted them by several acts of parliament, in the time of Edward I. &c. though somewhat abridged under Edward III. and Charles I.

STANZA. See Poetry.

STAPELIA, a genus of the pentandria digynia class of plants, the corolla whereof consists of a large, plane, single petal, quinquefid beyond the middle; the fruit consists of two oblong subulated follicles, made up of only one valve, and containing one cell; the seeds are numerous, imbricated, compressed, and pappose. See Plate Nat. Hist. fig. 376.

Of this very curious genus, there are 49 species; though only two species were known to Linnæus, when he published his Species Plantarum, in 1762. They are all succulent plants of warm climates, and require either a dry store or a very good greenhouse. They should not be watered in the winter-season.

STAPES. See Anatomy.

STAPHYLEA, Bladder-nut, a genus of plants, belonging to the class of pentandria, and order of trigynia; and in the natural system arranged under the 23d order, trihilatæ. The calyx is quinquepartite. There are five petals. The capsules are three, inflated, and joined together by a longitudinal suture. The seeds are two, and are globose with a scar. There are three species. The pinnata, or bladder-nut tree, is a tall shrub or tree. The leaves are pinnated; the pinnæ are generally five, oblong, pointed, and notched round the edges. The flowers are white, and grow in whorls on long pendulous footstalks. This plant flowers in June, and is frequent in hedges about Pontefract and in Kent. The trifoliata, or three-leaved bladder-nut is a native of Virginia.

STAPHYLINUS, a genus of insects of the order coleoptera: the generic character is, antennæ moniliform; wing-sheaths halved, wings, covered; tail simple, protruding occasionally two oblong vesicles. In the genus staphylinus, which is pretty numerous, the wings which are rather large, are curiously pleated or convoluted beneath the short abruptly terminated wing-sheaths. The larger species are of an unpleasing appearance, and generally run with considerable swiftness. One of the most remarkable, as well as the largest of the British species, is the staphylinus major of Degeer, which is more than an inch long, entirely of a deep-black colour, and when disturbed, sets up the hinder parts of its body, as if in a posture of defence; it is very frequently seen, during the autumnal season, about sunny pathways, fields, and gardens, and is furnished with a large head, and very strong forcipated jaws. This species has often been quoted as the staphylinus maxillosus of Linnæus, but it appears from late observations to be a larger, and totally distinct species from that insect. There are nearly 200 species.

STAPLE, primarily signifies a public place or market, whither merchants, &c. are obliged to bring their goods to be bought by the people. Formerly the merchants of England were thus obliged to carry their wool, cloth, lead, and other staple-like commodities of this realm, in order to utter the same by wholesale: and these staples were appointed to be constantly kept at York, Lincoln, Newcastle upon Tyne, Norwich, Westminster, Canterbury, Chichester, Winchester, Exeter, and Bristol; in each of which a public mart was appointed to be kept, and each of them had a court of the mayor of the staple, for deciding differences, held according to the law-merchant in a summary way.

The staple-commodities of this kingdom are said by some to be these, viz. wool, leather, wool-fells, lead, tin, butter, cheese, cloth, &c. but others allow only the first five to be staple-commodities.

STAR. See Astronomy.

STARS, *falling*, in meteorology, meteors which dart through the sky in form of a star. See Meteors.

Mr. John Farey (Monthly Mag. xxii, 144) has given the name Satellitulæ, to the numerous masses of solid matter, probably composed of iron and nickel principally, which are supposed by him to be revolving in all directions round this earth in elliptical orbits; and which, by passing through the higher parts of the atmosphere, with the immense velocity peculiar to planetary motion, are rendered luminous for a short space, when in perigæo, and occasion the appearance of shooting-stars; which are found to move in all directions so numerously, that M. Benzenberg, in the space of one night, observed 500 of them (Monthly Mag. xxii. 223). The same masses, when they dip deeper into the atmosphere, being more heated, are supposed to appear as meteors; and, by the increasing resistance of the air in each of their revolutions, to fall at length to the earth in the fragments called meteoric stones, (see that article, where the opinions of different philosophers on the origin of these very curious substances may be seen.) In the same manner that Dr. Herschel uses the term asteroids, to express the planetary bodies revolving round the sun, which are smaller than the anciently known planets; satellitula are bodies, smaller than the moon, revolving round the earth as their centre of gravitation.

STAR. See HERALDRY.

STAR, in pyrotechny, a composition of combustible matters, which, being thrown aloft in the air, exhibits the appearance of a real star. See PYROTECHNY.

STAR-BOARD, in the sea-language, denotes the right-hand side of a ship: thus they say, star-board the helm, or helm a star-board, when he that conds would have the men at the helm, or steering-wheel, put the helm to the right side of the ship.

STAR-FISH. See ASTERIAS.

STAR-SHOT, a gelatinous substance frequently found in fields, and supposed by the vulgar to have been produced from the meteor called a falling-star; but, in reality, is the half-digested food of herons, sea-mews, and the like birds; for these birds, when shot, have been found to disgorge a substance of the same kind.

STAR-STONE, asteria, in natural history, a name given to certain extraneous fossil stones, in form of short, and commonly somewhat crooked, columns, composed of several joints; each resembling the figure of a radiated star, with a greater or smaller number of rays in the different species: they are usually found of about an inch in length, and of the thickness of a goose-quill. Some of them have five angles, or rays, and others only four; and in some the angles are equidistant, while in others they are irregularly so; in some also they are short and blunt, while in others they are long, narrow, and pointed; and some have their angles so very short and obtuse, that at first sight they might be taken for entrochoasteriæ. The several joints in the same specimen are usually all of the same thickness; this however is not always the case, but in some they are larger at one end, and in others at the middle, than in any other part of the body; and some species have one of the rays bifid, so as to emulate the appearance of a six-rayed kind.

STARCH. If a quantity of wheat-flour is formed into a paste, and then held under a very small stream of water, kneading continually till the water runs off from it colourless, the flour by this process is divided into two distinct constituents. A tough substance of a dirty-white colour, called gluten, remains in the hand; the water is at first milky; but soon deposits a white powder, which is known by the name of starch. A sweet-tasted mucilaginous substance remains dissolved in the water.

The starch obtained by this process is not altogether free from gluten; hence its colour is not very white, and it has not that fine crystallized appearance which distinguishes the starch of commerce. Manufacturers employ a more economical and more efficacious process. Good wheat, or the bran of wheat, is allowed to steep in cold water till it becomes soft, and yields a milky juice when squeezed. It is then taken out of the water; put into coarse linen sacks, which are subjected to pressure in a vat filled with water; a milky juice containing abundance of starch exudes, and mixes with the water of the vat. This process is repeated as long as the wheat yields any milky juice. The sack and its contents are then removed. The starch soon falls to the bottom of the vat; and the water which covers it gradually ferments, in consequence of the substances which it holds in solution. Alcohol and vinegar are formed in it; partly, no doubt, at the expence of the starch. The vinegar, thus formed, dissolves all the impurities, and leaves nothing behind but starch. It is then poured off, and the starch edulcorated with water. It is afterwards dried by a moderate heat. During the drying it usually splits into small columnar masses, which have a considerable degree of regularity. The water which has stood over the starch was analyzed by Vauquelin. It contains a considerable portion of alcohol and of acetic acid. The acid holds in solution gluten somewhat altered, phosphat of lime, and ammonia.

Starch was well known to the antients. Pliny informs us, that the method of obtaining it was first invented by the inhabitants of the island of Chio.

Starch has a fine white colour, and is usually concreted in longish masses; it has scarcely any smell, and very little taste. When kept dry, it continues for a long time uninjured though exposed to the air.

Starch does not dissolve in cold water, but very soon falls to powder, and forms with it a kind of emulsion. It combines with boiling water, and forms with it a thick paste. Linen dipt into this paste, and afterwards dried suddenly, acquires, as is well known, a great degree of stiffness. When the paste is allowed to cool, it assumes the form of a semi-transparent jelly; which, when dried by artificial heat, becomes brittle, and assumes an appearance not unlike that of gum. Hence it is supposed that starch, by being boiled in water, undergoes a certain degree of decomposition, which brings it nearly to the state of gum. When this paste is left exposed to damp air, it soon loses its consistency, acquires an acid taste, and its surface is covered with mould.

Starch is so far from dissolving in alcohol, even when assisted by heat, that it does not even fall to powder.

When starch is thrown into any of the mineral acids, at first no apparent change is visible; but if an attempt is made to reduce the larger pieces, while in acids, to powder, they resist it, and feel exceedingly tough and adhesive. Sulphuric acid dissolves it slowly, and at the same time a smell of sulphurous acid is emitted; and such a quantity of charcoal is evolved, that the vessel containing the mixture may be inverted without spilling any of it. Indeed, if the quantity of starch is sufficient, the mixture becomes perfectly solid. The charcoal may be separated by dilution and filtration. In muriatic acid starch dissolves still more slowly. The solution resembles mucilage of gum-arabic, and still retains the peculiar odour of muriatic acid. When allowed to stand for some time, the solution gradually separates into two parts: a perfectly transparent straw-coloured liquid below; and a thick, muddy, oily, or rather mucilaginous substance, above. When water is poured in, the muriatic smell instantly disappears, and a strong smell is exhaled, precisely similar to that which is perceived in corn-mills. Ammonia occasions a slight precipitate, but too small to be examined.

Nitric acid dissolves starch more rapidly than the other two acids; it acquires a green colour, and emits nitrous gas. The solution is never complete, nor do any crystals of oxalic acid appear unless heat is applied. In this respect starch differs from sugar, which yields oxalic acid with nitric acid, even at the temperature of the atmosphere. When heat is applied to the solution of starch in nitric acid, both oxalic and malic acid are formed, but the undissolved substance still remains. When separated by filtration, and afterwards edulcorated, this substance has the appearance of a thick oil, not unlike tallow; but it dissolves readily in alcohol. When distilled, it yields acetic acid, and an oil having the smell and the consistence of tallow.

The alkalies dissolve starch; but their action has not been examined with care. In pure potass it swells, and assumes the appearance of a transparent jelly. In this state the solution is soluble in alcohol.

When starch is thrown upon a hot iron, it melts, blackens, froths, smells, and burns with a bright flame like sugar, emitting, at the same time, a great deal of smoke; but it does not explode, nor has it the calomel smell which distinguishes burning sugar. When distilled, it yields water impregnated with an acid, supposed to be the pyromucous, a little empyreumatic oil, and a great deal of carbonic acid and carbureted hydrogen gas. The charcoal which remains is easily dissipated when set on fire in the open air; a proof that it contains very little earth.

Barley-grain consists almost entirely of starch, not however in a state of perfect purity. In the process of malting, which is nothing else than causing the barley to begin to vegetate, a great part of the starch is converted into sugar. During this process oxygen gas is absorbed, and carbonic acid gas is emitted. Water, too, is absolutely necessary; hence it is probable that it is decomposed, and its hydrogen retained. Starch, then, seems to be converted into sugar by diminishing the proportion of its carbon, and increasing that of its hydrogen and oxygen. Its distillation shews us that it contains no other ingredient than these three.

Starch is contained in a great variety of vegetable substances; most commonly in their seeds or bulbous roots, but sometimes also in other parts. Mr. Parmentier, whose experiments have greatly contributed towards an accurate knowledge of starch, has given us the following list of plants from the roots of which it may be extracted.

Arctium lappa,
Atropa belladonna,
Polygonum bistorta,
Bryonia alba,
Colchicum autumnale,
Spiræa filipendula,
Ranunculus bulbosus,
Scrophularia nodosa,
Sambucus ebulus,
——— nigra,
Orchis morio,
Imperatoria ostrutheum,
Hyoscyamus niger,
Rumex obtusifolius,
——— acutus,
——— aquaticus,
Arum maculatum,
Orchis mascula,
Iris pseudacorus,
— fœtidissima,
Orobosus tuberosus,
Bunium bulbocastanum.

It is found also in the following seeds;

Oats,	Millet,	Peas,
Rice,	Chesnut,	Beans,
Maize,	Horse-chesnut,	Acorn.

Indeed the greater number, if not the whole, of the vegetable seeds employed by man as an article of food, consists chiefly of starch. But that substance is always combined with some other which serves to disguise its properties; such as sugar, oil, extractive, &c. It is only by processes similar to those described in the beginning of this article, that it is extracted from these substances in a state of tolerable purity. The following substances, which may be considered as varieties of starch, deserve particular attention:

1. Potatoe starch. We are not yet in possession of a precise chemical analysis of the potatoe. When raw, its taste is exceedingly disagreeable, and it is said to be in some degree noxious; but it loses these qualities when boiled. The water acquires a deep brown colour, and the potatoe itself, when broken, appears to be composed of a congeries of fine soft shining crystals, to which it owes its mealy appearance. When exposed to the action of frost, it becomes soft, and acquires a very sweet taste. The nature of this change has not been examined into. When the potatoe is grated down to a pulp, and placed on a fine searce, if water is poured on it, a great deal of starch passes through the meshes of the searce, and may be collected in proper vessels. When washed with water and dried, it assumes a fine white colour, and possesses all the essential properties of starch. Indeed it goes much farther; a smaller quantity being sufficient to form a thick paste with water than is required of wheat-starch. It has a very perceptible crystallized appearance, and is much heavier apparently than common starch. It is not likely therefore that it could be employed with the same advantage as a hair-powder.

2. Sago. This substance is extracted from the pith of several species of palm in the Moluccas, Philippines, and other East Indian islands. The palm is cut into pieces of five or six feet in length; the woody part is cut off one side, exposing the pith lying, in a manner, in the hollow of a canoe. Cold water is poured in, and the pith well stirred; by which means the starch is separated from the fibrous part, and passes through with the water when the whole is thrown on a searce. The sago, thus separated, is allowed to settle; the water is poured off; and when it is half dry it is granulated, by being forced through a kind of funnel. It is said to acquire its grey colour while dried in an artificial heat. This substance is employed as an article of food, and its nourishing properties are well known.

3. Salop. This substance comes from Persia; but is said also to be manufactured in Europe. It is supposed to be the prepared roots of different species of orchis, as the morio, mascula, bifolia, pyramidalis. According to Moult, the bulbous roots of these plants are deprived of their cuticle, baked in an oven for ten or twelve minutes, which gives them their semitransparency, and then fully dried in a moderate heat. Like sago, salop is used as a nourishing article of food.

4. Cassava is prepared from the roots of the jatropha manihat, an American plant. They are peeled, and subjected to pressure in a kind of bag made of rushes. The juice that is forced out is a deadly poison, and is employed by the Indians to poison their arrows; but it deposits gradually a white starch, which when properly washed is innocent. What remains in the bag consists chiefly of the same starch. It is dried in smoke, and afterwards passed through a kind of sieve. Of this substance the cassava bread is made.

5. Sowans. This very nutritious article of food is made in this country from the husk of oats, by a process not unlike that by which common starch is made. The husk of the oat (called seeds) is separated from oatmeal by the sieve. It still retains a considerable portion of farinaceous matter, which forms a very nourishing food.

STARLING. See STURNUS.

STATICE, THRIFT, a genus of plants belonging to the class of pentandria, and order of pentagynia; and in the natural system ranging under the forty-eighth order, aggregatæ. The calyx is monophyllous, entire, folded, and scaricose. There are five petals, with one superior seed. There are thirty-nine species; three of these are British plants. 1. The armeria, thrift, or sea gilly-flower, has a simple naked stem about six inches high. The radical leaves are like grass. The flowers are terminal, pale red, with a round head, and not very large. This plant flowers in July or August, and grows in meadows near the sea. 2. Limonium, sea-lavender. The stem is naked, branched, and about a foot high. 3. Reticulata, matted sea-lavender. The stem is prostrate, and terminated by a panicle of flowers. This species is also found on the sea-coast of South Britain.

STATICS, that branch of mathematics which considers the motion of bodies arising from gravity. See MOTION.

Statics then is the doctrine, or theory, of motion, considered merely as arising from the weight of bodies; in which sense it is distinguished from mechanics, which is the application of statics to machines, engines, &c. though, it must be owned, that statics and mechanics are frequently confounded. See MECHANICS. For the laws and principles whereon the doctrine of statics is founded, see the articles GRAVITY, GRAVITATION.

STATIONARY. See ASTRONOMY.

STATISTICS, a word lately introduced to express a view or survey of any kingdom, county, or parish.

A grand and extensive work of this kind was undertaken in Scotland in the year 1790 by sir John Sinclair, whose patriotic exertions in favour of his country will be gratefully remembered by posterity. The great object of it is to give an accurate view of the state of the country, its agriculture, its manufactures, and its commerce; the means of improvement, of which they are respectively capable; the amount of the population of a state; and the causes of its increase or decrease: the manner in which the territory of a country is possessed and cultivated; the nature and amount of the various productions of the soil; the value of the personal wealth or stock of the inhabitants, and how it can be augmented; the diseases to which the people are subject, their causes and their cure: the occupations of the people; where they are entitled to encouragement, and where they ought to be suppressed; the condition of the poor, the best mode of maintaining them, and of giving them employment; the state of schools, and other institutions, formed for purposes of public utility; the state of the villages and towns, and the regulations best calculated for their police and good government; the state of the manners, the morals, and the religious principles of the people, and the means by which their temporal and eternal interests can best be promoted.

STATUARY, a branch of sculpture, said to be the invention of Dædalus, amidst other productions of ingenious talents: others assert him to have been only the improver of an art known long before his time, and that he was the first who endeavoured to give the appearance of motion and action to figures.

The Phenicians are said to have been the first who erected statues in honour of their gods; but, if we believe the accounts generally given of the Phenician worship, the religious statuary of that nation did not exhibit human forms, but merely pointed stones or other symbolical expressions of their divinities.

STATUES, are figures, representing living or deceased creatures, of whatever species, real or imaginary; and carved, cast, modelled, or moulded, in full relievo, insulated on every part.

Statues are formed with the chisel, of several materials, such as marble, stone, &c.: they are carved in wood; or cast in plaister of Paris, or other matter of the same nature; they are also cast in several metals, as lead, brass, silver and gold.

Statues are divided into

Colossal, or considerably exceeding the dimensions of nature; as, for instance, the celebrated statue of Apollo, at Rhodes.

Allegorical, or such as, under human or other symbolical forms, represent subjects of a different kind, as Time, Ocean, Winds, or qualities of an intellectual nature, as Mercy, Justice, &c. &c.

Statues of deities, demi-gods, and heroes were, among the antients, generally represented somewhat larger than life.

Monumental, either representing the person, the virtues, or the actions of the deceased.

Equestrian, generally of some illustrious person on horseback.

Pedestrian; or on foot.

The most celebrated statues are those of the Egyptians, Grecians, and Romans. Of the Egyptian statues, sufficient has been said under the article sculpture. See SCULPTURE. Of the Grecian and Roman we propose to add some important particulars.

STATUES, *antique*. The denomination of antique statues is applicable to all antient statues, found either in India, Egypt, &c.; but is especially given, in preference, to the statues wrought by the antient Greek and Roman sculptors. The works of the Grecians are considered as the most perfect examples of sculpture. Their statues are eminently admirable for the various beauty of their forms, for characteristic expression and grace. See SCULPTURE.

The Grecian statues of men are generally naked. The Roman are clothed agreeably to the manner of the country, and are distinguished into

Paludatæ (statuæ), those of emperors with long robes over their armour.

Loricatæ, those of soldiers with cuirasses.

Thoracatæ, those with coats of armour.

Togatæ, those of magistrates with the toga, or robe worn in office.

Trabeatæ; those of senators and augurs.

Tunicatæ, those clothed with a plain tunic.

Stolatæ, those of women with long trains.

The antique statues are most particularly remarkable for their systematic representation of the human form. As the principle most apparent in their system is that of proportions, we shall give, first, an account of their general proportions to which they chiefly adhered, and next, an accurate measurement of the various parts of the body, taken at Rome, from some of their most celebrated original statues.

It is to be observed, however, that although the inferior antique possesses little other merit than that of proportion, the excellence of the finer works of Greece is of a much more comprehensive description.

Proportions of the antique statues.

Proportion is the basis of beauty, and there can be no beauty without it; on the contrary, proportion may exist where there is little beauty. Experience teaches us, that knowledge is distinct from taste; and proportion, therefore, which is founded on knowledge, may be strictly observed in any figure, and yet the figure have no pretensions to beauty. The antients considering ideal beauty as the most perfect, have frequently employed it in preference to the beauty of nature.

It is probable that the Grecian, as well as the Egyptian artists, determined the great and small proportions by fixed rules; that they established a positive measure for the dimensions of length, breadth, and circumference. This supposition alone can enable us to account for the great conformity which we meet with in antient statues. Winkelman thinks that the foot was the measure which the antients used in all their great dimensions, and that it was by the length of it that they regulated the measure of their figures by giving to them six times that length. This, in fact, is the length which Vitruvius assigns, L. 3, cap. 1. That celebrated architect thinks the foot is a more determinate measure than the head or the face, the parts from which modern painters and sculptors often take their proportions. This proportion of the foot to the body, which has appeared strange and incomprehensible to the learned Huetius, and has been entirely rejected by Perrault, is, however, founded upon experience. After measuring with great care a vast number of figures, Winkelman found this proportion not only in Egyptian statues, but also in those of Greece. This fact may be determined by an inspection of those statues, the feet of which are perfect; and one may be more fully convinced of it by examining some figures of the Greek divinities, in which the artists have made some parts beyond their natural dimensions. In the Apollo Belvedere, which is a little more than seven heads high, the foot is three Roman inches longer than the head. The head of the Venus de Medicis is very small, and the height of the statue is seven heads and a half; the foot is three inches and a half longer than the head, or precisely the sixth part of the length of the whole statue.

Other writers are of opinion, that the following rules form a principal part of the system of Grecian sculpture:

The body consists of three parts, as well as the members. The three parts of the body are, the trunk, the thighs, and the legs. The inferior part of the body are the thighs, the legs, and the feet. The arms also consist of three parts. These three parts must bear a certain proportion to the whole, as well as to one another. In a well formed man, the head and body must be proportioned to the thighs, the legs, and the feet, in the same manner as the thighs are proportioned to the legs and the feet, or the arms to the hands. The face also consists of three parts, that is, three times the length of the nose; but the head is not four times the length of the nose, as some writers have asserted. From the place where the hair begins to the crown of the head, are only three-fourths of the length of the nose, or that part is to the nose as 9 to 12.

MEASUREMENTS TAKEN AT ROME FROM ORIGINAL ANTIQUE STATUES.

Hercules (Farnese).

Length of the face as nearly as can be found, 11 inches and a half.

From the pit between the clavicles to the bottom of the belly, 2 feet 10 inches.

From the point of the (right) os ilium to the top of the petella, the same, viz. 2 feet 10 inches.

From the top of the patella to the sole of the right foot, 2 feet 10 inches and a half.

From the top of the head as nearly as can be guessed, to the bottom of the belly, 4 feet 2 inches and a half.

From the bottom of the belly to the sole of the foot, 5 feet 2 inches and three-fourths.

Colossal Commodus (of the Capitol).

Length of the face from the top of the forehead to the bottom of the chin, as nearly as can be guessed, (the hair being down on the forehead) 3 feet 2 inches.

Flora (Farnese).

From the pit between the clavicles to the bottom of the belly; from the point of the (right) os ilium to the centre of the patella; and from the centre of the patella to the sole of the foot, exactly equal.

From the pit between the clavicles to the right nipple, 14 inches and a half.

From the bottom of the belly to the sole of the foot, 5 feet 8 inches.

Length of the leg from the centre of the patella to the sole of the foot, 3 feet 1 inch.

The measurements of the four following female statues, have for their rule the real length of their respective faces, divided into three parts, and those parts subdivided into twelve minutes. See Plate No. 9, (entitled Antique Statues.)

Venus de Medicis.

From the bottom of the right ear to the pit between the clavicles, 3 parts.

From the bottom of the left ditto to the said pit, 2 parts 9 minutes.

From the said pit to the bottom of the sternum, as near as can be found, 3 parts 6 minutes and one-third.

From the said pit to the bottom of the belly, as near as can be found, 9 parts 1 minute and three-fourths.

From the point of the (right) os ilium, as near as can be found, to the centre of the patella, 9 parts 4 minutes and one-third.

From the said pit to the right pap, 3 parts 5 minutes; to the left ditto, 3 parts 6 minutes.

From the centre of the right patella to the sole of the foot, 9 parts 8 minutes and one-third.

From the point of the left ilium, as near as can be found, to the centre of the patella, 9 parts 1 minute.

From the centre of the said patella to the sole of the foot, 9 parts.

Length of the right foot from the heel to the joint of the great toe, 4 parts 9 minutes and two-thirds.

Length of the left ditto, 4 parts 8 minutes.

Breadth of the face from ear to ear, 2 parts 3 minutes.

From the right ear to the tip of the nose, 2 parts 1 minute and one-third.

Thickness of the neck, measured with the face in front, 1 part 11 minutes and a half.

Distance from pap to pap, 3 parts 11 minutes.

From point to point of the ileum, as near as can be found, 4 parts and half a minute.

Breadth of the shoulder, just below the heads of the humerus, measured obliquely, viz. parallel with the shoulders, 7 parts 9 minutes and a half.

Breadth of the breast, from the point where the pectoral and deltoid muscles join, 5 parts 5 minutes and one-fourth.

Narrowest part of the body, a little above the navel, 4 parts 9 minutes and a half.

Breadth of the hips, measured upon the ilium under the obliq. descend. 6 parts 4 minutes and a half.

Thickest part of the right thigh measured as near as can be across the centre of the rectus, 3 parts 6 minutes.

Thickness of the said knee across the centre of the patella, 2 parts 1 minute.

Thickest part of the calf of the said leg, 2 parts 2 minutes and a half.

Small ditto, just above the ancle, 1 part 2 minutes and three-fourths.

Thickness of the said ancle from centre to centre of each bone, 1 part 5 minutes and one-fourth.
Thickness of the left knee measured across the patella, 2 parts.
Thickest part of the calf of the left leg, 2 parts 2 minutes.
Small ditto, just above the ancle, 1 part 2 minutes.
From centre to centre of the ancle bones of the left leg, 1 part 4 minutes and one-fourth.
Breadth of the left foot upon the joints, at the roots of the toes, 1 part 9 minutes.
Length from the head of the deltoid to the tip of the left elbow, 7 parts; right ditto, 7 parts 2 minutes.
Length of the lower right arm from the tip of the elbow to the centre of the wrist bone, 4 parts 11 minutes.
Length of the left ditto, ditto, 5 parts 1 minute, and two-thirds.
Thickest part of the right arm above the elbow, 1 part 11 minutes.
Thickness of the lower arm, measured with the back of the hand in front, 1 part 8 minutes and a half.
Ditto of the said wrist from bone to bone, 1 part three-fourths of a minute.
Thickest part of the left arm, measured in front, 1 part 9 minutes and a half.
Thickness of the lower arm ditto, measured like the former, 1 part 7 minutes and one-fourth.
Thickness of the said wrist from bone to bone, 1 part and one-half minute.
From the centre of the wrist to the root of the middle finger, 1 part 10 minutes.
Length of the middle finger, 1 part 8 minutes and one-fourth.
Breadth of the hand across the joints at the roots of the fingers, 1 part 4 minutes and a half.
Ditto of the body from the most prominent part of the breast bone to ditto of the shoulder behind, measuring and observing the curve of the figure, 4 parts 2 minutes and one-third.
Narrowest part of the body, measured from the hollow above the navel, to the most prominent part of the sacro-umbalis, observing the curve of the figure, 3 parts 10 minutes.
Distance from the navel to the bottom of the belly, 4 parts and one-half minute.
Length from the point of the (left) os ilium, as near as can be found, to the most prominent part of the glutæus below, 5 parts.
Distance from ditto to ditto, of the right side, 4 parts 7 minutes.
Thickest part of the right thigh in profile, from the centre of the rectus, 3 parts 7 minutes.
Thickness of the said knee in profile from the centre of the patella, 2 parts 4 minutes and two-thirds.
Ditto of the calf of the right leg, in ditto, 2 parts 3 minutes; smallest part ditto, 1 part 5 minutes and one-fourth.
Thickness of the left thigh from just under the glutæus to the rectus above in profile, 3 parts 8 minutes.
Ditto of the left knee, in profile, from the centre of the patella, 2 parts 4 minutes.
Thickness of the said leg above, 2 parts 4 minutes; ditto of ditto at the small, 1 part 5 minutes and one-fourth.
Total length of the figure, allowing 4 parts for the head, and measuring down the centre of the figure, 31 parts 11 minutes and a half.

Flora Vestita, or draped.

From the bottom of the ear to the pit between the clavicles, 2 parts 8 minutes and a half.
Length of the neck from where it joins the bottom of the chin to the said pit, 1 part 4 minutes.
From the said pit to the right nipple, 3 parts 5 minutes and a half; left ditto, 3 parts 2 minutes.
From the pit between the clavicles to the bottom of the belly as near as can be guessed, 11 parts 10 minutes.
From nipple to nipple, 3 parts 7 minutes and a half.
From the roots of the hair on the forehead to the sole of the foot, 10 faces, or 30 parts 8 minutes.
Length of the leg bent from the top of the patella to the sole of the foot, 9 parts 3 minutes.

Cleopatra of the Belvidere.

From the bottom of the chin to the pit between the clavicles, 1 part 7 minutes.
From the tip of the right ear to the said pit, 3 parts 3 minutes.
From the said pit to the left nipple, 3 parts 4 minutes; right ditto 3 parts.
Total length of the body, as it lies, from the said pit to the bottom of the belly, 9 parts 4 minutes.
From the bottom of the belly to the middle of the patella, as near as can be guessed, 9 parts 2 minutes.
From the middle of the patella to the instep, 9 parts 5 minutes.
From the instep to the sole of the foot within, 1 part 9 minutes.
Length of the left arm underneath, from where it joins to the pectoral, to the point of the elbow, 5 parts 9 minutes.
From the same elbow to the joint of the wrist, 5 parts 6 minutes and a half.
Thickness of the same arm above the elbow, measured from underneath, to about where the deltoid muscle is inserted, 2 parts 5 minutes.
Thickest part of the same arm below the elbow, 2 parts 3 minutes.
Breadth of the wrist from bone to bone, 1 part 5 minutes.
Thickness of ditto from the centre below to the centre above, 9 minutes.
Breadth of the body across the breasts as near as can be measured, 7 parts 3 minutes.
Ditto of ditto, as near, &c. across the belly just below the navel from hip to hip, 7 parts 10 minutes and a half.
Breadth from nipple to nipple, 4 parts 3 minutes.
Thickness of the upper thigh, measured over and across about the middle, 3 parts 10 minutes and a half.
Ditto knee ditto, across the middle of the patella, 2 parts 9 minutes and a half.
Calf of the leg, ditto, 2 parts 10 minutes and a half.
Ancle ditto from bone to bone, 1 part 7 minutes and a half.
Total length of the figure, allowing 1 part above the roots of the hair upon the forehead, and measuring down the middle of the figure, down the centre of the uppermost thigh and leg to the sole of that foot, as near as can be known, somewhat less than 36 parts.
Breadth of the right foot from the joint at the root of the great toe to the joint on the other side at the root of the little toe, 2 parts 3 minutes.
Length of the great toe from the centre of the joint, 1 part 7 minutes.

Beautiful daughter of Niobe.

From the chin next the throat to the pit between the clavicles, 1 part 10 minutes.
From the tip of the left ear to ditto, 3 parts 1 minute and a half.
From the tip of the right to ditto, 2 parts 7 minutes and three-fourths.
From the said pit to the left nipple, 2 parts 10 minutes.
From ditto to the right nipple, 3 parts 2 minutes.
From nipple to nipple, as near as can be guessed, 4 parts.
Length of the body from the pit between the clavicles to the bottom of the belly, 9 parts.
From the point of the ilium, (guessed) to the centre of the patella, 8 parts 5 minutes.
From the centre of the patella to the sole of the foot, 8 parts 8 minutes and a half.

The measurements of the following male figures, have for their rule, the real length of their respective heads, divided into four equal portions, called fourths, and those fourths subdivided into twelve equal parts. See the Plate.

Apollino.

From the bottom of the chin next the throat to the pit between the clavicles 1 fourth 9 parts.
From the pit between the clavicles to the pit at the bottom of the breast, 2 fourths 6 parts and one-half
From ditto to the pap of the right breast, 2 fourths 6 parts and one-half.
From ditto to the pap of the left breast, 2 fourths 8 parts; from pap to pap 1 head.
Whole length of the body from the pit between the clavicles to the bottom of the belly, about 3 faces.
From point to point of the os ilium next the belly, 1 head wanting 2 parts.
From the point of the right os ilium to the middle of the patella, 3 faces.
From the left ditto to the upper edge of the patella, 3 faces.
From the middle of the right patella to the sole of the foot, 3 faces.
Breadth of the face from ear to ear, 2 fourths 3 parts.
Thickness of the neck immediately under the ears, 2 fourths and half a part.
Thickness of the body in a line drawn across the paps, almost 6 fourths.
Narrowest part of the body from the lowest rib to rib, 5 fourths.
Breadth of the body where it joins the thigh, 6 fourths 8 parts.
Utmost thickness of the thigh, 3 fourths, 1 part.
Thickness of the knee across the centre of the right patella, 2 fourths nearly.
Thickest part of the calf of the leg in front, 2 fourths 2 parts.
Thinnest part of the right ancle, above the ancle bone 1 fourth 1 part and two-thirds.

Thinnest part of the right instep, below the ancles, 1 fourth 2 parts.
Thickest part of the ancle from the centre to the centre of each bone, 1 fourth 4 parts.
Thickest part of the foot, across the joint at the roots of the toes, 1 fourth 10 parts.
Utmost length of the right foot, 4 fourths 9 parts and a half.
Utmost length of the left arm from the top of the shoulder to the tip of the elbow, 6 fourths 4 parts.
From the same elbow to the joint of the wrist, nearly, 5 fourths.
From the same joint to the root of the middle finger, 1 fourth 9 parts and a half.
Thickest part of the left arm, across the insertion of the deltoid, 1 fourth 11 parts.
Thickest part of the ditto below the elbow, 1 fourth 7 parts and a half.
Thickest part of the wrist, measured from above, 1 fourth and two-thirds of a part.
From the elbow to the centre of the right arm, below where the latissimus dorsi passes, as near as can be guessed, 5 fourths and a half.
Thickest part of that arm, measured in front across the biceps, 1 fourth 10 parts.
Thickest part of the body, measured in profile on the left side, from the pit between the breasts to the back in a horizontal direction, 4 fourths 3 parts.
Thinnest part of the body on the same side, measured just above the navel, 3 fourths 9 parts.
Thickest part of the thigh in profile, measured in a horizontal direction, from the root of the penis to the glutæus, 4 fourths 6 parts.
Thinnest part, just above the knee, 2 fourths 2 parts and three-fourths.
Thickest part of the right knee, 2 fourths and 3 parts.
Thickest part of the calf of the leg, 2 fourths 3 parts and a half.
Thinnest part of the same leg, just above the instep, 1 fourth 6 parts and one-fourth.
From the centre of the inner ancle to the bottom of the heel, 1 fourth 6 parts.
From the centre of the outer ditto to ditto, 1 fourth 2 parts.

Apollo Belvidere.

From the tip of the right ear to the pit between the clavicles, 2 fourths 10 parts.
From the bottom of the left ear to the same pit, 3 fourths and half a part.
From the pit between the clavicles to the centre of the pit at the bottom of the sternum, 2 fourths 11 parts and a half.
From the pit between the clavicles to the bottom of the belly, 2 fourths 9 parts and a half.
From the point of the right ilium to the centre of the patella, 8 fourths 11 parts and a half.
From the point of the left ditto to the centre of the patella, 9 fourths 3 parts and three-fourths.
Length of the right leg from the centre of the patella to the sole of the foot, 9 fourths 1 part and one-third.
Length of the left ditto ditto, 9 fourths 5 parts and a half.
Breadth of the face from ear to ear, 2 fourths 2 parts and a third.
Breadth of the neck, taken in front like the face, 2 fourths exactly.
From the pit between the clavicles to the right pap, 3 fourths 4 parts.
From ditto to the left pap, 3 fourths 5 parts and one-fourth.
Distance across from pap to pap, 4 fourths 9 parts and three-fourths.
Breadth of the body across the paps, 6 fourths and half a part.
Narrowest part of the body, measured a little above the navel, 5 fourths 1 part and one-fourth.
Breadth of the hips, measured upon the ilium just under the obliq. descendens, 5 fourths 2 parts and a half.
Breadth from point to point of the ilium, 3 fourths 10 parts and a half.
Thickest part of the right thigh, measured in front across the head of the rectus, 2 fourths 11 parts.
Thickest part of the left ditto, 2 fourths 11 parts and a half.
Thickness of the right knee across the centre of the patella, 1 fourth 10 parts.
Thickness of the left ditto, 1 fourth 9 parts and a half.
Thickness of the calves of the legs, taken in front, 2 fourths 1 part and a half.
Small of the right leg just above the ancle, 1 fourth 2 parts and a half.
Ditto of the left leg ditto, 1 fourth 1 part.
From centre to centre of the ancle bones of each leg, 1 fourth 4 parts.
Thickness of the instep on the foot immediately under the right ancle, 1 fourth and half a part.
Length of the right foot from the point of the heel to the point of the great toe, 4 fourths 5 parts and one-fourth.
Ditto of left ditto ditto, 4 fourths 8 parts.
Breadth of the right foot on the joints at the roots of the toes, 1 fourth 6 parts and two-thirds.
Length of the right arm from the head of the deltoid to the tip of the elbow, 6 fourths 3 parts.
From the tip of the elbow to the centre of the wrist bone, 4 fourths 10 parts and two-thirds.
Thickness of the right arm, taken in front, 1 fourth 6 parts and one-third.
Ditto in profile about the middle, 2 fourths and one-third of a part.
Thickest part of the right thigh in profile as near as can be taken, 3 fourths 5 parts and three-fourths.
Thickness of the right knee ditto to the centre of the patella, 2 fourths and two-thirds of a part.
Thickness of the calf of the leg in profile, 2 fourths 2 parts.
Thickness of the small of the leg in profile, 1 fourth 5 parts and a fourth.
Total length of the Apollo, including four parts to the head, and measuring down the centre of the body, 32 fourths 2 parts.

Borghese Faun.

From the bottom of the right ear to the pit between the clavicles, 4 fourths.
Total length of the body from the pit between the clavicles to the bottom of the belly, 8 fourths 3 parts.
Length of the right thigh from the point of the ilium to the centre of the patella, 9 fourths 2 parts and one-third.
Length of the right leg from the centre of the patella to the sole of the foot, 9 fourths 6 parts.
Breadth of the shoulders just below the head of the deltoid, 8 fourths 1 part.
Breadth of the body below, measured on the obliquus descendens, 5 fourths 2 parts.
Utmost breadth of the right thigh, measured from the bottom of the testicles, 2 fourths 10 parts and a half.
Breadth of the right knee across the patella, 1 fourth 10 parts and a half.
Narrowest part immediately below the knee, 1 fourth 8 parts.
Thickest part of the calf of the right leg, 2 fourths 1 part; left leg ditto.
Narrowest part just above the ancle, 1 fourth.
Broadest part of the ancle from centre to centre of each bone, 1 fourth 4 parts and a third.
Narrowest part of the instep immediately under the ancle bone, 1 fourth.
Ditto of the left ditto, 1 fourth 1 part and a half.
Utmost length of the right foot, 4 fourths 7 parts and three fourths; ditto of the left foot, 4 fourths 7 parts.
Length of the left arm leaning from the shoulder to the point of the elbow, 6 fourths 8 parts and a third.
Ditto of the right as near as can be guessed, 6 fourths 5 parts.
From the elbow ditto to the centre of the wrist bone, 5 fourths and half a part.
Utmost thickness of the left arm across the centre of the biceps, 1 fourth 10 parts.
Breadth of the left wrist across the centre of the bones, 1 fourth 3 parts.
Thickest part of the thigh in profile from the most prominent part of the glutæus, 4 fourths 4 parts.
From the bottom of the same glutæus, measured horizontally from back to front, 3 fourths 6 parts.
Thickest part of the right knee from the head of the patella, 2 fourths 2 parts and a third.
Ditto of the calf of the right leg, 2 fourths 2 parts and a third; left leg ditto.
Thinnest part immediately under the knee, 1 fourth 11 parts and a half.
Thinnest part of the right ancle just above the instep, 1 fourth 6 parts and a half.
From the centre of the inner ancle to the sole of the foot, 1 fourth 1 part and a third.
Length of the right leg from the head of the patella to the instep, 7 fourths 8 parts and a half.
Ditto of the left from the centre of the patella, as near as can be guessed, 7 fourths 3 parts and a half.
From point to point of the ilium, 4 fourths.

Sleeping Faun (Barberini).

Distance from the right ear to the pit between the clavicles, 3 fourths.
Length of the neck from the bottom of the chin to the pit between the clavicles, 1 fourth 9 parts and a half.
From the said pit to the pit at the bottom of the sternum, 2 fourths 6 parts and a half.
Total length of the body from the said pit to the bottom of the belly, 7 fourths 1 part.
Length of the left thigh in its restored state

from the point of the ilium to the top of the patella, 9 fourths 7 parts.
From the top of the patella to the sole of the foot, 8 fourths 10 parts and a half.
Breadth of the face from ear to ear, as near as can be measured, 2 fourths 5 parts and a half.
Breadth of the neck from side to side, 2 fourths 1 part.
Ditto of the breast from pap to pap, 3 fourths 3 parts and a half.
Breadth from point to point of each ilium, 3 fourths 11 parts and one-third.
From the pit at the bottom of the sternum to the navel, 2 fourths 6 parts and a half.
Utmost thickness of the thigh across the head of the rectus, 3 fourths 2 parts and a third.
Utmost thickness of the body across the paps, 6 fourths 4 parts.
Narrowest part of ditto at the bottom of the ribs, 5 fourths 3 parts and a half.
Length of the arm over the head, from the centre of the head of the humerus, as near as can be found, to the tip of the elbow, 6 fourths.
Length of that arm below, from the tip of the elbow to the centre of the wrist, 5 fourths and one-third of a part.
Utmost thickness of the body from the most prominent part of the breast to the trapezius behind below the shoulder, measured in a right line, 4 fourths 8 parts and a half.
From the hollow part of the rectus before, a little above the navel, to the sacro-lumbalis behind, measured in a right line, 4 fourths 7 parts and a half.
Thickness of the arm from the centre of the biceps to the triceps behind, 2 fourths and half a part.

N. B. The tip of the right elbow; all the left arm below the deltoid; all the right thigh and leg, with so much of the left thigh as is between the broadest part of the rectus and its insertion at the knee, (all of which is antique, together with a part of the solæus, gasterocnemius, and peronei withoutside of the leg) and all the other part of that leg and foot, have been restored by Bernini.

Laocoon.

From the bottom of the right ear to the pit between the clavicles, 3 fourths 3 parts and one-third.
From ditto of the left ear to the said pit, 2 fourths 10 parts and a half.
From the said pit to the centre of the pit at the bottom of the sternum, 3 fourths 4 parts.
From the pit ditto to the top of the navel in a straight line, 3 fourths 4 parts.
From the top of the navel to the privities, 2 fourths 8 parts.
From the point of the ilium to the centre of the patella of the left thigh, 9 fourths 8 parts.
From the point ditto of the right thigh to the centre of the patella, 9 fourths 2 parts.
From the centre of the left patella to the instep or annular ligament, 8 fourths 2 parts.
From the said point at the instep to the bottom of the heel ditto, 1 fourth 11 parts.
Length of the right leg from the centre of the patella to the instep, 7 fourths 9 parts and a quarter.
From the said point at the instep to the bottom of the heel, 1 fourth 5 parts.

From the pit between the clavicles to either pap, 3 fourths 2 parts and three-fourths.
Length of the left arm from the head of the deltoid to the tip of the elbow, 6 fourths 7 parts and a quarter.
From the tip of the said elbow to the centre of the joint of the wrist, 5 fourths 1 part and a half.
Length of the back of the hand from the centre of the wrist to the joint of the middle finger, 1 fourth 4 parts and a third.
Length of the first joint of the middle finger, 1 fourth 1 part.
Thickness of the neck in front, about the middle, 2 fourths 3 parts.
Distance across from pap to pap, 4 fourths 2 parts and two-thirds.
Breadth of the body measured horizontally across the nipples, 6 fourths 5 parts and a half.
Breadth of ditto measured horizontally at the narrowest part across the bottom of the ribs, 5 fourths.
Breadth across on the ilium immediately under the obliquus descendens, 5 fourths 4 parts.
Thickness of the left thigh measured across the centre of the rectus, 3 fourths 3 parts and one-third.
Thickness of the knee measured across the centre of the patella, 1 fourth 11 parts and a half.
Thickness of the right ditto, 1 fourth 11 parts and a half.
Thickness of the calf of either leg, 2 fourths 2 parts.
Thickness of the smallest part just above the ancle, 1 fourth and half a part.
From centre to centre of the left ancle bone, 1 fourth 5 parts; right, ditto.
Narrowest part of the instep just under the ancles, 1 fourth and two-thirds of a part.
Breadth of the foot from the centre of the joint at the root of the great toe to ditto of the little one, 1 fourth 11 parts and one-third.
Thickest part of the left arm measured across the centre of the biceps, 2 fourths 2 parts and one-third.
Ditto of the said arm measured on the supinator just below the elbow, 1 fourth 9 parts and a half.
Breadth across the wrist measured from the centre of the joint, 1 fourth 3 parts.
Breadth of the hand measured upon the joint at the roots of the fingers, 1 fourth 10 parts and two-thirds.
Thickness of the body in profile measured from the centre of the pectoral muscle to the most prominent part of the trapezius behind, 4 fourths 9 parts.
Thinnest part of the body in profile measured just above the navel, 3 fourths 6 parts and a half.
Thickness of the knee from the head of the gasterocnemius to the centre of the patella, 2 fourths 6 parts and a half.
Thickest part of the calf of the right leg in profile, 2 fourths 4 parts.
Thinnest part of the small of the left leg in profile, 1 fourth 6 parts.
Length of the left foot from the heel to the top of the great toe, 4 fourths 8 parts.
Total length of the figure of the Laocoon, allowing 4 fourths for the head, and measuring from the bottom of the chin to the pit between the clavicles, and from thence, following with the utmost exactness the line of the centre of the body, then measuring on the centre of the left thigh (after having found the point by laying a rule across from the bottom of the belly parallel with the two points of the ilium), and so down the centre of the patella, and upon the leg to the sole of the foot, 34 fourths.

Laocoon's elder son.

From the bottom of the left ear to the pit between the clavicles, 2 fourths 11 parts.
From ditto of the right ear to the said pit, 2 fourths 6 parts and a half.
From the said pit to the centre of the pit at the bottom of the sternum, 2 fourths 7 parts and a half.
From the centre of the said pit to the centre of the navel, 2 fourths 7 parts.
From the centre of the navel to the privities, 2 fourths 3 parts and one-third.
From the point of the right ilium to the centre of the patella, 8 fourths 7 parts and a half.
From the centre of the patella to the instep, 8 fourths 1 part.
From the said instep to the bottom of the heel, 1 fourth 8 parts and one-third.
From the centre between the clavicles to either pap, 2 fourths 10 parts and three-fourths.
Distance from pap to pap, 4 fourths 5 parts and one-third.
Ditto from point to point of the ilium, 3 fourths 4 parts.
Length of the left arm measured from the head of the humerus, as near as can be guessed, to the tip of the elbow, 5 fourths 8 parts and two-thirds.
From the tip of the elbow to the centre of the wrist bone, 4 fourths 7 parts and one-third.
Broadest part of the body measured across the paps, 6 fourths 4 parts.
Narrowest part of ditto measured across the bottom of the ribs, 5 fourths 3 parts.
Breadth of the body measured upon the ilium immediately under the obliquus descendens, 5 fourths 7 parts and a half.
Thickest part of the right thigh in front, across the centre of the rectus, 2 fourths 7 parts and a half.
Thickness of the knee across the centre of the patella, 1 fourth 11 parts and one-third.
Thickest part of the calf of the leg, 2 fourths 3 parts.
Thickness of the small of ditto just above the ancle, 1 fourth 1 part and a half.
Thickness of the ancle from the centre of each bone, 1 fourth 4 parts and a quarter.
Broadest part of the right foot across the joints at the roots of the toes, 1 fourth 8 parts.
Thickness of the upper arm in profile across the middle of the biceps, 1 fourth 11 parts and a half.
Ditto of the lower arm just below the elbow, ditto, 1 fourth 6 parts.
Thickness of the right thigh in profile, 3 fourths 4 parts and three-fourths.
Ditto of the knee ditto from the centre of the patella, 2 fourths 6 parts.
Thickness of the calf of the leg ditto, 2 fourths 4 parts.

Thickness just above the ancle ditto, 1 fourth 5 parts.

Thickness of the body in profile from the most prominent part of the pectoral muscle to the trapezius behind, 4 fourths 3 parts and a half.

Narrowest part of ditto measured a little above the navel, 3 fourths 3 parts.

Total length of the figure measured down the centre, allowing 4 fourths to the head, and observing the same method as with the foregoing statue of the father, 30 fourths exact.

Younger son of Laocoon.

From the tip of the right ear to the pit between the clavicles, 2 fourths 8 parts.

From the said pit to the pit at the bottom of the sternum, 2 fourths 8 parts.

From ditto to the right pap, 2 fourths 8 parts.

From the pit between the clavicles to the bottom of the belly, 8 fourths.

From the point of the right ilium to the top of the patella, 7 fourths 9 parts.

From the top of the patella ditto to the sole of the foot, 8 fourths 7 parts.

Length of the right foot from the heel to the great toe, 4 fourths 2 parts and one-third.

Breadth of the narrowest part of the body in front at the bottom of the ribs, 4 fourths 2 parts.

Thickness of the thigh measured across the centre of the rectus, 3 fourths and half a part.

Thickness of the calf of the leg ditto, 2 fourths 3 parts.

Thickness of the smallest part of the leg just above the ancle, 1 fourth 2 parts.

From centre to centre of each ancle bone 1 fourth 4 parts.

Thickness of the body from the most prominent part of the pectoral muscle to the trapezius behind, 4 fourths.

Narrowest part of the body just above the navel, 2 fourths 9 parts and two-thirds.

Thickness from the most prominent part of the glutæus, to the point of the ilium, 3 fourths 8 parts and a half.

Thickest part of the thigh in profile about the centre of the rectus, 2 fourths 10 parts and two-thirds.

Thickness of the calf of the leg, 2 fourths 2 parts.

Thickness of the smallest part in profile, 1 fourth 5 parts.

Length of the arm on the body from the head of the deltoid to the tip of the elbow, 5 fourths 6 parts and two-thirds.

From the tip of the elbow to the centre of the wrist bone, 4 fourths 5 parts and one-third.

From the joint of the wrist upon the extensores communes to the joint of the middle finger, 2 fourths 9 parts.

Meleager.

From the left ear to the pit between the clavicles, 2 fourths 10 parts and a half; from the right ditto, 2 fourths 9 parts and a half.

From the pit between the clavicles to the bottom of the belly, 9 fourths.

From ditto to the centre of the pit at the bottom of the sternum, 3 fourths.

From ditto to the pap on the right breast, 4 fourths 1 part and a half.

Length of the right thigh from the point of the ilium to the top of the patella, 9 fourths.

From the top of the patella to the sole of the foot ditto, 9 fourths 3 parts.

Distance from pap to pap, 4 fourths 2 parts.

Broadest part of the body measured across the paps, 8 fourths 9 parts and two-thirds.

Narrowest part of ditto measured at the bottom of the ribs, 5 fourths 5 parts.

Breadth of the hips measured on the ilium immediately under the obliquus descendens, 5 fourths 7 parts and a half.

Thickest part of the thigh measured in front, 2 fourths 10 parts and one-third.

Thickness of the right knee across the centre of the patella, 1 fourth 10 parts and a half.

Thickest part of the calf of the leg, 2 fourths 1 part and one-third.

Thickness of the small of the leg ditto just above the ancle, 1 fourth.

From centre to centre of each ancle bone, 1 fourth 5 parts.

Length of the right foot from the heel to the tip of the toe, 4 fourths and 9 parts.

Broadest part of the said foot from the joint at the root of the great toe to ditto of the little toe, 1 fourth 9 parts.

Breadth of the face from ear to ear in front, 2 fourths 3 parts.

Ditto of the neck ditto in front about the middle, 2 fourths and half a part.

Length of the arm from the head of the deltoid to the tip of the elbow, 6 fourths 11 parts and one-third.

Thickest part of the arm measured in front across the biceps, 1 fourth 7 parts and a half.

Thickness of the arm in profile from the biceps to the triceps behind, 2 fourths 1 part and three-fourths.

Ditto of the body measured from the most prominent part of the pectoral muscle to the trapezius, 4 fourths 6 parts and one-third.

Narrowest part of the body in profile ditto, just above the navel, 3 fourths 7 parts and one-third.

Thickest part of the thigh on the rectus just under the glutæus, 3 fourths 4 parts and one-third.

Thickness of the knee in profile on the centre of the patella, 2 fourths 2 parts.

Thickest part of the calf of the leg in profile, 2 fourths 2 parts and three-fourths.

Smallest of ditto, 1 fourth 4 parts.

Breadth from point to point of the ilium, 3 fourths 9 parts and two-thirds.

Total length of the figure, allowing 4 fourths to the head, and measuring down the line of the centre of the body, then laying a line parallel with the points of the ilium, and measuring down the middle of the thigh to the sole of the right foot, 31 fourths 4 parts.

Antinous.

From the bottom of the left ear to the pit between the clavicles, 2 fourths 9 parts.

From the pit between the clavicles to the pit at the bottom of the breast, 2 fourths 10 parts and two-thirds.

From ditto to either pap, 3 fourths 4 parts.

From ditto to the bottom of the belly, 9 fourths.

From the point of the ilium to the centre of the patella, 9 fourths.

From ditto to the sole of the foot, 9 fourths.

From pap to pap, 4 fourths 10 parts.

From point to point of the ilium, 3 fourths 10 parts and one-third.

Breadth of the face from ear to ear, 2 fourths 3 parts and two-thirds.

Thickness of the neck about the middle, 2 fourths 1 part and a half.

Broadest part of the shoulders from deltoid to deltoid, 8 fourths 9 parts and a half.

Narrowest part of the body at the bottom of the ribs, 5 fourths 1 part.

Breadth measured on the ilium immediately under the obliquus descendens, 5 fourths 4 parts and a half.

Ditto of the thickest part of the left thigh across the rectus, 3 fourths 1 part.

Ditto of the right ditto, 2 fourths 11 parts.

Thickness of the left knee across the centre of the patella, 1 fourth 11 parts.

Ditto of the right ditto, 2 fourths.

Thickness of the right leg at the thickest part, 2 fourths 3 parts.

From centre to centre of the ancle bones, 1 fourth 4 parts and one-third.

The foot is not antique.

Length from the head of the deltoid to the centre of the right elbow, 6 fourths 9 parts and a half.

From ditto to the centre of the wrist bone, 4 fourths 6 parts and a half.

From the centre of the wrist bone to the joint of the little finger, 1 fourth 6 parts and a half.

Breadth of the body in profile from the shoulder to the most prominent breast, 4 fourths 10 parts and a half.

Narrowest part of the body ditto at the bottom of the ribs, 3 fourths 4 parts and three-fourths.

Thickness from the most prominent part of the glutæus to the head of the rectus ditto, 4 fourths 1 part.

Thickest part of the thigh about the middle of the rectus, 3 fourths 5 parts.

Thickest part of the knee ditto, 2 fourths 3 parts.

Thickness of the arm ditto about the middle of the breasts, 2 fourths 2 parts and one-third.

Germanicus.

From the bottom of the chin to the pit between the clavicles, 1 fourth and two-thirds of a part.

From the tip of each ear to the said pit, 2 fourths 7 parts and a third.

From the pit between the clavicles to the bottom of the belly, 9 fourths exactly.

From the point of the ileum to the centre of the patella of the left leg, 9 fourths 3 parts.

From the centre of the patella to the sole of the foot of ditto, 7 fourths 9 parts and a third.

From the pit between the clavicles to the pit at the bottom of the sternum, 3 fourths 3 parts and a half.

From ditto to the right and left pap of the breast, 3 fourths 3 parts and a half.

From pap to pap, 4 fourths 5 parts and a half.

From point to point of each ilium, (in their oblique situation) 3 fourths 10 parts.

From ear to ear measured across the face, 2 fourths 5 parts and a half.
Utmost thickness of the neck in front, 2 fourths 1 part.
From the pit between the clavicles to the left shoulder measured horizontally, 4 fourths 4 parts.
From the great trochanter of the left thigh to the most prominent part of the right thigh measured horizontally, 5 fourths 9 parts and one-half.
Thickest part of the right thigh measured horizontally across the middle of the rectus, 3 fourths.
Ditto of the left ditto continuing the same horizontal line, 2 fourths 8 parts.
Right knee across the centre of the patella, 1 fourth 10 parts; left ditto, ditto.
Thickest part of the calf of the right leg, 2 fourths 1 part and a half; ditto of the left, 2 fourths and a third of a part.
Thinnest part of the ancle of the left leg, 1 fourth 1 part and a fourth; right, ditto.
Thickest part of the ancles from the centre of bone to bone, 1 fourth 2 parts and three-fourths.
Thickest part of the right foot from the joint at the root of the great toe, 1 fourth 9 parts.
Ditto, ditto of the left foot, 1 fourth 8 parts.
From the head of the deltoid muscle to the tip of the right elbow measured within, in front, 6 fourths 2 parts.
From the tip of the elbow to the centre of the ulna at the right wrist, 4 fourths 4 parts and a half.
From the head of the deltoid to the left elbow, 5 fourths 9 parts and a half.
Thickest part of the body from the most prominent part of the pectoral muscle before, to the most prominent part of the scapula, taken horizontally in profile, 4 fourths 10 parts and a half.
Narrowest part of the body measured just above the navel, 3 fourths 6 parts.
From the hollow of the thigh at the head of the rectus before, to the most prominent part of the glutæus behind, 4 fourths 2 parts.
Thickest part of the right thigh measured below the glutæus, 3 fourths 5 parts and a half.
Thickness of the right knee in profile from the centre of the patella to the hollow behind, 2 fourths 2 parts and a half.
Thickest part of the calf of the right leg in profile, 2 fourths 2 parts; ditto above the ancle, 1 fourth 5 parts.
Length of the right foot, 4 fourths 4 parts and three-fourths.
Thickest part of the right arm from the biceps to the triceps, 1 fourth 11 parts and one-third.
Broadest part of the wrist from bone to bone, 1 fourth 2 parts.
Thickest part of the neck taken in profile, 2 fourths.

Far the greatest number of the so much admired Grecian statues lay, for a long series of years, buried under the ruins of Rome. The following is a brief account of the

Discovery of several of the most celebrated statues, or groups, in various parts of Rome.

I. The equestrian statue of M. Aurelius was found on the Cælian hill, near the present church of St. John Lateran, in the pontificate of Sixtus IV. (1471 to 1484) who placed it in that area. About the year 1540 it was removed to the capitol, under the direction of Michel Angelo.

II. The torso of Hercules in the Vatican, was found in the Campo de Fiori, in the time of Julius II.

III. The group of the Laocoon was discovered in the vineyard of Gualtieri, near the baths of Titus, by Felix de Fredis, in 1512, as recorded on his tomb in the church of Ara Cœli.

IV. In the reign of Leo X: the Antinous, or Mercury according to Visconti, was found on the Esquiline hill, near the church of St. Martin.

V. Leo was likewise successful in recovering from oblivion the Venus called de Medicis. It was found in the portico of Octavia, built by Augustus, near the Theatre of Marcellus, in the modern Pescheria. Removed to the gallery at Florence by Cosmo III. in 1676.

VI. The colossal Pompey of the Spada palace, was found during the pontificate of Julius III. (1550 to 1555) near the church of St. Lorenzo in Damasco.

VII. The Hercules, and the groupe of Dirce, Zethus, and Amphion, called "Il toro," now at Naples, were dug up in the baths of Caracalla, and placed in the Farnese palace, about the middle of the sixteenth century.

VIII. The Apollo Belvidere, and the Gladiator of the Villa Borghese, were taken from under the ruins of the palace and gardens of Nero at Antium, 40 miles from Rome, when the Casino was made there by cardinal Borghese, during the reign of Paul V. (1605 to 1621).

IX. Soon afterward, the sleeping Faun, now in the Barberini palace, was found near the mausoleum of Hadrian.

X. The Mirmillo Expirans, or Dying Gladiator of the capitol, was dug up in the gardens of Sallust, on the Pincian hill, now the Villa Borghese: it was purchased by Benedict the 14th, of cardinal Lodovisi.

XI. The small Harpocrates and the Venus of the Capitol were found at Tivoli in the same reign.

XII. The Meleager, once in the Picchini collection, now in the Vatican, was found near the church of St. Bibiena.

STATUTE, in its general sense, signifies a law, ordinance, decree, &c. Statute, in our laws and customs, more immediately signifies an act of parliament made by the three estates of the realm; and such statutes are either public, of which the courts at Westminster must take notice, without pleading them; or they are special and private, which last must be pleaded. It is held, that a public statute, made in affirmation of the common law, extends to all times after the making thereof, although it mentions only a remedy for the present; and where a thing is given or granted by statute, all necessary incidents are at the same time granted with it. The most natural exposition of a statute is, to construe one part by another of the same statute, because that best expresses the intent of the makers; also statutes, in general, ought to be expounded in suppression of the mischief, and for the advancement of the remedy designed by any statute, yet so that no innocent person may suffer or receive any damage thereby. It is held, that statutes will continue in force, though the records of them are destroyed. &c. But if a statute is against reason, or impossible to be performed, the same is void of course.

When a statute is repealed, all acts done under it, while it was in force, are good; but if it is declared null, all these are void. Jenk. 233., pl. 6.

Where a statute, before perpetual, is continued by an affirmative statute, for a time, this does not amount to a repeal of it at the end of that time. Lord Raym. 397.

Where two acts contradictory to each other, are passed in the same session, the latter only shall take effect. 6 Mod. 287.

STATUTE MERCHANT, is a bond of record, acknowledged before one of the clerks of the statute merchant, and lord mayor of the city of London, or two merchants of the said city, for that purpose assigned, or before the mayor or warden of the town, or other discreet men for that purpose assigned. This recognizance is to be entered on a roll, which must be double, one part to remain with the mayor, and the other with a clerk, who shall write with his own hand a bill obligatory, to which a seal of the king for that purpose appointed, shall be affixed, together with the seal of the debtor. 2 Bac. Abr. 331.

The design of this security was to promote and encourage trade, by providing a sure and speedy remedy for merchant-strangers, as well as natives, to recover their debts at the day assigned for payment.

But though the statute-merchant seems first to be introduced, and wholly calculated, for the ease and benefit of merchants, as the name itself imports; yet they were not long engrossed by them: for other men finding from their own observation, that they have much of the same nature with judgments in Westminster-hall, but obtained with less trouble and expence, out of regard to their own interest and quiet, easily fell into this way of contracting, and by degrees it came to be improved into a common assurance, as we find it at this day. Winch. 83. See INSURANCE.

STATUTE STAPLE, is a bond of record, acknowledged before the mayor of the staple, in the presence of all or one of the constables. But now statute staple, as well as statute merchant, are in a great measure become obsolete.

STATUTES, or STATUTES SESSIONS, otherwise called petit sessions, are a meeting in every hundred, of all the shires in England, where by custom they have been used, whereto the constables and others, both householders and servants, repair for the debating of differences between masters and servants, the rating of servants' wages, and bestowing such people in service, as being fit to serve, either refuse to seek or get masters. Stat. 5 Eliz. c. 5.

STAVE, in music, the five horizontal and parallel lines on and between which the notes are placed.

Guido, the great improver of the modern music, is said by some to have first used the stave; but others give an earlier date to its introduction. Kircher affirms, that in the jesuit's library at Messina he found a Greek manuscript of hymns more than seven hundred years old, in which some of the music was written on staves of eight lines, marked at the beginning with eight Greek letters; the notes, or rather points, were on the lines, but no use was made of the spaces. This, however, at most, only deprives Guido of the original invention of the stave, and still leaves him the credit of its great improvement by reducing it to five lines, and employing both lines and spaces.

STAUROLITE, in mineralogy. This stone has been found at Andreasberg in the Hartz. It is crystallized, and the form of its crystals has induced mineralogists to give it the name of cross-stone. Its crystals are two four-sided flattened prisms, terminated by four-sided pyramids, intersecting each other at right angles; the plane of intersection passing longitudinally through the prism. Sometimes these prisms occur solitary. Primitive form, an octahedron with isosceles triangular faces. The faces of the crystals striated longitudinally.

Its texture is foliated. Its lustre glassy. Brittle. Specific gravity 2.33 to 2.36. Colour milk-white. When heated slowly, it loses 0.15 or 0.16 parts of its weight, and falls into powder. It effervesces with borax and microcosmic salt, and is reduced to a greenish opaque mass. With soda it melts into a frothy white enamel. When its powder is thrown on a hot coal, it emits a greenish-yellow light.

A specimen analysed by Westrum was composed of

44 silica
20 alumina
20 barytes
16 water

100.

Klaproth found the same ingredients, and nearly in the same proportions.

A variety of staurolite has been found only once, which has the following properties:

Its lustre is pearly, 2. Specific gravity 2.361. Colour brownish-grey. With soda it melts into a purplish and yellowish frothy enamel. It is composed, according to Westrum, of

47.5 silica
12.0 alumina
20.0 barytes
16.0 water
4.5 oxides of iron and manganese

100.0.

STAY, in the sea-language, a strong rope fastened to the top of one mast, and to the foot of that next before it, towards the prow, serving to keep it firm, and prevent its falling aftwards or towards the poop. All masts, top-masts, and flag-staves, have their stays, except the sprit-sail top-masts. That of the main-mast is called the main-stay. The main-mast, fore-mast, and those belonging to them, have also back-stays to prevent their pitching forwards or overboard.

STEALING, the fraudulent taking away of another man's goods, with an intent to steal them, against, or without, the will of him whose goods they are. See BURGLARY, LARCENY, and ROBBERY.

STEAM. See WATER.

STEAM-ENGINE. See ENGINE, *steam*.

STEATITES, in mineralogy, is usually amorphous, but sometimes crystallized in six-sided prisms. Its texture is commonly earthy: specific gravity 2.61 to 2.79; feels greasy; seldom adheres to the tongue: colour white or grey, with a tint of other colours; the foliated green. Does not melt per se before the blowpipe. There are three varieties: specimens analyzed by Klaproth and Chenevix, contained as follows;

By Klaproth.	By Chenevix.
59.5 silica	60.00 silica
30.5 magnesia	28.50 magnesia
2.5 iron	3.00 alumina
5.5 water	2.50 lime
	2.25 iron
98.0	97.25.

STEEL, a carburet of iron, or that metal combined with a small portion of carbon. See IRON.

STEERAGE, on board a ship, that part of the ship next below the quarter-deck, before the bulk-head of the great cabin, where the steersman stands in most ships of war. See the next article.

STEERING, in navigation, the directing of a vessel from one place to another by means of the helm and rudder. He is held the best steersman who causes the least motion in putting the helm over to and again, and who best keeps the ship from making yaws, that is, from running in and out. There are three methods of steering: 1. By any mark on the land, so as to keep the ship even by it. 2. By the compass, which is by keeping the ship's head on such a rhumb or point of the compass as best leads to port. 3. To steer as one is bidden or conned, which, in a great ship, is the duty of him that is taking his turn at the helm.

STELLARIA, *stichwort*, a genus of plants belonging to the class of decandria, and order of trigynia, and in the natural system arranged under the 22d order, caryophylleæ. The calyx is pentaphyllous and spreading. There are five petals, each divided into two segments. The capsule is oval, unilocular, and polyspermous. There are 17 species; three of these are British plants. 1. Nemorum, broad-leaved stichwort. 2. Holostea, greater stichwort; it is common in woods and hedges. 3. Graminea, less stichwort. The stem is near a foot high. It is frequent in dry pastures.

STELLATE. See BOTANY.

STELLERA, *German groundsel*, a genus of plants belonging to the class of octandria, and order of monogynia, and in the natural system arranged under the 31st order, vepreculæ. There is no calyx; the corolla is quadrifid. The stamina are very short; there is only one seed, which is black. The species are two in number, passerina and chamaejasme.

STEM. See BOTANY.

STEM *of a ship*, that main piece of timber which comes bending from the keel below, where it is scarfed, as they call it, that is, pieced in; and rises compassing right before the forecastle. This stem it is which guides the rake of the ship, and all the butt-ends of the planks are fixed into it. This, in the section of a first-rate ship, is called the main stem. See SHIP-BUILDING.

STEMMATA, in the history of insects, are three smooth hemispheric dots, placed generally on the top of the head, as in most of the hymenoptera and other classes.

STEMODIA, a genus of plants belonging to the class of didynamia, and order of angiospermia, and in the natural system ranging under the 40th order, personatæ. The calyx is quinquepartite; the corolla bilabiated; there are four stamina; each of the filaments is bifid, and they have two antheræ. The capsule is bilocular. There are four species, herbs of the East and West Indies.

STENOGRAPHY. The art of stenography, or short-hand writing, was known and practised by most of the antient civilized nations. The Egyptians, who were distinguished for learning at an early period, at first expressed their words by a delineation of figures called hieroglyphics. A more concise mode of writing seems to have been afterwards introduced, in which only a part of the symbol or picture was drawn. This answered the purpose of short-hand in some degree. After them the Hebrews, the Greeks, and the Romans, adopted different methods of abbreviating their words and sentences, suited to their respective languages. The initials, the finals, or radicals, often served for whole words; and various combinations of these sometimes formed a sentence. Arbitrary marks were likewise employed to determine the meaning, and to assist legibility; and it seems probable that every writer, and every author of antiquity, had some peculiar method of abbreviation, calculated to facilitate expression of his own sentiments, and intelligible only to himself.

It is also probable, that some might by these means take down the heads of a discourse or oration; but few, very few, it is presumed, could have followed a speaker through all the meanders of rhetoric, and noted with precision every syllable, as it dropt from his mouth, in a manner legible even to themselves. To arrive at perfection in the art was reserved for more modern times, and is still an acquisition by no means general.

In every language of Europe, till about the close of the 16th century, the Roman plan of abbreviating (viz. substituting the initials or radicals, with the help of arbitrary characters for words), appears to have been employed. Till then no regular alphabet had been invented expressly for stenography, when an English gentleman of the name of Willis invented and published one; since which we have had a multitude of others by Mason, Gurney, Byrom, Palmer, &c. &c. The following is extracted from Dr. Mavor's treatise on the art, which has met with general approbation:

Rules for Orthography in SHORT HAND.

1. All quiescent consonants in words are to be dropped; and the orthography to be directed only by the pronunciation: which, being known to all, will render this art attainable by those who cannot spell with precision in long hand. 2. When the absence of consonants, not entirely dormant, can be easily known, they may often be omitted without the least obscurity. 3. Two, or sometimes more consonants, may, to promote greater expedition, be exchanged for a single one of nearly similar sound; and no ambiguity as to the meaning ensue. 4. When two consonants of the same kind or same

sound come together, without any vowel between them, only one is to be expressed; but if a vowel or vowels intervene, both are to be written: only observe, if they are perpendicular, horizontal, or oblique lines, they must only be drawn a size longer than usual; and characters with loops must have the size of their heads doubled. See Plate.

Might is to be written *mit*, fight *fit*, machine, *mashin*, enough *enuf*, laugh *laf*, prophet *profet*, physics *fisiks*, through *thro'*, foreign *foren*, sovereign *soveren*, psalm *sam*, receipt *reset*, write *rite*, wright *rit*, island *iland*, knavery, *navery*, temptation *temtation*, knife *nife*, stick *stik*, thigh *thi*, honour *onour*, indictment *inditement*, acquaint *aquaint*, chaos *kaos*, &c.

Strength *strenth*, length *lenth*, friendship *frenship*, connect *conek*, commandment, *comanment*, conjunct *conjunt*, humble *humle*, lumber *lumer*, slumber *slumer*, number *numer*, exemplary *exemlary*, &c.

Rocks *rox*, acts, *aks* or *ax*, facts *faks* or *fax*, districts *distriks*, or *distrix*, affects *afeks* or *afex*, afflicts *afliks* or *aflix*, conquer, *konkr*, &c.

Letter *leter*, little *litle*, command *comand*, error *eror*, terror *teror*, &c. But in *remember*, *moment*, *sister*, and such like words, where two consonants of the same name have an intervening vowel, both of them must be written.

These four rules, with their examples, being carefully considered by the learner, will leave him in no doubt concerning the disposition and management of the consonants in this scheme of short-writing; we shall therefore proceed to lay down rules for the application of the vowels with ease and expedition.

1. Vowels, being only simple articulate sounds, though they are the connectives of consonants, and employed in every word and every syllable, are not necessary to be inserted in the middle of words; because the consonants, if fully pronounced, with the assistance of connection, will always discover the meaning of a word, and make the writing perfectly legible.

2. If a vowel is not strongly accented in the incipient syllable of a word, or if it is mute in the final, it is likewise to be omitted; because the sound of the incipient vowel is often implied in that of the first consonant, which will consequently supply its place.

3. But if the vowel constitutes the first or last syllable of a word, or is strongly accented at its beginning or end, that vowel is continually to be written.

4. If a word begins or ends with two or more vowels, though separated, or when there is a coalition of vowels, as in diphthongs and triphthongs, only one of them is to be expressed, which must be that which agrees best with the pronunciation.

5. In monosyllables, if they begin or end with a vowel, it is always to be inserted, unless the vowel is *e* mute at the end of a word.

Such are the general principles of this art; in vindication and support of which it will be needless to offer any arguments, when it is considered that brevity and expedition are the chief objects, if consistent with legibility; and the subsequent specimens in the orthography recommended, will, we hope, be sufficient to show that there is no real deficiency in the last-mentioned particular.

He who md us mst be etrnl, grt, nd mnptnt. It is ur dty, as rtnl bngs, to srv, lv, nd oby hm. A mn tht wd avd blm, shd be srkmspk in al hs axns, nd ndvr wth al hs mt to pls evry bdy. I wd nt frm any knxns wth a mn who hd no rgrd fr hmslf: nthr wd I blv a mn who hd ons tld me a li. Onr is of al thngs the mst dfklt to prsrv ntrnshd; nd whn ons mpchd, lk the chsty of a wmn, nvr shns wth its wntd lstr. Wth gd mnrs, kmplsns nd an esy plt adrs, mny mk a fgr in the wrl, whs mntl ablts wd skrsly hv rsd thm abv the rnk of a ftmn. Idlns is the prnt of a thsnd msfrtns, wch ar nvr flt by the ndstrs: it is a pn nd a pnshmnt of itslf, nd brngs wnt nd bgry in its trn. Vrtu is the frst thng tht shd be rgrdd; it is a rwrd of itslf; mks a mn rspktbl hr, nd wl mk hm etrnly hpy hrftr. Prd is a mst prnss psn, wch yt ws plntd by hvn in ur ntr, to rs ur emlsn to imtt grt nd wrthy krktrs or axns, to xt in us a sl fr wht is rt nd gst, nd a ldbl ndgnsn gnst oprsrs nd wrkrs of any knd of nkty; in shrt, to mk us st a prpr vlu upn urslvs, nd dsps a wrthls flo, hu evr xltd. Ths fr prd is a vrtu, nd my gstly be kld a grtns of sl. Bt prd, lk othr psns, gnrly fxs upn rng obgks, or is apld in rng prprsns. Hu kmn is it to se a rtch whm evry vs hs rndrd msrbl, nd evry fly kntmtbl, vlng hmslf on his hi brth, nd bstng ths ilstrs nssttrs, of whm he nhrts nthng bt the nm or ttl! nsstrs who if thy nu hm, wd dsn thr dpndnt wth kntmt. But al prd of ths srt is fly, nd evr to be avdd.

As the whole of this art depends upon a regular method and a simple alphabet, we have not only endeavoured to establish the former on satisfactory principles, but have been careful to appropriate, according to the comparative frequency of their occurrence, such characters for the letters as, after repeated trials and alterations, were conceived to be the best adapted for dispatch.

The short-hand alphabet consists of 18 distinct characters (viz. two for the vowels and the rest for the consonants) taken from lines and semicircular curves; the formation and application of which we shall now explain, beginning with the vowels.

For the three first vowels, *a*, *e*, and *i*, a comma is appropriated in different positions; and for the other three, *o*, *u*, and *y*, a point. The comma and point, when applied to *a* and *o*, is to be placed, as in the Plate, at the top of the next character; when for *e* and *u*, opposite to the middle; and when for *i* and *y*, at the bottom.

This arrangement of the vowels is the most simple and distinct that can be easily imagined. Places at the top, the middle, and the bottom of characters, which make three different positions, are as easily distinguished from one another as any three separate characters could be; and a comma is made with the same facility as a point.

Simple lines may be drawn four different ways; perpendicular, horizontal, and with an angle of about forty-five degrees to the right and left. An ascending oblique line to the right, which will be perfectly distinct from the rest when joined to any other character, may likewise be admitted. These characters being the simplest in nature, are assigned to those five consonants which most frequently occur, viz. *l*, *r*, *t*, *c* hard or *k*, and *c* soft or *s*.

Every circle may be divided with a perpendicular and horizontal line, so as to form likewise four distinct characters. These being the next to lines in the simplicity of their formation, we have appropriated them for *b*, *d*, *n*, and *m*.

The characters expressing nine of the consonants are all perfectly distinct from one another; eight only remain which are needful, viz. *f*, *g*, or *j*, *h*, *p*, *q*, *v*, *w*, and *x*, to find characters for which we must have recourse to mixed curves and lines. The characters which we have adopted are the simplest in nature after those already applied, admit of the easiest joining, and tend to preserve lineality and beauty in the writing.

It must be observed that we have no character for *c* when it has a hard sound, as in *castle*; or soft, as in *city*; for it naturally takes the sound of *k* or *s*, which in all cases will be sufficient to supply its place.

R likewise is represented by the same character as *l*; only with this difference, *r* is written with such an ascending stroke and *l* with a descending; which is always to be known from the manner of its union with the following character; but in a few monosyllables, where *r* is the only consonant in the word, and consequently stands alone, it is to be made as is shown in the alphabet for distinction's sake.

Z, as it is a letter seldom employed in the English language, and only a coarser and harder expression of *s*, must be supplied by *s* whenever it occurs; as for *Zedekiah*, write *Sedekiah*, &c.

The prepositions and terminations in this scheme are so simple, that the greatest benefit may be reaped from them, and very little trouble required to attain them; as the incipient letter or the incipient consonant of all the prepositions, and of several of the terminations, is used to express the whole. But although in the Plate sufficient specimens are given of the manner of their application, that the learner of less ingenuity or more slow perception may have every assistance, we have subjoined the following directions:

1. The preposition is always to be written without joining, yet so near as plainly to show what word it belongs to; and the best way is to observe the same order as if the whole was to be connected.

2. A preposition, though the same letters that constitute it may be met with in the middle or end of a word, is never to be used, because it would expose it to obscurity.

3. Observe that the preposition omni is expressed by the vowel *o* in its proper position; and for *anti*, *anta*, *ante*, by the vowel *a*, which the radical part of the word will easily distinguish from being only simple vowels.

The first rule for the prepositions is (allowing such exceptions as may be seen in the Plate) to be observed for the terminations; and also the second *mutatis mutandis*, except that whenever *sis*, *sus*, *sys*, *cious*, *tious*, and *ces*, occur, they are to be expressed as directed in the fourth rule for the consonants, whether in the beginning, middle, or end of words.

4. The terminative character for *tion*, *sion*, *cion*, *cian*, *tian*, is to be expressed by a small circle joined to the nearest letter, and turned to the right; and the plurals, *tions*, *sions*, *cions*, *cians*, *tians*, *tience*, by a dot on the same side.

5. The terminative character for *ing* is to be expressed likewise by a small circle, but drawn to the left hand; and its plural *ings* by a dot.

6. The plural sign *s* is to be added to the terminative characters when necessary.

7. The separated terminations are never to be used but in polysyllables, or words of more syllables than one.

These directions duly observed, together with a proper attention to the engraved plate, and a regard to what has gone before in this art, will point out a method as concise and elegant as can be desired, for expressing the most frequent and longest prepositions and terminations in the English language. If it should be thought necessary to increase their number by the addition of others, it will be an easy matter for any one of the least discernment to do so, by proceeding on the principles before laid down.

STEP *of the mast and capstan*, in a ship, is that piece of timber whereon the masts or capstans stand at bottom.

STEPHANIUM, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 47th order, stellatæ. The calyx is monophyllous, turbinated, and quinquepartite; the corolla is monopetalous, funnel-shaped, having its tubes curved and ventricose; the pericarpium is a bilocular berry, containing two seeds, flattened on one side, and round on the other. This genus is nearly allied to that of psychotria. There is only one species, viz. guianense, a native of the warmer parts of America.

STERBEEKIA, a genus of the class and order polyandria monogynia; the calyx is three or five valved; corolla three or five petalled; caps. corticose; seeds intricate; nothing in pulp. There is one species, a shrub of Guiana.

STERCULIA, a genus of plants belonging to the class dodecandria, and order of monogynia, and in the natural system ranking under the 38th order, tricocceæ. The calyx is quinquepartite; there is no corolla; the nect. is bell-shaped; germ pedicelled; and the capsule is quinquelocular, and many-seeded. There are eight species, all foreign plants.

STEREOGRAPHIC PROJECTION. See PROJECTION.

STEREOGRAPHY, the art of drawing the forms and figures of the solids upon a plane.

STEREOMETRY, that part of geometry which teaches how to measure solid bodies, that is, to find the solidity or solid content of bodies, as globes, cylinders, cubes, vessels, ships, &c.

STEREOTYPE PRINTING. This is said to be an improvement in the art, and was introduced into this country by Mr. Ged, of Edinburgh, who, instead of types or single letters, formed a plate for each separate page, from which the work is printed. With the first inventor it did not succeed; though the pretensions of Ged, as an inventor, may be disputed, for precisely the same principle was adopted many hundred years ago by the Chinese and Japanese, who first practised the art of printing by means of wooden blocks. The mode of stereotype printing is, first to set up a page, for instance, in the common way, and when it is rendered perfectly correct, a cast is taken from it, and in this cast the metal for the stereotype plate is poured. This method of printing has lately been brought into practice by earl Stanhope, who seems to have overcome all difficulties, and to have rendered the art as perfect as can be expected. His lordship intends to make the invention public.

STERLING, a term frequent in British commerce. A pound, shilling, or penny, sterling, signifies as much as a pound, shilling, or penny, of lawful money of Great Britain, as settled by authority.

STERN *of a ship*, usually denotes all the hindermost part of her, but properly it is only the outmost part abaft.

STERN-FAST, denotes some fastenings of ropes, &c. behind the stern of a ship, to which a cable or hawser may be brought or fixed, in order to hold her stern to a wharf, &c.

STERN-POST, a great timber let into the keel at the stern of a ship, somewhat sloping, into which are fastened the afterplanks; and on this post, by its pintle and gudgeons, hangs the rudder.

STERNA, *the tern*, a genus of birds of the order anseres. The marks of this genus are a straight, slender, pointed bill, linear nostrils, a slender and sharp tongue, very long wings, a small back toe, and a forked tail. There are 25 species, according to Dr. Latham; the caspia, cayana, surinamensis, fuliginosa, africana, stolida, philippina, simplex, nilotica, boysii, striata, vittata, sadicea, pilcata, hirundo, panaya, cinerea, alba, minuta, sinensis, australis, metopoleucos, fissipes, nigra, and obscura. Three of these only are found in Great Britain; the hirundo, minuta, and fissipes. See Plate Nat. Hist. fig. 377.

1. The hirundo, common tern, or great sea-swallow, weighs four ounces one quarter; the length is fourteen inches; the breadth thirty; the bill and feet are of a fine crimson; the former tipt with black, straight, slender, and sharp-pointed; the crown, and hind part of the head, black; the throat, and whole underside of the body, white; the upper part, and the coverts of the wings, a fine pale-grey. This is a very common species, frequents our sea-coasts, and banks of lakes and rivers during the summer, but is most common in the neighbourhood of the sea. It is found also in various parts of Europe and Asia, according to the season; in the summer, as far as Greenland and Spitzbergen, migrating in turn to the South of Austria and Greece. It lays three or four eggs about the month of June, of a dull olive-colour.

These are laid among the grass or moss. The young are hatched in July, and quit the nest very soon after. They are carefully fed by their parents, and fly in about six weeks. This bird appears to have all the actions on the water which the swallow has on land, skimming on the surface, and seizing on every insect which comes in its way; besides which, the moment it spies a fish in the water, it darts into that element, and seizing its prey, arises as quickly to the place from which it dipped.

2. The minuta, or smaller sea-swallow, weighs only two ounces five grains; the length is eight inches and a half, the breadth nineteen and a half. The bill is yellow, tipt with black; the forehead and cheeks white; from the eyes to the bill is a black line; the top of the head and hind part black; the breast and under side of the body clothed with feathers so closely set together, and of such an exquisite rich gloss and so fine a white, that no satin can be compared to it. These two species are very delicate, and seem unable to bear the inclemency of the weather on our shores during winter, for we observe that they quit their breeding-place at the approach of it, and do not return till spring. The manners, haunts, and food, of this species, are the same with those of the former; but they are far less numerous.

3. The fissipes, or black tern, is of a middle size between the first and second species. The usual length is ten inches; the breadth 24; the weight two ounces and a half. The head, neck, breast, and belly, as far as the vent, are black; beyond is white; the male has a white spot under its chin; the back and wings are of a deep ash-colour; the tail is short and forked; the exterior feather on each side is white; the other ash-coloured; the legs and feet of a dusky red. These birds frequent fresh waters, breed on their banks, and lay three small eggs of a deep olive-colour, much spotted with black. They are found during spring and summer in vast numbers in the fens of Lincolnshire, make an incessant noise, and feed on flies as well as water-insects and small fishes. Birds of this species are seen very remote from land.

STERNOPTYX, a genus of fishes of the order apodes. The generic character is head obtuse, teeth very minute; gill membrane 0; body compressed, without apparent scales; breast, carinate folded; belly pellucid. There is but a single species, that inhabits America, viz. diaphana.

STERNUM. See ANATOMY.

STEWARD, a man appointed in a place or stead, and always signifies a principal officer within his jurisdiction. The greatest of these is the lord-high-steward of England; but the power of this officer being very great, of late he has not usually been appointed for any length of time, but only for the dispatch of some special business, as the trial of some nobleman in cases of treason, &c. after which his commission expires.

STICKLEBACK. See GASTEROSTEUS.

STICKS, *foot*, in printing, slips of wood that lie between the foot of the page and the chase, to which they are wedged fast by the quoins, to keep the form firm, in conjunction with the side-sticks, which are placed at the side of the page, and fixed in the same manner by means of quoins.

STIGMA, in entomology, a spot or anastomosis in the middle of the wings of insects near the anterior margin, conspicuous in the hymenopterous tribes.

STIGMATA, in natural history, the apertures in different parts of the bodies of insects communicating with the tracheæ, or air-vessels, and serving for the office of respiration.

STIGMATIZING, among the antients, was inflicted upon slaves as a punishment, but more frequently as a mark to know them by; in which case it was done by applying a red-hot iron marked with certain letters to their foreheads, till a fair impression was made, and then pouring ink into their furrows, that the inscription might be the more conspicuous. Stigmatizing, among some nations, was, however, looked upon as a distinguishing mark of honour and nobility.

STILAGO, a genus of plants belonging to the class of gynandria, and order of triandria. There is one female. The calyx is monophyllous, and almost three-lobed. There is no corolla, and the berry is globular. There are two species, the bunius and diandria, trees of the East Indies.

STILBE, in botany, a genus of plants belonging to the class of polygamia, and order of diœcia. The exterior calyx of the hermaphrodite flower is triphyllous; the interior is quinquedentate and cartilaginous. The corolla is funnel-shaped and quinquefid. There are four stamina; and there is one seed in the interior calyx calyptrate. The female flower is similar, has no interior calyx nor fruit. There are three species, the pinastra, ericoides, and cernua, all foreign plants.

STILBITE. This stone was first formed into a distinct species by Mr. Hauy. Formerly it was considered as a variety of zeolite.

The primitive form of its crystals is a rectangular prism, whose bases are rectangles. It crystallizes sometimes in dodecahedrons, consisting of a four-sided prism with hexagonal faces, terminated by four-sided summits, whose faces are oblique parallelograms; sometimes in six-sided prisms, two of whose solid angles are wanting, and a small triangular face in their place.

Its texture is foliated. The laminæ are easily separated from each other, and are somewhat flexible. Lustre pearly. Hardness inferior to that of zeolite, which scratches stilbite. Brittle. Specific gravity 2.500. Colour pearl white, or greasy. Powder bright white, sometimes with a shade of red. This powder, when exposed to the air, cakes and adheres as if it had absorbed water. It causes syrup of violets to assume a green colour. When stilbite is heated in a porcelain crucible, it swells up and assumes the colour and semitransparency of baked porcelain. By this process it loses 0.185 of its weight. Before the blowpipe it froths like borax, and then melts into an opaque white coloured enamel. Does not gelatine in acids. Not electric by heat.

According to the analysis of Vauquelin, it is composed of

52.0	silica
17.5	alumina
9.0	lime
18.5	water
97.0.	

It occurs most commonly in lava, but is found also in primitive rocks.

STILL. See Distillation.

STILLINGIA, a genus of plants belonging to the class of monœcia, and to the order of monadelphia. The male calyx is hemispherical and multiflorous. The corolla is tubulous, and erose or gnawed. The female calyx is uniflorous and inferior. The corolla is superior. The style is trifid, and the capsule three-grained. There is only one species, the sylvatica.

STING, an apparatus in the body of certain insects, in form of a little spear, serving them as a weapon of offence. The sting of a bee or wasp is a curious piece of mechanism: it consists of a hollow tube, at the root whereof there is a bag full of sharp penetrating juice, which in stinging is injected into the flesh, through the tube; within the tube, Mr. Derham has observed, there lie two sharp small bearded spears. In the sting of a wasp he told eight beards on the side of each spear, somewhat like the beards of fish-hooks. One of these spears in the sting, or sheath, lies with its point a little before the other, to be ready, as should seem, to be first darted into the flesh, which once fixed by means of its foremost beard, the other then strikes too, and so they alternately pierce deeper and deeper, their beards taking more and more hold in the flesh; after which the sheath or sting follows to convey the poison into the wound, which, that it may pierce the better, is drawn into a point with a small slit below that point for the two spears to come out at. By means of these beards it is, that the animal is forced to leave its sting behind it, when disturbed, because it can have no time to withdraw the spears into the scabbard.

STIPA, *feather-grass*, a genus of plants belonging to the class of triandria, and order of digynia, and in the natural system ranging under the 4th order, gramina. The calyx is bivalved. The exterior valve of the corolla is terminated by an awn; the base is jointed. There are 14 species. Of these one only is British; the pennata, or common feather-grass. The beards are feathered. The plant rises to the height of ten inches, grows on mountains, and flowers in July or August.

STIPULA. See Botany.

STIRRUP *of a ship*, a piece of timber put upon a ship's keel, when some of her keel happens to be beaten off, and they cannot come conveniently to put or fit in a new piece; then they patch in a piece of timber, and bind it on with an iron, which goes under the ship's keel, and comes up on each side of the ship, where it is nailed strongly with spikes, and this they call a stirrup.

STOCKING, the clothing of the leg and foot. Antiently the only stockings in use were made of cloth, or of milled stuffs, sewed together; but since the invention of knitting and weaving stockings of silk, wool, cotton, thread, &c. the use of cloth stockings is obsolete. The modern stockings, whether woven or knit, are a kind of plexuses, formed of an infinite number of little knots, called stitches, loops or mashes, intermingled with one another. Knit stockings are wrought with needles made of polished iron or brass wire, which interweave the threads, and form the meshes the stockings consist of. This operation is called knitting, the invention whereof is commonly attributed to the Scots, on this ground, that the first works of this kind came from thence. It is added, that it was on this account that the company of stocking-knitters established at Paris, in 1527, took for their patron St. Fiacre, who is said to be the son of a king of Scotland. Woven stockings are ordinarily very fine; they are manufactured in a frame, or machine of polished iron, the structure and apparatus whereof being exceedingly ingenious, are represented in Plate Miscel. fig. 225. where E is the stocking frame, or engine, 1. Are the treadles, like those of other sorts of looms: 2. is the bobbin of twisted silk, &c. fixed on the bobbin-wire, which it turns with ease to feed the engine: 3. is the wheel, by whose motion the jacks are drawn together upon the needles: 4. is the silk, &c. which runs off the bobbin, and is in that posture directed up to the needle to be looped: 5 is the needle on which the stockings are made according to art.

The loom has received many improvements, so that stockings of all sorts can be made on it with great expedition. By means of some additional machinery to the common stocking-frame, the turned ribbed stockings are made as well as those done with knitting-needles. Stocking-looms will cost from fifty to a hundred and fifty guineas each.

STOCK-JOBBING, a species of trade, or of commercial gambling, which has arisen in most states which are encumbered with national debts. It consists chiefly in making contracts for shares in the public funds against any certain period of time, without an actual transfer of stock being made at the time the bargain is concluded, and generally without any intention of making a transfer at all, the object of the transaction being to pay or receive at the time agreed for the difference between the price the funds may then be at, and the price when the bargain was made. Agreements to deliver stock at a certain price at a future period, began in England about the year 1693, in East India stock, and the practice increased greatly during the high discount upon all government securities about the year 1696, in consequence of which an act was passed for restraining the ill practices of brokers and stock-jobbers, by which the number of brokers was limitted to 100. The establishment of the new East India company, and the subsequent union of the two companies, had probably greater effect in lessening this species of gambling than the restrictions of the act; for while opportunities for speculation exist, some mode of carrying it on will generally be found. Thus in the year 1720, the fallacious project of the South Sea company offering a strong temptation to speculators, stock-jobbing was carried to an enormous extent, which ended in the ruin of thousands. When the mischief was done, a bill was brought into parliament to prevent this "infamous practice," though the experience of the past might have been considered as the best security that it would never again be carried to the same height. The act passed was soon found ineffectual, in consequence of which another bill was brought in by sir John Barnard in 1732, which being rejected, it was brought forward again in 1734, and passed. It is stat. 7. and 8. Geo. 2. c. 8. and declares all contracts and agreements whatsoever, upon which any premium shall be given or paid for liberty to deliver, receive, accept, or refuse any public or joint stock, or other public securities, or any part, share, or interest therein, and all wagers and contracts in the nature of puts and refusals to the then present or future price of such stock or securities, to be null and void, and the money paid thereon shall be restored, or it may be recovered by action commenced thereon within six months, with double costs.

All contracts and agreements whatsoever, made or entered into for buying, selling, assigning, or transferring any public or joint stock, or other public securities whatsoever, or of any part, share, or interest therein, whereof the person or persons contracting or agreeing, or on whose behalf the contract or agreement shall be made, to sell, assign, and transfer the same, shall not, at the time of making such contract or agreement, be actually possessed of, or entitled unto, in his, her, or their own name or names, or in trust for their use, are null and void to all intents and purposes whatsoever; and all and every person whatsoever contracting or agreeing, or on whose behalf, or with whose consent any contract or agreement shall be made to sell, assign, or transfer any public or joint stock or stocks, or other public securities, whereof such person or persons shall not, at the time of making such contract or agreement, be actually possessed of, or entitled unto, in their own name, or in the names of trustees to their use, shall forfeit 500*l*.

Notwithstanding these prohibitions and penalties, the practice of stock-jobbing has continued, and greatly increased; and though it is certainly attended with many evil consequences, it is doubtful whether, if possible, it would be politic to prevent it, while the public debt continues of such enormous amount; as the current value of the public funds would frequently be greatly depressed if it was not supported by the transactions of those who make a regular trade of dealing therein.

STOCKS, the public funds of the nation instituted for the purpose of paying the interest upon loans. See Loan.

Stocks, among ship-carpenters, a frame of timber, and great posts made ashore, to build pinnaces, ketches, boats, and such small craft, and sometimes small frigates. Hence we say, a ship is on the stocks when she is a building.

Stocks, a wooden machine to put the legs of offenders in, for the securing of disorderly persons, and by the way of punishment in divers cases, ordained by statute, &c. And it is said, that every vill within the precinct of a torn is indictable for not having a pair of stocks, and shall forfeit 5*l*.

STOEBE, a genus of the syngenesia polygamia segregata class of plants; the corolla of all the floscules is equal; the proper one is monopetalous and funnel-shaped; the limb is quinquefid and patulous; there is no pericarpium; the seed, which is contained in the cup, is solitary, oblong, and crowned with a long hairy pap. There are nine species.

STOKESIA, a genus of the syngenesia polygamia æqualis class and order of plants. The corollets in the ray are funnel-form, longer, irregular; down four-bristled; recept. naked. There is one species, a herb of South Carolina.

STOLE, *groom of the*, the eldest gentleman of his majesty's bed-chamber, whose office and honour it is to present and put on his majesty's first garment, or shirt, every morning, and to order the things in the chamber.

STOLEN GOODS. To help people to stolen goods for reward without apprehending the felon, is felony. 4 G. I. c. 11.

Persons having or receiving lead, iron, copper, brass, bell-metal, or solder, knowing the same to be stolen, shall be transported. 29 G. II. c. 30.

STOMACH. See Anatomy.

STOMATEUS, a genus of fishes of the order apodes; the generic character is, head compressed; teeth in the jaws and palate; body oval, broad, slippery; tail forked. There are three species, viz. the fiatola, body beautifully barred, inhabits the Mediterranean and Red seas; has two stomachs: paru back gold-colour; belly silvery; inhabits South America: and the cumara, back blue; belly white; inhabits the fresh waters of Chili; is about a span long, and not crossed with stripes.

STOMOXYS, a genus of insects of the order diptera: the generic character is, sucker with a single-valved sheath, inclosing bristles, each in its proper sheath; feelers two, short, setaceous, of five articulations; antennæ setaceous. There are 16 species.

STONE, *calculus humanus*. See Calculi, and Medicine.

Stones from the atmosphere. See Meteoric stones.

Stones. See Mineralogy.

Stones and Earths, *analysis of*. The only substances which enter into the composition of the simple stones, as far at least as analysis has discovered, are the six earths, silica, alumina, zirconia, glucina, lime, and magnesia; and the oxides of iron, manganese, nickel, chromium, and copper. Seldom more than four or five of these substances are found combined together in the same stone: we shall suppose, however, in order to prevent unnecessary repetitions, that they are all contained in the mineral which we are going to analyse.

Let 100 or 200 grains of the stone to be analysed, previously reduced to a fine powder, be mixed with three times its weight of pure potass and a little water, and exposed in a silver crucible to a strong heat. The heat should at first be applied slowly, and the matter should be constantly stirred to prevent the potass from swelling and throwing any part out of the crucible. When the whole water is evaporated, the mixture should be kept for half an hour or three quarters in a strong red heat.

If the matter in the crucible melts completely, and appears as liquid as water, we may be certain that the stone which we are analysing consists chiefly of silica; if it remains opaque, and of the consistence of paste, the other earths are more abundant; if it remains in the form of a powder, alumina is the prevalent earth. If the matter in the crucible is of a dark or brownish red colour, it contains oxide of iron; if it is grass-green, manganese is present; if it is yellowish green, it contains chromium.

When the crucible has been taken from the fire and wiped on the outside, it is to be placed in a capsule of porcelain, and filled with water. This water is to be renewed, from time to time, till all the matter is detached from the crucible. The water dissolves a part of the combination of the alkali with the silica and alumina of the stone; and if a sufficient quantity was used, it would dissolve the whole of that combination.

Muriatic acid is now to be poured in till the whole of the matter is dissolved. At first a flaky precipitate appears, because the acid combines with the alkali which kept it in solution. Then an effervescence takes place, owing to the decomposition of some carbonat of potass formed during the fusion. At the same time the flaky precipitate is redissolved; as is also that part of the matter which, not having been dissolved in the water, had remained at the bottom of the dish in the form of a powder. This powder, if it consists only of silica and alumina, dissolves without effervescence; but if it contains lime, an effervescence takes place.

If this solution in muriatic acid is colourless, we may conclude that it contains no metallic oxide, or only a very small portion; if its colour is purplish red, it contains manganese; orange-red indicates the presence of iron; and golden yellow the presence of chromium.

This solution is to be poured into a capsule of porcelain, covered with paper, and evaporated to dryness in a sand-bath. When the evaporation is drawing towards its completion, the liquor assumes the form of jelly. It must then be stirred constantly with a glass or porcelain rod, in order to facilitate the disengagement of the acid and water, and to prevent one part of the matter from being too much, and another not sufficiently, dried. Without this precaution, the silica and alumina would not be completely separated from each other.

When the matter is reduced almost to a dry powder, a large quantity of pure water is to be poured on it; and, after exposure to a slight heat, the whole is to be poured on a filtre. The powder which remains upon the filtre is to be washed repeatedly, till the water with which it has been washed ceases to precipitate silver from its solutions. This powder is the whole of the silica which the stone that we are analysing contained. It must first be dried between folds of blotting paper, then heated red-hot in a platinum or silver crucible, and weighed while it is yet warm. It ought to be a fine powder, of a white colour, not adhering to the fingers, and entirely soluble in acids. If it is coloured, it is contaminated with some metallic oxide; and shews that the evaporation to dryness has been performed at too high a temperature. To separate this oxide, the silica must be boiled with an acid, and then washed and dried as before. The acid solution must be added to the water which passed through the filtre, and which we shall denominate A.

The watery solution A is to be evaporated till its quantity does not exceed 30 cubic inches, or nearly an English pint. A solution of carbonat of potass is then to be poured into it till no more matter precipitates. It ought to be boiled a few moments to enable all the precipitate to fall to the bottom. When the whole of the precipitate has collected at the bottom, the supernatant liquid is to be decanted off; and water being substituted in its place, the precipitate and water are to be thrown upon a filtre. When the water has run off, the filtre with the precipitate upon it is to be placed between the folds of blotting paper. When the precipitate has acquired some consistence, it is to be carefully collected by an ivory knife, mixed with a solution of pure potass, and boiled in a porcelain capsule. If any alumina or glucina is present, they will be dissolved in the potass; while the other substances remain untouched in the form of a powder, which we shall call B.

Into the solution of potass as much acid must be poured as will not only saturate the potass, but also completely redissolve any precipitate which may have at first appeared. Carbonat of ammonia is now to be added in such quantity that the liquid shall taste of it. By this addition the whole of the alumina will be precipitated in white flakes, and the glucina will remain dissolved, provided the quantity of carbonat of ammonia used is not too small. The liquid is now to be filtred; and the alumina which will remain on the filtre is to be washed, dried, heated red-hot, and then weighed. To see if it is really alumina, dissolve it in sulphuric acid, and add a sufficient quantity of sulphat of acetat of potass; if it is alumina, the whole of it will be converted into crystals of alum.

Let the liquid which has passed through the filtre be boiled for some time; and the glucina, if it contains any, will be precipitated in a light powder, which may be dried and weighed. When pure, it is a fine, soft, very light, tasteless powder, which does not concrete when heated, as alumina does.

The residuum B may contain lime, magnesia, and one or more metallic oxides. Let it be dissolved in weak sulphuric acid, and the solution evaporated to dryness. Pour a small quantity of water on it. The water will dissolve the sulphat of magnesia and the metallic sulphats; but the sulphat of lime will remain undissolved, or if any portion dissolves, it may be thrown down by the addition of a little weak alcohol. Let it be heated red-hot in a crucible, and weighed. The lime amounts to 0.43 of the weight.

Let the solution containing the remaining sulphats be diluted with a large quantity of water; let a small excess of acid be added; and then let a saturated carbonat of potass be poured in. The oxides of chromium, iron, and nickel, will be precipitated, and the magnesia and oxide of manganese will remain dissolved. The precipitate we shall call C.

Into the solution let a solution of hydrosulphuret of potass be poured, and the manganese will be precipitated in the state of a hydrosulphuret. Let it be calcined in contact with air, and weighed. The magnesia may then be precipitated by pure potass, washed, exposed to a red heat, and then weighed.

Let the residuum C be boiled repeatedly with nitric acid, then mixed with pure potass; and after being heated, let the liquid be decanted off. Let the precipitate, which consists of the oxides of iron and nickel, be washed with pure water; and let this water be added to the solution of the nitric acid and potass. That solution contains the chromium converted into an acid. Add to this solution an excess of muriatic acid, and evaporate till the liquid assumes a green colour; then add a pure alkali. The chromium precipitates in the state of an oxide, and may be dried and weighed.

Let the precipitate, consisting of the oxides of iron and nickel, be dissolved in muriatic acid; add an excess of ammonia; the oxide of iron precipitates. Let it be washed, dried, and weighed.

Evaporate the solution, and the oxide of nickel will also precipitate, or the whole may be precipitated by adding hydrosulphuret of ammonia; and its weight may be ascertained in the same manner as the other ingredients.

The weights of all the ingredients obtained are now to be added together, and their sum total compared with the weight of the matter submitted to analysis. If the two are equal, or if they differ only by .03 or .04 parts, we may conclude that the analysis has been properly performed; but if the loss of weight is considerable, something or other has been lost. The analysis must therefore be repeated with all possible care. If there is still the same loss of weight, we may conclude that the stone contains some substance, which has either evaporated by the heat, or is soluble in water.

A fresh portion of the stone must therefore be broken into small pieces, and exposed in a porcelain crucible to a strong heat. If it contains water, or any other volatile substance, it will come over into the receiver; and its nature and weight may be ascertained.

If nothing comes over into the receiver, or if what comes over is not equal to the weight wanting, we may conclude that the stone contains some ingredient which is soluble in water.

To discover whether it contains potass, let the stone, reduced to an impalpable powder, be boiled five or six times in succession with very strong sulphuric acid, applying a pretty strong heat towards the end of the operation, in order to expel the excess of acid; but taking care that it is not strong enough to decompose the salts which have been formed.

Water is now to be poured on; and the residuum, which does not dissolve, is to be washed with water till it becomes tasteless. The watery solution is to be filtred, and evaporated to dryness, in order to drive off any excess of acid which may be present. The salts are to be again dissolved in water; and the solution, after being boiled for a few moments, is to be filtred and evaporated to a consistence proper for crystallizing. If the stone contains a sufficient quantity of alumina, and if potass is present, crystals of alum will be formed: and the quantity of potass may be discovered by weighing them, it being nearly $\frac{1}{10}$th of their weight. If the stone does not contain alumina, or not in sufficient quantity, a solution of pure alumina in sulphuric acid must be added. Sometimes the alum, even when potass is present, does not appear for several days, or even weeks; and sometimes, when a great quantity of alumina is present, if the solution has been too much concentrated by evaporation, sulphat of alumina prevents the alum from crystallizing at all. Care, therefore, must be taken to prevent this last source of error. The alum obtained may be dissolved in water, and barytes water poured into it as long as any precipitate forms. The liquor is to be filtred, and evaporated to dryness. The residuum will consist of potass and a little carbonat of potass. The potass may be dissolved in a little water. This solution, evaporated to dryness, gives us the potass pure, which may be examined and weighed.

If no crystals of alum can be obtained, we must look for some other substance than potass. The stone, for instance, may contain soda. The presence of this alkali may be discovered by decomposing the solution in sulphuric acid, already described, by means of ammonia. The liquid which remains is to be evaporated to dryness, and the residuum is to be calcined in a crucible. By this method, the sulphat of ammonia will be volatilized, and the soda will remain. It may be redissolved in water, crystallized, and examined.

If sulphuric acid does not attack the stone, as is often the case, it must be decomposed by fusion with soda, in the same manner as formerly directed with potass. The matter, after fusion, is to be diluted with water, and then saturated with sulphuric acid. The solution is to be evaporated to dryness, the residuum again dissolved in water, and evaporated. Sulphat of soda will crystallize first; and by a second evaporation of the stone, contains potass and alumina, crystals of alum will be deposited.

Stones, *earthy*. Cronstedt divided this order into nine genera, corresponding to nine earths; one of which he thought composed the stones arranged under each genus. The names of his genera were, calcareæ, siliceæ, granatinæ, argillaceæ, micaceæ, fluores, asbestinæ, zeolithicæ, magnesiæ. All his earths were afterwards found to be compounds, except the first, second, fourth, and ninth. Bergman, therefore, in his Sciagraphia, first published in 1782, reduced the number of genera to five; which was the number of primitive earths known when he wrote. Since that period five new earths have been discovered. Accordingly, in the latest systems of mineralogy, the genera belonging to this order are proportionably increased. Each genus is named from an earth, as follows:

1. Jargon genus,	5. Magnesian genus,
2. Siliceous genus,	6. Calcareous genus,
3. Glucina genus,	7. Barytic genus,
4. Argillaceous genus,	8. Strontian genus.

Mr. Kirwan, in his valuable system of mineralogy, has adopted the same genera. Under each genus those stones are placed which are composed chiefly of the earth which gives a name to the genus, or which at least are supposed to possess the characters which distinguish that earth.

A little consideration will be sufficient to discover that there is no natural foundation for these genera. Most stones are composed of two, three, or even four, ingredients; and in many cases the proportion of two or more of these is nearly equal. Now, under what genus soever such minerals are arranged, the earth which gives it a name must form the smallest part of their composition. Accordingly, it has not been so much the chemical composition as the external character, which has guided the mineralogist in the distribution of his species. The genera cannot be said properly to have any character at all, nor the species to be connected by any thing else than an arbitrary title. This defect, which must be apparent in the most valuable systems of mineralogy, seems to have arisen chiefly from an attempt to combine together an artificial and natural system.

The only substances which enter into the minerals belonging to this order, in such quantity as to deserve attention, are the following:

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Alumina,	Oxide of iron,
Silica,	Oxide of chromium,
Magnesia,	Oxide of nickel,
Lime,	Oxide of copper,
Barytes,	Potass,
Glucina,	Soda,
Zirconia,	Water.
Yttria,	

Stones, *saline*. Under this arrangement are comprehended all the minerals which have an earthy basis combined with an acid. The minerals belonging to it are of course salts, and as such have been described under their respective names. But as they occur native in states which cannot always be imitated by art, it will be necessary to take a view of them as they are found in the earth. They naturally divide themselves into five genera; as only five earths have hitherto been discovered native in combination with an acid. These genera, and the species belonging to them, are the following:

I. Calcareous Salts.
1. Carbonat of lime,
2. Sulphat of lime,
3. Phosphat of lime,
4. Fluat of lime,
5. Arseniat of lime.

II. Barytic Salts.
1. Carbonat of barytes,
2. Sulphat of barytes.

III. Strontian Salts.
1. Carbonat of strontian,
2. Sulphat of strontian.

IV. Magnesian Salts.
1. Sulphat of magnesia,
2. Carbonat of magnesia,
3. Borat of magnesia.

V. Aluminous Salts.
1. Alum,
2. Mellat of alumina,
3. Fluat of alumina-and-soda.

The minerals belonging to this order are distinguished without much difficulty from the last. Almost all of them are insoluble in water; but soluble in nitric acid, or in hot sulphuric acid. Most of them melt before the blowpipe. Their specific gravity varies; but it is often above 3.5 when the mineral is too soft to scratch glass. None of them have the metallic lustre.

STONEHENGE, in antiquity, a famed pile or monument of huge stones on Salisbury plain, six miles distant from that city.

It consists of the remains of four ranks of rough stones, ranged one within another, some of them, especially in the outermost and third rank, twenty feet high, and seven broad; sustaining others laid across their heads and fastened by mortises, so that the whole must have antiently hung together.

Antiquaries are now pretty well agreed that it was a British temple; and Dr. Langwith thinks it might easily be made probable at least, that it was dedicated to the sun and moon.

STONE WARE. Under the denomination stone ware are comprehended all the different artificial combinations of earthy bodies which are applied to useful purposes. These vary in their names according to their external appearance, the manner in which they are manufactured, and the purposes to which they are applied. Thus we have porcelain, stone ware, pots, crucibles, bricks, tiles, &c. All these substances, however, are formed on the same principles, nearly of the same materials, and owe their good qualities to the same causes.

These combinations have been known from the remotest ages of antiquity. They were well known to the Jews, as we learn from the Old Testament, long before the Babylonish captivity. Porcelain, or the finest kind of stone ware, was early brought to perfection in China and Japan; but the discovery of the art of making it in Europe is of much later date.

Specimens of it were brought first from China and Japan to modern Europe. These were admired for their beauty, were eagerly sought after, and soon became the ornaments of the tables of the rich. Various attempts were made to imitate them in different countries of Europe, but the greater number were without success. Accident led to the discovery in Germany about the beginning of the 18th century. A chemist in Saxony, during a set of experiments in order to ascertain the best mixtures for making crucibles, stumbled upon a compound which yielded a porcelain similar to the eastern. In consequence of this discovery, Saxony soon produced porcelain scarcely inferior to that of Japan in beauty, and superior to it in solidity and strength: but its composition was kept secret; nor were there any accurate ideas respecting the component parts of porcelain among men of science, till Reaumur published his dissertations on the subject in 1727 and 1729. He examined the porcelain of Japan, and the different imitations of it which had been produced in France and other parts of Europe. The texture of the first was compact and solid, but that of the imitations was porous. When both were exposed to a strong heat, the first remained unaltered, but the others melted into glass. From these experiments he drew the following ingenious conclusions:

Porcelain owes its semitransparency to a kind of semivitrification which it has undergone. Now it may receive this two ways: 1. Its component parts may be such as easily vitrify when sufficiently heated; but the degree of heat given may be just sufficient to occasion a commencement of vitrification. This porcelain when strongly heated will easily melt. Such, therefore, was the composition of the European imitations of porcelain. 2. It may be composed of two ingredients; one of which easily vitrifies, but the other is not altered by heat. When a porcelain composed of such materials is baked in a sufficient heat, the fusible part melts, invelopes the infusible, and forms a semitransparent substance, which is not farther altered by the same degree of heat. Such therefore must be the porcelain of Japan. Father Entrecolles, a missionary to China, had sent an account of the Chinese mode of making porcelain, which coincided exactly with this ingenious thought of Reaumur. The ingredients, according to him, are a hard stone called petunse, which they grind to powder, and a white earth called kaolin, which is intimately mixed with it. Reaumur found the petunse fusible, and the kaolin infusible, when exposed separately to a violent heat. See Porcelain

Stone ware is not formed by mixing together the pure earths, which would be a great deal too expensive; but natural combinations or mixtures of earths are employed. These combinations must possess the following properties: 1. They must be capable, when reduced to powder, of forming with water a paste sufficiently ductile to be made into any form which is required. 2. This paste, after being exposed to a sufficient heat, or after being baked as it is termed, must acquire such a permanent degree of hardness as to be able to resist the action of the weather and of water. 3. The vessels formed of it must in that state be capable of resisting changes of temperature. 4. They must be able to resist a strong heat without being melted. 5. They must not be permeable to liquids, nor liable to be acted on by chemical agents.

Common clay possesses a good many of these qualities. When finely ground, it may be formed into a very ductile paste; heat makes it hard enough to strike fire with steel, and capable of resisting the action of most chemical agents; and it is not liable to be melted by heat. Clay accordingly was the first substance employed, and it is still employed for a variety of purposes.

Bricks, for instance, are always made of this substance. The clay is dug out of the earth, and after being exposed for some time to the air is reduced to powder, and formed into a paste with water. The bricks are then formed in moulds, exposed for some time to dry in the open air, and then burnt in a large furnace constructed on purpose. Tiles which are employed for covering houses are formed in the same way. The clay, however, is finer, and it is usually ground in a mill.

Bricks and tiles should be impervious to water: they should be capable of withstanding the action of heat, and not be subject to moulder. It is obvious that these qualities must depend upon the nature of the clay of which they are formed, and on the degree in which they have been burned. Clay is a mixture of alumina and silica in various proportions. When the proportion of alumina is great, the brick contracts much in its dimensions, and is apt to crack during the burning. Clay therefore must be chosen which contains the proper proportion of silica, or the defect must be remedied by adding sand. Bergman recommends the addition of a little lime, which has the property of rendering the clay fusible. The clay of which bricks and tiles are made contains some oxide of iron: hence the red colour which it acquires when burnt.

But though the addition of lime may be proper in some cases in the manufacture of bricks and tiles, it would be exceedingly improper in other cases. Lime ought to be carefully excluded from the clay destined for making pots, and every other utensil which is to be exposed to a violent heat, as it renders the clay fusible. Now lime enters not unfrequently into the composition of clays. It is evident therefore that all clays are not proper for the manufacture of stone ware. They must be free from lime, barytes, and every other ingredient which renders them fusible. They must also be free from metallic oxides, which not only render them fusible, but also injure the colour of the porcelain. The clays which answer are those which consist of a mixture of alumina and silica. These are known by the names of potter's clay, tobacco-pipe clay, porcelain-clay, &c. according to the purposes to which they are applied. It is necessary to mix the clay with some fine colourless sand, in order to prevent the vessels from contracting too much during the baking.

Thus stone ware is composed of two materials, pure clay and sand; and the beauty of the ware depends upon the purity and fineness of these two materials. What is called English stone ware is composed of tobacco-pipe clay and powdered flints; delft ware is composed of clay and fine sand; and the coarsest wares of still more common clay and sand.

The materials are ground very fine in a mill, then mixed together, and formed into a paste. The different vessels are coarsely moulded on the potter's wheel, and allowed to dry till they can bear handling. After this they receive their destined form completely; and when they are sufficiently dry, they are covered with the requisite enamel, and then put into the furnace and baked.

Such, in general, is the method of manufacturing stone ware. The particular processes followed in the making of porcelain are concealed by the manufacturers; but the component parts are always analogous to those pointed out by Reaumur. The refractory ingredient is a fine white clay, consisting essentially of alumina and silica, and the fusible ingredient is a mixture of siliceous sand and lime.

It is necessary to glaze the surface of vessels, whether of stone ware or porcelain, both for the purpose of beauty and utility; for the body of the vessel, or biscuit as it is called, would not be sufficiently compact to contain liquids. Now this glazing is of three kinds: 1. A vitrified metallic oxide. 2. An enamel. 3. A glass. The first is applied to the coarsest vessels, the second to fine kinds of stone ware, the third to porcelain.

The glazing of coarse vessels is formed by covering their surface while hot with a little litharge, which has the property of running into an opaque glass at a moderate heat when spread thin upon an earthen vessel. The colour of this glazing is yellow or red. It is seldom perfect; hence these coarse vessels are frequently porous, and incapable of resisting the action of corrosive substances. Common salt is sometimes employed instead of lead. It facilitates the fusion of the surface of stone ware, and occasions a kind of vitrification.

The glazing of fine vessels consists of white enamel. This is made as follows: one hundred parts of lead are melted with from 15 to 40 parts of tin, and the mixture oxidized completely, by exposing it to heat in an open vessel. One hundred parts of this oxide are mixed with 100 parts of a fine white sand composed of three parts silica and one part of talc, and with about 25 parts of common salt. This mixture is melted, then reduced to powder, and formed into a paste, which is spread thin over the porcelain vessel before it is baked. The excellency of a good enamel is, that it easily fuses into a kind of paste at the heat which is necessary for baking porcelain, and spreads equally on the vessel, forming a smooth glassy surface, without losing its opacity, or flowing completely into a glass. Its whiteness depends upon the proportion of the tin, its fusibility upon the lead.

Porcelain is always covered with a glass, composed of earthy ingredients, without any mixture of metallic oxides. Hence the high temperature necessary to fuse it, and the property which porcelain vessels have of resisting the action of the most corrosive substances precisely as common glass does. The substance commonly employed is felspar; a mineral of a fine white colour and foliated texture, which is found abundantly in the mountains.

It is usual to paint both stone ware and porcelain of various colours. These paintings are often excellent, both in elegance of workmanship and in brilliancy of colours. The colours are given by means of metallic oxides, which are mixed up with other ingredients proper to constitute an enamel, and applied in the usual manner with a pencil.

On this subject much light has been thrown by the experiments of Wedgewood; and Brogniart has lately published a general account of the processes at Sevres, of which he is director.

The process differs a little according to the substance on which the colours are to be applied. When the vessels are covered with enamel, less flux is necessary, because the enamel melts at a low heat, and the colours readily incorporate with it; but this renders them more dilute, and makes it often necessary to retouch them. The colours on enamel generally appear brilliant and soft, and are not liable to scale. The flux is either a glass of flint and lead, or borax mixed with flint glass. The colours are usually made into a paste by means of gum-water or volatile oils. Some of them are liable to alteration by the action of the lead on them.

The colours applied upon hard porcelain, or porcelain glazed with felspar, are nearly the same as those applied on enamel, but more flux is necessary. They are not liable to dilution, as the felspar glaze does not melt at the heat requisite for fusing the colours and their flux. They are liable to scale off when repeatedly heated.

Colours are sometimes applied over the whole surface of the porcelain; the flux in that case is porcelain. But such colours are not numerous, because few oxides can stand the heat necessary for melting felspar without being altered or volatilized.

1. Purple is given by means of the purple oxide of gold precipitated by the smallest possible quantity of muriat of tin. This oxide is mixed with a proper quantity of powdered glass, borax, and oxide of antimony, and applied with a pencil. It cannot bear a strong heat without losing its colour.

2. Red is given by oxide of iron. A mixture of two parts of sulphat of iron and one part of alum is calcined slowly, till it acquires a fine red colour when cold. This powder is mixed with the usual flux, and applied with a pencil.

3. Yellow is given by the oxide of silver; or, by oxides of lead, antimony, and sand; green, by the oxide of copper; blue, by the oxide of cobalt; and violet, by the oxide of manganese.

STOP, in music, a word applied by violin and violoncello performers to that pressure of the strings by which they are brought into contact with the finger-board, and by which the pitch of the note is determined. Hence a string, when so pressed, is said to be stopt.

Stop *of an organ*. A collection of pipes similar in tone and quality, which run through the whole, or a great part, of the compass of the instrument. In a great organ the stops are numerous and multifarious, commonly comprising the following:

Open-diapason stop. A metallic stop which commands the whole scale of the organ, and which is called open in contradistinction to the stopt diapason, the pipes of which are closed at the top.

Stopt-diapason stop. A stop, the pipes of which are generally made of wood, and its base up to middle C always of wood. They are only half as long as those of the open diapason, and are stopped at the upper end with wooden stoppers or plugs, which render the tone more soft and mellow than that of the open diapason.

Principal stop. A metallic stop originally distinguished by that name, because holding, in point of pitch, the middle station between the diapason and fifteenth, it forms the standard for tuning the other stops.

Twelfth stop. A metallic stop so denominated from its being tuned twelve notes above the diapason. This stop, on account of its pitch, or tuning, can never properly be used alone. The open diapason, stopt diapason, principal, and fifteenth, are the best qualified to accommodate it to the ear.

Fifteenth stop. A stop which derives its name from its pitch, or scale, being fifteen notes higher than that of the diapason. This stop and the twelfth, mellowed and embodied by the two diapasons and principal, form a proper compound for accompanying choral parts in common choirs and parochial churches.

Sesquialtera stop. A mixed stop running through the scale of the instrument, and consisting of three, four, and sometimes five ranks of pipes, tuned in thirds, fifths, and eighths. In small organs this stop is generally divided at middle C, when the lower part is called the sesquialtera, and the upper part the cornet. The whole of the stop lies above the fifteenth; the first rank being a seventeenth, the second rank a nineteenth, and the third rank a twenty-second, above the diapason.

Mixture or furniture stop. A stop comprising two or more ranks of pipes, shriller than those of the sesquialtera, and only calculated to be used together with that and other stops. The mixture is nearly the same as the sesquialtera, and greatly enriches the instrument.

Trumpet stop. A reed metallic stop, so called because its tone is imitative of the trumpet. In large organs it generally extends through the whole compass. The mouths of its pipes are not formed like those of the pipes of other stops, but resemble that of the real trumpet. At the bottom of each of the pipes of this stop, in a cavity called the socket, is fixed a brass reed, stopt at the lower end, and open in front; it is furnished with a tongue, or brass ring, which covers the opening, and which, when the wind is impelled into the pipe, is thereby put into a vibratory motion, which produces the imitative tone peculiar to this stop. The trumpet stop is the most powerful in the instrument, and improves the tone, as much as it increases the peal of the chorus. Unisonous with the diapasons, it strengthens the foundation, subdues the dissonances of the thirds and fifths of the sesquialtera, and imparts to the compound a richness and grandeur of effect adequate to the sublimest subjects.

Clarion or octave trumpet stop. A reed stop resembling the tone of the trumpet, as may be inferred from its name; but the scale of which is an octave higher than the trumpet stop. This stop forms a brilliant supplement to the chorus, and is judiciously employed on occasions which require every power of the instrument; but should not be commonly opened, or indeed, ever without the other stops.

Tierce stop. A stop which is tuned a major third higher than the fifteenth, and only employed in the full organ.

Larigot stop, or octave twelfth. A stop, the scale of which is an octave above the twelfth. Only used in the full organ.

Cornet stop. A stop consisting of five pipes to each note, tuned somewhat in the manner of the sesquialtera, having, beside the unison of the diapason, its third, fifth, eighth, and seventeenth. The cornet being only a treble stop, it is employed in parish-churches in conjunction with the diapason in interludes, and the giving out of the psalms.

Dulciana stop. A stop in the choir organ of a peculiar sweetness of tone, which it chiefly derives from the bodies of its pipes being longer and smaller than those of the pipes of other stops. It is in unison with the diapasons, and equals them in compass upward, but only descends to G gamut.

Flute stop. A stop imitative of the common flute, or flageolet. It is in unison with the principal, but of a much softer tone than that stop.

Bassoon stop. A reed stop imitative of the instrument from which it derives its name. This stop, so far as it extends upward in the scale, is in unison with the diapasons, in company with which it only ought to be used.

Vox-humana stop. A reed stop, the tone of which, as its name implies, resembles the human voice. The quality of this stop is seldom so good as to render it agreeable when heard alone; it is therefore advantageously blended with the diapasons, with which it is in unison.

Hautboy stop. A reed stop voiced in imitation of the hautboy. It in unison with the diapasons, with which it only should be used.

Cremona stop. A reed stop in unison with the diapasons. The name of this stop has induced most organ-builders erroneously to suppose that it was originally meant as an imitation of the Cremona violin; but the writers best informed upon the subject inform us, that it was designed to imitate an antient instrument calted a krum-horn, which word has been corrupted into cremona.

STOPPAGE, for the subsistence of the sick. In the regulations for the better management of the sick in regimental hospitals, it is particularly laid down, under the head subsistence, page 16, that sufficient funds should be established for the support of the sick without any additional charge to government; and at the same time, that the sick soldier should be provided with every reasonable comfort and indulgence that can be afforded. The sum of four shillings per week from the pay of each soldier will, under proper regulations, and with strict economy, be sufficient for this purpose; which sum is to be retained by the paymaster of the regiment.

The sick are to be furnished with bread made of the finest wheat-flour, and fresh meat, perfectly good and wholesome.

That the greatest economy may be used in laying out the money for the sick, every article ought to be purchased by the surgeon, who is required to keep a book, in which he is to enter the amount of the weekly consumption of each man according to the diet table; and this book, with the diet table, is to be laid before the commanding officer and paymaster every week, to be examined and signed by each.

STOPPAGES, in a military sense, deductions from a soldier's pay, the better to provide him with necessaries, &c. A soldier should never be put under a greater weekly stoppage from his pay, than what will afterwards leave him a sufficiency for messing. Since the abolition of arrears a regulation has taken place, by which soldiers are directed to be stopped one shilling and sixpence per week in the infantry, and to be accounted with on the 24th of every month.

STORAX. See STYRAX, and RESINS.

STORES. If any person who has the charge or custody of any of the king's armour, ordnance, ammunition, shot, powder, or habiliments of war, or of any victuals for victualling the navy, shall, to hinder his majesty's service, embezzle, purloin, or convey away the same to the value of 20*s.* or shall steal or embezzle any of his majesty's sails, cordage, or any other of his naval stores, to the value of 20*s.* he shall be adjudged guilty of felony without benefit of clergy. 22 Car. II. c. 5.

The treasurer, comptroller, surveyor, clerk of the acts, or any commissioner of the navy, may act as justices in causing the offender to be apprehended, committed, and prosecuted for the same. 9 G. III. c. 30.

If any person shall wilfully and maliciously set on fire, burn, or destroy, any of his majesty's military, naval, or victualling stores, or other ammunition of war, or any place where any such stores or ammunition shall be kept, he and his abettors shall be guilty of felony without benefit of clergy. 12 Geo. III. c. 24.

STORK. See ARDEA.

STOVE, in gardening. See HOT-HOUSE.

STRANDED, among seamen, is said of a ship that is driven ashore by a tempest, or runs on ground through ill steerage, and so perishes. Where any vessel is stranded, the justices of the peace are impowered to command the constables near the sea-coast to call assistance, in order to preserve the same if possible.

STRANGURY. See MEDICINE.

STRAP, in a ship, is a rope spliced about any block, or made with an eye, to fasten it any where, on occasion.

STRATA, in natural history, the several beds or layers of different matters, whereof the body of the earth is composed. See EARTH, *structure of.*

SRTATIFICATION *of the earth.* Scarcely any of the natural phenomena have been so slightly treated of by the philosophers of the present and past ages, as the strata of the earth. Few, if any, among the writers on this curious and interesting subject, have distinguished between the undisturbed or regular strata, forming the solid matter of the earth, and the alluvial or mixed, violently moved, and worn substances, which are found upon its surface; while these again, in their observations, have been in too many instances confounded with the alluvial depositions of rivers and the ocean, formed in modern times, or since they have been confined nearly to their present limits. The effects of vegetation, in accumulating peaty matters, and, in conjunction with frost, alternate wetting and drying, the atmospheric air, and cultivation, in gradually changing the surface of almost any of the stratified matters, to a soil or mould fit for the growth of some kind of vegetables, have in a great degree been overlooked; and accordingly we find a great number of writers, confidently mentioning different series of substances, which they assert, on observations entirely local, to be the order of the strata on proceeding downwards beneath the vegetable soil.

Notwithstanding that Mr. Hauksbee many years ago, at the instance of the Royal Society of London, carefully examined a succession of thirty strata, in the shaft of a coal-pit, and found that strata specifically heavier, were frequently found lodged above lighter strata; yet, a large portion of the writers since, to the present time, have contended that the strata are found deposited in the order, or nearly, of their specific gravities.

John Stracey, esq. a writer in the Philosophical Transactions (No. 391), started an opinion, that the strata were at first formed while in a soft state, as so many wedges, each pointing to and terminating in the centre of the earth; and that by the diurnal revolution of the earth from west to east, these became bent into spirals (as represented in fig. 223, Plate Miscel.), in which case, says he, "there needs no specific gravitation to cause the lightest to be uppermost, &c. for every one in its turn, in some place of the globe or other, will be uppermost;" this last remark, made in the year 1725, we do not remember to have seen noticed by any subsequent writer or observer, although, from a series of minute observations made within the last fifteen years by a gentleman formerly resident at Mitford near Bath, and now in London, Mr. William Smith, there is great reason to think that this is really the case with all the strata composing the surface of the British islands, and perhaps of the whole earth, in what manner soever the strata in the inner parts of the earth may be disposed.

We do not understand that Mr. Smith was at all acquainted with the above remark of Mr. Stracey; but that in the exercise of his profession of a land-surveyor, superintendant of some coal-mines, and engineer for the cutting of the Somerset coal-canal, he saw ample reason to conclude that the several strata in the neighbourhood of Bath, all rise westwardly successively to the surface. His subsequent observations in almost every part of the kingdom, have confirmed this most completely; and we understand that sections and maps of the out-crop of all the principal strata in England, Wales, and part of Scotland, have been prepared and repeatedly submitted by Mr. Smith to the inspection of the learned and curious in these matters; and that a first part or volume on the subject, may shortly be expected from that gentleman. The subject is of immense importance to the owners of the soil, to those who are in search of springs of good and wholesome water, and to mine-owners in particular, while science cannot but be benefited by the new field of investigation which is thus opened.

STRATIOTES, *water-soldier*, a genus of plants belonging to the class of polyandria, and to the order of hexagynia, and in the natural system ranking under the first order, palmæ. The spatha is diphyllous; the perianthium is trifid; there are three petals, and the berry is six-celled and inferior. There are three species, the aloides, the acoroides, and alismoides. The aloides alone is of British extraction, which is also called the water aloe, or fresh-water soldier. The root consists of long fibres tufted at the ends. The leaves are thick, triangular, pointed, and prickly at the edges. The flowers are white and floating on the water, and blossom in June. This plant may be seen in slow rivers and fens.

STRAWBERRY. See FRAGARIA.

STRAWBERRY-TREE. See ARBUTUS.

STRELITZIA, a genus of the class and order pentandria monogynia. The spathes are universal and partial; no calyx; corolla three-petalled; nectarium three-leaved; capsule three-celled; cells many-seeded. There are two species of this magnificent plant, natives of the Cape.

STRENGTH. See TIMBER, *strength of.*

STREPTIUM, a genus of the didynamia angiospermia class and order. The calyx is five-toothed; stigma two-lipped; drupe two-lobed. There is one species.

STRIKE, a measure of capacity, containing four bushels. See MEASURE.

STRIKE, among seamen, is a word variously used. When a ship, in a fight, or on meeting with a ship of war, lets down or lowers her top-sails, at least half-mast-high, they say she strikes, meaning she yields, or submits, or pays respect to the ship of war. Also, when a ship touches ground, in shoal-water, they say she strikes. And when a top-mast is to be taken down, the word of command is, strike the top-mast, &c.

STRIX, the *owl*, in ornithology, a genus belonging to the order of accipitres. The bill is hooked, but has no cere or wax; the nostrils are covered with setaceous feathers; the head is very large, as are also the ears and eyes; and the tongue is bifid. There are 46 species; the most remarkable are,

1. The bubo, or great-eared owl, in size is almost equal to an eagle. Irides bright yellow; the head and whole body finely varied with lines, spots, and specks of black, brown, cinereous, and ferruginous; wings long; tail short, marked with dusky bars; legs thick, covered to the very end of the toes with a close and full down of a testaceous colour; claws great, much hooked and dusky. It has been shot in Scotland and in Yorkshire. It inhabits inaccessible rocks and desert places; and preys on hares and feathered game. Its appearance in cities was deemed an unlucky omen; Rome itself once underwent a lustration because one of them strayed into the capitol. The antients had them in the utmost abhorrence, and thought them, like the screech-owls, the messengers of death. Pliny styles it bubo funebris, and noctis monstrum. See Plate Nat. Hist. fig. 378.

2. The brachyotos, or short-eared owl, is 14 inches long, three feet broad; the head is small and hawk-like; the bill is dusky; weight 14 ounces. The horns of this species are very small, and each consists of only a single feather; these it can raise or depress at pleasure; and in a dead bird they are with difficulty discovered. These species may be called long-winged owls; the wings when closed reaching beyond the end of the tail; whereas, in the common kinds, they fall short of it. This is a bird of passage, and has been observed to visit Lincolnshire in the beginning of October, and to retire early in the spring; so probably, as it performs its migrations with the woodcock, its summer retreat is Norway. During day it lies hid in long old grass; when disturbed, it seldom flies far, but will light, and sit looking at one, at which time the horns may be seen distinctly. It has not been observed to perch on trees like other owls; it usually flies in search of prey in cloudy hazy weather. Farmers are fond of seeing these birds in the fields, as they clear them from mice.

3. The flammea, or common white owl. The elegant plumage of this bird makes amends for the uncouthness of its form; a circle of soft white feathers surround the eyes. This species is almost domestic; inhabiting, for the greatest part of the year, barns, hay-lofts, and other out-houses; and is as useful in clearing those places from the mice as the congenial cat. Towards twilight it quits its perch, and takes a regular circuit round the fields, skimming along the ground in quest of field-mice, and then returns to its usual residence: in the breeding season it resorts to the eaves of churches, holes in lofty buildings, or hollows of trees. During the time the young are in the nest, the male and female alternately sally out in quest of food, make their circuit, beat the fields with the regularity of a spaniel, and drop instantly on their prey in the grass. They very seldom stay out above five minutes; return with their prey in their claws; but as it is necessary to shift it into their bill, they always alight for that purpose on the roof, before they attempt to enter their nest. This species does not hoot, but snores and hisses in a violent manner; and while it flies along will often scream most tremendously. Its only food is mice. As the young of these birds keep their nest for a great length of time, and are fed even long after they can fly, many hundreds of mice will scarcely suffice to supply them with food. Owls cast up the bones, fur, or feathers, of their prey, in form of small pellets, after they have devoured it, in the same manner as hawks do. A gentleman, on grubbing up an old pollard ash that had been the habitation of owls for many generations, found at the bottom many bushels of this rejected stuff. Some owls, when they are satisfied, hide the remainder of their meat like dogs.

4. The stridula, or tawny owl, weighs 19 ounces. This is a hardier species than the former; and the young will feed on any dead thing, whereas those of the white owl must have a constant supply of fresh meat. It is the strix of Aldrovandus, and what we call the screech-owl, to which the folly of superstition has given the power of presaging death by its cries.

5. The ulula, or brown owl, agrees with the former in its marks, differing only in the colours. Both these species inhabit woods, where they reside the whole day; in the night they are very clamorous, and when they hoot, their throats are inflated to the size of a hen's egg. In the dusk they approach our dwellings, and will frequently enter pigeon-houses, and make great havoc in them. They destroy numbers of little leverets, as appears by the legs frequently found in their nests. They also kill abundance of moles, and skin them with as much dexterity as a cook does a rabbit. They build in hollow trees or ruined edifices; lay four eggs, of an elliptic form, and of a whitish colour.

6. The passerina, or little owl, is very rare in England; it is sometimes found in Yorkshire, Flintshire, and also near London. In size it scarcely exceeds a thrush, though the fulness of its plumage makes it appear larger. The Italians make use of this owl to decoy small birds to the limed twig; the method of which is exhibited in Olina's Uccelliera.

7. The spectacle owl of Cayenne, which is accurately described by Dr. Latham, is 21 inches in length: the upper parts of the body are of a reddish colour; the lower parts of a rufous white; the head and neck are white, and not so full of feathers as those of owls generally are, and from this circumstance it appears not unlike a hawk; a large patch of dark brown surrounds each eye, giving the bird much the appearance of wearing spectacles; the legs are covered with feathers quite to the toes, and are of a yellowish colour.

STROMBUS, a genus of the vermes testacea. The generic character is, animal a limax; shell univalve, spiral; aperture much dilated; the lip expanding, and produced into a groove leaning on the left. This genus comprises 53 species, which are separated into divisions. Only one species, viz. the pes pelecane, or corvorant's foot, is found in this country. These shells, in their younger state, want the lip, and have a thin turbinate appearance. On this account they have by many naturalists been referred to a genus to which they do not belong.

STRONGYLUS, a genus of vermes intestina. The generic character is, body round, long, pellucid, glabrous; the fore part is globular, truncate, with a circular aperture fringed at the margin; the hind part of the female entire and pointed; of the male dilated into loose, distant, and pellucid membranes. There are two species: 1, the equinus, that inhabits the stomach of the horse in great numbers; and, 2, the ovinus, found in the intestines of sheep.

STRONTIAN. About the year 1787, a mineral was brought to Edinburgh by a dealer in fossils, from the lead-mine of Strontian, in Argyleshire, where it is found imbedded in the ore, mixed with several other substances. It is sometimes transparent and colourless, but generally has a tinge of yellow or green. Its specific gravity varies from 3.4 to 3.726. Its texture is generally fibrous; and sometimes it is found crystallized in slender prismatic columns of various lengths.

Strontian is found abundantly in different places of the world, and always combined with carbonic acid or sulphuric acid.

1. The carbonic acid may be expelled from the carbonat, and the strontian obtained pure by mixing the mineral with charcoal powder, and exposing it to a heat of 140° Wedgewood; or by dissolving the mineral in nitric acid, evaporating the solution till it crystallizes, and exposing the crystals in a crucible to a red heat till the nitric acid is driven off.

2. Strontian thus obtained, is in porous masses, of a greyish white colour; its taste is acrid and alkaline; and it converts vegetable blues to green. Its specific gravity, according to Hassenfratz, is 1.647. It does not act so strongly on animal bodies as barytes, nor is it poisonous.

It does not melt when heated like barytes; but before the blowpipe it is penetrated with light, and surrounded with a flame so white and brilliant that the eye can scarcely behold it.

3. When water is sprinkled on strontian it is slacked, becomes hot, and falls to powder exactly like barytes; but it is not so soluble in water as that earth. One hundred and sixty-two parts of water, at the temperature of 60°, dissolve nearly one part of strontian. The solution, known by the name of strontian water, is clear and transparent, and converts vegetable blues to a green. Hot water dissolves it in much larger quantities; and as it cools, the strontian is deposited in colourless transparent crystals. These are in the form of thin quadrangular plates, generally parallelograms, the largest of which seldom exceeds one-fourth of an inch in length. Sometimes their edges are plain, but they oftener consist of two facets, meeting together, and forming an angle like the roof of a house. These crystals generally adhere to each other in such a manner as to form a thin plate of an inch or more in length, and half an inch in breadth. Sometimes they assume a cubic form. They contain about 68 parts in 100 of water. They are soluble in 51.4 parts of water, at the temperature of 60°. Boiling water dissolves nearly half its weight of them. When exposed to the air, they lose their water, attract carbonic acid, and fall into powder. Their specific gravity is 1.46.

4. Strontian is not acted on by light; neither does it combine with oxygen.

5. Sulphur and phosphorus are the only simple combustibles with which it unites.

The sulphuret of strontian may be made by fusing the two ingredients in a crucible. It is soluble in water by means of sulphureted hydrogen, which is evolved. When the solution is evaporated, hydrosulphuret of strontian is obtained in crystals, and hydrogenated sulphuret remains in solution. These compounds resemble almost exactly the sulphuret, hydrosulphuret, and hydrogenated sulphuret of barytes; and do not therefore require a particular description. The same remark applies to the phosphuret of strontian, which may be prepared by the same process as the phosphuret of barytes.

6. Strontian does not combine with azote; but it unites readily with muriatic acid, and forms the substance called muriat of strontian.

7. Strontian has no action upon metals; but it combines with several of their oxides, and forms compounds which have not hitherto been examined.

8. It does not combine with alkalies nor with barytes. No precipitation takes place when barytes and strontian water are mixed together.

9. Strontian has the property of tinging flame of a beautiful red, or rather purple colour; a property discovered by Dr. Ash in 1787. The experiment may be made by putting a little of the salt composed of nitric acid and strontian into the wick of a lighted candle; or by setting fire to alcohol, holding muriat of strontian in solution. In both cases the flame is of a lively purple. In this respect it differs from barytes, which when tried in the same way is found to communicate a blueish yellow tinge to flame.

10. The affinities of strontian, as ascertained by Dr. Hope and Mr. Vauquelin, are as follows:

Sulphuric acid,	Muriatic,
Phosphoric,	Succinic,
Oxalic,	Acetic,
Tartaric,	Arsenic,
Fluoric,	Boracic,
Nitric,	Carbonic.

Barytes and strontian resemble each other in their properties as closely as potass and soda: hence, like these two alkalies, they were for some time confounded. It is in their combination with acids that the most striking differences between these two earths are to be observed.

STRUMPFIA a genus of plants belonging to the class of syngenesia, and to the order of monogamia. The calyx is quinquedentate and superior; the corolla is pentapetalous; and the berry monospermous. There is only one species, the maritima, a shrub of Curaçoa.

STRUTHIO, in natural history, a genus of birds belonging to the order of grallæ of Linnæus. It includes, 1. The ostrich, has a bill somewhat conical; the wings are so short as to be unfit for flying; the thighs and sides of the body are naked; the feet are formed for running, having two toes, one only of which is furnished with a nail. The head and bill somewhat resemble those of a duck; and the neck may be likened to that of a swan, but that it is much longer; the legs and thighs resemble those of a hen, though the whole appearnce bears a strong resemblance to that of a camel. But though usually seven feet high from the top of the head to the ground, from the back it is only four; so that the head and neck are above three feet long. From the top of the head to the rump, when the neck is stretched out in a right line, it is six feet long, and the tail is about a foot more. One of the wings without the feathers, is a foot and a half; and being stretched out, with the feathers, is three feet.

The plumage is much alike in all; that is, generally black and white; though some of them are said to be grey. There are no feathers on the sides, nor yet on the thighs, nor under the wings. The lower part of the neck, about half-way, is covered with still smaller feathers than those on the belly and back; and those also are of different colours.

At the end of each wing there is a kind of spur almost like the quill of a porcupine. It is an inch long, being hollow and of a horny substance. There are two of these on each wing; the largest of which is at the extremity of the bone of the wing, and the other a foot lower. The neck seems to be more slender in proportion to that of other birds, from its not being furnished with feathers. The skin in this part is of a livid flesh-colour, which some improperly would have to be blue. The bill is short and pointed, and two inches and a half at the beginning. The external form of the eye is like that of a man, the upper eye-lid being adorned with eye-lashes which are longer than those on the lid below. The tongue is small, very short, and composed of cartilages, ligaments, and membranes, intermixed with fleshy fibres. In some it is about an inch long, and very thick at the bottom; in others it is but half an inch, being a little forked at the end.

The ostrich is a native only of the torrid regions of Africa, and has long been celebrated by those who have had occasion to mention the animals of that region. Its flesh is proscribed in scripture as unfit to be eaten; and most of the antient writers describe it as well known in their times. Like the race of the elephant, it is transmitted down without mixture; and has never been known to breed out of that country which first produced it. It seems formed to live among the sandy and burning deserts of the torrid zone; and, as in some measure it owes its birth to their genial influence, so it seldom migrates into tracts more mild or more fertile. The Arabians assert that the ostrich never drinks; and the place of its habitation seems to confirm the assertion. In these formidable regions ostriches are seen in large flocks, which to the distant spectator appear like a regiment of cavalry, and have often alarmed a whole caravan. There is no desert, how barren soever, but what is capable of supplying these animals with provision; they eat almost every thing; and these barren tracts are thus doubly grateful, as they afford both food and security. The ostrich is very voracious. It will devour leather, grass, hair, iron, stones, or any thing that is given. Those substances which the coats of the stomach cannot soften, pass whole; so that glass, stones, or iron, are excluded in the form in which they were devoured.

In their native deserts, however, it is probable they live chiefly upon vegetables, where they lead an inoffensive and social life; the male, as Thevenot assures us, assorting with the female with connubial fidelity. They are said to be very much inclined to venery; and the make of the parts in both sexes seems to confirm the report. It is probable also they copulate like other birds, by compression. They lay very large eggs, some of them being above five inches in diameter, and weighing above fifteen pounds. These eggs have a very hard shell, somewhat resembling those of the crocodile, except that those of the latter are less and rounder.

The season for laying depends on the climate where the animal is bred. In the northern parts of Africa, this season is about the beginning of July; in the south it is about the latter end of December. These birds are very prolific, and lay generally from forty to fifty eggs at one clutch. It has been commonly reported, that the female deposits them in the sand, and covering them up, leaves them to be hatched by the heat of the climate, and then permits the young to shift for themselves. Very little of this, however, is true: no bird has a stronger affection for her young than the ostrich, nor none watches her eggs with greater assiduity. It happens, indeed, in those hot climates, that there is less necessity for the continual incubation of the female; and she more frequently leaves her eggs, which are in no danger of being chilled by the weather: but though she sometimes forsakes them by day, she always carefully broods over them by night; and Kolben, who has seen great numbers of them at the Cape of Good Hope, affirms, that they sit on their eggs like other birds, and that the male and the female take this office by turns, as he had frequent opportunities of observing. Nor is it more true what is said of their forsaking their young after they are excluded the shell. On the contrary, the young ones are not even able to walk for several days after they are hatched. During this time the old ones are very assiduous in supplying them with grass, and very careful to defend them from danger; nay, they encounter every danger in their defence. The young, when brought forth, are of an ash-colour the first year, and are covered with feathers all over. But in time these feathers drop; and those parts which are covered assume a different and more becoming plumage.

The beauty of a part of this plumage, particularly the long feathers that compose the wings and tail, is the chief reason that man has been so active in pursuing this harmless bird to its deserts, and hunting it with no small degree of expence and labour. The antients used those plumes in their helmets; our military wear them in their hats; and the ladies made them an ornament in their dress. Those feathers which are plucked from the animal while alive are much more valued than those taken when dead, the latter being dry, light, and subject to be worm-eaten.

Besides the value of their plumage, some of the savage nations of Africa hunt them also for their flesh; which they consider as a dainty. They sometimes also breed these birds tame, to eat the young ones, of which the females are said to be the greatest delicacy. Even among the Europeans now, the eggs of the ostrich are said to be well tasted, and extremely nourishing; but they are too scarce to be fed upon, although a single egg is a sufficient entertainment for eight men.

As the spoils of the ostrich are thus valuable, it is not to be wondered at that man has become their most assiduous pursuer. For this purpose, the Arabians train up their best and fleetest horses, and hunt the ostrich still in view. Perhaps, of all varieties of the chase, this, though the most laborious, is yet the most entertaining. As soon as the hunter comes within sight of his prey, he puts on his horse with a gentle gallop, so as to keep the ostrich still in sight; yet not so as to terrify him from the plain into the mountains. Of all known animals, the ostrich is by far the swiftest in running; upon observing himself, therefore, pursued at a distance, he begins to run at first but gently; either insensible of his danger, or sure of escaping. Unfortunately for the silly creature, instead of going off in a direct line, he takes his course in circles; while the hunters still make a small course within, relieve each other, meet him at unexpected turns, and keep him thus still employed, still followed, for two or three days together. At last, spent with fatigue and famine, and finding all power of escape impossible, he endeavours to hide himself from those enemies he cannot avoid, and covers his head in the sand or the first thicket he meets. Sometimes, however, he attempts to face his pursuers; and though in general the most gentle animal in nature, when driven to desperation he defends himself with his beak, his wings, and his feet. Such is the force of his motion, that a man would be utterly unable to withstand him in the shock.

The Struthophagi have another method of taking this bird: they cover themselves with an ostrich's skin, and passing up an arm through the neck, thus counterfeit all the motions of this animal. By this artifice they approach the ostrich, which becomes an easy prey. He is sometimes also taken by dogs and nets; but the most usual way is that mentioned above.

When the Arabians have thus taken an ostrich they cut its throat; and making a ligament below the opening, they shake the bird as one would rinse a barrel; then taking off the ligature, there runs out from the wound in the throat a considerable quantity of blood mixed with the fat of the animal; and this is considered as one of their greatest dainties. They next flay the bird; and of the skin, which is strong and thick, sometimes make a kind of vest, which answers the purposes of a cuirass and a buckler.

There are others who, more compassionate or more provident, do not kill their captive, but endeavour to tame it, for the purposes of supplying those feathers which are in so great request. The inhabitants of Daara and Lybia breed up whole flocks of them, and they are tamed with very little trouble. But it is not for their feathers alone that they are prized in this domestic state; they are often ridden upon and used as horses. Moore assures us, that at Joar, he saw a man travelling upon an ostrich; and Adanson asserts, that at the factory of Podore he had two ostriches, which were then young, the strongest of which ran swifter than the best English racer, although he carried two negroes on his back. As soon as the animal perceived that it was thus loaded, it set off running with all its force, and made several circuits round the village; till at length people were obliged to stop it by barring up the way. How far this strength and swiftness may be useful to mankind, even in a polished state, is a matter that perhaps deserves inquiry. See Plate Nat. Hist. fig. 379.

2. The cassowary (the casuarius of Linnæus, and galeated cassowary of Dr. Latham) was first brought into Europe from Java by the Dutch about the year 1597. It is nearly equal in size to the ostrich, but its legs are much thicker and stronger in proportion. This conformation gives it an air of strength and force, which the fierceness and singularity of its countenance conspire to render formidable. It is five feet and a half long from the point of the bill to the extremity of the claws. The legs are two feet and a half high from the belly to the end of the claws. The head and neck together are a foot and a half; and the largest toe, including the claw, is five inches long. The claw alone of the least toe is three inches and a half in length. The wing is so small that it does not appear, it being hidden under the feathers of the back. In other birds, a part of the feathers serve for flight, and are different from those that serve merely for covering; but in the cassowary all the feathers are of the same kind, and outwardly of the same colour. They are generally double, having two long shafts, which grow out of a short one, which is fixed in the skin. Those that are double are always of unequal length; for some are fourteen inches long, particularly on the rump, while others are not above three. The beards that adorn the stem or shaft are about half-way to the end, very long, and as thick as a horse-hair, without being subdivided into fibres. The stem or shaft is flat, shining, black, and knotted below; and from each knot there proceeds a beard; likewise the beards at the end of the large feathers are perfectly black, and towards the root of a grey tawny colour; shorter, more soft, and throwing out fine fibres like down; so that nothing appears except the ends, which are hard and black; because the other part, composed of down, is quite covered. There are feathers on the head and neck; but they are so short and thinly sown, that the bird's skin appears naked, except towards the hinder part of the head, where they are a little longer. The feathers which adorn the rump are extremely thick; but do not differ in other respects from the rest, except in their being longer. The wings, when they are deprived of their feathers, are but three inches long; and the feathers are like those on other parts of the body. The ends of the wings are adorned with five prickles, of different lengths and thickness, which bend like a bow: these are hollow from the roots to the very points, having only that slight substance within which all quills are known to have. The longest of these prickles is eleven inches; and it is a quarter of an inch in diameter at the root, being thicker there than towards the extremity: the point seems broken off.

The part, however, which most distinguishes this animal is the head; which, though small, like that of an ostrich, does not fail to inspire some degree of terror. It is bare of feathers, and is in a manner armed with a helmet of horny substance, that covers it from the root of the bill to near half the head backwards. This helmet is black before and yellow behind. Its substance is very hard, being formed by the elevation of the bone of the skull; and it consists of several plates one over another, like the horn of an ox. The neck is of a violet colour, inclining to that of slate; and it is red behind in several places, but chiefly in the middle. About the middle of the neck before, at the rise of the large feathers, there are two processes formed by the skin, which resemble somewhat the gills of a cock, but that they are blue as well as red. The skin which covers the fore part of the breast, on which this bird leans and rests, is hard, callous, and without feathers.

The same degree of voraciousness which we perceived in the ostrich obtains as strongly here. The cassowary swallows every thing that comes within the capacity of its gullet. The Dutch assert, that it can devour not only glass, iron, and stones, but even live on burning coals, without testifying the smallest fear of feeling the least injury. It is said, that the passage of the food through its gullet is performed so speedily, that even the very eggs which it has swallowed whole pass through it unbroken in the same form they went down. In fact, the alimentary canal of this animal, as was observed above, is extremely short; and it may happen, that many kinds of food are indigestible in its stomach, as wheat or currants are to a man when swallowed whole.

The cassowary's eggs are of a grey ash-colour, inclining to green. They are not so large nor so round, as those of the ostrich. They are marked with a number of little tubercles of a deep green, and the shell is not very thick. The largest of these is found to be fifteen inches round one way, and about twelve the other.

The southern parts of the most eastern Indies seem to be the natural climate of the cassowary. His domain, if we may so call it, begins where that of the ostrich terminates. The latter has never been found beyond the Ganges; while the cassowary is never seen nearer than the islands of Bandana, Sumatra, Java, the Molucca islands, and the corresponding parts of the continent. Yet even here this animal seems not to have multiplied in any considerable degree, as we find one of the kings of Java making a present of one of these birds to the captain of a Dutch ship, considering it as a very great rarity.

The casuarius Novæ Hollandiæ, or New Holland cassowary, differs considerably from the common cassowary. It is a much larger bird, standing higher on its legs, and having the neck longer than in the common one. Total length seven feet two inches. The bill is not greatly different from that of the common cassowary; but the horny appendage or helmet on the top of the head in this species is totally wanting: the whole of the head and neck is also covered with feathers, except the throat and fore part of the neck about half-way, which are not so well feathered as the rest; whereas in the common cassowary the head and neck are bare and carunculated as in the turkey.

The plumage in general consists of a mixture of brown and grey, and the feathers are somewhat curled or bent at the ends in the natural state: the wings are so very short as to be totally useless for flight, and indeed are scarcely to be distinguished from the rest of the plumage, was it not for their standing out a little. The long spines which are seen in the wings of the common sort are in this not observable, nor is there any appearance of a tail. The legs are stout, formed much as in the galeated cassowary, with the addition of their being jagged or sawed the whole of their length at the back part.

This bird is not uncommon in New Holland, as several of them have been seen about Botany-bay and other parts. Although it cannot fly, it runs so swiftly, that a greyhound can scarcely overtake it. The flesh is said to be in taste not unlike beef.

STRUTHIOLA, a genus of plants belonging to the class of tetrandria, and order of monogynia. The corolla is wanting; the calyx is tubulous, with eight glandules at its mouth; the berry is without juice, and monospermous. The species are 5, shrubs of the Cape.

STRYCHNOS, a genus of plants belonging to the class of pentandria, and order of monogynia; and in the natural system ranging under the twenty-eighth order, luridæ. The corolla is quinquefid; the berry is unilocular, with a woody bark. The species are three, the nux vomica, colubrina, and potatorum, natives of foreign countries.

STUARTIA, a genus of plants belonging to the class of monadelphia, and order of polyandria; and in the natural system ranging under the 37th order, columniferæ. The calyx is simple; the style is simple, with a quinquefid stigma; the apple is without juice, quinquelobed, monospermous, bursting open with a spring five ways. There are two species, foreign plants.

STUCCO, in building, a composition of white marble pulverised, and mixed with plaister of lime; and the whole being sifted and wrought up with water, is to be used like common plaister: this is called by Pliny marmoratum opus, and albarium opus.

STUM, in the wine trade, denotes the unfermented juice of the grape, after it has been several times racked off, and separated from its sediment.

STURGEON. See ACCIPENSER.

STURNUS, the *starling*, a genus of birds belonging to the order of passeres. The beak is subulated, depressed, and somewhat blunt; the superior mandible is entire, and somewhat open at the edges; the nostrils are marginated above; and the tongue is sharp and emarginated. There are 15 species, according to Dr. Latham; the vulgaris, capensis, ludovicianus, militaris, cellaris, carunculatus, gallinaceus, sericeus, viridis, olivaceus, moritanicus, loyca, dauricus, junceti, and mexicanus.

The vulgaris, or common starling, is the only species of the sturnus that is indigenous. The weight of the male of this species is about three ounces; that of the female rather less. The length is eight inches three quarters. The whole plumage is black, very resplendent, with changeable blue, purple, and copper: each feather marked with a pale yellow spot. The lesser coverts are edged with yellow, and slightly glossed with green.

The stare breeds in hollow trees, eaves of houses, towers, ruins, cliffs, and often in high rocks over the sea, such as that of the Isle of Wight. It lays four or five eggs, of a pale-greenish ash-colour; and makes its nest of straw, small fibres of roots, &c. In winter, stares assemble in vast flocks: they collect in myriads in the fens of Lincolnshire, and do great damage to the fen-men by roosting on the reeds, and breaking them down by their weight; for reeds are the thatch of the country, and are laid up in harvest with great care. These birds feed on worms and insects; and it is said they will get into pigeon-houses, for the sake of sucking the eggs. Their flesh is so bitter as to be scarcely eatable. They are fond of following oxen and other large cattle, as they feed in the meadows, attracted, as it is said, by the insects which flutter round them, or by those, perhaps, which swarm in their dung, or in meadows in general. From this habit is derived the German name rinder staren. They live seven or eight years, or even longer, in the domestic state. The wild ones cannot be decoyed by the call, because they regard not the scream of the owl. A method has been discovered of taking entire families, by fixing to the walls and the trees where they lodge, pots of earthenware of a convenient form, which the birds often prefer to place their nests in. Many are also caught by the gin and draw-net.

The stare, it is said, can be taught to speak either French, German, Latin, Greek, &c. and to pronounce phrases of some length. Its pliant throat accommodates itself to every inflection and every accent. It can readily articulate the letter R, and acquires a sort of warbling which is much superior to its native song. This bird is spread through an extensive range in the antient continent.

The sturnus cinclus, see Plate Nat. Hist. fig. 380, inhabits Europe and the northern parts of Persia; frequents waters, and feeds on aquatic insects and small fishes. It is very solitary, and breeds in the holes of banks; makes a very curious nest of hay and roots, lined with dead leaves, and having an entrance of green moss.

STYLE, a word of various significations, originally derived from ϛυλος, a kind of bodkin, wherewith the antients wrote on plates of lead, or on wax, &c. and which is still used to write on ivory leaves, and paper prepared for that purpose, &c.

STYLE. See DIALLING.

STYLE. See BOTANY.

STYLE, in matters of language. See RHETORIC, and POETRY.

STYLEPHORUS, a genus of fishes of the order apodes. The generic character is, eyes pedunculated, standing on a short thick cylinder; snout lengthened, directed upwards, retractile towards the head by means of a membrane; mouth without teeth; branchiæ three pair beneath the throat; fins, pectoral small, dorsal the length of the back, caudal short, with spiny rays; body very long, compressed. This highly singular genus was first described in the year 1788, from a specimen then introduced into the Leverian Museum, and figured in the first volume of the Linnæan Transactions, see Plate Nat. Hist. fig. 381.

Chordated stylephorus. The head of this extraordinary animal bears some distant resemblance to that of the genus syngnathus, and its structure cannot so easily be described in words as conceived by the figure. The rostrum or narrow part, which is terminated by the mouth, is connected to the back part of the head by a flexible leathery duplicature, which permits it to be either extended in such a manner that the mouth points directly upwards, or to fall back, so as to be received into a sort of case formed by the upper part of the head. On the top of the head are placed the eyes, which are of a form very nearly approaching to those of the genus cancer; except that the columns or parts on which eye is placed are much broader and thicker than in that genus; they are also placed close to each other; and the outward surface of the eye, when magnified, does not shew the least appearance of a reticulated structure. Below the head, on each side, is a considerable compressed semicircular space, the fore part of which is bounded by the covering of the gills, which covering seems to consist of a single membrane, of a moderately strong nature. Beneath this, on each side, are three small pair of branchiæ. The body is extremely long, and compressed very much, and gradually diminishes as it approaches the tail, which terminates in a string or process of an enormous length, and finishes in a very fine point. This string, or caudal process, seems to be strengthened throughout its whole length, or at least as far as the eye can trace it, by a sort of double fibre or internal part. The pectoral fins are very small, and situated almost immediately behind the cavity on each side the thorax. The general colour of this fish is a rich silver, except on the flexible part belonging to the rostrum, which is of a deep brown: the fins and caudal process are also brown. There is no appearance of scales on this fish.

STYLITES, an appellation given to a kind of solitaries, who spent their lives seated on the tops of columns, to be, as they imagined, the better disposed for meditation, &c. Of these we find several mentioned in antient writers, and even as low as the eleventh century. The founder of the order was St. Simon Stylites, a famous anchoret in the fifth century, who took up his abode on a column six cubits high; then on a second of twelve cubits; a third, of twenty-two; and, at last, on another of thirty-six. The extremity of these columns was only three feet in diameter, with a kind of rail or ledge about it that reached almost to the girdle, somewhat resembling a pulpit. There was no lying down in it. The faquirs, or devout people of the East, imitate this extraordinary kind of life even to this day.

STYLO-CERALOIDES, STYLO-Glossus, Stylo-*Hyoidæus*, Stylo-*Pharyngæus*, STYLOIDES, the names of different muscles in the human body. See Anatomy.

STYPTIC. See Pharmacy.

STYRAX. See Resins.

Styrax, the *storax-tree*, a genus of plants belonging to the class of decandria, and to the order of monogynia, and in the natural system ranging under the 18th order, bicornes. The calyx is inferior; corolla funnel-form; drupe two-seeded. Linnæus only mentions one species of this genus, the styrax officinale; but Aiton, in his Hortus Kewensis, has added two more; namely, the grandefolium, and lævigatum; and a fourth may now be added, the styrax benzoin.

The officinale usually rises about twenty feet in height; it sends off many strong branches, which are covered with a roughish bark of a grey colour: the leaves are broad, elliptical, entire, somewhat pointed, on the upper surface smooth, and of a light-green colour, on the under surface covered with a whitish down; they are placed alternately, and stand upon short footstalks: the flowers are large, white, and disposed in clusters upon short peduncles, which terminate the branches: the corolla is monopetalous; the fruit is a pulpy pericarpium.

The resinous drug called storax issues in a fluid state from incisions made in the trunk or branches of the tree. Two sorts of this resin have been commonly distinguished in the shops: 1. Storax in the tear, is scarcely, if ever, found in separate tears, but in masses, sometimes composed of whitish and pale reddish brown tears, and sometimes of an uniform reddish yellow or brownish appearance; unctuous and soft like wax, and free from visible impurities. This is supposed to be the sort which the antients received from Pamphylia in reeds or canes, and which was thence named calamita.

2. Common storax: in large masses, considerably lighter and less compact than the former, and having a large admixture of woody matter like saw-dust. This appears to be the kind intended by the London college, as they direct their styrax calamita to be purified, for medicinal use, by softening it with boiling water, and pressing it out from the feces betwixt warm ironplates: a process which the first does not stand in need of; and indeed there is rarely any other than this impure storax to be met with in the shops.

Storax, with some of the antients, was a familiar remedy as a resolvent, and particularly used in catarrhal complaints, coughs, asthmas, menstrual obstructions, &c. and from its affinity to the balsams, it was also prescribed in ulcerations of the lungs, and other states of pulmonary consumption. And our pharmacopœias formerly directed the pilulæ e styrace; but this odoriferous drug has now no place in any of the officinal compounds; and though a medicine which might seem to promise some efficacy in nervous debilities, yet by modern practitioners it is almost totally disregarded.

The styrax benzoin, see Plate Nat. Hist. fig. 382, has been characterised by oblong acuminated leaves, which are downy underneath, and nearly of the length of the racemi.

This tree, which is a native of Sumatra, is deemed in six years of sufficient age for affording the benzoin, or when its trunk acquires about seven or eight inches in diameter; the bark is then cut through longitudinally, or somewhat obliquely, at the origin of the principal lower branches, from which the drug exudes in a liquid state, and by exposure to the sun and air soon concretes, when it is scraped off from the bark with a knife or chisel. The quantity of benzoin which one tree affords never exceeds three pounds, nor are the trees found to sustain the effects of these annual incisions longer than ten or twelve years. The benzoin which issues first from the wounded bark is the purest, being soft, extremely fragrant, and very white; that which is less esteemed is of a brownish colour, very hard, and mixed with various impurities, which it acquires during its long continuance upon the trees.

The benzoin which we find here in the shops is in large brittle masses, composed partly of white, partly of yellowish or light-brown, and often also of darker-coloured pieces; that which is clearest, and contains the most white matter, called by authors benzoe amygdaloides, is accounted the best. This resin has very little taste, impressing on the palate only a slight sweetness: its smell, especially when rubbed or heated, is extremely fragrant and agreeable. It totally dissolves in rectified spirit (the impurities excepted, which are generally in a very small quantity) into a deep yellowish-red liquor, and in this state discovers a degree of warmth and pungency, as well as sweetness. It imparts, by digestion, to water also a considerable share of its fragrance, and a slight pungency: the filtred liquor, gently exhaled, leaves not a resinous or mucilaginous extract, but a crystalline matter, seemingly of a saline nature, amounting to one-tenth or one-eighth of the weight of the benzoin. Exposed to the fire in proper vessels, it yields a quantity of a white saline concrete, called flores benzoes, of an acidulous taste and grateful odour, soluble in rectified spirit, and in water by the assistance of heat.

The principal use of this fragrant resin is in perfumes, and as a cosmetic; for which last purpose, a solution of it in spirit of wine is mixed with so much water as is sufficient to render it milky, as twenty times its quantity or more. It promises, however, to be applicable to other uses, and to approach in virtue, as in fragrance, to storax, and balsam of tolu. It is said to be of great service in disorders of the breast, for resolving obstructions of the pulmonary vessels, and promoting expectoration: in which intentions the flowers are sometimes given from three or four grains to fifteen. The white powder, precipitated by water from solutions of the benzoin in spirit, has been employed by some as similar and superior to the flowers, but appears to be little other than the pure benzoin in substance: it is not the saline, but the resinous matter of the benzoin, that is most disposed to be precipitated from spirit by water. The flowers, snuffed up the nose, are said to be a powerful errhine.

SUBALTERN, a subordinate officer, or one who discharges his post under the command and subject to the direction of another: such are lieutenants, sub-lieutenants, cornets and ensigns, who serve under the captain; but custom has now appropriated the term to those of much lower ranks, as serjeants, &c. We also say subaltern courts, jurisdictions, &c. such are those of inferior lords, with regard to the lord paramount; hundred-courts with regard to county-courts, &c.

SUBCLAVIAN. See Anatomy.

SUBCOSTAL MUSCLES. See Anatomy.

SUBDUPLE RATIO, is when any number or quantity is contained in another twice: thus 3 is said to be subduple of 6, as 6 is duple of 3.

SUBDUPLICATE RATIO of any two quantities, is the ratio of their square roots.

SUBER. This name has been introduced into chemistry by Fourcroy, to denote the outer bark of the quercus suber, or the common cork, a substance which possesses properties different from all other vegetable bodies.

It is exceedingly light, soft, and elastic; very combustible, burning with a bright white flame, and leaving a light black bulky charcoal; and when distilled it yields a little ammonia. Nitric acid gives it a yellow colour, corrodes, dissolves, and decomposes it, converting it partly into suberic acid, partly into a substance resembling wax.

SUBERATS, salt formed with the suberic acid, which see.

SUBERIC ACID may be formed by pouring six parts of nitric acid of the specific gravity 1.261 on one part of cork grated down or simply broken down into small pieces, and distilling the mixture with a gentle heat as long as red vapours continue to escape. As the distillation advances, a yellow matter like wax makes its appearance on the surface of the liquid. While the matter contained in the retort is hot, it is to be poured into a glass vessel, placed upon a sand-bath over a gentle fire, and constantly stirred with a glass rod. By this means it becomes gradually thick. As soon as white vapours, exciting a tickling in the throat, begin to disengage themselves, the vessel is removed from the bath, and the mass continually stirred till it is almost cold.

By this means an orange-coloured mass is obtained of the consistence of honey, of a strong and sharp odour while hot, but having a peculiar aromatic smell when cold.

On this mass twice its weight of boiling water is to be poured, and heat applied till it becomes liquid; and then that part of it which is insoluble in water is to be separated by filtration. The filtred liquor becomes muddy; on cooling it deposits a powdery sediment, and a thin pellicle forms on its surface. The sediment is to be separated by filtration, and the liquor reduced to a dry mass by evaporating in a gentle heat. This mass is suberic acid. It is still a little coloured, owing to some accidental mixture, from which it may be purified either by saturating it with potass and precipitating it by means of an acid, or by boiling it along with charcoal-powder.

Suberic acid thus obtained is not crystallizable, but when precipitated from potass by an acid it assumes the form of a powder: when obtained by evaporation it forms thin irregular pellicles.

Its taste is acid and slightly bitter; and when dissolved in a small quantity of boiling water it acts upon the throat, and excites coughing.

It reddens vegetable blues; and when dropped into a solution of indigo in sulphuric acid (liquid blue, as it is called in this country), it changes the colour of the solution, and renders it green.

Water at the temperature of 60° or even 70° dissolves only $\frac{1}{576}$ part of its weight of suberic acid; and if the acid is very pure, only $\frac{1}{144}$th part: boiling water, on the contrary, dissolves half its weight of it.

When exposed to the air, it attracts moisture, especially if it is impure.

When exposed to the light of day, it becomes at last brown; and this effect is produced much sooner by the direct rays of the sun.

When heated in a matrass, the acid sublimes, and the inside of the glass is surrounded with zones of different colours. If the sublimation is stopped at the proper time, the acid is obtained on the sides of the vessel in small points formed of concentric circles. When exposed to the heat of the blowpipe on a spoon of platinum, it first melts, then becomes pulverulent, and at last sublimes entirely with a smell resembling that of sebacic acid.

It is not altered by oxygen gas: the othe acids do not dissolve it completely. Alcoho developes an aromatic odour, and an ether may be obtained by means of this acid.

It converts the blue colour of nitrat of copper to a green; the sulphat of copper also to a green; green sulphat of iron to a deep yellow; and sulphat of zinc to a golden yellow.

It has no action either on platinum, gold, or nickel; but it oxidizes silver, mercury, copper, lead, tin, iron, bismuth, arsenic, cobalt, zinc, antimony, manganese, and molybdenum.

With alkalies, earths, and metallic oxides, it forms compounds known by the name of suberats.

Its affinities are as follows:

Barytes,
Potass,
Soda,
Lime,
Ammonia,
Magnesia,
Alumina.

SUBLIMATION, a process by which certain volatile substances are raised by heat, and again condensed by cold in a solid form. Flowers of sulphur are made in this way. Soot is also an instance of sublimation. See CHEMISTRY.

SUBNORMAL, in geometry, is a line which determines the point in the axis of a curve, where a normal, or perpendicular, raised from the point or contact of a tangent to the curve, cuts the axis. Or the subnormal is a line which determines the point wherein the axis is cut by a line falling perpendicularly on the tangent in the point of the contact.

SUBPŒNA, is a writ by which all persons under the degree of peerage are called into chancery, in such case only where the common law fails, and has made no provisions; so as the party who in equity has wrong, can have no other remedy by the rules and course of common law. But the peers of the realm in such cases are called by the lord chancellor's, or lord keeper's letters, giving notice of the suit intended against them, and requiring them to appear. There is also a subpœna ad testificandum for the summoning of witnesses as well in chancery as other courts.

There is also a subpœna in the exchequer, as well in the court of equity there, as in the office of pleas.

SUBROGATION, or SURROGATION, in the civil law, the act of substituting a person in the place, and entitling him to the rights, of another; but, in its general sense, subrogation implies a succession of any kind, whether of a person to a person, or of a person to a thing. There are two kinds of subrogation, the one conventional, the other legal. Conventional subrogation is a contract, whereby a creditor transfers his debt, with all appurtenances thereof, to the profit of a third person. Legal subrogation is that which the law makes, in favour of a person who discharges an antecedent creditor, in which case there is a legal translation of all rights of the antient creditor to the person of the new one. This the civilians more usually call succession, as being wholly the work of the law; and to distinguish it from the conventional subrogation, which they also call cession.

SUBSIDY, in law, signifies an aid or tax granted to the king, by parliament, for the necessary occasions of the kingdom; and is to be levied on every subject of ability, according to the rate or value of his lands or goods: but this word, in some of our statutes, is confounded with that of customs.

SUBSISTENCE, in the military art, is the money paid to the soldiers weekly, not amounting to their full pay; because their clothes, accoutrements, tents, bread, &c. are to be paid. It is likewise the money paid to officers upon account, till their accounts are made up, which is generally once a year, and then they are paid their arrears.

SUBSTITUTION, in the civil law, a disposition of a testament, whereby the testator substitutes one heir for another, who has only the usufruit, and not the property of the thing left him. Substitution is only a kind of fiduciary inheritance, called also fidei commissio, in regard the immediate inheritor has only the use or produce of the thing; the body thereof being substituted and appropriated to certain persons, who are likewise to have the usufruit in their turns, but are never to have the property.

SUBSTITUTION, in algebra, &c. is the putting, in the room of any quantity in an equation, some other quantity, which is equal to it, but expressed in another manner.

SUBTANGENT *of a curve*, in the higher geometry, is the line which determines the intersection of the tangent with the axis; or, that determines the point wherein the tangent cuts the axis prolonged.

In any equation, if the value of the subtangent comes out positive, it is a sign that the points of intersection of the tangent and axis fall on that side of the ordinate where the vertex of the curve line lies, as in the parabola and paraboloids: but if it comes out negative, the point of intersection will fall on the contrary side of the ordinate, in respect of the vertex, or beginning of the abscissa; as in the hyperbola and hyperboliform figures. And universally, in all paraboliform and hyperboliform figures, the subtangent is equal to the exponent of the power of the ordinate, multiplied into the abscissa.

If CB is an ordinate to AB, in any given angle, terminating in any curve AC, and AB $= x$, BC $= y$, and the relation between x and y, that is, the nature of the curve, is expressed by this equation, $x^3 - 2xxy + bxx - bbx + byy - y^3 = 0$; then this will be the rule of drawing a tangent to it: multiply the terms of the equation by an arithmetical progression; suppose, according to the dimensions of y,

$$\begin{matrix} x^3 & - 2xxy & + bxx & - bbx & + byy & - y^3; \\ 0 & 1 & 0 & 0 & 2 & 3 \end{matrix}$$

as also according to the dimensions of x, as

$$\begin{matrix} x^3 & - 2xxy & + bxx & - bbx & + byy & - y^3: \\ 3 & 2 & 2 & 1 & 0 & 0 \end{matrix}$$

the former product shall be the numerator, and the latter, divided by x, the denominator, of a fraction expressing the length of the subtangent; which, in this case, will be

$$= \frac{-2xxy + 2byy - 3y^3}{3xx - 4xy + 2bx - bb}.$$

SUBTENSE, in geometry, the same with the chord of an arch. See CHORD.

Hence, the subtense of an angle is a right line supposed to be drawn between the two extremities of the arch that measures that angle.

SUBTRACTION. See ARITHMETIC, and ALGEBRA.

SUBULARIA, *rough-leaved alysson*, or *awlwort*, a genus of plants belonging to the class of tetradynamia, and order of siliculosa; and in the natural order ranking under the 39th order, siliquosæ. The silicula is entire and ovate; the valves are ovate, concave, and contrary to the partitions. The style is shorter than the silicula. There is only one species, the aquatica, which is a native of Britain.

SUBULATED. See BOTANY.

SUCCINATS, salts formed with the succinic acid, which see.

SUCCINIC ACID. Amber is a well-known brown, transparent, inflammable body, pretty hard, and susceptible of polish, found at some depth in the earth, and on the sea-coast of several countries. It was in high estimation among the antients both as an ornament and a medicine. When this substance is distilled, a volatile salt is obtained, which is mentioned by Agricola under the name of salt of amber; but its nature was long unknown. Boyle was the first who discovered that it was an acid. From succinum, the Latin name of amber, this acid has received the appellation of succinic acid.

1. It is obtained by the following process: Fill a retort half-way with powdered amber, and cover the powder with a quantity of dry sand; lute on a receiver, and distil in a sand-bath without employing too much heat. There passes over first an insipid phlegm; then a weak acid, which, according to Scheele, is the acetic; then the succinic acid attaches itself to the neck of the retort; and if the distillation is continued, there comes over at last a thick brown oil, which has an acid taste.

The succinic acid is at first mixed with a quantity of oil. It may be made tolerably pure by dissolving it in hot water, and putting upon the filtre a little cotton, previously moistened with oil of amber: this substance retains most of the oil, and allows the solution to pass clear. The acid is then to be crystallized by a gentle evaporation; and this process is to be repeated till the acid is sufficiently pure. Guyton Morveau has discovered that it may be made quite pure by distilling off it a sufficient quantity of nitric acid, taking care not to employ a heat strong enough to sublime the succinic acid.

2. The crystals of succinic acid are transparent, white, shining, and of a foliated triangular, prismatic form: they have an acid taste, but are not corrosive: they redden tincture of turnsole, but have little effect on that of violets.

They sublime when exposed to a considerable heat, but not at the heat of a water-bath. In a sand-bath they melt, and then sublime and condense in the upper part of the vessel; but the coal which remains shews that they are partly decomposed.

3. One part of this acid dissolves in 96 parts of water at the temperature of 50°, according to Spielman; in 24 parts at the temperature of 52°; and in two parts of water at the temperature of 212°, according to Stockar de Neuforn; but the greatest part crystallizes as the water cools. According to Roux, however, it still retains more of the acid than cold water is capable of dissolving.

Two hundred and forty grains of boiling alcohol dissolve 177 of this acid; but crystals again shoot as the solution cools.

4. The compounds which this acid forms with alkalies, acids, and metallic oxides, have received the name of succinats. Scarcely any of them have been examined with attention.

5. When combined with soda, it crystallizes in four and six-sided prisms. When this salt is distilled in a retort, the succinic acid is completely decomposed. There pass over into the receiver an acid liquor, which is the acetic much diluted, and a quantity of brown oil. At the same time carbonic acid gas, and carbureted hydrogen gas, are disengaged, and there remain in the retort soda and charcoal. Hence it follows that this acid, like the others of the same class, is decomposed by heat, and that it is composed of oxygen, hydrogen, and carbon.

6. The affinities of succinic acid, according to Morveau, are as follows:

Barytes,
Lime,
Potass,
Soda,
Ammonia,
Magnesia,
Alumina,
Metallic oxides.

SUCCINUM. See AMBER.

SUDORIFIC. See MATERIA MEDICA.

SUFFERANCE. Tenant at sufferance is he who holds over his term at first lawfully granted. A person is tenant at sufferance who continues after his estate is ended, and wrongfully holds against another, &c. 1 Co. Inst. 57.

Tenants holding over, after determination of their term, and after demand made in writing to deliver possession, are rendered liable to pay double the yearly value. And tenants giving notice of their intention to quit, and not accordingly delivering up the possession at the time in such notice contained, are rendered liable to pay double rent. And it has been held, that under this act, the notice need not be in writing, and that the landlord may levy his double rent by distress. Bur. 1603.

SUGAR, which at present forms so important an article in our food, seems to have been known at a very early period to the inhabitants of India and China. But Europe probably owes its acquaintance with it to the conquests of Alexander the Great. For ages after its introduction into the West, it was used only as a medicine; but its consumption gradually increased: and during the time of the crusades, the Venetians, who brought it from the East, and distributed it to the northern parts of Europe, carried on a lucrative commerce with sugar. It was not till after the discovery of America, and the extensive cultivation of sugar in the West Indies, that its use in Europe, as an article of food, became general.

Sugar was formerly manufactured in the southern parts of Europe; but at present almost all our sugar comes from the East and West Indies. The plant from which it is procured is the saccharum officinarum (see SACCHARUM), or sugar-cane. Other plants indeed contain it, but not in such abundance. In North America, however, it is extracted from the acer saccharinum, or sugar-maple. Attempts have been lately made to extract it from the beet.

1. The method of making sugar practised in Indostan is exceedingly simple, and requires little or no expensive apparatus. The soil chosen is a rich vegetable mould, in such a situation that it can be easily watered from a river. About the end of May, when the soil is reduced to the state of soft mud either by rain or artificial watering, slips of the cane, containing one or two joints, are planted in rows about four feet from row to row, and eighteen inches asunder in the rows. When they have grown to the height of two or three inches, the earth round them is loosened. In August small trenches are cut through the field to drain off the rain, if the season proves too rainy, and to water the plants if the season proves too dry. From three to six canes spring from each slip set. When they are about three feet high, the lower leaves of each cane are carefully wrapt round it; and then the whole belonging to each slip are tied to a strong bamboo eight or ten feet high, and stuck into the earth in the middle of them. They are cut in January and February, about 9 months after the time of planting. They have now reached the height of eight or ten feet, and the naked cane is from an inch to an inch and a quarter in diameter. They have not flowered. When this happens, the juice loses much of its sweetness. The canes are now put through the rollers of a mill, and their juice collected into large iron boilers; where it is boiled down smartly to a proper consistence, the scum being carelessly taken off. The fire is then withdrawn, and the liquid by cooling becomes thick. It is then stirred about with sticks till it begins to take the form of sugar; when it is put in mats made of the leaves of the palmira-tree (borassus flabelliformis), and the stirring continued till it is cold. This process yields a raw or powdered sugar; but it is clammy, and apt to attract moisture from the atmosphere, because the acids in the juice have not been removed. By the addition of quicklime to the juice, in the proportion of about three spoonfuls to every 14 gallons, the sugar loses this property. The impure sugar prepared by this method is called jagary. Every three quarts of juice, or every six pounds, yields about one pound of sugar. From an acre of ground about 5000 pounds of sugar, and consequently about 30,000 pounds of juice, are obtained.

2. In the West India islands the raising of sugar is much more expensive, and the produce much less, owing to the high price of labour; or, which is the same thing, to the nature of the labourers, and to the inferiority of the soil. The juice is put into large boilers, mixed with quicklime, and boiled to a proper consistency; the scum in the mean time being carefully taken off. When it ceases to be ropy, it is drawn off into another vessel, where it is allowed to concrete, and the liquid and impure part called molasses to separate from it. The more completely this separation is allowed to be, the finer is the sugar. The sugar thus obtained is in small hard grains of a brownish-white colour, and is imported to Europe under the name of raw sugar.

3. In North America the farmers procure sugar for their own use by a still simpler pro-

cess, from the sap of the acer saccharinum, or sugar maple-tree, which abounds in the woods. (See Acer.) Every forty pounds of sap yields about a pound of sugar; so that it is not one sixth so rich as the East India sugar-cane.

The sap ought never to be kept longer than twenty-four hours after it is procured from the tree. It is improved by straining through a cloth. It is put into large flat kettles, mixed usually with quicklime, white of egg, and new milk. A spoonful of slacked lime, the white of one egg, and a pint of new milk, are sufficient for fifteen gallons of sap. A little butter is added to prevent the sap from boiling over. When boiled down sufficiently, it is allowed to grain, or form into small crystals, which constitute raw sugar, and then purified in the usual manner.

4. The raw sugar imported into Europe is still farther purified. It is dissolved in water, mixed with lime, clarified by means of bullock's blood, boiled down to a proper consistency, skimming off the impurities as they rise to the top, and then poured into unglazed conical earthen vessels, where it is allowed to grain. The point of the cone is undermost, and perforated to allow the impurities to separate. The base of the cone is covered with moist clay; the water of which gradually filtres through the sugar, and displaces a quantity of impure liquid. The sugar thus purified is called loaf-sugar. When redissolved, and treated in the same way a second time, it it called refined sugar.

5. Sugar, thus procured, has a very strong sweet taste. When pure it has no smell. Its colour is white; and when crystallized it is somewhat transparent. It has often a considerable degree of hardness: but it is always so brittle that it can be reduced without difficulty to a very fine powder. When two pieces of sugar are rubbed against each other in the dark, a strong phosphorescence is visible.

Sugar is not altered by exposure to the atmosphere, excepting only that in damp air it absorbs a little moisture.

It is exceedingly soluble in water. At the temperature of 48°, water, according to Mr. Wenzel, dissolves its own weight of sugar. The solvent power of water increases with its temperature; when nearly at the boiling point, it is capable of dissolving any quantity of sugar whatever. Water thus saturated with sugar is known by the name of syrup.

Syrup is thick, ropy, and very adhesive; when spread thin upon paper it soon dries, and forms a kind of varnish, which is easily removed by water. Its specific caloric, according to the experiments of Dr. Crawford, is 1.086. When syrup is sufficiently concentrated, the sugar which it contains precipitates in crystals. The primitive form of these crystals is a four-sided prism, whose base is a rhomb, the length of which is to its breadth as 10 to 7; and whose height is a mean proportion between length and breadth of the base. The crystals are usually four or six-sided prisms, terminated by two-sided, and sometimes by three-sided summits. The specific gravity of sugar is 1.4045.

When heat is applied to sugar it melts, swells, becomes brownish black, emits air-bubbles, and exhales a peculiar smell, known in French by the name of caromel. At a red heat it instantly bursts into flames with a kind of explosion. The colour of the flame is white with blue edges.

6. Sugar, as far as is known, is not acted upon by oxygen gas. The effect of the simple combustibles on it has not been tried; but it does not appear to be great. Azotic gas or the metals have no sensible actions on it.

The lower compartment of Plate Saw-mill, &c. represents a mill for squeezing the juice from the sugar-canes. ABDE is a strong frame of wood, the lower part D of which is a large block: the upper surface of this is cut out into a bason, to collect and receive the juice of the canes; which is expressed by the three rollers FGH, whose lower pivots work in sockets in the block D, and the upper sockets are fixed in the beam E. The sockets of the middle roller are fixed firmly in the beams D and E. The sockets of the other two are held between two wedges *ab*, put in in contrary directions, the small end of one wedge being on the same side with the large end of the other. By this means the rollers can always be set nearer together, or farther from each other. When it is wanted to set the outside rollers nearer the middle roller, drive out that wedge which is nearest the middle roller, and drive the other in; and the contrary when they are wanted farther apart. The rollers are usually of cast iron, and each has a cog-wheel, as I, on its upper end, which causes them all to turn together, the power of the first mover being applied to the middle one by a shaft K.

When the machine is at work, a man stands on each side of it. The one in the front takes the canes, and puts them in between the rollers FG, which, as they turn, draw the canes through, and express their juice. The man behind them directs the ends of the canes back between the rollers GH, which are somewhat nearer together than the others; and as they come through, a third man carries them away. The juice runs down the rollers into the reservoir, and is conveyed by the trough L to the boiling-house. It must be observed, that the reservoir in the top of the block D must be only cut in channels round the outside of the rollers; being left the full height near the centres, to prevent the liquor running down, and getting out between the wedges *ab*.

When a sugar-mill is worked by wind, the shaft K is connected with the vertical shaft of the mill. If by horses, the levers they work from are fixed to the shaft K; and either the horse-walk is raised above ground higher than the trough L, or the juice is conveyed by a pipe laid under the walk.

Sugar-mills that are worked by a water-wheel, or steam-engine, have a bevelled wheel fixed upon the shaft K, and another upon the wheel or engine shaft which turns it.

The earths proper do not seem to have any action whatever on sugar; but the alkaline earths unite with it. When lime is added to a solution of sugar in water, and the mixture boiled for some time, a combination takes place. The liquid still indeed retains its sweet taste; but it has acquired also a bitter and astringent one. A little alcohol added to the solution produced a precipitate in white flakes, which appeared to be a compound of sugar and lime. Sulphuric acid precipitated the lime in the state of sulphat, and restored the original taste of the sugar. When the compound of sugar and lime was evaporated to dryness, a semitransparent tenacious syrup remained which had a rough bitter taste, with a certain degree of sweetness.

The fixed alkalies combine with sugar, and form compounds, not unlike that which has been just described. Potass destroys the sweet taste of syrup more completely than lime; but when it is neutralized by sulphuric acid, and the sulphat precipitated by alcohol, the sweet taste is completely restored. When alcohol is agitated with the compound of sugar and potass dissolved in water, it refuses to unite with it, but swims on the top in a state of purity.

The acids are capable of dissolving sugar, and those which are concentrated decompose it. Sulphuric acid very soon acts upon it; water is formed, and perhaps also acetic acid; while charcoal is evolved in great abundance, and gives the mixture a black colour, and a considerable degree of consistency. The charcoal may be easily separated by dilution and filtration. When heat is applied, the sulphuric acid is rapidly converted into sulphureous acid.

Nitric acid dissolves it with an effervescence, occasioned by the evolution of nitrous gas, and converts it into malic and oxalic acids. 480 grains of sugar, treated with six ounces of nitric acid diluted with its own weight of water, and cautiously heated, separating the crystals as they formed, yielded 280 grains of oxalic acid; so that 100 parts of sugar yield by this treatment 58 parts of oxalic acid. When liquid oxymuriatic acid is poured upon sugar in powder, it is dissolved, and immediately converted into malic acid; and the oxymuriatic acid is converted into common muriatic acid.

Sugar absorbs muriatic acid gas slowly, and assumes a brown colour and very strong smell. The vegetable acids dissolve it; but seemingly without producing any alteration on it.

The action of the oxides of carbon and azote upon sugar has scarcely been examined.

Sugar is soluble in alcohol, but not in so large a proportion as in water. According to Wenzel, four parts of boiling alcohol dissolve one of sugar. It unites readily with oils, and renders them miscible with water. A moderate quantity of it prevents, or at least retards, the coagulation of milk; but Scheele discovered that a very large quantity of sugar causes milk to coagulate.

The hydrosulphurets, sulphurets, and phosphurets of alkalies and alkaline earths, seem to have the property of decomposing sugar, and of bringing it to a state not very different from that of gum. Mr. Cruickshank introduced a quantity of syrup into a jar standing over mercury, and then added about an equal quantity of phosphuret of lime. Phosphureted hydrogen gas was immediately extricated. In eight days the syrup was withdrawn: it had lost its sweet taste, and acquired a bitter and astringent one (the taste of phosphuret of lime). From this solution alcohol threw down white flakes, very much resembling those of mucilage separated from water by the same liquid. A little sugar was dissolved in alcohol, and phosphuret of lime added to it. No apparent action took place. The mixture, after standing in the open air for some days, was evaporated, and water added. No gas was disengaged, as the phosphuret had been converted into a phosphat. The liquid being filtred and evaporated, a tenacious substance remained, much resembling gum arabic. Its taste was bitter, with a slight degree of sweetness. It did not seem soluble in alcohol. It burned like gum.

7. When sugar is distilled in a retort, there comes over a fluid which at first scarcely differs from pure water; soon it is mixed with what was formerly called pyromucous acid, and is now known to be a compound of oil and acetic acid; afterwards some empyreumatic oil makes its appearance, and a bulky charcoal remains in the retort. This charcoal very frequently contains lime, because lime is used in refining sugar; but if the sugar, before being submitted to distillation, is dissolved in water, and made to crystallize by evaporation in a temperature scarcely higher than that of the atmosphere, no lime whatever, nor any thing else, except pure charcoal, will be found in the retort. During the distillation, there comes over a considerable quantity of carbonic acid and carbureted hydrogen gas. Sugar therefore is decomposed by the action of heat; and the following compounds are formed from it: water, acetic acid, oil, charcoal, carbonic acid, carbureted hydrogen gas. The quantity of oil in a separate state is inconsiderable; by far the most abundant product is pyromucous acid. Sugar indeed is very readily converted into pyromucous acid; for it makes its appearance always whenever syrup is raised to the boiling temperature. Hence the smell of caromel which syrup at that temperature emits. Hence also the reason, that, when we attempt to crystallize syrup by heat, there always remains behind a quantity of incrystallizable matter, known by the name of molasses: whereas if the syrup is crystallized without artificial heat, every particle of sugar may be obtained from it in a crystalline form. Hence we see the importance of properly regulating the fire during the crystallization of the sugar, and the saving that would probably result from conducting the operation at a low heat.

We are indebted to Mr. Cruikshank for the most precise set of experiments on the decomposition of sugar by heat. 480 grains of pure sugar were introduced into a coated retort, and heated gradually to redness. The products were

Pyromucous acid with a drop or two of oil	270	grains
Charcoal	120	
Carbureted hydrogen, and carbonic acid gas	90	
	480	

The pyromucous acid required about 75 grains of a solution of potass to saturate it; and when thus neutralized, no ammonia was disengaged. Hence sugar contains no azote, unless we suppose a very minute portion to be present in the pyromucous acid; and even this is not likely. The charcoal burns away without leaving any residue. Hence sugar contains no earth nor fixed alkali. The proportion of the gaseous products was 119 ounce-measures of carbureted hydrogen, and 41 ounce-measures of carbonic acid gas. The carbureted hydrogen, according to the experiments of Cruikshank, was composed of five parts carbon and one hydrogen.

These experiments are sufficient to shew us, that sugar is composed entirely of oxygen, carbon, and hydrogen. It is of course a vegetable oxide. Lavoisier has concluded, from a series of experiments on the vinous fermentation, that these substances enter into the composition of sugar in the following proportions:

64	oxygen
28	carbon
8	hydrogen
100.	

But these proportions can only be considered as very distant approximations to the truth.

8. From the experiments of different chemists, especially of Proust and Gottling, it appears that there are different species of sugar found ready-prepared in the vegetable kingdom; distinguished from each other by the figure of their crystals, and other variations in their properties. The species hitherto examined are three in number, namely, common sugar, sugar of grapes, and sugar of beet. As far as is known at present, there is no difference between the sugar of the maple and common sugar.

9. That grapes contain abundance of sugar has been long known. The Duc de Boullion first extracted it from the juice of grapes, and Proust pointed out the difference between it and common sugar. The juice of grapes, according to him, yielded from 30 to 40 per cent. of this sugar.

10. Margraf discovered sugar in the root of the beta vulgaris; but it is to Achard that we are indebted for the first attempts to extract it from that plant in a large way. The experiments of that philosopher, of Lampadius, of the committee appointed by the national institute, and of Goettling, have thrown more light on this interesting subject. The method which succeeded best with Achard, was to boil the beet-roots (deprived of the heart) till they became so soft as to be easily pierced by a straw. They are then cut into slices, and the juice forced out by pressure. What remains is left for twelve hours in water, and the whole subjected to the press a second time. The liquids thus obtained are filtered through flannel, boiled down to two-thirds, filtered a second time, reduced by boiling to one-third of the original liquid, filtered a third time, and then evaporated to the consistence of syrup. The crystalline crust which forms on the surface is to be broken from time to time, and the spontaneous evaporation continued till the surface becomes covered with a tough coat instead of crystals. The whole is then to be thrown into woollen bags, and the mucilaginous liquid separated from the crystals by pressure.

The sugar obtained by these processes, has much the appearance of raw sugar; but it may be refined by the common processes, and brought into the state of common sugar. From the experiments of Goettling, it appears that beet-sugar is distinguished by a certain degree of a nauseous bitter taste; owing, it is supposed, to the presence of a bitter extractive matter, which Lampadius has shewn to be one of the constituents of the beet.

11. The plants containing sugar are very numerous. The following are the chief of those from which it has been actually extracted by chemists:

The sap of the acer saccharinum,
——— betula alba,
——— asclepias syriaca,
——— heraclium sphondilium,
——— cocos nucifera,
——— juglans alba,
——— agave Americana,
——— fucus saccharinus,
——— ficus carica,
The juice of arundo saccharifera,
——— zea mays,
The roots of pastinaca sativa,
——— sium sisarum,
——— beta vulgaris and cicla,
——— daucus carota,
——— apium petroselinum.

Parmentier has also ascertained, that the grains of wheat, barley, &c. and all the other similar seeds which are used as food, contain at first a large quantity of sugar, which gradually disappears as they approach to a state of maturity. This is the case also with peas and beans, and all leguminous seeds: and is one reason why the flavour of young peas is so much superior to that of old ones.

SUIT, in law, is used in different senses, as, 1. Suit personal. 2. Suit of court, or suit service, is an attendance that tenants owe to the court of their lord. 3. Suit covenant, is where the ancestor has covenanted with another, to sue to his court. 4. Suit custom, when a man and his ancestors have been seized time out of mind, of his suit. 5. Suit real, or regal, when men come to the sheriff 's torn or leet. 6. Suit signifies the following one in chase, as fresh suit. 7. It signifies a petition made to the king or any great person. Cowel.

SUKOTYRO, a genus of quadrupeds of the order bruta; the generic character, horn on each side near the eyes. There is but a single species, viz. the indicus: mane upright, short, narrow, reaching from the top of the head to the rump. It inhabits Java, and feeds on herbs.

SULPHATS, salts formed with the sulphuric acid, which see.

SULPHITES, salts formed with the sulphurous acid, which see.

SULPHUR, distinguished also in English by the name of brimstone, was known in the earliest ages. As it is found native in many parts of the world, it could not fail very soon to attract the attention of mankind. It was used by the anticnts in medicine, and its fumes were employed in bleaching wool. See Pliny, Lib. xxxv. c. 15.

1. Sulphur is a hard brittle substance, commonly of a yellow colour, without any smell, and of a weak though perceptible taste.

It is a non-conductor of electricity, and of course becomes electric by friction. Its specific gravity is 1.990.

Sulphur undergoes no change by being allowed to remain exposed to the open air. When thrown into water, it does not melt as common salt does, but falls to the bottom, and remains there unchanged. It is therefore insoluble in water.

2. If a considerable piece of sulphur is exposed to a sudden though gentle heat, by holding it in the hand, for instance, it breaks to pieces with a crackling noise.

When sulphur is heated to the temperature of about 170°, it rises up in the form of a fine powder, which may easily be collected in a proper vessel. This powder is called flowers of sulphur. When substances fly off in this manner on the application of a moderate heat, they are called volatile; and the process itself, by which they are raised, is called volatilization.

When heated to the temperature of 212° of Fahrenheit's thermometer, it melts and becomes as liquid as water. If this experiment is made in a thin glass vessel, of an egg shape, and having a narrow mouth, the vessel may be placed upon burning coals without much risk of breaking it. The strong heat soon causes the sulphur to boil, and converts it into a brown-coloured vapour, which fills the vessel, and issues with considerable force out from its mouth.

3. Sulphur is capable of crystallizing, if it is melted, and as soon as its surface begins to congeal, and the liquid sulphur beneath is poured out, the internal cavity will exhibit long needle-shaped crystals of an octahedral figure. This method of crystallizing sulphur was contrived by Rouelle. If the experiment is made in a glass vessel, or upon a flat plate of iron, the crystals will be perceived beginning to shoot when the temperature sinks to 220°.

4. If sulphur is kept melted in an open vessel, it becomes gradually thick and viscid. When in this state, if it is poured into a bason of water, it will be found to be of a red colour, and as soft as wax. In this state it is employed to take off impressions from seals and medals. These casts are known in this country by the name of sulphurs. When exposed to the air for a few days, the sulphur soon recovers its original brittleness, but it retains its red colour. It is supposed at present, that sulphur, rendered viscid and red by long fusion, has combined with a little oxygen. It is therefore no longer pure sulphur, but a compound of sulphur and oxygen. Mr. Fourcroy has given it, when in this state, the name of oxide of sulphur.

5. When sulphur is heated to the temperature of 560° in the open air, it takes fire spontaneously, and burns with a pale blue flame, and at the same time emits a great quantity of fumes of a very strong suffocating odour. When set on fire and then plunged into a jar full of oxygen gas, it burns with a bright reddish white flame, and at the same time emits a vast quantity of fumes. If the heat is continued long enough, the sulphur burns all away without leaving any ashes or residuum. If the fumes are collected, they are found to consist entirely of sulphuric acid. By combustion, then, sulphur is converted into an acid.

The combustion of sulphur, in fact, is nothing else than the act of its combination with oxygen; and for any thing which we know to the contrary, it is a simple substance.

6. The affinities of sulphur, according to Bergman, are as follows:

Fixed Alkalies.

Iron,	Antimony,
Copper,	Mercury,
Tin,	Arsenic,
Lead,	Molybdenum,
Silver,	Bismuth.

SULPHURETS are combinations of alkalies or metals with sulphur.

SULPHURIC ACID is generally procured by burning a mixture of sulphur and nitre in chambers lined with lead. The theory of this process requires no explanation. The nitre supplies a quantity of oxygen to the sulphur, and the air of the atmosphere furnishes the rest. The acid thus obtained is not quite pure, containing a little potass, some lead, and perhaps also nitric and sulphurous acids. At first it is very weak, being diluted with the water necessary for condensing it; but it is made stronger by distilling off a portion of this water. By this process it is made quite transparent; but it still contains a little lead, which it dissolved from the vessels in which it was manufactured, and a little potass which it acquired from the nitre employed in burning the sulphur. To obtain it in a state of complete purity, the sulphuric acid of commerce must be distilled. This is easily done by putting it into a small retort with a long beak. The bottom of the retort is placed upon a fire of charcoal, and fixed steady by means of an iron ring; while its beak is plunged half-way into a receiver, whose mouth it fits nearly, but not exactly. The acid soon boils, and is gradually condensed in the receiver. Too great a quantity should not be distilled at once, otherwise the retort generally breaks in consequence of the violent agitation into which the boiling acid is thrown.

Sulphuric acid is a liquid somewhat of an oily consistence, transparent and colourless as water, without any smell, and of a very strong acid taste. When applied to animal or vegetable substances, it very soon destroys their texture.

It always contains a quantity of water; part of which, however, may be driven off by the application of a moderate heat. This is called concentrating the acid. When as much concentrated as possible, its specific gravity is said to be 2.000; but it can seldom be obtained denser than 1.85.

It changes all vegetable blues to a red except indigo. According to Erxleben, it boils at 546°; according to Bergman, at 540°.

When exposed to a sufficient degree of cold, it crystallizes or freezes; and after this has once taken place, it freezes again by the application of a much inferior cold. Sulphuric acid has a very strong attraction for water.

Mr. Lavoisier attempted to ascertain the proportion of the constituents of this acid, by measuring the quantity of oxygen absorbed by a given weight of sulphur during its combustion. His result was 71 parts of sulphur, and 29 of oxygen. But this method was not susceptible of sufficient precision to warrant much confidence. Mr. Thenard had recourse to a much better method, which was employed still more lately for the same purpose by Mr. Chenevix with much address. Nitric acid was distilled off 100 parts of pure sulphur repeatedly, till the whole sulphur was converted into an acid. The sulphuric acid, thus formed, was separated by means of barytes, with which it forms an insoluble compound. The 100 parts of sulphur, thus acidified, yielded 694 parts of dry sulphat of barytes. Hence 100 parts of sulphat of barytes contain 14.5 parts of sulphur. By another set of experiments, to be described hereafter, Mr. Chenevix ascertained, that 100 parts of sulphat of barytes contain 23.5 parts of sulphuric acid. Hence it follows that 23.5 parts of sulphuric acid contain 14.5 of sulphat; the remaining 9 parts must be oxygen. Therefore sulphuric acid is composed of 14.5 parts of sulphur and 9 of oxygen; or, which is the same thing, of

61.5	sulphur
38.5	oxygen
100.0	

Sulphuric acid is not altered by the action of light nor caloric. It does not combine with oxygen. It was affirmed, indeed, by some chemists, that sulphuric acid might be combined with oxygen by distilling it off the black oxide of manganese; but the assertion was refuted by the experiments of Vauquelin.

None of the simple combustibles act upon it at the usual temperature of the atmosphere, or at least, their action is so slow as not to be perceptible. But when they are assisted by heat, they are all capable of decomposing it.

When sulphur is boiled in this acid, it absorbs a portion of its oxygen, or at least combines with it, and the whole is converted into sulphurous acid. Phosphorus also absorbs oxygen from it by the assistance of heat, sulphurous acid is driven off, and phosphoric acid formed. At the boiling temperature charcoal also absorbs oxygen from it, and converts it into sulphurous acid. At a red heat it even converts it into sulphur. When hydrogen gas and sulphuric acid are made to pass together through a red-hot tube of porcelain, the acid is completely decomposed, water is formed, and sulphur deposited.

Azote has no action on sulphuric acid; but this acid readily absorbs muriatic acid, and forms with it a liquid of a brownish tinge, which emits the dense and suffocating odour of muriatic acid, and corrodes vegetable and even metallic bodies near which it happens to be placed.

When zinc or iron is thrown into sulphuric acid, a violent action takes place, if the acid is diluted; water is decomposed, its hydrogen flies off, and its oxygen combines with the metals. If the acid is concentrated, the action is much less violent, and sulphurous acid exhales. Upon tin and copper the acid acts very slowly and feebly, unless its action is assisted by heat, when it oxidizes and dissolves them. On silver, mercury, antimony, bismuth, arsenic, and tellurium, it does not act except at pretty high temperatures. These metals abstract part of its oxygen, and convert one portion of it into sulphurous acid, while another portion combines with the oxides thus formed. When boiling-hot it oxidizes lead, and dissolves cobalt, nickel, and molybdenum: but it has no perceptible action on gold or platinum at any temperature to which it can be raised.

It unites readily with all the alkalies and earths except silica, and with most of the metallic oxides, and forms salts denominated sulphats. Thus the combination of sulphuric acid and soda is called sulphat of soda; the compound of sulphuric acid and lime, sulphat of lime, &c.

It absorbs a very considerable quantity of nitrous gas, and acquires by that means a purplish colour.

Its affinities are as follows:

Barytes,	Ammonia,
Strontian,	Glucina,
Potass,	Yttria,
Soda,	Alumina,
Lime,	Zirconia,
Magnesia,	Metallic oxides.

This is one of the most important of all the acids, not only to the chemist but to the manufacturer also; being employed to a very great extent in a variety of manufactures, especially in dyeing.

Sulphurous acid. Though some of the properties of this acid must have been known in the remotest ages, as it is always formed during the slow combustion of sulphur, Stahl was the first chemist who examined it, and pointed out its peculiar nature. His method of procuring it was to burn sulphur at a low temperature, and expose to its flames cloth dipped in a solution of potass. By this method he obtained a combination of potass and sulphurous acid; for at a low temperature sulphur forms by combustion only sulphurous acid. Scheele pointed out, in 1771, a method of procuring sulphurons acid in quantities. Dr. Priestley, in 1774, obtained it in the gaseous form, and examined its properties while in a state of purity.

1. Sulphurous acid may be procured by the following process: Put into a glass retort two parts of sulphuric acid and one part of mercury, and apply the heat of a lamp; the mixture effervesces, and a gas issues from the beak of the retort, and may be received in glass jars filled with mercury, and standing in a mercurial trough. This gas is sulphurous acid.

2. Sulphurous acid, in the state of gas, is colourless and invisible like common air. It is incapable of maintaining combustion; nor can animals breathe it without death. It has a strong and suffocating odour, precisely the same with that exhaled by sulphur burning with a blue flame: sulphur, by such a combustion, being totally converted into a sulphurous acid. Its specific gravity, according to Bergman, is 0.00246; according to Lavoisier, 0.00251. It is therefore somewhat more than twice as heavy as air. One hundred cubic inches of it weigh nearly 63 grains.

3. This acid reddens vegetable blues, and gradually destroys the greater number of them. It exercises this power on a great variety of vegetable and animal colours. Hence the use of the fumes of sulphur in bleaching wool and in whitening linen stained by means of fruits.

4. Dr. Priestley discovered, that when a strong heat is applied to this acid in close vessels, a quantity of sulphur is precipitated, and the acid is converted into sulphuric. Berthollet obtained the same result; but Fourcroy and Vauquelin could not succeed.

5. Water absorbs this acid with avidity. According to Dr. Priestley, 1000 grains of water, at the temperature 54.5°, absorb 39.6 grains of this acid. Fourcroy, on the other hand, affirms that water at 40° absorbs the third of its weight of sulphurous acid gas. Ice absorbs this gas very rapidly, and is instantly melted. Water saturated with this gas, in which state it is known by the name of liquid sulphurous acid, or sulphurous acid, is of the specific gravity 1.040. It may be frozen without parting with any of the acid gas. When water, which has been saturated with this acid at the freezing temperature, is exposed to the heat of 65.25°, it is filled with a vast number of bubbles, which continually increase and rise to the surface. These bubbles are a part of the acid separating from it. It freezes a few degrees below 32°.

6. When liquid sulphurous acid is exposed to atmospheric air or to oxygen gas, it gradually combines with oxygen, and is converted into sulphuric acid. This change takes place more completely if the acid is combined with an alkali or earth. When a mixture of sulphurous acid gas and oxygen gas is made to pass through a red-hot porcelain tube, the two bodies combine, and sulphuric acid is formed.

7. Of the simple combustibles, sulphur and phosphorus have no action on it whatever; hydrogen gas and charcoal do not alter it while cold, but at a red-heat they decompose it completely; water or carbonic acid is formed, and sulphur deposited.

8. Neither azote nor muriatic acid produces any change on it.

9. Sulphurous acid does not seem capable of oxidizing or dissolving any of the metals except iron, zinc, and manganese.

10. It combines with alkalies, earths, and metallic oxides, and forms salts known by the name of sulphites.

11. Sulphuric acid absorbs this gas in considerable quantity. It acquires a yellowish-brown colour, a penetrating odour, and the property of smoking when exposed to the air. When this mixture is distilled, the first vapour which comes over, and which is a compound of the two acids, crystallizes in long white prisms. This singular compound, formerly known by the name of glacial sulphuric acid, smokes in the air; and when the atmosphere is moist, melts with effervescence. When thrown into water, it hisses like a red iron. It has the odour of sulphurous acid. Fourcroy has lately demonstrated, that this is a compound of sulphuric and sulphurous acids.

12. The affinities of sulphurous acid, as far as they have been investigated, are as follow:

Barytes,	Magnesia, }
Lime,	Ammonia, }
Potass,	Glucina,
Soda,	Alumina,
Strontian,	Zirconia.

13. As this acid is formed by the combustion of sulphur, it cannot be doubted that it is composed of the same ingredients with sulphuric acid; and as it is evolved from sulphuric acid by the action of sulphur, and likewise by some of the metals, it cannot be doubted that it contains a smaller proportion of oxygen. But no precise set of experiments has yet been made to determine the proportion of its component parts. Fourcroy affirms that it contains

85 sulphur
15 oxygen
———
100.

But he does not inform us upon what evidence he assigns these proportions.

SUM, in mathematics, signifies the quantity that arises from the addition of two or more magnitudes, numbers, or quantities together.

The sum of an equation is, when the absolute number being brought over to the other side of the equation, with a contrary sign, the whole becomes equal to 0; thus, the sum of the equation $x^3 - 12x^2 + 41x = 42$, is $x^3 - 12x^2 + 41x - 42 = 0$. See Algebra, and Arithmetic.

SUMACH. See Rhus.

SUN. See Astronomy.

SUNDAY. See Lord's Day.

SUPERCARGO, a person employed by merchants to go a voyage, and oversee their cargo, or lading, and dispose of it to the best advantage.

SUPERFICIES, or Surface. See Geometry.

SUPERSEDEAS, a writ that lies in a great many cases, and signifies in general, a command to stay proceedings, on good cause shewn, which ought otherwise to proceed. By a supersedeas, the doing of a thing, which might otherwise have been lawfully done, is prevented; or a thing that has been done, is (notwithstanding it was done in a due course of law) thereby made void. 4 Bac. Abr. 667.

A supersedeas is either expressed or implied; an express supersedeas is sometimes by writ, sometimes without a writ; where it is by writ, some person to whom the writ is directed, is thereby commanded to forbear the doing something therein mentioned; or if the thing has been already done, to revoke, as that can be done, the act. 4 Bac. Abr. 667.

SUPER STATUTO de articulis cleri, in law, a writ that lies against the sheriff, or other officer that distrains in the king's highway, or in the lands antiently given to the church.

Super statuto facto pour seneschal et marshal de roy, &c. a writ which lies against the steward or marshal, for holding plea of freehold in his court, or for trespass, or contracts not made within the king's household.

SUPPLIES, the sums granted by parliament for defraying the public expenditure for the current year. The known or probable amount of the different branches of the year's expences, is stated to the house of commons in a committee of supply, by the chancellor of the exchequer; and after they have been voted by the committee, are formally granted by an act of parliament. The granting of the annual supplies as well as permanent taxes, is a peculiar privilege of the house of commons, who never permit any alteration or amendment to be made by the lords, in the bills passed for this purpose.

The grants of parliament were originally considered, merely as temporary aids, to assist the sovereign in defraying such extraordinary expences as he was subject to for the benefit of the public; and unless the commons happened to entertain at the time, any particular jealousy of the crown and its ministers, the sum granted was commonly left entirely to their disposal. But after the restoration of Charles II., not only more frequent grants were demanded, but, in consequence of the property to which the crown was reduced, parliamentary grants had become really necessary almost every year. It was impossible, however, for the parliament, distrusting not only Charles's economy, but his regard for the interest of his kingdoms, to vest considerable sums of money in such unsafe and improvident hands: it was, therefore, thought requisite to specify the purposes for which each sum was voted. Thus appropriating clauses came to be introduced, which practice has continued ever since; and at the commencement of each session, an account is presented of the disposition of the grants of the preceding session, shewing how much has been actually paid on each branch of the public service, what remains unpaid of the sums appropriated, with the funds for discharging the same, and the surplus or deficiency of the ways and means.

The supplies annually voted do not include the interest and charges of the national debt, the civil list, and some other articles which are provided for as permanent charges on the consolidated fund; but merely the expences of the army, navy, ordnance, and such miscellaneous services as are granted from year to year.

SUPPORTERS. See HERALDRY.

SUPPRESSION. See MEDICINE.

SUPREMACY, in our polity, the superiority or sovereignty of the king over the church as well as state, whereof he is established head. The king's supremacy was at first established, or, as others say, recovered, by king Henry VIII. in 1534, after breaking with the pope. It is since confirmed by several canons, as well as by the articles of the church, and is passed into an oath which is required as a necessary qualification for all offices and employments both in church and state, from persons to be ordained, from the members of both houses of parliament, &c.

SURA. See ANATOMY.

SURD, in arithmetic and algebra, denotes any number or quantity that is incommensurable to unity: otherwise called an irrational number or quantity.

The square roots of all numbers, except 1, 4, 9, 16, 25, 36, 49, 64, 81, 100, 121, 144, &c. (which are the squares of the integer numbers, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, &c.) are incommensurables: and after the same manner the cube roots of all numbers but of the cubes of 1, 2, 3, 4, 5, 6, &c. are incommensurables: and quantities that are to one another in the proportion of such numbers, must also have their square-roots, or cube-roots, incommensurable.

The roots, therefore, of such numbers, being incommensurable, are expressed by placing the proper radical sign over them: thus $\sqrt[2]{2}$, $\sqrt[2]{3}$, $\sqrt[2]{5}$, $\sqrt[2]{6}$ &c. express numbers incommensurable with unity. However, though these numbers are incommensurable themselves with unity, yet they are commensurable in power with it; because their powers are integers, that is, multiples of unity. They may also be commensurable sometimes with one another, as the $\sqrt[2]{8}$, and $\sqrt[2]{2}$; because they are to one another as 2 to 1: and when they have a common measure, as $\sqrt[2]{2}$ is the common measure of both, then their ratio is reduced to an expression in the least terms, as that of commensurable quantities, by dividing them by their greatest common measure. This common measure is found as in commensurable quantities, only the root of the common measure is to be made their common divisor: thus $\frac{\sqrt{12}}{\sqrt{3}} = \sqrt{4} = 2$, and $\frac{\sqrt{18a}}{\sqrt{2}} = 3\sqrt{a}$.

A rational quantity may be reduced to the form of any given surd, by raising the quantity to the power that is denominated by the name of the surd, and then setting the radical sign over it; thus

$a = \sqrt[2]{a^2} = \sqrt[3]{a^3} = \sqrt[4]{a^4} = \sqrt[5]{a^5} = \sqrt[n]{a^n}$, and $4 = \sqrt{16} = \sqrt[3]{64} = \sqrt[4]{256} = \sqrt[5]{1024} = \sqrt[n]{4^n}$.

As surds may be considered as powers with fractional exponents, they are reduced to others of the same value that shall have the same radical sign, by reducing these fractional exponents to fractions having the same value and a common denominator. Thus $\sqrt[n]{a} = a^{\frac{1}{n}}$, and $\sqrt[m]{a} = a^{\frac{1}{m}}$, and $\frac{1}{n} = \frac{m}{nm}$, $\frac{1}{m} = \frac{n}{nm}$; and therefore, $\sqrt[n]{a}$ and $\sqrt[m]{a}$, reduced to the same radical sign, become $\sqrt[nm]{a^m}$ and $\sqrt[nm]{a^n}$. If you are to reduce $\sqrt[2]{3}$ and $\sqrt[3]{2}$ to the same denominator, consider $\sqrt[2]{3}$ as equal to $3^{\frac{1}{2}}$, and $\sqrt[3]{2}$ as equal to $2^{\frac{1}{3}}$, whose indices reduced to a common denominator, you have $3^{\frac{1}{2}} = 3^{\frac{3}{6}}$, and $2^{\frac{1}{3}} = 2^{\frac{2}{6}}$, and, consequently, $\sqrt[2]{3} = \sqrt[6]{3^3} = \sqrt[6]{27}$, and $\sqrt[3]{2} = \sqrt[6]{2^2} = \sqrt[6]{4}$; so that the proposed surds $\sqrt[2]{3}$ and $\sqrt[3]{2}$, are reduced to other equal surds $\sqrt[6]{27}$ and $\sqrt[6]{4}$, having a common radical sign.

Surds of the same rational quantity are multiplied by adding their exponents, and divided by subtracting them; thus, $\sqrt[2]{a} \times \sqrt[3]{a} = a^{\frac{1}{2}} \times a^{\frac{1}{3}} = a^{\frac{3+2}{6}} = a^{\frac{5}{6}} = \sqrt[6]{a^5}$; and $\frac{\sqrt[3]{a}}{\sqrt[5]{a}} = \frac{a^{\frac{1}{3}}}{a^{\frac{1}{5}}} = a^{\frac{1}{3} - \frac{1}{5}} = a^{\frac{5-3}{15}} = a^{\frac{2}{15}} = \sqrt[15]{a^2}$; $\sqrt[m]{a} \times \sqrt[n]{a} = a^{\frac{m+n}{mn}}$; $\frac{\sqrt[m]{a}}{\sqrt[n]{a}} = a^{\frac{n-m}{mn}}$; $\sqrt[2]{2} \times \sqrt[3]{2} = \sqrt[6]{2^5} = \sqrt[6]{3^2}$; $\frac{\sqrt[2]{2}}{\sqrt[3]{2}} = \sqrt[6]{2}$.

If the surds are of different rational quantities, as $\sqrt[n]{a^2}$ and $\sqrt[n]{b^3}$, and have the same sign, multiply these rational quantities into one another, or divide them by one another, and set the common radical sign over their product or quotient. Thus, $\sqrt[n]{a^2} \times \sqrt[n]{b^3} = \sqrt[n]{a^2b^3}$; $\sqrt[2]{2} \times \sqrt[2]{5} = \sqrt[2]{10}$; $\frac{\sqrt[m]{a^4}}{\sqrt[m]{b^3a}} = \sqrt[m]{\frac{a^4}{b^3a}} = \sqrt[m]{\frac{a^3}{b^3}}$; $\frac{\sqrt[3]{9}}{\sqrt[3]{24}} = \sqrt[3]{\frac{9}{24}} = \sqrt[3]{\frac{3}{8}} = \frac{1}{2}\sqrt[3]{3}$.

If surds have not the same radical sign, reduce them to such as shall have the same radical sign, and proceed as before; $\sqrt[m]{a} \times \sqrt[n]{b} = \sqrt[nm]{a^n b^m}$; $\frac{\sqrt[m]{a}}{\sqrt[n]{x}} = \sqrt[mn]{\frac{a^n}{x^m}}$; $\sqrt[2]{2} \times \sqrt[3]{4} = 2^{\frac{1}{2}} \times 4^{\frac{1}{3}} = 2^{\frac{3}{6}} \times 4^{\frac{2}{6}} = \sqrt[6]{2^3 \times 4^2} = \sqrt[6]{8 \times 16} = \sqrt[6]{128}$; $\frac{\sqrt[3]{4}}{\sqrt[2]{2}} = \frac{4^{\frac{1}{3}}}{2^{\frac{1}{2}}} = \frac{4^{\frac{2}{6}}}{2^{\frac{3}{6}}} = \sqrt[6]{\frac{4^2}{2^3}} = \sqrt[6]{\frac{16}{8}} = \sqrt[6]{2}$. If the surds have any rational co-efficients, their product or quotient must be prefixed; thus, $2\sqrt[2]{3} \times 5\sqrt[2]{6} = 10\sqrt[2]{18}$. The powers of surds are found as the powers of their quantities, by multiplying their exponents by the index of the power required; thus the square of $\sqrt[3]{2}$ is $2^{\frac{1}{3} \times 2} = 2^{\frac{2}{3}} = \sqrt[2]{4}$; the cube of $\sqrt[2]{5} = 5^{\frac{1}{2} \times 3} = 5^{\frac{3}{2}} = \sqrt[2]{125}$. Or you need only, in involving surds, raise the quantity under the radical sign to the power required, continuing the same radical sign; unless the index of that power is equal to the name of the surd, or a multiple of it, and in that case the power of the surd becomes rational. Evolution is performed by dividing the fraction, which is the exponent of the surd, by the name of the root required. Thus the square root of $\sqrt[3]{a^4}$ is $\sqrt[3]{a^2}$, or $\sqrt[6]{a^4}$.

The surd $\sqrt[m]{a^m x} = a\sqrt[m]{x}$; and, in like manner, if a power of any quantity of the same name with the surd divides the quantity under the radical sign without a remainder, as here a^m divides $a^m x$, and 25 the square of 5 divides 75, the quantity under the sign in $\sqrt[2]{75}$, without a remainder; then place the root of that power rationally before the sign, and the quotient under the sign, and thus the surd will be reduced to a more simple expression. Thus $\sqrt[2]{75} = 5\sqrt{3}$; $\sqrt[2]{48} = \sqrt[2]{3 \times 16} = 4\sqrt[2]{3}$; $\sqrt[3]{81} = \sqrt[3]{27 \times 3} = 3\sqrt[3]{3}$.

When surds are reduced to their least expressions, if they have the same irrational part, they are added or subtracted, by adding or subtracting their rational co-efficients, and prefixing the sum or difference to the common irrational part. Thus,

$\sqrt[2]{75} + \sqrt[2]{48} = 5\sqrt{3} + 4\sqrt{3} = 9\sqrt{3}$;

$\sqrt[3]{81} + \sqrt[3]{24} = 3\sqrt[3]{3} + 2\sqrt[3]{3} = 5\sqrt[3]{3}$;

$\sqrt[2]{150} - \sqrt[2]{54} = 5\sqrt{6} - 3\sqrt{6} = 2\sqrt{6}$;

$\sqrt{a^2x} + \sqrt{b^2x} = a\sqrt{x} + b\sqrt{x} = \overline{a+b} \times \sqrt{x}$.

Compound surds are such as consist of two or more joined together; the simple surds are commensurable in power, and by being multiplied into themselves, give at length rational quantities; yet compound surds multiplied into themselves, commonly give still irrational products. But, when any compound surd is proposed, there is another compound surd which, multiplied into it, gives a rational product. Thus, if $\sqrt{a} + \sqrt{b}$ were proposed, multiplying it by $\sqrt{a} - \sqrt{b}$, the product will be $a - b$.

The investigation of that surd, which, multiplied into the proposed surd, gives a rational product, is made easy by three theorems, delivered by Mr. Maclaurin, in his Algebra, p. 109, seq. to which we refer the curious.

This operation is of use in reducing surd expressions to more simple forms. Thus, suppose a binominal surd divided by another, as $\sqrt[2]{20} + \sqrt[2]{12}$, by $\sqrt[2]{5} - \sqrt[2]{3}$, the quotient might be expressed by $\frac{\sqrt{20} + \sqrt{12}}{\sqrt{5} - \sqrt{3}}$. But this might be expressed in a more simple form, by multiplying both numerator and denominator by that surd which, multiplied into the denominator, gives a rational product: thus,

$$\frac{\sqrt{20}+\sqrt{12}}{\sqrt{5}-\sqrt{3}}=\frac{\sqrt{20}+\sqrt{12}}{\sqrt{5}-\sqrt{3}}\times\frac{\sqrt{5}+\sqrt{3}}{\sqrt{5}+\sqrt{3}}=$$

$$\frac{\sqrt{100}+2\sqrt{60}+6}{5-3}=\frac{16+2\sqrt{60}}{2}=8+$$

$2\sqrt{15}$. To do this generally, see Maclaurin, lib. cit. p. 113.

When the square root of a surd is required, it may be found, nearly, by extracting the root of a rational quantity that approximates to its value. Thus to find the square root of $3+2\sqrt{2}$, first calculate $\sqrt{2}=1{,}41421$. Hence $3+2\sqrt{2}=5{,}82842$, the root of which is found to be nearly 2,41421.

In like manner we may proceed with any other proposed root. And if the index of the root, proposed to be extracted, is great, a table of logarithms may be used. Thus $\sqrt[7]{5+\sqrt[13]{17}}$ may be most conveniently found by logarithms.

Take the logarithm of 17, divide it by 13; find the number corresponding to the quotient; add this number to 5; find the logarithm of the sum, and divide it by 7, and the number corresponding to this quotient will be nearly equal to $\sqrt[7]{5+\sqrt[13]{17}}$.

But it is sometimes requisite to express the roots of surds exactly by other surds. Thus, in the first example, the square root of $3+2\sqrt{2}$ is $1+\sqrt{2}$: for $\overline{1+\sqrt{2}}\times\overline{1+\sqrt{2}}=1+2\sqrt{2}+2=3+2\sqrt{2}$. For the method of performing this, the curious may consult Mr. Maclaurin's Algebra, where also rules for trinomials, &c. may be found.

SURETY, in law, generally signifies the same with bail. See Bail.

SURETY *of the peace*. A justice of the peace may, according to his discretion, bind all those to keep the peace, who in his presence shall make any affray, or shall threaten to kill or beat any person, or shall contend together in hot words; and all those who shall go about with unlawful weapons or attendance to the terror of the people; and all such persons as shall be known by him to be common barrators; and all who shall be brought before him by a constable, for a breach of the peace in the presence of such constable; and all such persons who, having been before bound to keep the peace, shall be convicted of having forfeited their recognizance. Lamb, 77.

When surety of the peace is granted by the court of king's bench, if a supersedeas comes from the court of chancery to the justices of that court, their power is at an end; and the party as to them discharged.

If security of the peace is desired against a peer, the safest way is to apply to the court of chancery, or king's bench. 1 Haw. 127. If the person against whom security of the peace is demanded, is present, the justice of the peace may commit him immediately, unless he offers sureties; and a fortiori he may be commanded to find sureties, and be committed for not doing it. Id.

Surety *of the good behaviour*, includes the peace; and he that is bound to the good behaviour, is therein also bound to the peace; and yet a man may be compelled to find sureties both for the good behaviour and the peace. Dalt. c. 122. See Good Behaviour.

SURFEIT. See Medicine.

SURGERY, is the art of curing or alleviating diseases by local and external applications, manual or instrumental. As a science it may be defined, that department of medicine which treats of maladies thus susceptible of alleviation or cure.

This, like other parts of medicine, must necessarily have been practised in the earliest ages; and the supposition has the authority of history, both sacred and profane, that the whole of the healing art was for some time restricted to the treatment of external injuries; and that consequently, surgery has not merely been coeval with, but antecedent to, the other branches of medical science.

The history, however, of surgery, among the early Asiatics, and even as cultivated and practised by the Greeks, is involved in fable, and obscured by fiction. Hippocrates was in a manner the founder of surgery as of medicine; and it was not indeed until after the time of this author, that the science was divided into separate branches. This division was effected in the time of Ptolemy Philopater, king of Egypt, and has continued with some modifications, but without precise limits, down to the present day.

Among the Romans, Celsus is the first author, in whose writings we meet with any thing of importance in relation to this art. In the works of Celsus, we find a minute statement of all its improvements, from the time of Hippocrates; and by many among even the moderns, an assiduous study of the precepts contained in Celsus, has been earnestly recommended to the student. The Latinity, however, of this medical classic, is greatly preferable to his surgery.

After Celsus, lived the celebrated Galen, whose authority for so long a period influenced the language and practice of physic, and who, although his works are principally medicinal, wrote likewise on surgery. Galen was the last writer of consequence among the Romans.

About the year 500, Aetius added many observations to those of Celsus and Galen. Aetius was succeeded and much excelled by Paulus Egineta, whose surgical writings have been pronounced superior to those of all the other antients; this last author, together with Celsus, were employed as text-books by Fabricius ab Aquapendente, a writer of celebrity in the sixteenth century.

Among the Arabians, Rhazes and Avicenna are the principal writers who treated of surgery. The Canon Medicinæ of the latter, a compilation principally from Galen and Rhazes, was for a number of years held in much estimation. It was not, however, until the time of Albucasis, that surgery was much in repute among the Arabians; and from this period to the 14th century, its history is extremely barren. Even at the commencement of the 16th century, "surgery was held in contempt in this island, and was practised indiscriminately by barbers, farriers, and sow-gelders. Barbers and surgeons continued for 200 years afterwards to be incorporated in one company, both in London and Paris. In Holland and some parts of Germany, even at this day, barbers exercise the razor and lancet alternately."

We find no surgical work worthy of notice in the 16th century, before that of Carpus. A system published by the above-mentioned Fabricius, shortly afterwards attracted much notice, and has been highly commended by Boerhaave; about this time likewise, Ambrose Parée, a French surgeon, made several bold and very important innovations in the art as then practised; one of which, viz. the use of the needle and ligature, for stopping bleeding arteries, in place of the cautery, astringents, styptics, boiling oils, and other cruel and absurd practices of the older surgeons, has been said by one well capable of appreciating its value, to have raised Parée to a rank not inferior even to that of Harvey, the discoverer of the circulation. To the works of Parée may be added those of Maggius and Botallus, writers on gun-shot wounds; and of Cruce, the author of a systematic treatise.

In the succeeding century, surgery made considerable advances. The most conspicuous writers of this period, are Severinus, Vidius, Wiseman, Le Clerc, Scultetus, Mangetus, Spigellius, Hildanus, Bartholin, and Marchett.

In our own times, the science of which we are now to treat, has begun to assert its just claims to an equality with that which is usually denominated the science of medicine. These claims have been vindicated, not less powerfully and successfully by the importance of surgery, than the respectability of its professors.

A mere enumeration, however, of the names and writings of such as have been deservedly celebrated in the present and immediately preceding centuries, would carry us beyond our limits. We shall, therefore, here close this hasty sketch of surgical history, and proceed to discuss the subject of the present article.

Of Wounds. *Their kind, degree, and treatment.*

It ought to be the surgeon's endeavour to familiarize himself with those circumstances which immediately indicate the mortality of a wound; and this aptitude of discrimination is more especially requisite in the practice of the army or navy, where a speedy and irrevocable decision is frequently called for. The mortality of wounds is, indeed, often evident to the most superficial and uninitiated observer; but this is by no means invariably the case: and there are many instances, in which a prompt and accurate judgment respecting their consequences, immediate and remote, can only be formed by habits of reflective observation, grounded on a thorough knowledge of the anatomy, and a general acquaintance with the functions, of the body.

Wounds which penetrate the cavity of the heart; those which cut off the communication of vital organs with the brain, as injuries done to the medulla oblongata, or spinal marrow; of the small vessels which circulate within the brain; of the nerves supplying the heart; of the great receptacle of the chyle, or those which interrupt the course of this fluid to the blood-vessels, such as wounds of the larger lacteals, &c. may easily be admitted to rank with very little exception among mortal wounds; such are from their nature irremediable; others, however, although almost as surely fatal if neglected, may, by speedy and appropriate application, be often remedied; such as wounds of any of the larger blood-vessels, which are situated externally. But it is principally as it relates to wounds of the two great cavities of the chest and belly, that a speedy decision of their nature and tendency requires a knowledge of the anatomy, structure, relative connections, and functions, of the parts concerned; for the sword or the bullet may, by the smallest difference in its direction, occasion instantaneous death; give rise to tedious, intractable, and ultimately fatal diseases; or penetrate and even pass through the body, almost with impunity.

Wounds of the breast and lungs. Extreme difficulty of breathing, coughing up of blood, a discharge of air from its exterior orifice, or the sudden formation of emphysema or windy tumour, &c. are described by authors, among the signs indicating a wound in the lungs' substance. If, together with these symptoms, "the patient is oppressed, tossing, insensible; his face ghastly, and his extremities cold; his condition is doubtful; it looks much like a wound of some vessel near the root of the lungs, and if so, he is surely gone. If the oppression comes on more slowly, the pulse only hurried and fluttering, and the extremities not so cold, there is reason to hope that the wound is merely in the edges of the lungs; and as it is at a distance from the great veins and arteries, he may escape." (J. Bell on Wounds.) If, when the breast is wounded, there is no emphysema, no spitting of blood; none of that oppression in breathing, which proves that the blood is pouring either into the proper air-cells of the lungs, or the cellular texture of these organs, it may be concluded, that the wounding instrument has not passed into the thoracic cavity, but is merely in the external part of the chest. To ascertain whether the suffocative oppression just noticed, proceeds from extravasation of blood into the air-cells, or merely into the thoracic cavity, we are directed, that the finger be thrust into the wound, and some blood let out; which operation, if it is attended with very sensible relief, proves, that the air-cells or proper cavity of the lungs are uninjured; and the danger in this last case, is much less than if these cells had been wounded.

Wounds of the belly. Wounds of the belly are for the most part mortal; and this, when it does not arise from an injury to any of the large viscera or their great blood-vessels, principally depends upon the extreme susceptibility to peritonæal inflammation. "Wounds of the head are deadly, from the oppression of the brain, and there delirium or coma are the deadly signs. Wounds of the breast are fatal by the oppression of the lungs; and there difficult breathing, tossing, coughing of blood, coldness of the extremities, and a faultering, pulse are the mortal signs. Wounds of the abdomen are mortal by the inflammation and gangrene; and the signs of danger are, swelling of the abdomen, intense pain, vomitings, costiveness, hiccup, faintings; then an interval of deceitful ease, which is merely a sign of intellectual gangrene, and of the near approach of death. The wounding instrument, however, may penetrate or pass through the liver or the spleen, and prove mortal in another way beside that of inducing peritonæal inflammation; viz. by occasioning a sudden and copious extravasation of blood, and in these last cases the fatal symptoms present themselves with more rapidity. "In wounds of the liver, there is great inward bleeding: the patient immediately sinks, and faints, languishes in a slumbering state, insensible almost and without pain, lies cold and death-like for perhaps twenty-four hours, and then expires."

When the spleen or vena cava is wounded, the signs and consequences of the internal bleeding are nearly the same as in wounds of the liver. "A wound," says Mr. J. Bell, "of the spleen, liver, or vena cava, is as deadly as a wound of the heart, so full are they of blood." To this rule, however, there are some very few exceptions.

The inward bleedings from smaller vessels, as of the mesentery, the kidney, the emulgent veins, &c. for the most part prove mortal, in the secondary manner above alluded to, viz. by inducing inflammation; in these last instances then, the progress and nature of the symptoms are different. "And here it may be noticed, that if there are immediate fainting on receiving the wound, and then coldness, accompanied with a continued faintness, swelling of the belly, and oppressed breathing, most likely there is blood extravasated, and in dangerous quantity, from some greater vessel; but if the patient has lain easy, and there come pain, swelling, fever, and other threatening signs on the sixth or seventh day, with a tumour in one part of the belly, it is most likely a bloody tumour, which has begun to excite inflammation. If there are pain and swelling on the first or second day, it is from wounded intestine; if there are pain and swelling, but not till the sixth day, it is from blood; if there is no pain nor swelling till after the fifteenth day, our patient is almost safe."

When the stomach is wounded, a burning sensation is experienced at the pit of this organ, then follow heat, thirst, an accelerated pulse, and violent vomiting, which are succeeded by fainting, extreme prostration of the vital powers, an extremely rapid and fluttering pulse, swelling of the abdomen, hiccup, and death.

If the wound is in the intestines, the fæces often escape from the orifice; fever, pain, irritable pulse, swelling of the belly, faintings, mortification, and death, ensue.

We have hitherto spoken of peritonæal inflammation, as occasioned by an extravasation of blood; frequently, however, the irritating cause by which it is induced, consists of the contents of the viscus or viscera, that may be wounded. Thus, when the gall-bladder is the seat of the injury, the bile is poured out; when the urinary bladder is wounded, the urine; when the stomach, the food; and when the intestines, the fæces are discharged, and excite this fatal inflammation.

It is scarcely necessary to add, that beside the symptoms already enumerated, jaundice will almost invariably be attendant upon a wound of the gall-bladder or ducts; and an incontinence or suppression of urine, of the urinary bladder.

Further, a large wound penetrating the cavity of the belly is generally attended with a protrusion of some of the viscera; and even when the wound does not penetrate the abdominal cavity, the peritonæum sometimes protrudes and occasions hernia. Wounds likewise of the belly, which do not pierce the cavity of the abdomen, often prove distressing, tedious, and ultimately fatal, by occasioning sinuous ulcers among the muscles, and caries of the bones, and hectic fever. This is frequently the case in gun-shot wounds where, the bullet being lodged about the loins and in the heart of the muscles, the patient may have escaped the first danger, but will at length, after many months, be the victim of tedious suppuration, and lingering wasting hectic.

Respecting the symptoms which succeed to injuries of the head, we shall defer our remarks till we come to notice the surgical operations on the skull; and shall now go on to consider the treatment of wounds.

Treatment of wounds. It will first be necessary to consider the management of what are called simple wounds, without supposing the injury to have extended to the internal organs; to state the circumstances which may interfere with the orderly course of healing of such wound: and then to notice the more particular treatment of wounds in the breast or belly.

In conducting the cure of simple wounds, the surgeon will find "his duties happily reduced within the narrowest bounds, viz. of saving the patient from immediate bleeding, and of laying the wounded parts so clearly, so neatly, and so evenly in contact with each other, that they may adhere. The rest we leave to nature." "I fear," says the author from whom we have taken the above extract, "that from my announcing a rule of conduct so simple as this is, you will suppose, that I mean to speak only of the slighter and more trivial wounds; while I do really mean to include, under this general view, the greatest and the smallest wounds; and to establish but one rule for all, from the amputation of a limb, or the extirpation of a tumour, to the most trivial cut of the cheek or hand.

"What is amputation but a wound? the greatest wound, clean and fair, made carefully by the hand of the surgeon, disposed to heal in the easiest way? and in this great wound, which a fortiori includes the doctrine of every lesser wound, what is there to attend to but the procuring of adhesion, or the stopping of the flow of blood? What were the defects of the old operations, but that the surgeon knew not how to procure this adhesion? that he had no means by which he could stop the bleeding? The hæmorrhage was fatal to most of those who needed to suffer this operation; and the few who survived lingered through all the miseries of a nine-months cure, tedious and imperfect, with conical, ulcerated, and tender stumps. What indeed is the chief perfection of modern surgery, or the excellency of our operations? but that in bleeding from great vessels we trust nothing to compression, cauteries, or astringents, but tie our arteries firmly; and that we talk no longer about mundifying, incarning, or cicatrizing of wounds; that we never dress the cut surfaces as distinct wounds, but put the sides or lips in close contact, and keep them so. We boast nothing of our own powers, but trust all to nature; whose business it is, to make those surfaces adhere which will adhere; or reunite by the slower process of suppuration and granulation, those parts among which there has been a loss of substance." (J. Bell on Wounds.)

We have thus taken the liberty of copying the masterly and impressive language of this author, in order to convey a lively and firm conviction in the mind of the student, of the established, and in its application to practice, most important fact, that cut surfaces, if placed "neatly and evenly in contact with each other," will adhere: that from the slightest to the most serious wound, the process of healing is not in the smallest degree accelerated, but, on the contrary, greatly retarded by balsams, astringent gums, ointments, and other idle inventions for "mundifying, incarning, or cicatrizing of wounds." We repeat then this most important practical rule, than in endeavouring to heal recent wounds, the whole duty of a surgeon consists in securing bleeding vessels, and then bringing the edges of such wounds as accurately as possible in contact. "The rest we leave to nature."

When this union can be effected and retained (which it can in a great number of instances) without the aid of stitches, so much the better. This is likewise another improvement in modern surgery. In the most trivial wounds, the older surgeons were used to torture the patient with stitching, when the object, as it is now most satisfactorily proved, can be obtained with more readiness and safety by the mere application of a simple adhesive plaster. As this, however, is not always the case, we are to proceed in describing those circumstances in which the sewing of a wound is, and those in which it is not, necessary or proper.

When the skin merely is divided by a longitudinal cut, the edges of the wound are to be brought together by the adhesive plaster, by common court-plaster, or by a plaster of diachylon. "In applying such plaster, we are careful first to let the bleeding subside, then to make an assistant put the lips of the wound neatly together; then we apply one end of the sticking-plaster to the skin on one side of the wound, and let it fix there so that we may pull by it; then we pull that edge by the plaster; then moisten the remaining half of the plaster; then lay it neatly down over the opposite edge of the wound; then apply successive plasters till we have crossed the whole line of the wound; then, if any one of the slips of plaster has lost its hold by the oozing out of the blood, we take it gently off, wipe the surface, and apply a new one neatly, until we have got the whole clean and fair, all the plasters sticking soundly; and, lastly, we lay a compress over the whole, which we bind down a little with a circular roller, in order to prevent internal bleeding." This substitute for sutures is to be employed, likewise, in fleshy wounds which do not penetrate deep: it is to be used in parts where the skin lies close upon the bone, as in the back of the hand, and upon the hairy scalp. Even, however, in superficial wounds, when they are angular it will sometimes be necessary to employ one stitch of the needle in the situation of the angle, which will thus be supported while sticking-plasters, in the manner just directed, are to be applied to the sides of the wound, where the lips can be easily brought into contact.

When wounds, even although they may not be very deep, are made in parts which are constantly subjected to the action of strong muscles, as in the cheeks or lips, a stitch of the needle is to be employed; or that suture made use of which is termed the twisted or hare-lip suture, from its bein g principally had recourse to in order to unite the cut edges of a hare-lip. The manner of using this suture is the following: The broad edges of the wound are brought as nearly and neatly as possible in contact, and transfixed at opposite points with pins employed for the purpose. In the hare-lip operation, two of these pins are inserted, one at the edge of the lip, and one in or above the middle of the cut; we then twist a thread from one to the other pin, in the form of a figure of 8. (See fig. 9 in the Surgical Plates.)

In long and deep wounds among muscular substance, stitching will generally be requisite, and in proportion to their length must the stitches be multiplied. We are commonly directed by authors to make "for each inch of the wound, one stitch of the needle," passing, according to the extent of the wound, so many separate ligatures, which, after being all passed, are to be each tied over the surface, first by a single, then by a slip-knot. In this manner is the interrupted suture of the antients formed; which they distinguished from the continued suture, from the latter being sewed in the manner of a continued seam all along the wound. In each interstice of the interrupted suture, it will be necessary to lay one strip of adhesive plaster.

When the wound is still deeper, so that the stitches cannot go to the bottom, the compress, and what is called the uniting bandage, must be applied after stitching. This is formed by putting a double-headed roller round the part, passing one head through a slip in the opposite side, and drawing both at once.

"If the wound is pretty deep among the muscular flesh, so that the several stitches of the interrupted suture would make (if tied by the common knots) an awkward and painful suture, likely to excite inflammation, we then convert the interrupted suture into what is called the quilled suture; which is made by splitting each end of the ligature (after the stitches are made) into two threads; then laying a quill or bougie along each side of the wound, we tie all the ligatures of one side round one bougie; then draw that bougie tight down, by pulling the ligatures from the other side; then tie the ligatures also on the other side, round the opposite bougie; so that the two bougies, like two large rolls, keep the sides of the wound neat and even." This suture is not often employed.

After describing these different methods of effecting union between the divided edges of a wound, it is necessary to caution the reader further against using them indiscriminately in very deep muscular wounds. "Stitches after all can support only the edges of the wound, while it is the compress and the uniting bandage that must support all below." Thus stitches carried to a great depth have not only failed of their object, but have too often been the immediate occasion of convulsions, inflammations, and their long and dreadful train of consequences.

Stitches must also be employed cautiously if the patient, previous to the accident, has not been in firm health; or where he is to be exposed during the cure to the contaminated and deadly atmosphere of a crowded, filthy, and unventilated hospital.

With respect to the manner of arresting the bleeding, when one principal, or several ramifications of an artery are divided in a wound, so that profuse hæmorrhage takes place, the application of the tourniquet (fig. 10) is called for. The arteries are afterwards to be taken up, and secured in, the following manner: The tourniquet being a little loosened in order to discover the artery, an assistant makes a noose on the ligature to be employed: this being placed over the tenaculum (see fig. 11), the sharp point of this instrument is pushed through the sides of the bleeding vessel; and so much of it taken out from the surrounding flesh, as is sufficient to afford surface for a secure knot, which the assistant makes upon it.

If, from the depth of the wound, the tenaculum cannot be used, the crooked needle is to be employed instead; and if it is to be passed under the artery, as little of the muscular substance as possible is to be included in the ligature. If the artery to be secured is superficial, and lies against bone, as in the temple, in the hand, or the foot, it will be best secured by a firm compress. If it is convenient to make this compress within the wound, it may be formed of a piece of sponge, cork, folded leather, or linen. Such application will necessarily for a time interrupt the cure by adhesion.

When the wound has been sewed, the ends of the ligatures that are round the arteries are to be left hanging from its corners.

Such then is the immediate business of the surgeon, viz. to arrest hæmorrhage; and to bring as speedily as possible the divided edges of the wound into contact, in order to ensure the commencement of that adhesive process already spoken of. But with the closing of the wound the surgeon's business is not finished. For the most part, indeed, if the junction has been duly effected, if the patient is in health and properly managed, a certain degree of union will be shortly formed, the ligatures that have been employed will come away on the fourth or fifth day, and the adhesive action that is going on will not amount either to actual inflammation (although it is called the adhesive inflammation), or be accompanied by any systematic irritation of consequence. In the progress, however, of cure, in all wounds that have been closed by ligature, some degree of actual inflammation is always produced; and for this reason, that the ligatures themselves cannot but act as local irritants. Now if the tendency in the system is to inflame; if the stitches have been carried too deep, or the ligatures are too lightly pulled; if there is blood poured out under the skin, by which it is separated from the parts below; if, in a word, any cause has place of either separation or undue irritation; instead of the kindly progress of this adhesive natural and healthy action, pain, inflammation, and swelling of the parts, will ensue; and if these arise to any extent, "you must immediately undo your bandage, draw out your pins, or cut your stitches, and take away every thing that is like stricture upon the wound: these prudent measures may abate the rising inflammation, and prevent the total separation of the skin; while you may still endeavour to keep the wound tolerably close by the more gentle means of sticking-plasters.

"But should the inflammation rise still higher, and should you perceive that a total separation and turning out of the wound are inevitable; you must throw all loose, put a large soft poultice round the whole, and forsake without hesitation all hopes of procuring adhesion; for should you in this critical juncture persist in keeping the parts together by sutures, the inflammation would, in the form of erysipelas, extend itself over the whole limb, attended with a fetid and bloody suppuration, wasting the skin with great loss of substance. Therefore throw all loose, apply your poultice, allow the wound to separate right as it is, and to pass slowly into a soft and easy state of suppuration; and then a second time try to bring the edges up to one another, not by stitches, but by adhesive straps, or by a gentle bandage.

"When the wound has fallen into a full suppuration, then the suppuration, granulation, and all that follows, belong (as indeed adhesion also does) to nature alone, over which we have no other power than that of supporting the action of parts, *i. e.* keeping the system in good health; and when the suppuration goes wrong, it is in general by taking the form of a profuse, thin, gleety discharge; and this profuse discharge is to be suppressed, and the right suppuration restored, by bark, wine, rich diet, and good air; and this is what is usually meant by supporting the suppuration, or moderating the profuse discharge." J. Bell's Discourses on Wounds.

Of contused, and lacerated, and gun-shot wounds.

From the above observations, it will readily be inferred that (unless in cases of systematic irritation, or unfavourable circumstances), if a wound does not unite and heal, it is because its divided edges are not placed and preserved in neat and even contact; and this inference will serve to explain why those wounds are of most difficult and intractable treatment, which are not simple and fair divisions of parts with cutting instruments, but are what authors term contused and lacerated. A contused wound, in systematic language, is that in which, without the skin being penetrated, the parts below are crushed or broken, rather than divided; if the outer skin is broken at the same time, the wound is said to be contused and lacerated; such are gun-shot wounds. Suppose an individual to receive a ball from a musket or pistol, in the arm or thigh; suppose that the ball has entered at one point and passed out at the opposite, has taken a more oblique direction, or, instead of passing out, has lodged among the muscles of the part; in either case we shall have not a mere division of substance, in which the divided vessels can be secured, and the separated edges brought again into contact, but there will be a bruise rather than a clean cut; it will of course be impossible to dispose the parts so as that the adhesive action shall commence, and therefore "no gun-shot, nor indeed any bruised wound, heals by adhesion."

In this then consists all the peculiarity of gun-shot wounds: it is not that the ball (as the antients supposed) is possessed of any poisonous quality, that such wounds are difficult and tedious in healing; but solely because the injury inflicted is in the shape of a bruise, not of a cut; the vessels and fibres are crushed, not divided.

If then gun-shot or bruised wounds cannot be made to heal directly, or by adhesion, it follows that the treatment they demand is in some measure peculiar; we are, therefore, now to discuss the question of such peculiarity, and in so doing we shall for the present limit our remarks to those wounds which have not penetrated the thoracic, or abdominal cavities. The symptoms of wounds in the breast and belly, we have already enumerated; on their management, medical and surgical, we shall shortly enlarge.

Treatment of gun-shot wounds.

In gun-shot wounds which have neither penetrated the two great cavities of the chest and abdomen, nor have been made upon the head, the principal points of consideration are, the direction or place of lodgment of the ball, whether one or more bones have been splintered or broken, whether any considerable artery has been torn up, whether the wound has reached any of the joints, and lastly, whether the ball has carried with it any foreign matter, such as the patient's clothes. These points are to be determined by an acquaintance with the anatomy of the parts; by probing, scarifying, or dilating the wound; and by an attentive examination of the symptoms which the injury has occasioned.

"All probing should be done at the time of the wound," while the parts are still deadened by the injury, and before pain and inflammation have come on. The finger is the best probing-instrument; "it is not apt to catch upon tendons or nerves; it does not so much as the probe endanger the arteries; and by feeling with the finger, we judge most accurately of the condition of the wound. The finger both directs our operations, and instructs us what is to be done. Perhaps we feel the ball, and then we cut directly upon it; perhaps we feel the wound making a crooked or spiral turn, and we follow it with our incisions; perhaps we are sensible that it touches a great artery, and in working with our bistoury we are careful of that artery; we know also where the ball has touched a joint, or broken any bone; accidents which not only increase the danger, but which may even incline us in certain circumstances to cut off the limb. In short, all that we resolve, is from the information that we have through the finger, and it directs all our operations."

What are these operations? Either to scarify or dilate the wound, as circumstances shall demand, to make a counter-opening when necessary, and to extract balls, clothes, or splinters of bone. The purposes of scarifying are, "to open the vessels that they may bleed, to enlarge the wound that when it inflames it may have room to swell," and to enable the surgeon when requisite to take up the bleeding arteries, and to extract the ball, the splinters of bone, or any other foreign and irritating material.

Every gun-shot wound which is deep and penetrating, with a narrow opening, and with a tense fascia (even if no foreign body is to be extracted), requires immediate scarification; the incision, it must be carefully remembered, is "to pass through the fascia as well as the skin; the wound must have vent, as the older surgeons were wont to express themselves, in other words "it must have room to swell" during that inflammation which inevitably precedes its cure. The stricture, as in strangulated hernia, must be taken off. So far then all is plain and simple. But the practice is too often in the cure of gun-shot wounds more complicated. Counter-openings are sometimes to be made; splinters or foreign matters are to be searched for and taken out, and great vessels to be secured. When the ball has passed entirely through, the opening which it has formed by its exit is called the counter opening; when it has passed a considerable way, but not entirely through, it becomes the business of the surgeon to make this counter-opening in order to extract the ball. This practice is advised by the generality of surgeons, "when the ball has only passed two-thirds through the limb." Such direction is for the most part to be followed, and the operation should be performed as speedily as possible.

But there is also another kind of counter-opening (let this rule be especially attended to), which the surgeon is at times obliged to practise. The opening which he must afterwards make in the middle of a long wound, when the track of the wound swells, or when the abscess forms, and the matter, the sloughs, and the foul ichor, seem to be confirmed. For example: a man is wounded by a ball, which breaks one or two of the fingers, pierces the hand, runs up the fore arm, rakes along the bones, and goes out far from its entrance, as at the elbow or shoulder-joint. Here we can hardly prevent a long suppuration, and too often an exfoliation or spoiling of the bones: and three openings are required; one where the ball entered, another at the counter-opening or that by which the ball passed out, and if the swelling, pain, irritation, or perhaps nervous symptoms, come on, then there will be required also another opening in the middle of the wound. Such an opening will ease the swelling, and prevent a suffocation of the wound. It will prevent gangrene, bring on a good suppuration, and allow a free vent for the matter; it will also prevent sinuses, and so save the arm; and it will save us from the severe or rather cruel practice of the older surgeons, who were accustomed, in such cases, to run a large seton through the tube of the longest wound. These last (setons) are only proper when the wound has become entirely callous, and pours out a thin gleety discharge; or when, from the adherence of some piece of cloth which prevents its healing, healthy action cannot otherwise be excited.

So far then with respect to the scarifications which are required in gun-shot wounds; we now proceed to treat of the extraction of balls, cloth, or splinters of bones.

Here dilatations rather than scarifications are needful: for there is this difference between scarifying and dilating; that scarifying is that superficial incision of the mouth of the wound by which we relieve the tension of the fascia or the stricture of the skin; but dilating is that deeper incision which we make by pushing our finger deep, and to the bottom of the wound, following it with the bistoury, to make a free way for getting at the bleeding artery, or extracting the fractured bone. When we wish then to extract the ball, we are to employ free incisions, The fingers are to be used more than the forceps; these when the ball is found are to be introduced, and made to grasp it. Sometimes the ball will have been stopped by a bone and flattened, without breaking or splintering such bone; at other times, however, the bone by the force with which the ball has struck it will be shivered: in this case the splinters of bone are to be all carefully taken out, and the limb treated as in other cases of fracture. If the ball has entered and sticks in the bone, so that it cannot be extracted in the common way, then a more free incision must be made, and the trepan applied; "or if it is a narrow and firm bone, M. de la Faye orders us to cut the bone both above and below, so as to cut away that piece in which the ball is fixed."

But it is principally on account of fractured bones, wounded arteries, or pieces of cloth, that these dilatations of a wound are called for. "It is only the openness of the wound, and the nearness of the ball, that tempts us to search for it; for a ball sometimes works its way outward through the cellular substance, and comes to the surface with little pain, or often it lies without danger buried in the flesh for years, or for life. If there was no other occasion for opening the wound, we shold never give the patient pain on account of the ball, since it seldom itself gives him pain." It must, however, be carefully kept in mind, that wounds, even though fair and promising for a short time, will never heal kindly while the foreign matters above-mentioned are suffered to remain.

When there is much blood spouting from a gun-shot wound, it will be concluded that a great artery is injured: in this case the surgeon, guided by his knowledge of the anatomy of the limb, will make free dilatations from the mouth of the wound, until he finds the vessel, which he will tie up or secure. He must not, however, if the bleeding artery is of a large size, trust to compress or bandage. A piece of lint dry, or with some simple ointment, is then to be laid over the orifice of the wound, its sides are to be brought as close together as possible, without occasioning much irritation, and adhesive plaster or bandage to be placed over the whole. But there is another kind of hæmorrhage from gun-shot wounds still more dangerous, which may be called the secondary hæmorrhage. This often occurs eight or nine days after the injury was first received, and the patient has often fallen a victim to it, even when "at the first the wound was scarcely stained with blood." This hæmorrhage is occasioned by the loosening of the eschar of the mortified and bruised parts, leaving a breach in the sides of a great artery. In the course then of healing a wound, the proximity of which to a considerably artery is known, the patient ought to be attentively and incessantly watched: and in some cases it is necessary to keep constantly a tourniquet round the limb.

We conclude this part of our subject by repeating the motives for scarifying and for dilating gun-shot wounds. The first is, for the purpose "of opening the vessels that they may bleed," and in order thus to reduce the wound as nearly as may be to one made by a cutting instrument. The dilatation of a wound is for the purpose of enabling us to secure any great artery that may have been divided, and to extract splinters of bone, or any other foreign material, the ball itself being that about which, on account of its shape and smooth surface, we are the least solicitous.

Of tubular or penetrating wounds.

But there is further another kind of wound which is different in its nature and treatment from that made by a plain and fair division of parts, viz. a penetrating or tubular wound, such as is made by the bayonet or sword; and in this last case it is the surgeon's duty to bring it as much as possible into that condition in which its sides may, by being applied to each other, adhere. "Suppose," says Mr. J. Bell, "a young man in fighting a duel with the sword, is wounded in the sword arm, his antagonist's weapon goes in at the wrist, and out at the elbow. If in such case any great artery is wounded, then indeed it injects the arm with blood, forming a proper aneurism, so that we are forced to cut up the fore arm, and tie the wounded artery; but if it is merely a flesh wound, it is no doubt somewhat dangerous from being deep and penetrating; but still it is so little different from a common and open wound, that could we bring the sides of this tube-like wound fairly in contact with each other, it would close in a day; and the reason that it does not happen so is plainly this, that the blood which exudes from the very small arteries is sufficient to fill the tube of the wound: it not only fills it, but the bleeding going on withinside, while it is prevented by a compress and close bandage from getting out, the tube of the wound is not only filled but dilated with blood, and therefore cannot adhere, just for the same reason as the healing of an ill-amputated stump is delayed where the arteries, not being fairly tied, have bled after the dressing so as to fill the bason of the stump, and separate the flaps from each other. This not only prevents adhesion and brings on suppuration, but produces a gangrenous stump filled with foul and stinking matter, partly purulent, and partly filled with blood."

The obvious inference from all this is, that the healing of those kinds of wounds of which we are now speaking, is principally to be facilitated, nay, is alone to be effected, by cleansing it of this blood (when no important artery is divided), by closing the mouth of the wound with a slight compress, and "laying its sides together with a slight bandage." It was in thus cleansing these wounds of blood previously to closing them, that the remarkable success attended what was denominated some time since in France, the secret dressing. This used to be performed by men who were denominated suckers, one of whom was present at every sword-duel. "The rencounter ended the instant that one of the combatants received a wound; the sucker immediately applied himself to suck the wound, and continued sucking and discharging the blood till the wound ceased to bleed; and then, the wound being clean, he applied a piece of chewed paper on the mouth of the wound, tied up the limb with a tight bandage, and then the patient walked home."

This mode of treatment has proved successful even in wounds which have pierced, or passed through, one of the cavities, when there have been no veins, nor any great blood-vessel, wounded.

In a deep and penetrating wound, therefore, the method of cure consists in purging it of its extravasated blood, and causing its sides to adhere. We do not here need to make incisions or scarifications, as in gun-shot wounds, unless for the purpose of securing some great artery that may have been divided.

Having thus gone over the surgical treatment of wounds, fair, angular, bruised, lacerated, and penetrating, we now proceed to lay down some rules respecting the medical management of patients under these injuries, and which is still more important than the surgery itself of wounds; "for if the connection is not understood betwixt the particular wound and the general health; if the army or hospital surgeon (and the same remark applies with modifications to private practice) does not know with a glance the constitution of a patient, or the true state of his sore; if he is not careful to retain some general principle, which, like a mystic clue, may lead him through this labyrinth, he will see thousands dying around him without knowing the cause, like the fable of the Grecian camp falling under the invisible shafts of Apollo."

Among the very many mistakes and unmeaning prejudices which have crept into the practice of both medicine and surgery, that of indiscriminate blood-letting has, perhaps, proved the most pernicious. Than this practice followed up, as it has been, nothing can possibly be more preposterous, or more dangerous. The writer of this article not many days since heard of an instance (an extreme case it must be confessed, yet, as such, more especially illustrative of the injudicious conduct now referred to) of a superannuated lady, by some accident having been literally scorched to death: the surgeon who was summoned found himself preceded by another "practitioner," who was actually, while the writer's friend entered the room, unsheathing his lancet in order "to take some blood." In like manner, with more colour of propriety, it must be admitted, when a wounded patient is first brought to a surgeon, it is by numbers, even to this day, deemed a necessary preliminary to further proceedings, to bleed the patient. "The sovereign cordial of the landlady" is often more appropriate; and many lives have, perhaps, been saved by the absence of the village surgeon.

Let the following invaluable rules be treasured in the mind of the young practitioner, not as dogmas to force, but as principles to regulate, his practice. They are more directly drawn up for the use of army and navy surgeons, but will be found highly important to surgeons in general.

1st. "When your wounded patient is first brought to you, he is in great confusion; there is a tremor, a tonic stiffness, or almost a convulsion of the whole frame; there are coldness, fainting, and nervous affection; but it is merely a nervous affection, and it must be treated as such. You may expect it to subside in time, and therefore should give some good warm cordial, and large opiates to quiet the commotion. This is no time for bleeding, whatever the nature of the wound may be. If the stupor continues, you should give cordial draughts and wine.

2d. " If this nervous commotion being quieted, a sharp fever should come on, still do not bleed, but rather be upon the reserve; for perhaps this, which at first seems to be a pure inflammatory fever, may turn out to be a fit of an ague, to which the patient is subject; it may be a low and malignant fever; it may be an attack of some camp disease; and if a diarrhœa, great weakness, and low muttering delirium, should come on immediately after you have bled your patient freely, you would be distressed at the thought of what you had done, and you would indeed have much to answer for.

3d. " Reserve your bleedings for those more dangerous cases, where high inflammation is so often fatal, and do not bleed in wounds of the hips, shoulders, or limbs. Reserve bleeding for wounds of the breast or belly, or great joints; for in all wounds of cavities, inflammation, which can hardly be escaped, is the great danger.

4th. " If a man is wounded after a full meal, there can be no doubt that a gentle vomiting must be useful, where it is allowed by the circumstances of the wound. The old physicians found their advantage in it, and ascribed the good effects of vomiting to the preventing of crude and ill-concocted chyle from entering into the system, so as to kindle up a fever. There is no doubt that a meal which was no load during health, will be a great oppression upon a disordered system, and the carrying it off must be a great relief, although the old physicians, by talking this useless jargon about ill-concocted chyle, might almost provoke us to reject both the doctrine and the practice. The system cannot be weakened by a gentle emetic; and if the system should fall low after vomiting, it were easy to substitute a fitter support, and better excitement, than that of an oppressed stomach and loaded intestines, by first discharging these crude meats, and giving, when the stomach was emptied, food of easy digestion, and cordials suited to the condition of the system.

5th. " But in every wound there comes a period of weakness, in which we repent of every bleeding we have made, even when it was really needed; a period in which, by confinement and pain, occasional fever, diarrhœa, profuse suppuration, or colliquative sweats, the patient falls so low that it is not easy to support him through the cure: and thus there are two great principles in the treatment of gun-shot wounds: that even at first we should be sparing of blood; and that the period of weakness which is to succeed, is the great danger; on this single point hangs all the practice."

The author afterwards adds, that in mere flesh-wounds we are not entitled to bleed; for if there is no wound of a joint, or fractured bone, the first inflammation never runs too hight.

By due attention to the above rules, the surgeon will never find himself at a loss with regard to the immediate requisitions of the wounded, either in army, navy, hospital, or private practice. It will scarcely be necessary to observe, that where immediate bleeding is judged necessary (and this is always the case, as above stated, in wounds of cavities and joints), it may be employed most freely in the young, full-fed, vigorous, and plethoric, in dry and healthy situations, in the spring of the year, when no epidemic disorder prevails, and when the patient is afterwards to enjoy all the advantages of cleanliness, air, and a suitable diet.

In the progress of the cure, the surgeon is still not for a moment to lose sight of the intimate connection between the condition of the general system, and the state of the wound. Still fever is to be distinguished from inflammation: and the two opposite kinds of inflammation treated of in the article Medicine, vol. ii. p. 250, are likewise to be sedulously discriminated: the one will require a low diet, evacuating medicines, and, as it is expressed, a cooling antiphlogistic regimen; the other as loudly calls for bark, wine, opium, elixir of vitriol, and above all pure air, and (so as not to overload or oppress the weakened organs of digestion), rich or rather nourishing food. Here, instead of further reducing the system, " you must trust to air and cleanliness, and bark and wine."

We now proceed to speak of the treatment of wounds in the two cavities of the chest and belly.

The first and great danger in a wound which has penetrated the thoracic cavity, is that of suffocation from blood poured into the air-cells, or towards the trachea. The first and principal object then of the surgeon is to obviate this consequence as speedily as possible; and here immediate and oftentimes frequently-repeated bleedings are called for, even should the patient be in a condition unfavourable to the discharge of blood. " Here it is your duty to keep the patient low, and to drain his system so thoroughly of blood, that none shall pass towards the lungs to suffocate him, and that there may not be blood enough in the system to serve as fuel for that inflammation which sooner or later must come on."

When the blood is merely poured into the cellular membrane or cavity of the breast, without entering the air-cells, the finger, as already mentioned, is to be introduced into the wound; or if this wound is too high for the necessary discharge of the extravasated blood, a fresh wound may be made lower down upon the breast, and this so that the surgeon may have it in his power to reach and tie the intercostal artery, if this artery has been divided.

For the emphysenia or windy swelling, which is often so alarming to the bystanders, but which is in reality the most trivial symptom, scarifications are to be made in order to discharge the collected air.

If, during the cure of a breast-wound, there comes on a pricking in the side; if the cough is aggravated, the discharge becomes more copious, and the systematic irritation increased, there will be reason to suspect the remains of some irritating material, as a splinter of bone; in this case, the wound is to be probed, injected, and every endeavour made to extract the irritating cause.

" Sensible, at every turn, how slight a matter will irritate the pleura and lungs, the surgeon will never allow himself to do so unnatural and cruel a thing as to pass a great cord across the chest, which is thus easily irritated by the most trifling piece of bone or rag of cloth; but he merely lays a bit of oiled caddis gently within the wound, with a large emollient poultice over all."

To conclude. In the wounds we are now describing, the surgeon must in the first day bleed copiously, and repeatedly; he must again bleed should bloody expectoration recur, weakening the system in order to prevent suffocation; " and when the time comes in which the oppression is forgotten, and the danger of suffocation, and the bleedings from the lungs, are over, he begins to support his patient's strength with opium and bark, and nourishing diet and milk."

Wounds in the abdomen. While the danger from wounded lungs is chiefly of suffocation, in wounds of the abdomen, as before stated, we have principally to fear either sudden death from internal hemorrhage, or peritonæal inflammation, when the bleeding has not been so profuse. Against this internal bleeding, bleeding from the arm is the great preservative; and this, as in wounded lungs, must be done with a very liberal hand. When the peritonæal inflammation has come on, the patient must be assiduously preserved from all motion and irritation; clysters of a mild gentle kind must be injected, the belly fomented, and opiates adminstered.

No food is to be given for the first ten or twelve days; nourishment is to be conveyed by clyster, or if any thing is taken by the stomach, it must be extremely mild and gelatinous. If the wound has not penetrated the intestine, but part of the sound gut is protruded, it must be gently returned with the finger, and the outward wound stitched over it.

When, from the passing out of the fæces, it is evident that an intestine is wounded, this is not to be searched for with the finger, but suffered to remain; and from the universal pressure among the parts, the outward and inward wound will be brought opposite to each other. If, however, the wounded intestine is protruded, it is to be connected by a single stitch to the external wound, in order that the fæces may be thrown out from this last, and the adhesive process encouraged.

When, through a narrow wound, a sound bowel is obtruded, and becomes inflamed, the stricture is to be relieved by opening the wound a little wider, the intestine is to be carefully returned, and then the outer wound stitched.

Before we quit this subject of wounds, an apology may be thought necessary for enlarging disproportionately on this division of the article. We have done so for the purpose of illustrating the advantage that practical surgery has received from the natural, as opposed to the artificial cure of wounds; a fact which the young surgeon will find it necessary to impress on his mind as a directory in every step of his practice, whether operative or medicinal. We shall conclude this section by an extract from an author to whose incomparable treatise on wounds we have been principally indebted for what information the preceding observations may have coveyed.

" It is an old, but it is a becoming and modest thought, that in our profession we are but as the ministers of nature; and, indeed, the surgeon, still more than the physician, achieves nothing by his own immediate power, but does all his services by observing and managing the properties of the living body; where the living principle is so strong and active in every part, that, by that energy alone it regenerates any lost substance, or re-unites, in a more immediate way, the more simple wounds." J. Bell's Discourses on the Nature and Cure of Wounds.

Of aneurisms.

Wounded arteries cannot always be secured. Very often, as we have above stated, a large vessel is divided or punctured at a considerable distance from the surface of the wound, or in situations where the artery cannot be commanded: the blood is by consequence immediately and profusely poured out, spreads among the contiguous parts, and produces an aneurismal tumour. This is the false or diffused aneurism of authors, and the manner in which it is formed is sufficiently obvious.

The progress of this aneurism varies according to the situation and size of the artery that has been wounded. In the course of a few hours, the blood has been known to diffuse itself through the whole extent of a limb; at other times a very small tumour about the size of a horse-bean will remain of the same size for some weeks. As the increase of the tumour in false aneurism is generally occasioned by a diffusion of blood among the surrounding parts; it does not, like the true aneurism immediately to be noticed, become more prominent as it enlarges. In the first stages of the disease, a pulsation is almost always perceived in the tumour. This gradually lessens, and often at length becomes imperceptible. After some time, more or less according to the depth and magnitude of the wounded vessel, the skin becomes of a livid appearance, the member becomes stiff, painful, and the contiguous joint immoveable, the integuments at length give way, and if the artery is large a fatal hæmorrhage ensues.

When an artery has been accidentally punctured by the transfixing of a vein, an accident which has happened sometimes in blood-letting at the arm, the extravasated blood either diffuses itself into the surrounding cellular substance, or, when the vein and artery are more immediately in contact, the communication between the vessels is preserved; the vein, by the consequent impetus of blood comes to be dilated, and what has been denominated varicose aneurism occasioned.

This kind of tumour may be recognized by the tremulous kind of motion which attends it, accompanied by a peculiar hissing noise, and by the tumor entirely disappearing for a time upon pressure.

When from accident or disease the coats of an artery lose in any particular point their ordinary power of resistance to the blood's impetus, and the diameter of the artery becomes in consequence dilated, the true or encysted aneurism is formed. It was, indeed, to this dilatation of arteries, without the rupture of their coats, and extravasation of blood, that the term aneurism was originally and is more properly applied.

In this disease, although it may be situated near the surface, the outer skin at first is of a natural appearance, the tumour is compressible, and a pulsation may almost always be observed in it. As the swelling increases, the skin becomes paler than ordinary, parts of the tumour are often firmer than others, and the pulsation cannot be discovered at all points upon pressure. Pain now comes on, the skin becomes discoloured as in false aneurism, an oozing of bloody matter is perceived, and at length the tumour bursts, and if the seat of the disease has been a large artery, in one of the cavities of the body where compression cannot be applied, death is the inevitable consequence. Sometimes the fatal termination is occasioned by the gradual destruction of surrounding parts. Even bones have become carious in consequence of their proximity to a large aneurism.

Besides these three species of aneurismal tumours, the false, the varicose, and the encysted, Mr. J. Bell describes another disease, which he calls aneurism from anastomosis. This, our author observes, is constituted not by the dilatation of any one branch of an artery, but by a mutual enlargement of the smaller arteries and veins; it proceeds from a trivial size to a large and formidable tumour; it is characterised by perpetual throbbing, which at length becomes a continual and distinct pulsation. It beats strongly when the circulation is unusually accelerated; in spring and summer, its pulsatory motions become fuller and more acute; it goes on to form sacs among the cellular substance, or among the dilated veins. These become at length livid, and burst from time to time; and then, as in other aneurisms, the tumour pours out its blood, and, according to its extent, reduces the patient.

Diagnostic marks. The existence of an aneurismal tumour is not always to be pronounced with decision, for although pulsation might be regarded as a true diagnostic character of the disease, it is not absolutely so; for other tumours may be situated so near a large artery, as to be regularly affected by its pulsations. When there is any doubt of the nature of the swelling, pressure should be made on it; and if it disappears or lessens, and immediately recovers its size upon the pressure being taken off, it may be considered as an aneurism. In the advanced stages, however, even of an aneurism, the reduction cannot always be effected.

Causes. The simple statement of the mode in which the two first species of aneurism above noticed are occasioned, is a sufficient account of the causes producing them. The true or encysted aneurism appears for the most part to depend upon a diseased disposition; often, indeed, it is brought on by violence or accident, but even then the pre-disposition is generally to be suspected. Women are less obnoxious to aneurism than men, especially the large aneurism of the ham; and this Mr. J. Bell ascribes to their exemption from the hard labour of the other sex. To this conclusion, however, it has been objected, that even where the labour of females is greater than that of the men, and where even their occupations are such as to occasion those exertions which principally endanger the artery, the immunity is still the same.

When aneurism is produced gradually and without violence, this disordered pre-disposition is more evident. In this case, likewise, the prospect of cure from operation will be more faintly marked than when the tumour has succeeded to external injury; for this reason a diffused and varicose aneurism promises to be remedied by operation, with more surety than the true or encysted aneurism.

Aneurisms, likewise, are more or less dangerous according to their situation. When they are formed in large blood-vessels near the heart, they are not the subject of operation; and it had generally been conceived that even in the extremities, when they were seated high up, as in the axilla, or ham, this would be inadmissible on account of the complete stoppage to the circulation, which was imagined a necessary consequence of obliterating the great artery of the thigh or arm. By an anatomical and practical investigation of this subject, it has, however, been demonstrated that the inosculating vessels are in either instance sufficient to supply the limb; and that where failure attends the operation for aneurism, it is to be ascribed to other sources. In this substitution of the collateral branches for the arterial trunk, consists, indeed, the cure of aneurism, when it is effected without operation.

Treatment. The cure of every species of aneurism has been attempted by continual pressure on the tumours. In the false, or diffused aneurism, however, no advantage can be derived from this treatment. In the varicose aneurism, moderate and equal pressure may be attended with benefit; and even the true aneurism, when the artery is so situated that pressure can be made, has been cured according to the accounts of authors by this means. When attempts of this kind do not seem to promise any benefit, the operation ought to be speedily performed.

When first the operation for aneurism was practised, it was invariably the rule to secure if possible the large artery leading to the tumour by the tourniquet; then to cut into the sac, lay the cavity of the tumour freely and fairly open, clear it of the clotted blood, secure the artery by ligature, and treat the wound according to circumstances. In some cases it is necessary still to pursue this plan, as in a large and spreading aneurism of the groin; but where the artery leading to the tumour can be dissected and taken up before it reaches the cavity of the sac, it has been proved that this mode of operating is the most expedient. Mr. John Hunter first proposed it, by directing, in popliteal aneurism, that the great vessel from which it is nourished should be laid bare on the fore part of the thigh, that the artery should be obliterated by ligature at this part, and that the tumour, now deprived of its nourishment, should be left to be dissipated by the absorbents. This plan is now generally adopted. The surgeon dissects down upon the artery, in the part which is judged most convenient for the operation, ties the vessel at two places at half an inch or more distant from each other, cuts it across in the middle between the ligatures, and thus destroys its communication with the tumour; the blood is gradually solicited by the inosculating branches, which enlarge and come at length fully to supply the place of the trunk.

In performing this operation, the surgeon is to dissect the artery very clean; it should be carefully tied by itself, without including the accompanying nerve; a firm waxed ligature, without any intervening substance, is to be passed round it by means of a blunt needle, or crooked probe, and the wound treated in the common manner.

In the aneurism by anastomosis, Mr. Bell observes that the only radical cure is complete extirpation: we are not to cut into it, or to attempt the interruption of any particular vessels leading into it, but the whole group of vessels by which the tumour is supplied must be entirely extirpated.

Of fractures.

Fractures are not in all instances easy of detection. Pain, swelling, distortion, loss of power in the injured member, shortening of the limb, and a peculiar crepitating sound upon the part being handled, are described as the signs denoting a broken bone; these, however, are all, excepting the last, which cannot in every case be perceived, in a greater or inferior degree, common to bruises, sprains, dislocations, and injuries independant of fracture.

When a bone is simply divided, without any protrusion of its broken ends, lacerations of considerable blood-vessels, or any other circumstance to render the accident complicated, the practice of the surgeon is obvious and easy. In wounds of soft parts, we have seen, adhesion is insured by merely bringing their divided edges together; in like manner, though much more tardily, junction will be effected between the divided extremities of a fractured bone, by replacing and preserving them in even and steady contact. The healing of wounds is not accelerated, but on the contrary retarded, by the several contrivances and interferences of the older surgeons: so by the cruel practice of tight compressing, bandaging, and the use of machinery, in fracture, not only unnecessary pain is occasioned to the patient, but the process of cure, instead of being facilitated and hastened, is considerably impeded. Nature, in either case, will not be interfered with.

The time which bones take in uniting is proportioned to the age and health of the individual. In persons of middle age and firm constitution, a simple fracture of the arm will for the most part be fully and firmly united in a little more than a month from the accident. Fractures of the shoulder and thigh-bone are, under the same circumstances, about six weeks or two months in healing; while the smaller bones, as the clavicle, the ribs, the fibula, and the bones of the hand, seldom occupy in their cure more than three weeks.

In simple fractures, provided the parts have not been unduly irritated, either by much motion after the accident, or by tight straining bandages, the symptoms of inflammation will subside in a few days. Sometimes, especially when the surgeon has been called late, it is necessary to subdue the local irritation by solution of lead, the application of leeches, and other means used in common inflammation, and these it is often necessary to continue for several days. Now and then it will be found expedient to bleed from the arm. These requisitions must be determined by the good sense and judgment of the surgeon. It is impossible to lay down abstract rules for conduct. To bleed, however, merely because a bone is broken, is a practice equally unmeaning and erroneous with that before alluded to, with regard to wounds in soft parts.

Before speaking of individual fractures, we shall present the reader with the following instructions of Mr. J. Bell, which, although especially applied to a broken leg, will be found applicable with proper exceptions to fractures in general.

"In setting a broken limb," says our author, "there is no extension required but such as common sense would direct you to use were you not a surgeon. Lay the patient in bed, and lay the limb upon a pillow; or if you design to use splints, have two long troughs, or pieces of pasteboard, (in figure 66 is represented the usual splint employed in a fractured leg) bent into a hollow form, lined, or rather cushioned, with two or three piles of flannel, with tapes or ribands, four or five in number, attached to the outside of one of the splints, by which both splints may, after all is over, be gently tied together with bow-knots, to be slackened or tightened according to the swelling of the limb. The pasteboard ought to be soaked and softened a little, that it may take a shape suitable to that of the limb.

A long splint of this kind being laid flat upon the bed by the side of the fractured leg, desire one of your assistants to apply his hands broad round the upper part of the limb, and grasp it gently and steadily; take the foot and ancle in the same manner in your own hand, slip your left hand under the broken part of the limb, and then sliding it gently along, lay it upon the pillow or its splints. The pillow should be like a mattrass, flat and firm.

Begin then to lay the limb smooth; let your assistant again grasp it, by spreading his hands upon the thigh or below the knee, with the design of extending along with you, not by lifting the leg from the pillow, but rather by keeping it down, and steadying it by pressure, while you with both hands lift the foot and ancle; grasp them gently, but very firmly; raise them a very little from the pillow, and draw them gently and very smoothly. When you have thus extended and smoothed the broken leg, in a manner which you almost suppose agreeable rather than painful to the patient, press it down steadily and gently; keep it flat and pressed until it gets a seat and bed in the pillow. If splints are applied, the limb is to be pressed against the lower splints; the upper splint is then to be laid above it, and by grasping the soft and moistened splints, you must model them a little. When the whole has taken a form, take several tapes one after another; and after having tied them in a general way, go over them again one by one, and tie them a little closer, so as to keep the limb agreeably firm."

This author, in another place, remarks (when speaking of fracture in general), "when the limb by accident has been disordered or shortened, you are to venture, without fear of hurting the callus, to extend it anew, and lay it straight."

It may be proper to observe, that while much inflammation is present, we are to defer the application of splints, even in the gentle manner above advised, till such inflammation has in a considerable degree subsided.

Of fractures of the lower extremities. Fractures of the body of the thigh bone may generally be ascertained by the signs above enumerated. When, however, the injury is in the neck of the bone, it requires much attention to distinguish luxation from fracture (see the section on *Luxation.*). Here we may observe, that luxation is usually occasioned by straining or twisting of the limb; while perpendicular falls, or leaps, are the more common causes of fracture. When the crepitation is discovered, the nature of the accident will be unequivocal.

Fracture of the thigh, on account of the strong contraction of the large muscles of this part, is the most difficult of cure. To counteract this tendency to contraction, the joints of the thigh and knee are to be gently bended; one assistant is then to take hold with both hands of the upper part of the thigh; another is to support, and very moderately to extend the lower extremity, while the surgeon adjusts the fractured bones. After thus reducing the fracture, the limb is to be secured, by being laid in a well framed case, stiff, and adapted to the form of the limb, bending gently, in order to admit of a relaxed posture, lined with a woollen cloth, or with flannel, each hollow being filled up with little cushions of tow; another splint is then to be laid on the opposite side of the thigh, the whole braced gently down with ribands, and then both the thigh and its case bound to the pillow by tapes. In order to preserve it against the weight of the bed-clothes, a frame with hoops may be placed over the thigh. From time to time the limb is to be examined, in order to ascertain whether the bones retain their situation: if it is disordered or shortened, the limb may be again gently extended and properly adjusted. After the second week, a small degree of flexion and extension may be used daily, in order to prevent an anchylosed joint.

Machines have been invented, one particularly by Mr. Gooch, represented in fig. 64, in order to obviate the contractile tendency, by making a counter-extension. These machines, however, do by no means answer the intention proposed. The counter-extension should not be continual, but must be made occasionally, and with the hands. When the patella is fractured, it is generally in the transverse direction. In healing such a fracture, the leg should be extended, the patient should be laid on a mattrass, and a splint placed under the limb, of sufficient length to reach from the upper part of the thigh to the under part of the leg, to which the limb is to be attached by straps. The fractured bones are then to be brought together, and the inflammation subdued by local applications. Here the pressure of the bed-clothes should likewise be guarded against by a frame of hoops, or some other contrivance. When the bone has been divided longitudinally, the common adhesive plaster is usually sufficient to maintain the junction. In transverse fractures, the divided pieces of bone recede from each other: and unless it can be done with facility, they are not to be brought together, for much force employed in this case would occasion a stiffness of the knee-joints and lameness. The bandage sometimes employed in a transverse fracture of the patella is represented in fig. 65.

For the treatment of fractures of the leg,

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see the directions given above. When the bones of the tarsus, metatarsus, and toes, are fractured, it will be necessary to apply a splint to the fractured part, and in general a large one beside over the sole of the foot.

Fractures of the upper extremities. Fractures of the scapula are by no means common: they are ascertained by the touch, by the great pain of the part, and by an incapability of moving the arm. It is with difficulty that the parts are retained after replacement: a long roller is to be used, with which the shoulder is to be supported, and the arm is to be kept suspended, in order to relax the muscles.

A fracture of the humerus is generally easy of detection. When it has been reduced, two splints are to be employed, and a flannel or linen roller is to be applied gently over them. The arm is to be supported in a sling. In a few days, or a week, from the accident, it may be examined, to ascertain whether the broken ends have been properly adjusted.

In fractures of the fore-arm, whether one or both bones are broken, the joint of the elbow is to be gently bent. Two splints of pasteboard are to be used, one large and long, upon which the arm is to be laid, the other smaller, is to be placed over it, and they are to be secured by slight tapes, ribands, rollers, or the twelve-tailed bandage. (See fig. 63.) The arm, during the cure, is to be supported in a sling, with the palm of the hand towards the breast.

When the olecranon is fractured, the arm must be preserved in an extended state, by a long splint reaching from some way above the elbow-joint, down to the point of the fingers. The arm should be hung by, and connected to, the side. In little more than a week from the accident, the dressings are to be removed, and a slight motion given to the joints, in order to prevent anchyloses.

When the carpal bones are fractured, there is usually considerable inflammation, which must, as much as possible, be obviated by local applications: splints are to be employed as in fractures of the fore-arm, and the arm is to be supported in a sling.

In fractures of the metacarpus, a firm splint should be placed over the palm of the hand, which should be made to reach from the points of the fingers to the elbow. When a finger is broken, a splint of pasteboard, moistened and moulded into the form, is to be used; and a large roller may be applied all over the hand, in order to prevent the motion of the fractured finger.

Of fractures of the clavicle, ribs, sternum, and spine. A fractured clavicle may sometimes be perceived by feeling along the course of the bone. The motions of the shoulder-joint are likewise necessarily impeded. In reducing this fracture, the arm is to be raised, so as to bring the ends of the bones towards each other; and it is to be preserved in this position till union is accomplished.

When a rib is fractured, which may generally be ascertained by feeling with the fingers, if one portion rises over another it should be reduced by moderate pressure, and a bandage applied round the chest, which should be continued for some weeks. If a portion of the rib is forced inwards, some surgeons direct that an opening be made over the depressed part, which is to be elevated by the finger or forceps. When the sternum is fractured, a similar treatment is said to be required. In this last case it is necessary sometimes to trepan.

When the vertebræ are broken, the accident is for the most part fatal, and by the fractured pieces pressing upon the spinal marrow, a palsy is occasioned in the parts below the injury. The surgeon, however, is to attempt the replacement of the bones, and when part is depressed, an incision has been advised, in order to raise the depressed portion.

Of compound fractures.

Those fractures are called compound in which the external teguments are wounded, from the same accident by which the bone has been broken. These are necessarily of much more difficult management than cases of simple fracture. Some surgeons indeed have indiscriminately recommended amputation of the limb in every case of compound fracture; while others have questioned the propriety of amputating, even for the worst accidents of this kind. This question, like many others, has been agitated too much in the abstract. The propriety of immediate amputation, or a prior attempt to preserve a limb, will depend not merely on the extent of the injury, but on the age, habits, and constitution of the patient, as well as the circumstances which he shall be under during the cure. In the army or navy practice, amputation is often necessary, where in private it would be premature and cruel.

When we are to attempt the cure of a compound fracture, the first object is to remove such pieces of bone as are detached in the form of splinters, as well as other extraneous bodies. If there is merely a protrusion of the bone through the wound, without any separated pieces, we are to attempt an immediate reduction, as in simple fracture. If this cannot be effected even by pretty strong extension, an endeavour must be made to force in the bone by pressure. If, on account of the narrowness of the wound, it is impossible to reduce the fracture, the wound must be dilated by a straight probe-pointed bistoury. It is sometimes necessary to saw off part of the projecting bone, in order to effect the reduction. When this has been accomplished, the wound is to be closed as much as possible, a pledget of emollient ointment placed over it, and the limb secured by an eighteen-tailed bandage. In order to encourage adhesion, and prevent suppuration of the wound as much as may be, the limb without inordinate pressure should be supported as firmly as possible. When suppuration has come on, the limb is to be carefully dressed every morning. Indeed the chief business of the surgeon will be to preserve the wound clean and clear by regular washing and sponging, by laying clean lint upon it, and by the occasional use of spirituous application. It is scarcely necessary to add, that the patient's health must be supported with much care. While causes of irritation are avoided, a due excitement must be kept up. (See the section on wounds.)

Of luxations.

Dislocations, like fractures, are sometimes difficult immediately to discover. An incapability of moving the limb, pain, tension, a lengthening, shortening, or other deformity, and often considerable inflammation, are the general symptoms attending a dislocated or luxated bone.

Endeavours to reduce luxations ought to be made as speedily as possible: as they grow older, they grow more difficult of treatment. Indeed, after a bone has been a considerable time dislodged from its place, it often forms a new and artificial joint for itself among the contiguous muscles, and the subject of the accident is by consequence rendered irrecoverably lame. When, however, dislocation accompanies fracture, it is sometimes necessary to cure the latter before the reduction of the former is attempted. This is the case when the fracture is contiguous to the joint.

When much local inflammation accompanies luxation, it is to be carefully subdued by the common anti-inflammatory applications; and, according to circumstances, it will be sometimes requisite to bleed at the arm. When the luxation has been reduced, the parts must be retained in their situation, by placing the limb in a relaxed position, and by applying appropriate bandages.

Luxation of the superior extremities.

Of the os humeri. The shoulder-joint may be luxated by the head of the humerus falling downwards and backwards. The more usual kind of dislocation, however, is by the head being forced downwards and forwards. An upward luxation cannot happen without a fracture of the upper parts of the scapula. The signs of a dislocacted shoulder are inability to raise the arm, the head of the humerus being felt out of its proper place, while a vacuity is observed under the acromion.

This luxation is often extremely easy of reduction. The surgeon should be provided with assistants to extend the arm, by means, if necessary, of a belt, or any substitute for this placed round the arms, with long straps attached to it, by which to extend the limb: another assistant is to draw back the shoulder-blade, while the operator, standing on the outside of the arm, directs the extension according to the situation of the bone, and thus raises it into the socket. Sometimes, when assistants are not at hand, an arm-dislocation may be reduced by placing it on the knee, and thus acting as with a lever. The arm, especially if the patient has been subject to the accident, may be supported in a sling some time after the reduction.

Luxation at the elbow is not common; it is attended with a shortening of the fore arm, a projection behind above the elbow; while in the bend of the elbow the extremity of the humerus may be felt.

It is to be reduced by gradually extending the fore-arm rather in an oblique direction, and gently increasing the curvature of the elbow, and by endeavours to disengage the ends of the bones. After the reduction, the muscles should be relaxed by preserving the elbow for some time rather in a bent position.

When the fore-arm is dislocated at the wrist, the rotatory motion of the hand is prevented. After the bones are replaced, a tight flannel roller should be bound round the wrist, and the arm supported in a sling.

When the bones of the wrist are luxated, which is by no means a common accident, much pain and inflammation follows, and the motion of the joint is destroyed. The arm is to be supported, and but very gently extended, and the bones pushed into their proper position, which is to be preserved by bandages or splints. The metacarpal bones when dislocated are to be managed in a similar manner. When the thumb or fingers are dislocated, the phalanx is to be held by an assistant, while the surgeon elevates the dislocated end, and replaces it.

Luxations of the inferior extremities.

Dislocations of the thigh-bone are not very common. This bone is however susceptible of displacement in four different directions; upwards and obliquely backwards, downwards and a little forward, directly forward upon the pubes, and backwards over the ischiatic notch.

In the first the limb is shortened, and the knee turned inwards. When the neck of the thigh-bone is fractured (an accident which has been confounded with dislocation), the knee and foot are on the contrary directed outwards: the limb also in case of dislocation is moved with more difficulty than when the neck of the bone is fractured.

This dislocation is to be reduced by extension downwards and forwards. The patient is to be laid on his side, and a double sheet may be placed under his thigh, which being attached to some fixed points, will serve to raise and support the limb during the proper extension.

In a dislocation downwards and forwards, the signs are reversed; the head of the thigh-bone may here be distinctly felt in the perinæum. The extension in this case must have an upward and outward direction; its reduction is easier than in the preceding case. In returning the ball of the bone into the socket, the surgeon must be careful to act cautiously; too precipitate a reduction is apt to push it again out of its place, and produce an upward dislocation.

When the dislocation is forward upon the pubes, we are directed by some surgeons to lay the patient on his side, and support the thigh by means of a pulley fixed to some point above the limb: the operator thus assisted is to press the knee inwards. In the fourth kind of hip-dislocation (over the ischiatic notch) the length of the limb is not interfered with; but the accident may be ascertained by the disappearance of the trocanters. Here the reduction must be attempted, by giving the bone an upward direction, while the knee is pressed inwards. The limb should not be used for some days after the reduction.

The patalla can only be dislocated upwards and downwards by a rupture of its ligament or tendons; in this case the bone will be drawn up, and assume the appearance of fracture. It may however be luxated to one or the other side. For reduction, the limb must be extended; and in lateral luxations the edge of the bone at the greatest distance from the joint may be depressed, by which the opposite edge is elevated, and may be returned into its place.

The tibia is very seldom luxated at the knee-joint; when the accident happens, it is easily detected. In reducing such a dislocation, the limb should be gently extended, and the bones replaced by the hand. Inflammation ought, with much solicitude, to be guarded against.

Dislocations of the ancle-joint are very rare. Indeed they are scarcely possible without a fracture of the end of the fibula. In reduction an extension of the foot, even with the leg, should be made, till the bones are readjusted. Luxations of the tarsal bones are to be treated in a similar manner. When the metatarsal bones and toes are dislocated, the reduction is to be effected as in the metacarpus and fingers.

Luxations of the spine, coccyx, ribs, and clavicle.

In consequence of the firm ligamentous connection of the vertebral bones, dislocation seldom happens without fracture. When it does, it is almost invariably fatal. When the coccyx is displaced, it may be generally felt protruding. It is to be reduced by pressure with the fingers. This bone is sometimes forced inwards, and occasions much pain, tenesmus, and sometimes a suppression of urine. In this case the finger is to be introduced into the anus, and the pressure made outwards. Dislocations of the ribs are exceedingly uncommon. All that can be effected towards the reduction is to bend the body backwards, in order to press out the rib.

When the clavicle is dislocated the end projects forwards under the skin, near its common place of junction with the breast-bone. The reduction is to be made by pushing the protuded bone in with the fingers, while an assistant pulls back the arms and shoulders. The arm must afterwards be properly supported in a sling.

Luxations of the bones of the head and face.

When the cranial bones are separated, the head must be supported by a bandage. If one of the nasal bones is luxated inwards, it is to be elevated and reduced by inserting a tube into the nostril covered with lint. If the luxation is outward, the bone is to be pressed in by the fingers, and a double headed roller applied round the face. To reduce luxations of the lower jaw, which are not very unfrequent, the thumbs protected by a covering of leather, are to be thrust as far as possible between the jaws, and then the fingers being applied on the outside of the angle of the jaw, attempts should be made to bring it forward till it moves a little. It is then to be pressed forcibly down.

Of amputation.

Than this, as it is now performed, scarcely any operation in surgery is more simple and secure. To preserve the teguments, so as that they can be fairly brought over the stump, and properly to tie, or otherwise secure the bleeding vessels, constitute the points of practice in amputation; and, as we have previously shewn, rank among the most important improvements in modern surgical practice.

The following are the general directions for performing amputation: The tourniquet is first to be placed on the most convenient part of the limb for securing the larger arteries; a circular incision is then to be made with the amputating knife (fig. 71) or common scalpel, which is to pass all round the limb, and go through the skin and cellular substance; these are next to be dissected away from the muscles to such a distance as will allow the divided edges of the integuments to come into contact over the stump. The skin thus separated is to be drawn up from the muscles, or turned back upon them, and kept by an assistant in this situation, while the operator now makes another incision at the edge of the reflected skin, beginning from beneath, and cutting in a circular direction down to the bone. The muscles are then to be separated from the bone, as the skin before was from the muscles, to such a distance, as to enable them afterwards completely to cover the end of the bone. The whole mass of flesh is then to be kept up from the bone by retractors (fig. 72 and 73); the periosteum is to be divided all round in the place where the saw is to be applied, but not at all taken up from the bone: the saw (fig. 74) is now to be used, and the bone divided with long firm strokes, taking especial care that during this part of the operation the assistant holds the limb with steadiness. If there have been any splinters of bone left, they should be immediately taken away with pincers (fig. 75). The retractors are now to be removed; the principal arteries drawn up, and tied free from the nerves. Some warm wine, or other cordial, is to be given to the patient. The wound is to be cleared of blood, the muscles and skin are to be fairly laid together over the stump; adhesive plaster and the requisite bandaging applied, the patient taken to bed, and the wound treated in the common manner (see section on wounds). Unless any untoward circumstance arises, a complete cure will be thus made in the course of a few weeks.

After this general statement of the mode in which amputation is to be performed, we might now be expected, as in our accounts of fracture and luxation, to go over the separate parts which at different times come to be operated upon. Such minuteness, however, would be inconsistent with our plan and limits, and we shall merely observe, that in all cases of amputation the above rules apply; that the surgeon must be determined by his own judgment respecting the particular point at which a limb should be amputated; it will of course be regulated by contingencies, but as a leading rule it may be observed, what indeed is almost too obvious to require notice, that in general as much as possible of the limb should be preserved.

When joints, are to be operated upon in the way of amputation, further directions are necessary. Amputation at the larger joints ought indeed, in every instance, if possible, to be avoided; for a wound in a joint is, as we have already seen, invariably hazardous. When, however, in consequence of abscesses in these parts, compound fractures at the union of bones, caries, or other diseases, it becomes necessary to amputate at the joints, it will be necessary, after first securing the artery, to make a circular incision, as in common cases of amputation; then on each side of the limb another cut is to be made in a longitudinal direction, from the joint to the circular incision, and passing down to the bone; the ligaments of the joint are now to be divided, and the limb removed. If during the operation any branches of arteries have been divided, these are to be taken up or secured, the wound is to be cleared of blood, and the muscles and skin brought neatly and fairly together. The union is to be effected by adhesive plaster and by proper bandages.

Wounds or injuries of the head.

Among many erroneous and unfounded opinions, this is by no means the most uncommon; that wounds of the head are dangerous in proportion to the degree and extent in which the skull is fractured. "It is the injury of the brain alone which is dangerous," and "very often are so close, the connection and sympathy of all the external and internal parts, that the brain is hurt by the very slightest injury of the scalp or bone," while the skull may be extensively injured, and the accident be comparatively trivial. Affections of the brain from blows or wounds of the head, are immediate or secondary; the last are those which do not directly follow the injury from which they proceed, but "make their slow insidious progress in the form of a disease." They are insidious, because they frequently arise to an alarming extent in consequence of a hurt which was at first deemed slight, and scarcely deserving of notice. They are slow: for a man, after receiving such an injury, shall perhaps continue in seemingly perfect health for more than a month, and shall at length fall a victim to the disorder, which has all this time lain as it were in embryo.

"One soldier, for example, shall have his temple grazed with a ball, shall hardly know that he is hurt, or be sensible for some time that he is indisposed; shall walk about for six weeks apparently in perfect health, and then all at once shall droop and fall low, become sick and weak; shall at last fall into coma, or awaken in the most dreadful struggling delirium, and then expire: and it shall be found, that the pericranium is separated from the skull, the skull itself black, and the dura mater inflamed and oppressed with pus. While, on the other hand, another soldier in the same battle shall be so wounded with a sabre, that the scalp, scull and all, shall be cut clean away with a wound even of the brain itself, and yet the patient escape; or which is more singular, a soldier wounded with a musket-ball, which is left sticking in the skull, with much depression, and many fractures of the bone, shall come to the hospital walking alone, shall suffer the extraction of the ball, and all the incisions and pickings of the bone which such a case requires; and shall eat and drink heartily, sleep soundly, and suffer not one bad symptom during the cure."

Most commonly, however, even in these secondary affections of the brain, a certain degree of sickness, faintness, and stupor, immediately follows the stroke, the blow, or the fall, upon the head. From this state the man revives very slowly; at length seems to have regained his health, but after the lapse of some weeks perhaps, the faintness, sickness, and giddiness, recur; then come on fever, delirium, weight or pain in the head, and every sign denoting a low inflammation of the brain; this state at length comes to be succeeded by paralysis, insensibility, and death.

This disorder "is plainly a diseased dura mater, and an abscess of the brain," almost sufficiently evidenced by the progress of the symptoms, but rendered doubtless when on the surface of the skull arises "a small, soft, puffy, regularly circumscribed tumour," not of the erysipelatous kind, for that denotes a mere affection of the scalp, nor a soft and fluctuating tumour, for this may proceed from blood poured out from one of the cranial arteries.

"The trepan is in this case almost a hopeless operation, and yet it is to be tried." The intention of operating under these circumstances is, to discharge that matter which collected either between the dura mater and skull, or between this membrane and the actual substance of the brain, gives rise to all the distressing and alarming symptoms. When this last is the case, it will be found necessary, not merely to trepan the skull, but to pierce the membrane. Such an operation will usually for a time lessen the patient's sufferings; "but often he is again oppressed, and sinks and dies; or if he lives, great fungi sooner or later shoot up through the opening, and by these, as well as by blood or matter, he is at last oppressed, and dies commonly in convulsions."

The danger in this last case seems to depend upon the exposure of the brain by the operation; the surgeon then will be careful not to multiply openings for the discharge of matter, "for the danger on one hand, viz. by oppression and inflammation of the brain, is just proportioned to the delay in opening the head: and on the other hand the danger after the operation is just proportioned to the number of holes."

The immediate injuries of the brain, as opposed to the secondary affections above described, are divided by surgical writers into those of compression and concussion.

A man, for example, receives a violent blow upon his skull, which by its force shall press in part of the bony defence of the brain directly upon the substance of this organ: he immediately falls down in a state of stupefaction; his pulse and breathing are oppressed, and he is carried off insensible. Now all this injury may arise from a fracture of the skull, when the fractured bone is pushed in upon the brain; or it may succeed to a similar degree of depression of any part of the cranium, even although not the smallest degree of fracture shall have been occasioned; indeed the fracture is not seldom a favourable circumstance. In either case the affections which follow result from compression.

Concussion is a kind of injury more obscure in its theory, but not less fatal in its consequences. It is an internal derangement of the brain, or of the nervous system, which dissection cannot trace, and which appears to be a shock to the whole, rather than an injury to any particular part of the organization.

In the former case, that of compression, relief may be expected from operation, but there is neither motive nor use in operating for concussion. In some instances of the former, blood-letting is imperiously called for; in the latter, to bleed is inevitably to increase the disease.

It is therefore absolutely necessary to decide early respecting the precise nature of the injury. This decision, however, is not in every case easy even to the surgeon who may have had frequent opportunities of comparative observation. Most of the symptoms which attend compression likewise accompany concussions; and the existence of depressed bone, which must form, at least in part, a case of compression, is not always to be detected by external examination.

In cases of an equivocal or undecided nature, where it is imagined that compression may exist, although it is not perceptible, it has been advised by a modern surgeon to trepan in many different parts of the skull, in order to ascertain and remove the cause producing the symptoms. "It often happens," says Mr. Benjamin Bell, "that no external mark is to be met with to lead to the seat of the injury; even after the whole head is shaved, and examined with the most minute attention, the skin will in various instances be found perfectly sound, without any appearance either of tumour or discolouration. A patient in such circumstances we suppose to be in great hazard, from the brain being compressed in one part or another; unless this compression is removed by an operation, he must, in all probability, die. In what manner then is a practitioner to conduct himself? The situation is distressing; but still, in my opinion, there should be no hesitation as to the line of conduct a surgeon ought to pursue, which should be quite the reverse of what is almost universally adopted." This author, in another place, adds, "it will be proper to perform the first perforation in the most inferior part of the cranium, in which it can with any propriety be made; and to proceed to perforate every accessible part of the skull, till the cause of the compression is discovered." Benj. Bell's System of Surgery.

In cautioning against such practice as is here recommended, we appeal to the unprejudiced judgment of the reader, under the sanction of high authority. It is observed by the celebrated Pott, "that symptoms of oppression are no good reason for cutting the integuments." And Mr. J. Bell, in his comment upon the above observations, thus addresses his readers: "I must in a few words entreat you to consider whither this practice would lead you. A boy is struck by another with a stone, lies for many days bleeding at the nose, comatose, vomiting, and with every bad symptom; his surgeons are all the while advising the operation, his friends are pleading for a respite, when the boy begins gradually to recover, and in a few days is perfectly restored. Consider," our author goes on to say, "if in any given case, the patient lying oppressed, and having no mark of injury outwardly upon the head, you should advise the trepan; while a man who had studied more the common sense of surgery than the authorities of school-books, should prevent this unmeaning operation; and if in the mean time the patient should be entirely relieved, what would become of you? Or if you should be allowed to perform the operation, and were to find nothing wrong, what consolation would that be?"

Indeed while there is but one motive for applying the trepan, viz. to relieve the brain from compression, whether that is from blood, matter, or depressed bone, the principal care of the surgeon ought to be, not to perforate the cranium upon the mere suspicion "of something lying somewhere," but on the contrary, to be ever wary of doing too much, rather than fearful of effecting too little, in the way of operation.

We cannot better conclude this subject, than by again extracting the rules of practice from an author, whom, from a sense of the rectitude and value of his doctrines and precepts, we have often taken so much pleasure in quoting. "If," says Mr. J. Bell, "there is an injury in the scalp, a hurt of the skull, an internal separation of the dura mater, or any injury which endangers inflammation of the brain; and if along with that kind of danger there are actually symptoms which mark inflammation of the brain; we try to prevent or moderate the inflammation by bleedings. If there is a concussion, and the patient lies oppressed, vomiting, with difficult breathing and a slow pulse, (and this, it may be observed, is the most frequent, direct, or immediate injury from a blow or fall on the head,) we give opium, wine, and all forms of stimulants. If there are along with this oppression external marks of injury after an accident, such as might cause extravasation of blood, or depression of the skull, in such case our duty is first to open the scalp, so as to examine the skull, and next to trepan the skull, if it is not sound, with the hopes of relieving the brain.' "If there is blood, it is to be known only by guess, by having opened the scalp at the place of the blow, in the expectation of finding a fracture of the skull, and by next trepanning the skull, in hopes of finding blood lying upon the surface of the brain. But still, if after opening the skull the patient should lie comatose and oppressed, it being plain he must die if not relieved; and if also from the tension of the dura mater we suspect there is blood under that membrane; we must venture to open it also, in hopes of relieving the brain. If matter lying upon the surface is the cause of compression, it will be known by the previous symptoms, by quickness of the pulse, head-ache, flushed face, turgid eyes, corded feeling in the head, and all the other signs marking an inflammation of the brain. And if after all these symptoms, shivering, languor, faintings, slight vomitings, and delirium, come on, we are sure of the case. If there is found a fissure of the skull, that fissure is not itself the cause of danger, but it is the mark of that degree of injury which may have produced extravasation: it also marks the place of the violence, and points out where we should apply the trepan. A fissure is not of itself a motive for trepanning the skull; but if with the fissure the patient lies oppressed, then the oppression is the mark of danger, perhaps from extravasated blood, and the fracture or fissure of the skull marks the point on which we should apply our trepan.

"When the bones are directly pressed down by the blow, our way of proceeding is very plain; if the bones are moveable, we raise them gently up; if they seem totally disengaged, we pick them away; if the bones are locked in with one another, and pressed under the sound skull, we cut one angle with the trepan, and that enables us to raise the depressed bone. In all this operation we should be gentle, and rather reserved; for when blood has covered the whole skull, from the sagittal suture, quite to the petrous bone, it has all been evacuated by one single opening, and the patient saved. When there has been pus generated in great quantity, and much of the dura mater detached, one single perforation has been sufficient. When pieces of skull have been apparently so detached from their membranes, that they have seemed irretrievably lost, they have notwithstanding lived and healed, especially in young patients; and often when the depression has seemed so great that the surgeon has neglected to raise it, or has been so difficult to raise that he has forsaken it, the patient has lived notwithstanding the great oppression, and been restored to perfect health."

Operation. The operation of trepanning will necessarily vary, according to the circumstances of the case; the following are given as the general rules of practice: After the head is shaved, an incision is first to be made through the integuments, in such a form as to enable the surgeon, when the operation is over, to bring the edges of the wound as nearly as possible together; when the part has been fixed upon for the application of the instrument, so much of the skull is to be denuded of its pericranium by a raspatory, (fig. 13) as will allow the trephine (fig. 14) to be fixed; a hole is to be made with the perforator, of sufficient depth to fix the central pin of the trephine, that the saw may be prevented from slipping; when the saw works steadily and securely, the central pin of the trephine may be removed; the saw is from time to time to be taken out of the groove, and cleaned by the brush (fig. 15.). During the progress of the operation, the depth of the groove ought to be examined; if one part is of greater depth than another, the pressure of the saw is to be made principally on the opposite side. The operator must often examine whether the piece is loose; when it is perceived so, it must be snapped away by the forceps (fig. 16.) or levator (fig. 17), for the sawing should by no means be continued until it is quite detached, lest the membranes of the brain are injured. When, after the piece of bone is extracted, the inner edges of the perforation appear ragged, they are to be carefully smoothed by the lenticular (fig. 18). The depressed portion of the bone is now to be raised with the levator: if there are any parts of bone totally disengaged, they are to be picked away, extravased blood let out; and, as above-mentioned, if blood or matter is contained under the dura mater, this membrane itself is to be punctured. From the extent of the fracture or depression, it is sometimes necessary to make more than one perforation: in these cases they ought to be made to run into each other, in order to prevent the necessity of dividing intermediate spaces. After the objects of the operation are accomplished, a pledget of lint, either dry or with some simple ointment, is to be laid on the wound in the dura mater (provided that membrane may have been punctured): the edges of the scalp are then to be brought up as nearly as may be together, and another piece of lint laid along the outer wound; some fine linen is to be placed over the whole, and the parts secured by proper bandaging, or by a common night-cap.

At every dressing the purulent matter is to be carefully absorbed by a sponge: the wound is to be treated upon the same principles as wounds in general; and should fungi arise out of its edges, we are, according to their nature and extent, to attempt their removal by caustic, by excision, or ligature.

Of inflammation, its characters and varieties.

Inflammation may be divided into ordinary, constitutional, and specific; the first dependant for its production upon those susceptibilities which in a greater or inferior degree are common to every individual, the second proceeding from a peculiar tendency to disorder in some constitutions, the last always arising from the application of a particular exciting cause.

For example. To that kind of vascular irritation which constitutes the inflamed state, and which has been the subject of inquiry in another place (see MEDICINE, Sect. *Phlegmasiæ*), all are obnoxious, provided the exciting cause acts with sufficient power: but those inflammations that are called scrophulous, although immediately excited by the same powers which are productive of common inflammatory action, will not in all individuals follow upon the application of such powers; such then furnish examples of constitutional inflammations. As an instance of the third or specific inflammation, we may adduce the venereal disease, either in its first introduction into the system, or in several of its secondary stages.

As all these disordered states have something in common, while at the same time each is distinguished by its separate characteristic, so the rules of treatment in relation to them are both general and particular. Thus the observations which apply to the management of a common abscess (the result of inflammation), apply likewise, to a certain extent, to one resulting from the venereal virus, while the requistions of this last are further regulated by the peculiarity of its exciting agent.

We shall first then treat of common, secondly of constitutional, thirdly of specific, inflammations. For the symptoms, progress, termination, and medical treatment of inflammation, consult MEDICINE. It is the simple surgery of this disorder alone that remains to be noticed. The local applications suited to the repulsion, or, as it is technically expressed, resolution of an inflamed surface, when the inflammation is of the active or sthenic kind, are the different preparations of lead dissolved in vinegar, mild expressed oils, or simple ointment. The first of these is often most conveniently employed in the shape of cataplasm, made by mixing the dissolved lead, Goulard's extract for example, with crumbs of bread. This application ought to be constantly renewed, and kept on the part cool. Lead is sometimes applied in combination with simple ointment; this, however, is not in general eligible, as the action of the lead is in some degree blunted by uniting it with oily or unctuous substances.

Local blood-letting by leeches, or by cupping and scarifying, is sometimes necessary, in order to reduce the inflamed state; and all heating, or otherwise irritating, applications to the diseased part, are to be assiduously guarded against.

In passive, asthenic, or indolent affections of the inflammatory kind, it is sometimes necessary, even while the inflammation continues in its first stage, to treat the complaint with local as well as general stimuli. In these cases we avoid cold applications, leeches, saturnine preparations, &c. and order warm and large poultices, made with linseed and oil, frequently renewed, fomentations, the infusion of white poppy, or of chamomile flowers, and sometimes even volatile embrocations.

When the suppurative stage of active inflammation has commenced, the repellent applications are likewise immediately to be laid aside. Action is now not to be checked, but encouraged; warm fomentations are to be applied; poultices made with bread and milk, with a small quantity of lard or simple ointment, are to be resorted to; these are to be laid upon the part soft and warm, and very frequently to be renewed. Sometimes when the suppurative process seems too tardy and indolent, it may be necessary to add to the poultices some of the heating or stimulating gums, such as galbanum, which may be made to unite with the poultice, by dissolving it in the white of an egg.

The completion of the suppurative process, or the full formation of abscess, is known by the cessation of throbbing, and other symptoms of suppuration, and by the pointing of the tumour, as well as its change of colour from a whitish or yellowish appearance. Sometimes when the tumour is not deep seated, the fluctuation of matter is evident.

The methods of opening abscess are by caustic, by incision, or by seton: the first, although still employed in some species of tumour, is at present by no means in common use; it is more painful and insecure than the mode by incision. When caustic is employed, a piece of sticking-plaster is to be laid on the tumour, with a hole cut into it, into which the caustic is to be introduced, and retained by plaster and bandage, until it has made an opening through the integuments of the tumour, which, generally, will not be till some hours after its application. When an eschar is formed, some emollient ointment is to be employed to soften and separate it.

When the knife is employed, all that is necessary to attend to is, to avoid any considerable blood vessels, to make the opening large enough to give free outlet to the matter, and at the most depending part of the swelling.

When a seton is used, such an instrument as represented in fig. 1, may be threaded with glovers' silk, inserted at the upper part of the tumour, and passed out at the under; and the matter of the abscess thus allowed gradually to discharge itself. Dry lint, changed once or twice a day, is the only dressing necessary in a common abscess.

When an inflamed part, instead of thus passing on into suppuration, becomes gangrenous, the external applications are required to be of a stimulating nature; such as solutions of sal-ammoniac, &c. in general, however, the arresting of gangrene is to be trusted to internal invigorating powers, and keeping the part clear and clean. When mortified parts lie deep, and are not thrown off by the living energy of the surrounding surface, it is often necessary to make incisions into the skin for the purpose of removing them.

Of ulcer. When the ischar or mortified part has been separated, the sore remains in the form of a simple purulent ulcer, which is one of the most common objects of surgical practice, the treatment of which is entirely resolvable into the means of assisting nature in her endeavours to procure proper and healthy granulations of new flesh, in preventing morbid luxuriancy, and disposing to an even and clear cicatrization. Various methods have been had recourse to, in order to accomplish these objects, such as turpentine, warm stimulating ointments, in conjunction with mercurial preparations; as an example of which, and as the best application of the kind, we may notice the common basilicon ointment of the shops, with the red-precipitate powder. But the management of obstinate ulcers has recently been abundantly facilitated by the employment of simple adhesive plaster, which is cut into strips, and laid carefully, firmly, and neatly, over the whole ulcerated surface; these, where it can be used, to be assisted by bandage. This practice was first generally introduced by Mr. Baynton, and has, with justice, been ranked among the highest improvements in modern surgery. At every dressing of an ulcer thus treated, the sore is first to be cleansed by sponge and warm water; if, notwithstanding the uniform pressure of the plasters, fungous excrescences arise, they may be touched, when dressed, with some kind of escharotic; the edges of the ulcerated surface are then to be brought up as near together as the loss of substance will admit of; and the strips of adhesive plaster separately passed over the sore, till it is entirely covered. Over this dressing common cerate spread on linen may be laid, and the bandages then applied. When the ulcer is attended with much inflammation and swelling, the management of it for a time is to be solely entrusted to warm and stimulative poultices. One of the most efficacious materials of which these may be constituted, and one of the best applications to obstinate ulcers of the leg, which are often attended with erysipalatous inflammation, is the grounds of stale beer.

Thus far of ordinary inflammation and its consequences: we now proceed to treat of this state as connected with, or modified by, a peculiarity of constitutional disposition. These kinds of inflammation are peculiar in their nature, and confined to certain parts of the system. Thus, inflammatory disorders of a scrophulous kind invariably affect secretory surfaces and cancerous inflammations, which are nearly allied to scrophulous, arise always in glandular parts. Suppose, for example, the breast of a female to be subjected to the causes of inflammation, the operation of such causes, if applied at a certain time of life, or under circumstances of cancerous predisposition, will end in the production of true cancer; the nature of the inflammation from the first being peculiar: while under circumstances of freedom from the cancerous tendency, an equal degree of actual inflammation may prevail in the breast, without having any peculiarity in its nature and progress, or without demanding a specific mode of treatment. Further, even in an individual predisposed to cancer, inflammation of a part which is not glandular, will, by consequence, not be cancerous. What, therefore, we have denominated constitutional inflammations, are inflammations of certain parts, and thus branch out into distinct diseases. We shall here only notice the two principal inflammations from a scrophulous diathesis, although every secretory surface is obnoxious to the affection; these are white-swelling of the knee joint, and lumbar, psoas abscess.

White-swelling. This disorder is most frequent in the knee joint, and indeed the name is usually made to denote a disease of this part.

Symptoms. Pain in the joint, especially on motion, or, when it is in a bent position, swelling, which gradually augments, with an enlargement and varicose appearance of the cuticular veins; while the joint swells, the parts below become either diminished or affected with an œdematous enlargement, partial suppurations, which break and form abscesses at different points; gradual decline of the patient's health, hectic fever. Sometimes the pain is more confined, and it is often then more acute; at other times the pain and swelling are from the first diffused through the whole extent of the joint.

Causes. White-swelling is a scrophulous inflammation. In those cases in which the enlargement of the joint commences with the pain, the pain itself being more diffused, the primary affection seems to be an inflamed state of the capsular ligament; in other cases the disease is perhaps originally seated in the bones. Mr. B. Bell has described these different species by the names of rheumatic and scrophulous; but the fact is, that they both depend upon the scrophulous diathesis; and it has been well observed by an able writer, "that between acute rheumatism and white-swelling, there is no sort of analogy, neither as to their causes, their symptoms, their terminations, their proper method of cure, nor any thing else." Dr. Herdman on White-Swelling.

Treatment. Both in the medical and surgical treatment of all scrophulous inflammations, it must be recollected that they partake more of the asthenic than the opposite character. Thus in white-swelling, however violent the inflammation, or urgent the pain, blood-letting, general or local, is seldom or never advisable. Blisters, warm fomentations, and bathing, volatile liniment, the counter irritation of caustic issues, mercurial friction, nourishing, but not irritating, diet, good air. When suppuration has taken place, "soft and easy dressings," warm poultices, small doses of calomel with opium. Cicuta? Amputation of the limb, which is often the only resource of the surgeon, yet it is not indiscriminately advisable, on account of the patient being, in some instances, too feeble and diseased to admit of the operation.

Of lumbar or psoas abscess.

Symptoms. Pain in the loins, which does not, as in lumbago, affect the muscles of the loins generally, but passes rather upwards in the direction of the spine, and downwards in an oblique direction, towards the inner part of the thigh. After the existence of this pain, for a longer or shorter period, marks of suppuration come on, and a tumour gradually appears in the groin. This is to be distinguished from hernia by a recollection of the preceding symptoms, and by the flaccidity and fluctuating feel of the swelling.

Causes and seat. This disease appears to be an inflammatory affection of the vertebral ligaments, occasioned by sudden alterations of temperature, blows, or any violence done to the part, and other causes of inflammation. It terminates in suppuration, which runs along the sheath of the psoas muscle, and thus appears in the groin.

Treatment. This, to be effectual, ought to commence with the commencement of the disease. When matter has formed to any extent, the malady is highly dangerous. Blisters to the loins, volatile embrocations; very small doses of calomel, with opium or hyoscyamus. When a tumour has formed in the thigh, which continues to increase, it is to be opened. During the subsequent discharge, the patient's strength is to be carefully supported, by nourishing diet, wine, opium, bark, and pure air.

Of cancer. Cancers, previously to their appearing in the form of ulcer, are termed occult. An occult cancer is a schirrous swelling of a gland, attended with lancinating pains, which state of parts often exists for some time before ulceration or open cancer is produced; this last, however, sometimes appears without any previous schirrosity. The symptoms of cancer will be best described by tracing the usual progress of a cancerous breast. A small knotty tumour is generally first perceived on some part of the mamma; this continues nearly in the same state, perhaps, for some months: it at length increases, and a pain is felt to proceed from it towards the axilla; the integuments gradually become discoloured, and at length ulceration is formed.

Causes and peculiarities. There has been much dispute whether cancer be a disease of parts merely, or of the system: all, however, that ought to be understood respecting the general nature of cancer, is, that a susceptibility, as we have above endeavoured to explain, exists in some habits, and especially at certain periods of life, to this malady, which in such habits may be induced by the same causes which occasion common inflammation. The usual time for the formation of cancerous mamma is when the menses disappear. Previous to this period, swellings of the breast assume more of the scrophulous character.

Treatment. Cicuta has been much extolled as a remedy for schirrus; faith in its virtues are, however, gradually declining. It may be combined with small doses of calomel. Mercurial ointment to the part, volatile embrocations, not too stimulating. Lac assafœtida has been employed as a lotion in occult cancer with seeming benefit. If the disease advance, no cure can be expected but from operation, which should be had recourse to early, previously to the extension of the disease into the contiguous glands.

Operation. If the skin be sound, a longitudinal or transverse incision, according to the shape of the tumour, is to be made with the scalpel along its whole length, at a small distance from the nipple; this incision is to pass through the skin and cellular substance, and while the patient's arm is extended, the mamma is to be carefully dissected from the integuments and pectoral muscle; all the glandular substance should be detached, although only a part be the seat of the disease. In closing the integuments after the completion of the operation, the twisted suture may be employed, assisted by straps of adhesive plaster; a pledget of simple ointment is to be laid over the part, covered by soft linen or tow, and the dressings are to be retained by appropriate bandage.

When the operation is performed, after the existence of the disease for some time in an open state, it will often be necessary to cut away a considerable portion of integument: the incision may, in this case, be made of an oval form; and if the axillary glands be found schirrous, the scalpel should be carried on full into the arm-pit, and the indurated bodies carefully dissected out. When the operation is over, the divided edges are to be brought up as nearly together as possible, and dressings and bandages applied, as in other similar wounds.

Venereal affection.

The venereal disease is an example of that species of inflammation which we have called specific. It appears in two forms. To the one is more generally applied the denomination of syphilis; the other is called gonorrhœa virulenta. These affections are imagined by some to originate from the same specific poison; by others, the cause productive of true syphilis, and that occasioning gonorrhœa, are supposed to be of a different kind. This last is perhaps the best founded opinion, viz. that the matter which, applied to the genital organs, produces a discharge from the urethra, called gonorrhœa, is not capable, under any circumstances, of producing true venereal chancre.

Symptoms of gonorrhœa. A peculiar itching and smarting sensation about the extremity of the urethra, attended with some feeling of stricture or tightness; this is succeeded by the appearance of mucus about the extremity of the penis, which soon increases in quantity: it is generally of a brown appearance, is attended with more or less smarting upon discharging the urine, and with nocturnal erections. Sometimes the lymphatic glands of one or both groins become inflamed, enlarged, and thus form bubo. The time at which the symptoms of gonorrhœa make their appearance is variable: sometimes the disorder will follow impure coition in the space of a few hours; at others it will be several days.

Treatment. In the first and inflammatory stages, demulcents largely drank, such as decoction of linseed, solution of gum arabic, tragacanth, &c. Mild purgatives, such as manna and senna. Opiates at night. Bathe the penis in warm milk and water. Saturnine lotions. If from the too precipitate or early use of astringent injections, or from other causes, the inflammation extends itself to the testicle, causing pain and swelling of this part (hernia humoralis), the scrotum is to be supported by bandage. Leeches are to be applied should the inflammation be violent, and the testicles are to be preserved constantly moistened with a solution of sugar of lead, or some other saturnine preparation. For the swelled glands, friction with mercurial or common ointment and camphor. Volatile embrocation. If the inflammation cannot be repelled, the suppurative process to be solicited by bread and milk poultices. If every symptom of the disorder go off, with the exception of a white mucous discharge from the urethra, which continues notwithstanding the use of astringent injections, give tincture of cantharides in gradually augmented doses, which will be for the most part found more efficacious than the balsams generally employed for this purpose. Should still the discharge continue, and, from the unusual appearance in the stream of urine, a stricture in some part or parts be suspected, introduce bougies.

Symptoms of syphilis. True syphilis is perhaps invariably introduced into the system through the medium of chancre, unless in cases where it is transmitted from parents to children. Chancre is a small ulcerated sore, occasioned always by contact or coition. This, when it appears on the penis, is frequently followed by an inflammation and enlargement of one or both groins; these, if neglected, pass on to suppuration; ulcers on the tonsils succeed, with eruptions of the skin, especially about the roots of the hair; at length come on pains in the bones, which are often highly excruciating, and although sometimes taken for, are to be distinguished from, rheumatic swellings, by their being rather in the centre of the bones, and deep seated, than in the joints, and superficial; by their not being accompanied with fever equivalent to the violence of the pain; by the absence of that general swelling of the soft parts which attends rheumatism, and sometimes by a circumscribed swelling extremely painful growing up from the bone. When any doubt exists respecting the nature of those ulcers in the tonsils, throat, &c. which are suspected to be venereal, they may generally be decided such by their peculiar coppery appearance: they are likewise, in general, more circumscribed than other ulcers, and their edges have a peculiar callosity.

Treatment. Mercurials given in such a form, and in such quantity, that what is called an alterative kind of action shall be for some length of time maintained in the system, without occasioning salivation, is an effect from mercury, which appears always to defeat its own object. Chancres on the penis may, if the application be made to them a very short time after their production, be totally destroyed by caustic, and the absorption of the virus and consequent disease thus prevented. When the swellings in the groin are first perceived, they are to be kept from enlarging by the vigorous application of mercurial ointment, which, if not inconvenient, is perhaps the best and surest mode of introducing this medicine into the general habit. For other preparations of mercury, see MATERIA MEDICA and PHARMACY. With respect to the time of continuing mercury, it may perhaps be laid down as a general rule, not to discontinue the medicine until two or three weeks after the apparent discontinuance of the disorder. Secondary affections, from the venereal action not having in the first instance been entirely subdued, are extremely frequent, and are always formidable. Opiates, sarsaparilla, and, recently, nitrous acid, have each been judged specifics for venereal affection; but it is now pretty generally supposed that they merely act as auxiliaries to mercurials.

There are some other affections that were not noticed in the article MEDICINE, which depend upon a specific poison, and which, though constituted by a species of cutaneous inflammation, are not, like the exanthemata of authors, preceded or accompanied by febrile irritation. The cutaneous eruptions which require to be noticed here, are the annulus repens, the tinea, and psora.

Annulus repens, ring-worm. This is a

prurient eruption formed in a circle; it affects children, and is thought to be constituted by small insects. These animalculæ Dr. Darwin supposes may be rather the effect than the cause of the eruption.

Treatment. Metallic or vegetable astringents in solution, such as nut-galls or white vitriol. The white precipitate ointment is perhaps equal, if not superior, in efficacy, both in this and the two following complaints; the head to be covered during the cure with an oil-skin cap.

Tinea, scald head. This eruption commonly breaks out about the roots of the hair; it appears in small ulcers, which at times spread over the whole head, and produce friable crusts.

The secretion of the contagious matter, upon which this disorder depends, is generally excited by poverty of diet, uncleanliness, and other mismanagement of infants.

Treatment. Shave the head; wash the surface first with warm water and soap; white precipitate ointment; tar ointment; a solution of corrosive sublimate; generous diet, cleanliness; small doses of calomel.

N. B. A milder disease than tinea often breaks out on the face and head of very young children: this (crusta lactea) is not infectious. It is to be treated by keeping the child clean, cool, and much in the air; and by sprinkling the eruption with calamine powder, if necessary, which is likewise the best application to those excoriations of the skin which are apt to break out about the genitals of infants.

Psora, itch. "Small pustules with watery heads, appearing first on the wrists and between the fingers." "There are two kinds of itch, that which appears between the fingers and the joints of the knees and elbows, and that which is seldom seen in these places, but all over the other parts of the body. The latter is seldom thought to be the itch, as it does not easily infect even a bedfellow, and resists the usual means of cure by brimstone." Darwin.

Treatment. Sulphur ointment; mercurial corrosive sublimate in a very weak solution; white precipitate ointment; sulphur taken internally.

Of indolent tumour.

Tumours which are not necessarily or in their origin attended by inflammation, are called indolent; these morbid enlargements of parts are principally seated in the cellular membrane: they are differently named, according to the nature of their contents. When the swelling is made up of a substance of the consistence of fat, it is denominated steatomatous; if of a firmer consistence, a sarcomatous tumour. When it is filled with a substance about the consistence of honey, the enlargement has been called a meliceratory tumour. The name artheromatous is applied to those swellings which are constituted by a substance of a harder kind. Sometimes the contents of tumours are formed of a coagulable fluid, when they are termed hydatids. Ganglions are swellings in the bursæ mueosæ of joints.

These tumours may be removed by making an opening with a lancet, if their contents be of a fluid nature, evacuating such fluid, and afterwards removing their sac. If the contents of the tumour are solid, they are to be extirpated by making a longitudinal incision through the integuments, and removing the tumour by the point of the finger, or any convenient instrument that is blunt.

Of nævi materni, corns, warts, and polypi.

When those marks on infants which are fancifully attributed to impressions made on the mind of the mother during pregnancy, do not rise above the level of the skin, they are not of course the subjects of surgical operation. Sometimes, however, these appear in the form of sarcomatous tumours, firm, prominent, and fleshy: in these cases the swelling may be cut out. If any considerable arteries run into it, these are to be taken up, and the skin that remains, brought over and united by adhesive plaister. If the tumour be connected with the sound parts by a narrow neck, it will generally be advisable to destroy it by making a ligature round its neck.

Corns are formed by a thickening and hardening of the external skin from pressure. They are to be treated by first bathing the feet in warm water, and then paring off as much of the swelling as can be done without giving pain. This operation is to be frequently repeated; some simple ointment may be laid over the corn, and all pressure avoided as much as possible.

Warts are to be removed by applying to them frequently any mild escharotics, such as a solution of blue vitriol, of crude sal ammoniac, &c. Sometimes astringent substances will make them subside, such as nutgalls: hence the common practice of applying ink to these excrescences.

Polypi are indolent tumours found in various parts of the body, as the nose, mouth, throat, vagina, uterus, and rectum. When, notwithstanding the use of astringent solutions, such as of alum, vinegar, &c. they continue to grow, become painful and troublesome, they are to be extirpated by the knife or scissars, when the roots of the tumour can be commanded, otherwise by tearing them up with forceps, fig. 3.; or, which is much less painful, while it is more secure, by ligature, of wire, of catgut, of silk, &c. The ligature is to be passed double over the tumour, and carried to its root by the fingers, split probes, fig. 4. or rings, fig. 5. The ends of the ligature are to be now introduced into a canula, fig. 6. which is to be pushed along the opposite side of the tumour, till its end reach the root of it, when the ligature is to be drawn with some tightness, and fastened to the canula, which is to remain in the passage; the ligature is to be daily tightened till the polypus drop off. When the polypus is in the throat, the ligature should be applied through one of the nostrils.

Diseases of the bones.

Bones, like the soft parts, are subject to inflammation, which often terminates in caries, or a kind of gangrene, forming the disease called spina ventosa, or gagræna ossis. This seems to be a scrophulous affection.

Symptoms of spina ventosa. Dull heavy pain following perhaps a blow on the part, or originating without any perceptible exciting cause; lameness and sensation of weight in the affected limb: after the continuance of these ymptoms for some time, without any appearance externally to indicate disease, the integuments, suddenly perhaps, will become pained and swelled. This arises from the matter having made its way through from the interior of the bone to the periosteum.

Treatment. After the abscess has been opened, let the parts be kept constantly clean and dry. In some cases it is necessary to apply the trephine, in order to remove the part of the bone that has become carious. Assiduously attend to the restoration and preservation of the constitutional excitement and health. Bark, steel, very small doses of calomel, good air, nourishing diet, chiefly of animal food.

The friabilitas and mollities ossium. The one disorder constituted by a disposition in the bones to be broken or injured from the most trifling exertion; the other, by a want of due firmness and hardness in the bone, are occasioned by disordered action in the secretory or absorbent vessels of these organs. They are alone to be remedied by internal strengthening remedies, suited to the nature of the prevailing malady.

The venereal node, as to its immediate cause, is obscure; the external swelling, with which after a time it is characterized, appears to be occasioned by an extension of the periosteum. Sometimes the pain of these tumours is mitigated by dividing the periosteum.

Among the diseases of the bones is often classed an affection which is very common, especially to young children, viz. a loss of power in the lower extremities, consequent upon a displacement of some part of the boney column of the spine. This, in fact, appears to be a disease of the ligaments. The frequency of this complaint in young children it is important to recollect, as the treatment, to be effectual, ought to commence early, and in its origin. Unless attended to with care, it is apt to be mistaken for a nervous or common infantile indisposition.

Symptoms. An unusual backwardness in walking, languor, listlessness, a tendency to hectic, and lastly, a feeling of protuberance or curvature in some of the spine.

Treatment. A seton in the back near to the disordered prominence, chalybeates, small doses of calomel, as in other scrophulous affections. Nourishing diet, cleanliness, air.

Of veresection and arteriotomy.

Blood-letting from the arm is an operation so simple and familiar as hardly to require notice. The ligature that is used for the purpose of stopping the venal circulation should consist of broad tape; this is to be firmly bound round the arm about an inch or two above the joint of the elbow; the intermediate space between this and the bend of the joint is in general the most convenient for introducing the lancet. The surgeon is to make choice of that vein which rolls least under the skin. The median basilic, although not always the most prominent, is usually chosen, both on account of its being less apt to slip from under the lancet, and because there is less danger of injuring any cutaneous nerves than when the cephalics are opened. The artery being felt to pulsate below is not to be regarded as an objection; for transfixing the vein under any circumstance should be carefully guarded against; and unless the instrument be thus carried through the opposite sides of the vessel, the artery, even if contiguous, must necessarily remain uninjured. In performing the operation, the thumb of the left hand is to be pressed firmly on the vein to be opened, a little below where the lancet is to enter; the instrument then being opened at about right angles, is to be laid hold of about half way down its blade; the surgeon is to rest his hand on the patient's arm, and to make the opening in the vein in somewhat of an oblique direction. When sufficient blood has been withdrawn, the ligature is immediately to be taken off, the arm cleaned with sponge and water, a dossil of lint, or piece of linen doubled, laid neatly over the orifice, and the tape bound over this in such a manner as to interfere as little as possible with the bend of the elbow.

When it is found impossible to bleed in this part of the arm, one of the veins may be pierced between the elbow and wrist. In this case the tape of course should be bound round below the joint.

When bleeding is required in the neck, the thumb is to be firmly pressed upon the external jugular about an inch below where the opening is to be made.

If venesection be required in the ancles or feet, a ligature is to be bound round a little above the ancle joint; the veins of the feet are usually prominent and superficial. The one that is most so is to be made choice of. Adhesive plaister is to be laid over the orifice when the operation is over.

Artiriotomy is only practised on the temporal artery. In opening this artery it is generally advisable first to divide the skin which covers it, before the lancet is introduced; the artery is then to be opened in the same manner as a vein: the discharge of blood may generally be stopped by cutting the artery directly across, and suffering it to retract. Bandages have likewise been contrived for stopping the flow of blood, one of which is represented in fig. 7.

Topical bleeding.

Leeches, scarifications of the skin with the point of a lancet, and cupping, are the means employed for topical bleeding. Cupping is performed by the scarificator and cupping glasses; the scarificator is an instrument so constructed, as, by means of a spring, several lancets are made to apply at one time to the vessels of the skin; over these punctures the cupping-glass is to be evenly placed, the air of which has been rarified by heat, as by burning a piece of paper dipped in spirits, and placing it in the bottom of the glass; the blood from the wounded vessels will immediately rise and flow into the glass. When it is required to take more blood than will fill one glass, the surface of the wound is to be bathed in warm water, wiped dry, and the second vessel immediately placed over it in the same manner as before.

It has been observed, that the flow of blood is facilitated in some instances by placing the cupping glasses over the surface to be scarified previously to the application of the scarifying instrument; and dry cupping is sometimes practised, in which, by the mere use of the glasses without the scarificator, a quantity of blood is diverted from other parts without being discharged.

Leeches are most easily applied by confining them under a wine glass; it is thought that these animals fix more readily if the surface be previously rubbed over with milk, or cream, or sugar.

Issues.

The most usual parts of opening an issue are on the fore part of the humerus, the hollow above the inside of the knee, the nape of the neck, the spine or between the ribs; in the two former places the pea or blister issue is commonly used, in the others the cord or seton.

A blister issue is made and kept up by the common blistering plaster being first applied, which is followed by the daily use of cantharides ointment. The pea issue is sometimes made by caustic, but more commonly, and much better, by pinching the skin up, and cutting it through, making a wound of sufficient size to receive the common issue pea; this is to be daily removed, a fresh pea put into the wound, and thus a purulent discharge will be excited and maintained.

The seton is, to be made with the seton needle, (fig. 8.) threaded with cotton or silk, this is to be pushed into the skin, and carried out at some distance, passing the instrument fairly through; and a few inches of the silk or cord that may be employed is to be left hanging out from the orifices; the cord is to be daily drawn out and renewed.

Diseases of the eyes.

Inflammation of the eyes is of two species; the one called by systematics, opthalmia membranarum, inflammation of the membranes of the eye; the other, opthalmia tarsi, inflammation of the eye-lid; the latter is a glandular and scrophulous affection. Membranous inflammation is to be subdued by saturnine lotions, by bleeding with leeches on the temples; and if the disorder be violent, and the inflamed vessels very turgid, by cutting the vessels across upon the eye. Light, and all other sources of irritation, it is hardly necessary to observe, should be kept from the eye as much as possible.

Opthalmia tarsi is best treated by rubbing over the lid, when the eye is closed, some one of the active mercurial ointments, of which perhaps the most efficacious is the ung. hydrargyri nitrati of the London Pharmacopeia.

Membranous inflammation, if violent or long continued, is apt to be followed by specks on the cornea; these may sometimes be removed by absorbent remedies, local or general, such as calomel thrown into the eye through a quill, or small quantities taken internally so as to produce a very gentle mercurial action in the system. Sometimes, when the speck on the cornea is very prominent, it may be removed by a small knife. When the membranous excrescence termed pterygium, spreads from the white of the eye over the cornea, a scarification should be made through it entirely round, and at a little distance from, the circumference. After the hemorrhage has subsided, a saturnine lotion is to be applied to the eye.

Inflammation now and then terminates in an abscess of the eye, which confounds the humours, and destroys vision; in this case the matter must be evacuated by an incision into the cornea. Ulcers of the eye may arise from the same causes, constitutional or local, that occasion ulcers in other parts: the general principles of treatment must likewise be the same.

The aqueous humour of the eye sometimes accumulates inordinately, and constitutes a kind of dropsical swelling of the organ; this disease is to be distinguished from abscess by the manner in which it has been produced, by the patient remaining more or less sensible to light, and by the pupil contracting. Dropsy of the eye may be remedied in its early stages by puncturing the under edge of the cornea, or by piercing the schleratic coat just behind the iris. After the operation, saturnine and astringent lotions are to be used.

It is sometimes necessary to puncture the eye, in order to discharge blood that may have been extravasated from its vessels and remain unabsorbed.

When the eye has become cancerous, the whole of it is to be dissected out, free from the lids, if the operation is performed before these parts have become diseased.

Cataract. This is a disorder either of the crystalline lens or of its capsule, preventing the rays of light from falling upon the retina. Cataract usually commences by a dimness of vision, followed by the sensation of particles of dust floating before the eyes, which is at length succeeded by almost total blindness. This disorder is usually without, but is sometimes accompanied with pain. It is distinguishable from the gutta serena by the opaque appearance of the lens, which in the last disorder is not present. In gutta serena the pupils do not contract in a strong light; in the cataract, the contraction of the pupil usually remains. Whether the capsule merely, or the body of the lens, is affected, it is not easy to ascertain.

In the commencement of cataract, advantage has sometimes been experienced from small doses of calomel, hyoscyamus; cicuta and electricity have each been used with supposed benefit. When the disorder is confirmed, it is only to be removed by an operation, by couching or extraction, by forcing the opaque lens down into the vitreous humour, or by taking it entirely out.

Of couching. "The operator is either to be seated with his elbow resting upon the table, or, which is preferred by some, he ought to stand resting his arm upon the side of the patient. The eye being fixed by the speculum, (fig. 19.) or in such a manner as to allow the whole of the cornea and a small portion of the scleortic coat to protrude, a couching needle, (fig. 21.) is to be held in the right hand in the manner of a writing pen, if the left eye be the subject of the operation; the ring and little fingers are to be supported upon the cheek or the temple of the patient; the needle is to be entered in an horizontal direction through the sclerotic coat, a little below the axis of the eye, and about one-fourth of a line behind the edge of the cornea, so as to get entirely behind the iris, to prevent that substance from being wounded. The point of the needle is to be carried forward till it be discovered behind the pupil. The operator is now commonly directed to push the point into the lens, and depress it at once to the bottom of the eye, but in this way the lens either bursts through the capsule at an improper place, or it carries the capsule with it, tearing it from the parts with which it is connected. Instead of this, the needle ought first to be pushed into the lens near its under edge, as Dr. Taylor advises, and then carried some way down into the vitreous humours, so as to clear the way for the lens. It is then to be drawn a little back, and carried to the upper part of the capsule; when, by pressing upon it, the lens, if solid, is to be pushed down by one, or if fluid, by several movements, to the bottom of the vitreous humour. It should then be pushed downwards and outwards, as Mr. Bell directs, so as to leave it in the under and outer side of the eye; where, in case it should rise, the passage of the light would be little obstructed. The needle is then to be withdrawn, the speculum removed, and the eyelids closed; and a compress soaked in a saturnine solution to be applied over them." It is not advisable, in general, to remove the dressings till about eight or ten days after the operation.

Operation of extracting the lens. "The operator takes the knife, (fig. 23.) and holds it in the same way as he does the needle for couching; he then enters the point of it with the edge undermost into the cornea, about the distance of half a line from its connection with the sclerotic coat, and as high as the centre of the pupil; he is then to pass it across the pupil to the inner angle in an horizontal direction, keeping the edge a little outwards, to prevent the iris from being cut; the point is then to be pushed through opposite to where it entered; the under half of the cornea is next to be cut, and at the same distance from the sclerotic with the parts at which the point of the knife went in and came out from the eye. In cutting the under half of the cornea, the pressure of the speculum upon the eye should be gradually lessened; for if the eye be too much compressed, the aqueous humour, with the cataract and part of the vitreous humour, are apt to be forced suddenly out immediately after the incision is made. The operator then takes a flat probe, and raises the flap made in the cornea, while he passes the same instrument, or another probe, (fig. 24.) rough at the extremity, cautiously through the pupil, to scratch an opening in the capsule of the lens. This being done, the eye should be shaded till the lens be extracted, or the eyelids are to be shut, to allow the pupil to be dilated as much as possible; and while in this situation, if a gentle pressure be made upon the eyeball, at either the upper or under edge of the orbit, the cataract will pass through the pupil more readily than it would do when the eyelids are open. If the lens cannot be easily pushed through the opening of the cornea, no violent force should be used, for this would tend much to increase the inflammation. The opening should be enlarged so as to allow the lens to pass out more freely. When the cataract does not come out entire, or when it is found to adhere to the contiguous parts, the end of a small flat probe or a scoop, (fig. 25.) is to be introduced, to remove any detached pieces or adhesions that may be present. The iris sometimes either projects too much into the anterior chamber, or is pushed out through the opening of the cornea. When this happens, it is to be returned to its natural situation by means of the probe already mentioned. Sometimes the opacity is not in the body of the lens, but entirely in the capsule which contains it. The extraction of the lens alone would here answer no useful purpose. Some practitioners attempt to extract first the lens and then the capsule by forceps; others the lens and capsule entire." The after treatment is to be the same as in couching.

A difference of sentiment prevails respecting the superior eligibility of the one or the other of these operations. Among the surgeons of London, the extraction is principally advised.

Of fistula lachrymalis.

An obstruction of the lachrymal sac or duct constitutes this disease; it is divided into four stages; the first is constituted by a mere dilatation of the sac, and is characterised by a tumour between the inner corner of the eye and the nose, attended with a discharge of tears and mucus over the cheek, the integuments being entire, and as yet free from inflammation. In the second stage the swelling is larger, the skin inflamed, and out of the puncta lachrymalia may be now pressed a yellowish purulent fluid. The bursting of the skin forms the third stage of the disorder; in the fourth, the passage from the sac into the nose is obliterated, its inside being ulcerated or fungous, and the bones being carious; it is only then to this last stage that the term fistula can with propriety be applied.

It has been attempted, by the introduction of a probe (fig. 27.) from one of the puncta lachrymalia into the nasal duct, to overcome the obstruction without wounding the integuments: the injection of astringent fluids has likewise been proposed by means of a syringe, (fig. 28.) the pipe of which is also to enter one of the puncta; but these operations are scarcely practicable; and all perhaps that, in the first period of the disorder, ought to be attempted, is frequent pressure with the finger on the tumour; when the disorder advances, and the tumour threatens to burst, an opening should be made into it with a small scalpel, beginning the incision a little above the line from the angle of the eye to the nose, and laying the sac fairly open; the contents of the tumour are then to be pressed out; and by some surgeons we are directed to search for the nasal duct with a probe, and if it can be found, to introduce a piece of catgut, bougie, or lead, bending it downwards so as to preserve it in the passage till the sides of the duct are healed. The wound is to be dressed with wax and oil, and the dressings retained by sticking plaster. When the passage of the duct is secured, the substance that had been introduced is to be withdrawn, and the wound healed.

In the last, or properly fistulous, stage of the disorder, the attempts at cure are attempts to procure a new duct for the passage of the tears, the original one being obliterated. For this purpose the canula of the trocar (fig. 30.) is to be introduced to the under and back part of the lachrymal sac, and retained while the stilette is to be passed into it in an oblique direction downwards and inwards, till it reach the nasal cavity; the perforation of the bones will be perceived by the operation; and the passing of the instrument into the nostrils, is usually followed immediately by the passage of some bloody mucus out of the nose. When the instrument has thus penetrated the spongy bones, it is to be withdrawn from the canula, and a leaden probe or piece of catgut introduced. The canula is now to be removed, one end of the probe is to remain in the new-formed duct, and the other bent so as to secure its retention, and hang over the edge of the wound, which is now to be covered with lint and adhesive plaster. The probe is to be removed almost daily until the new duct is completely callous, when it is entirely to be removed, and the wound healed.

In cases of much constitutional affection, where the disorder treated in the above manner is likely to recur, it has been proposed to introduce a canula of gold, silver, or lead, into the artificial opening, and to heal the skin over it. The instruments used for this purpose are represented in figs. 31, 32, 33.

Of diseases of the teeth.

The causes of tooth-ach are obscure. Caries of the teeth seems to be sometimes a constitutional, at others an entirely local disease. For the preservation of the teeth, they ought to be kept constantly brushed, with a brush simply, or with some powder that is not of an acid nature. For acids, although for a time they cleanse and whiten the teeth, eventually injure their texture: the acidity constitutes the objection to several of the commonly vended dentifrice powders. Tooth-ach when it proceeds from a disease of the tooth itself, only admits of temporary cure by the common applications of opium, camphor, and the warm essential oils. The empirical remedies for diseased teeth are perhaps generally composed of some strong concentrated mineral acid, by which the carious is for a time separated from the sound portion of the tooth.

Extraction of the teeth. Many are by far too liberal in disposing of their teeth: if the first fit of the tooth-ach be endured, the disorder will frequently, for years, or for life, be suspended, and the tooth remain useful, which by a precipitate extraction would have been unnecessarily lost. In some again, there is a tendency, from the fear of the operation, to the other extreme. When a tooth is extensively carious, it ought by all means to be extracted, for the sake of preserving those that are contiguous; and the momentary pain of extraction is trifling in comparison of the multiplied and protracted fits of toooth-ach.

The instruments for extracting teeth operate in a lateral direction: it is indifferent on which side they are forced out, whether outwardly or inwardly, excepting in the instance of the dentes sapientiæ of the lower jaw, which ought invariably to be forced outwards. Before the claw of the instrument is fixed on the tooth, the gum should be separated from it as deep down as possible; the fulcrum of the instrument is to be on the side opposite to that at which the tooth is to be extracted, and with a single turn, which should not be by jerk or violence, but made with a slow, regular movement, the tooth will come out of its socket.

From very violent affections of the teeth, and from other causes of inflammation, the membrane of the antrum maxillare sometimes inflames, and becomes the seat of abscess. The symptoms of this disease are, violent pain in the cheek, and swelling extending upwards towards the nose, the ears, and the eyes; the swelling generally points in the cheek, and sometimes a discharge of matter takes place from the nostrils or the roots of the teeth. This disease is to be cured by making a free opening for the discharge of the matter, either by extracting one of the molares and perforating the antrum with a trocar, (fig. 37.) through the bottom of the socket; or else, without extracting a tooth, the perforation may be made with a tubular instrument through that part of the antrum which projects over the molares. Astringent solutions may be thrown occasionally into the cavity.

Of ranula. An obstruction in the duct of one of the salivary glands sometimes produces a tumour under the tongue, of such a size as to impede the motion of this organ, and at length to threaten suffocation. This tumour is to be laid fully open, and the mouth may afterwards be washed with some astringent solution.

Enlarged tonsils and uvula are not unfrequent occurrences. When these by their size interfere with respiration or swallowing, they are to be removed by ligature in the same manner as polypi. When the enlarged tonsil is of a conical shape, Cheselden's needle (fig 38.) may be employed, which, threaded with a double ligature, is to be pushed through the base of the tumour; the ligature now being taken hold of by a hook is to be pulled forward, divided, and tied, so as that each division shall surround each half of the swelling. This kind of ligature may be employed for an enlarged uvula or for polypi.

Deafness, when consequent upon an inordinate accumulation or hardening of the wax, is best removed by syringing the ear with warm water in which some soap has been dissolved. When deafness arises from mere dryness in the meatus, some drops of sweet oil should be put into the passage. The suppurative discharge from the ears in young children may generally be relieved by some slightly astringent lotion, such as a weak solution of vitriolated zinc or sugar of lead. When deafness is consequent upon loss of nervous power, either local or general, no relief can be expected from these topical applications. Electricity has been tried with apparent benefit in these cases.

Wry neck generally depends upon a preternatural contraction of the mastoid muscle on one side. The muscle in this case to be carefully divided, lest the parts below it be injured. Mr. B. Bell has proposed a machine (fig. 40.) for supporting the head after the division of the muscle, until it unite and regain its power.

Bronchotomy. When the trachea is to be opened, we are directed to make a longitudinal incision, of about an inch and a half, through the skin and cellular substance, commencing at the under end of the thyroid cartilage; the muscles are then to be separated, the operator taking care to avoid the thyroid gland: when the trachea is laid bare, and the bleeding vessels secured, a puncture is to be made with a common lancet between two of the rings of the trachea, of such size as to admit a canula. Dr. Monro directs that a double canula be used, and the inner one withdrawn from time to time, and cleared of the obstructing mucus. He directs the instrument to be fixed by a strap round the neck. As soon as the purposes are accomplished for which an opening was made into the trachea, the canula is to be taken out, and the wound closed by adhesive plaster.

Paracentesis of the thorax. When the chest is opened in order to evacuate purulent matter, or water, from this cavity, an incision should be made with the scalpel through the skin and cellular membrane, between the sixth and seventh ribs, from one to two inches long; and, in the direction of the ribs, the muscles are next to be divided, and the incision made as near as possible to the upper edge of the inferior rib. The pleura now exposed is to be gently opened; if the lungs adhere to the ribs where the incision is made, the fluid will not immediately discharge itself from the opening: in this case, the adhesion may be separated by a blunt probe, or the incision may be carried a little on towards the sternum. When the fluid begins to flow out, a silver canula (fig. 43.) may be introduced into the wound, attached to the patient's body; and being provided with a cork to it, the operator is either to let out the whole of the matter at once, or to draw it off at different times according to the strength of the patient. The wound, after the evacuation of the fluid, is to be kept open for some time.

Paracentesis of the abdomen. Tapping is usually performed by puncturing the abdomen at about midway between the spine of the ilium and the navel. Others direct the opening to be made in the linea alba. An equal pressure is required during this operation upon the belly; such pressure may either be made by bandage, or by the hands of assistants; the part at which the puncture is to be made being drawn a little over the edge of the bed, if the patient be found lying in a horizontal situation, the surgeon fixes the head of the instrument (a trocar) while the fore-finger directs its point; he is then to push it forward till it ceases to meet with resistance. The perforator is now to be taken out, and the water allowed to discharge, while the pressure on the surrounding parts is continued and increased. After the whole of the water is drawn off, the wound may be covered with a pledget of simple ointment, over this may be laid some flannel dipped in spirits, and bandages are now to be applied round the body with firmness. The bandages should not be removed for one or two days succeeding the operation; after this time they may be taken off daily for a little while, and the abdomen rubbed with some stimulant embrocation.

Herniæ. From malconformation, pre-disposition, or accident, the contents of the abdomen may protrude beyond their boundaries, and thus constitute hernia, or rupture. The most usual places of this descent are through the ring of the external oblique muscle, constituting bubonocele or inguinal and scrotal hernia, and hernia congenita, from under the ligament of fallopius or poupart, forming femoral hernia, and from the navel constituting umbilical hernia.

The causes of rupture we have said are either pre-disposition, accident, or malconformation. Where the constitutional tendency is observed, the exciting causes should with solicitude be avoided. These are violent muscular exertion, particularly of those muscles whose action is principally upon the contents of the abdomen, such are especially called into action in violent strainings to procure stool, in fits of coughing, hurried respiration, laughter, &c.

It is hernia congenita alone that immediately follows upon malconformation, strictly speaking. This is occasioned by the protrusion of some portion of the bowels through the passage by which, just previous to birth, the testicles descend from the abdomen into the scrotum: such passage is commonly shortly closed after the descent, and thus the intestine prevented from entering the bag of the testicle. In the case of congenital hernia the opening is preserved.

Herniæ, with the exception of the one just mentioned, are invested with peritoneum, and thus enclosed in a sac; and to whatever extent the protrusion may have taken place, the tumour still forms in a manner a part of the abdominal cavity. Rupture is an improper apellation for the disorder.

It may easily be conceived that parts thus protruded, even independently of the immediate inconvenience with which they are attended, are in no measure free from danger of serious and alarming consequences. We have a large swelling, for instance; a part, in many cases, of the canal, by which the fæces are constantly passing forward to the anus; and this swelling, so disproportionate to the passage through which it has been protruded, that it is only in some situations of the body, when the parts are not full and tense, that in any case, and with duly managed pressure, they can even for a time be made to resume their former and natural situation.

The reduction of hernia ought then, by all means, to be attempted as soon as it is perceived; and future descents prevented by constant and uniform pressure over the part where the displacement had taken place. For the different kinds of trusses used for this purpose, see figs. 42, 43, 44.

When, from neglect on the part of the patient, a hernia is incapable of reduction, and is at the same time free from pain or stricture of any kind, especial care should be observed in avoiding a repetition of the causes which produced the disease. The alvine discharges are to be regularly maintained, and all violent exertions guarded against; and, with due care, an irreducible and increasing hernia often continues through life without any impediment in the functions, or any interruption in the communication between the protruded and contained portions of the abdominal contents.

The dangerous symptoms in herniæ originate either from spasmodiac stricture of the aperture through which the sac and its contents have passed, or from distention and inflammation of the parts protruded: in this last case, indeed, the symytoms may be attributed to stricture; for the opening, although of sufficient size to allow of the communication between the tumour and the abdominal cavity previous to their falling into disease, now that the contents of the tumour are preternaturally enlarged and inflamed, becomes too narrow for such communication; its unyielding edges form a stricture on the inflamed vessels, and thus increase the inflammation and its consequences. The disorder is now called strangulated hernia. The signs of approaching strangulation are the following: pain in the tumour, an unusual uneasy sensation over the whole belly, increased by any exertion of the abdominal muscles, costiveness, quick and hard pulse, nausea, vomiting, an increase and extension of the pain, greater tenseness in the abdomen, extreme anxiety, and other symptoms of peritoneal inflammation.

These symptoms demand speedy remedies; when the inflammation and pain are already too violent to admit of attempts to reduce the rupture, they should be, if possible, subdued by fomentations over the tumour, and the whole of the abdomen, by the injection of clysters, by warm bathing, and by topical and general blood-letting. The return of the bowels should as soon as possible be attempted, for inflammation may have been present for some time without so much of stricture on the ring having been induced as to prevent reduction, if properly regulated. The patient should be placed on the side opposite the hernia, with his pelvis and lower limbs raised, in order to relax the muscles; the tumour is then to be grasped, and pressure made with the fingers in a direction upwards, and a little inwards towards the crural arch, if the hernia be of the thigh; upwards, and outwards towards the ring, if it be an inguinal or scrotal hernia.

When the inflammatory symptoms continue, the tumour is incapable of reduction, and every appearance proves a complete strangulation of the hernial sac; there is no safety for the patient, unless in the operation which we are now briefly to describe for the inguinal and femoral hernia, which are the principal, and almost only cases of strangulated hernia for which the surgeon is called upon to operate.

Operations for inguinal or scrotal herniæ. The patient should be laid with his body in an almost horizontal position; while the buttocks are somewhat elevated, the thighs are to be raised, and secured by assistants; the parts are first to be shaved, an incision is then to be made with a scalpel through the skin and cellular texture, commencing about an inch above the tumour, and carrying it down some way below the abdominal ring; the ring being thus exposed, a directory is to be introduced between it and the sac, in a direction upwards and outwards. A blunt pointed bistuory is to be inserted in the groove of the directory, and the ring dilated by this instrument till the point of the finger can be introduced; while the surgeon makes the dilatation of the ring sufficient to reduce the hernia, he must be careful of not dilating too freely, lest the bowels be again forced down. The stricture being thus relieved, the protruding intestines are to be returned, the outer wound closed with stitches, and proper bandages applied. When the wound has cicatrized, a truss should be worn.

The operation for femoral herniæ is performed much in the same manner. Here the stricture is from the ligament of the thigh, which, after the sac has been opened, is to be divided to the requisite extent.

Hydrocele. Hydrocele, or dropsy of the scrotum, is either encysted or anasarcous; either diffused through the cellular membrane, or contained in the tunica vaginalis. The anasarcous hydrocele is distinguished from the encysted by the general spreading of the tumour, by its comparatively rapid progress; and although it sometimes depends upon a topical cause, by its being more usually connected with general dropsy. Anasarcous hydrocele is treated by scarifications, or punctures; but unless the dropsical tendency be counteracted by general remedies, much advantage is not to be expected from either.

Hydrocele of the vaginal coat generally first comes on with a sense of fulness about the inferior part of the testicle, which gradually becomes more tense, and rises higher in the body of the testicle: the increase of the swelling sometimes occasions the penis almost to disappear. The tumour throughout is scarcely attended with any pain; it is usually, but not invariably, transparent; its transparency and fluctuating feel, indeed, have been made a criterion to distinguish this from scrotal hernia; but such distinction is formed with more accuracy by the manner in which the disorder has commenced and proceeded, viz. from below, upwards; (the contrary is the case with herniæ) and by no degree of pressure making the swelling to disappear.

The tunica vaginalis may be punctured, and the water drawn off as in other species of dropsy; but this operation affords only a temporary, not a radical cure. The radical treatment consists in not merely evacuating the water from, but causing an irritation between the vaginal and albugineous coats of the testicle, to make them adhere, and thus obliterate the cavity. This is effected by incision, by caustic, or by injection; the last of which, recommended by Mr. Earle, is now, on account of its mildness and safety, very generally practised. The water is first drawn off by a trocar passed into the under and fore part of the tumour; the canula of which is still left in the orifice, the operator securing it with one hand, passes the tube of an elastic bag (filled with red wine somewhat diluted) directly through the canula; he then injects the contents of the bag into the cavity, leaves the tube of the instrument, which is provided with a stop-cock, in the canula, by which the injected fluid is retained. This, after remaining about five or six minutes, is to be taken out, and the fluid suffered to discharge itself through the canula.

The wound in the testicle is now to be covered with a pledgit of lint; the testicle itself is to be supported in a suspensary bandage, and the patient confined to his bed for some days. After this method of treatment, hydrocele is apt to return, but the operation can then be repeated.

The spermatic cord is subject to hydrocele, both of the anasarcous and encysted kind. The latter is sometimes confounded with hernia, but may be distinguished from it by the tumour commencing at some distance down the cord, though it is still above the testicle, which is not the case in the hydrocele of the tunica vaginalis. This swelling may likewise be distinguished from herniæ by its not being altered in size from any posture or pressure. When the tumour becomes large, the palliative, or radical cure, as in the vaginal hydrocele, must be resorted to.

Varicocele is an unusual distension of the scrotal veins. Circocele, the same affection of the spermatic cord. Spermatocele is a disordered distension of the vas deferens and epidydimis. Rheumatocele is a distension of the scrotum from a collection of air.

These several affections arise from local or constitutional derangements, by remedying which they are relieved or cured.

Sarcocele is a schirrous enlargement of the testicle, like other cancerous affections (for this disorder, sooner or later, commonly terminates in open ulcer), it is sometimes produced by obvious causes, at others it commences imperceptibly. Sometimes it remains in a schirrous state for a long time; at others, especially when the subject of the disorder is advanced in years, it soon breaks out into open cancer.

When for this affection it becomes necessary to extirpate the testicle, the operation is to be performed by making first an incision some way above the abdominal rings, which is to be carried through the adipose membrane to the bottom of the scrotum. A firm waxed ligature is to be passed round the spermatic cord, near the ring; the vessels are then to be tied by a running knot, and divided at a little distance below the ligature. The testicle and cord are to be removed by dissecting from above downwards, with the common scalpel. The spermatic arteries and veins are then to be taken up with the tenaculum, and ligatures passed round them; the ligature round the body of the cord being slackened, the edges of the wound are now to be brought as accurately together as possible, and secured by adhesive plaster, leaving the ligatures hanging out of the wound. The compress of linen and a T bandage are to be applied over the whole.

Inflammation is to be as much as possible prevented by keeping the dressings moistened with a saturnine lotion, but the wound is not to be examined until about four or five days from the operation.

Of stone in the bladder.

A disposition to calculary concretions very often displays itself in early life. Large stones have been extracted from the bladder of very young subjects. Most commonly, however, life has considerably advanced before these concretions form at least to any perceptible extent, either in the kidneys or in the bladder. The symptoms of stone are irregular. One of the first sensations is often an uneasiness referred to the point of the urethra, which is more observable during the passage of the urine. This sensation appears in a manner to increase the desire to make water, which is often discharged with difficulty, and only by drops. Sometimes a constant dull pain is experienced in the region of the pubis: at other times the pain is more severe, and not continued. Exercise, especially riding on horseback, increases the symptoms. When the calculus is secreted in the kidneys, pain is felt in the loins, which frequently passes along towards the bladder. Such are the symptoms by which the existence of stone may be without much hesitation decided upon. When small concretions are thrown out of the bladder with the urine, the nature of the complaint is of course unequivocal.

When there is room for doubt, a sound (fig. 50) is to be introduced into the bladder. This instrument, previously to its introduction, should be moistened with oil. The surgeon is to lay hold of the penis with his left hand, while with his right he introduces it with its concave side turned towards the belly; the left hand is now to draw the penis gently forward, and upon the instrument, which is thus gradually inserted into the bladder. If the sound drop immediately upon the stone, the surgeon will feel a tremulous motion. In this, however, he must be careful that he is not deceived. If the instrument have not, at its first introduction, hit upon the stone, it is to be moved in various directions, or the finger may be passed into the anus, or the body of the patient placed in different postures. Even if after these trials, the existence of stone does not appear obvious from sounding, the operation may in a day or two be repeated.

To dissolve stone in the bladder various expedients have been practised, but without success. All that art has hitherto been able to accomplish, is in some measure to obviate the constitutional tendency towards its production, and nothing appears more effectually to operate in this manner than a long continued use of vegetable or mineral alkali, saturated with carbonic acid. (See MATERIA MEDICA and PHARMACY). The pain of stone may sometimes be temporarily relieved by opiates and other antispasmodics, as well as by anodyne fomentations.

Of the operation for extracting stone. (Lithotomy). Two methods only of performing this operation are in the present day spoken of: the one, the high; the other, the lateral operation; and, indeed, the former, which consists of making an incision into the bladder above the pubes, is almost entirely laid aside. It cannot be done without wounding the peritoneum, and, consequently, endangering inflammation of this membrane, the mischiefs from which have been already expatiated on. See the section on wounds.

The lateral operation was first performed by Frere Jacques, a French priest. It was practised and improved by Cheselden, and has recently undergone some alterations.

The patient, properly prepared by laxatives, enemas; &c. without being too much reduced, should be directed to retain his urine some hours previous to the operation. The perinæum and neighbouring parts are to be shaved.

A table, a little more than three feet in height, is to be covered with blankets, pillows, &c. upon which the patient is to be laid, and secured in the following manner: Two pieces of broad tape, about five feet long, are to be doubled, and a noose formed upon them, to be passed over the patient's wrists; the patient is then to lay hold of the middle of his foot upon the outside; one end of the tape is to be passed round the hand and foot, and the other round the ancle and hand, and the turns repeated in the reverse way; each hand and foot is then to be tied; the buttocks are to be brought an inch or two over the edge of the table, and by pillows to be raised higher than the shoulders. One pillow should be placed under the patient's head.

The surgeon is now to introduce a grooved staff (fig. 51) through the urethra into the bladder, with this he feels the stone; he then inclines the staff obliquely over the right groin, so that its convex part may be felt in the perinæum, on the left of the raphæ. He then fixes it, and gives it to an assistant, who holding it with his right hand, is to press it gently, until, with his left hand, he raises and supports the scrotum. The operator, now seated or kneeling between the patient's thighs, makes an incision with a convex-edged scalpel through the skin and cellular texture, immediately below the symphisis pubis, which is just under the scrotum, and where the crus penis and bulb of the urethra meet; and on the left side of the raphæ, and in a slanting direction, continues it downwards and outwards to the space between the anus and tuber of the ischium, terminating somewhat lower than the base of that process. As soon as the integuments are thus divided, two fingers of the left hand are to be introduced, with one keeping back the lips of the wound next the raphæ, and with the other pressing down the rectum. The surgeon should be particularly careful not to cut the crus of the penis, which can be easily felt and separated with one of the fingers at their under part. The surgeon now makes a second incision almost in the same direction as the first, but rather nearer the raphæ and anus. The transversalis penis will by this second incision be divided, with as much of the levator ani and cellular texture as will make the prostate gland perceptible to the finger.

The operator now has a view of the membranous portion of the urethra; he is to seek the groove of the staff with the fore finger of the left hand, the point of which is to be pressed along from the bulb of the urethra to the prostate gland. It is to be kept there, and turning the edge of the scalpel upwards, he cuts upon the groove of the staff, and divides freely the membranous part of the urethra, from the prostate gland to the bulb, till the staff can be perceived perfectly bare, and the point of the finger admitted.

The prostate and neck of the bladder are now to be divided, which may be done by a scalpel, but the gorget (51) is more usually employed. The membranous part of the urethra being divided, and the fore finger retained in its position, the point of the gorget, previously adapted to the groove, is to be directed along the nail of the finger, which will serve to conduct it into the groove of the staff; to this particular attention is to be given. The operator now rises, takes the staff from the assistant, raises it to nearly a right angle, and presses the concave part against the symphisis pubis; again satisfies himself that the beak of the gorget is in the groove of the staff, and then pushes on the instrument till its point slips from the groove into the bladder; further than this the gorget is not to be carried, lest the opposite side of the bladder be wounded. The entrance of the gorget into the bladder will be shewn by the intermediate discharge of the urine from the wound; the staff is now to be withdrawn, and the finger pushed up along the gorget to search for the stone, that the manner of introducing the forceps may be known; at least that the finger serves to dilate the wound in the bladder. A pair of forceps (fig. 52) are now to be introduced with their blades shut close, and the gorget is then to be drawn slowly away in the same direction in which it entered. The handles of the forceps are now to be depressed till they are nearly horizontal; one blade is to be directed towards the symphisis pubis, when the stone is touched, the blades of the forceps are to be opened and moved in various directions, so as to lay hold of the stone; if the operator find a difficulty in doing this, the finger may be introduced into the rectum, and that part of the bladder which may lodge the stone, elevated. If the forceps happen to grasp the stone, in a direction inconvenient for its extraction, it should be permitted again to slip out of the blades. The stone should be extracted slowly. When it has broken in the bladder, or is in detached pieces, the scoop (fig. 53), or finger may be introduced to remove the smaller fragments. Sometimes it is necessary to inject the wound with warm water, and raise the patient's body, in order to wash out some of the remaining concretions.

When any considerable artery bleeds, it is, if possible, to be taken up with a ligature; if this cannot be done, pressure is to be made on the wound with a firm roller.

When the operation is over, the pelvis of the patient should be placed lower than the body, in order to preserve the wound in a depending posture, to facilitate the discharge of blood. When the bleeding has subsided, the bandages are to be untied, a piece of dry lint put between the lips of the wound, which is to be often renewed, and the thighs are to be brought together. The patient is then to be laid in a bed, with the pelvis low, a large dose of laudanum given; and when much pain is afterwards complained of in the abdomen, anodynes are to be given by the mouth and by enema, and fomentations, with bladders of warm water, are to be applied to the pubes. Sometimes after the operation of lithotomy, the wound will be healed in a month; at other times, even if the operation be successful, the patient will be confined for three or four months.

Incontinence of urine. This may arise from various causes; loss of power in the sphincter of the bladder, irritation about the neck of this organ, laceration of its coats, or pressure from the uterus in advanced stages of pregnancy, are circumstances which may be conceived fully adequate to produce an incontinence or suppression of urine.

When a suppression of urine arises from deficient power in the bladder to expel its contents, the catheter (figs. 75 and 76) is to be introduced in the same manner as the sound, in order to draw off the water; in cases likewise of suppression from the pressure of the gravid uterus, the catheter is often employed with much advantage.

When the urine is retained in consequence of irritation and inflammation in the neck of the bladder, the disorder is violent and alarming; it is characterised by the ordinary symptoms of inflammation, attended with an extreme pain and much swelling of the affected parts, so that the catheter cannot be introduced. Treatment: Topical and general blood-letting, anodyne fomentation, opiates in large dose; injections into the rectum of warm water, warm bath.

If the disorder, notwithstanding these means, continues, and every attempt has failed of introducing the catheter, a puncture must be made into the bladder; this operation is by some recommended to be performed above the pubis, by introducing a lancet-pointed trocar of two inches long, about an inch and a half above the pubes directly into the bladder, and withdrawing the stileete to permit the urine to flow through the canula; to the canula a cock is to be fitted, in order that the urinary discharge may afterwards not be continual, and by drops, but at intervals.

When the puncture is made from the perineum, the trocar must be introduced at a little distance from the rapha perinei, and passed into the bladder, a little to the upper and outer side of the prostate.

Fistula in perinæo. A sinuous ulcer in the perineum may be produced by wounds in the bladder, or neighbouring parts, or may arise from inflammation of these parts, common, venereal, or cancerous. When the complaint is local, it is to be treated by incision in the manner of other fistulous ulcers, and dressed with emollient applications, or with poultices, according to the nature and degree of the inflammation and discharge.

Fistula in ano. This is a sinuous ulcer in or near the rectum. It is called complete, when it has an external opening in the integuments, independant of the gut, while it at the same time communicates with the gut. When there is no actual communication of the ulcer with the rectum, it is called an incomplete fistula; and when without any external opening, the ulcer communicates with the gut, it is denominated occult.

Fistulous ulcers near the rectum, may be produced by any local causes of irritation; they frequently follow upon the inflammation produced by obstinate hæmorrhoidal affections. Piles, indeed, are perhaps the most common source of fistula in ano. These are to be remedied by laxatives of a bland and oily nature, by sitting over warm water as the best means of fomenting the parts; and if the pain and swelling are considerable, by the application of leeches upon the tumour: such applications are principally suited to what are termed blind piles. When the disorder is accompanied by a discharge of blood from the anus in an excessive degree, cold and astringent are to take place of warm and emollient applications, such as solutions of sugar of lead, or the simple application of cold water; while costiveness, even in the case of bleeding piles, is to be carefully guarded against, by laxatives: chalybeates internally will often be attended with much advantage. The tinctura ferri muriati of the London pharmacopœia, has been given as a preventive of piles, with much apparent benefit. In the treatment of the complaint, it ought always to be examined, whether it acknowledges a local or a general cause, and whether the hæmorrhoidal disposition depends upon debility, which is often the case, and is then only to be combated by tonic agents.

When an abscess has formed in or about the rectum, and the tumour points externally, a free incision ought to be made into its most depending part, in order to discharge the matter as speedily as possible; the wound is then to be covered with soft linen, upon which is spread some simple mild ointment; and if the surrounding parts are much inflamed, a large emollient poultice laid over the dressing.

When the abscess has been permitted to open itself either externally or internally, and has degenerated into a sinuous ulcer, which is known by the nature of the discharge, the direction of the sinus or sinuses must be ascertained, by feeling with the finger in the anus; when their course is ascertained, a free incision is to be made along their whole length; the patient is to be placed so that his body shall lean upon a table or a chair; the surgeon is to introduce his finger, previously oiled, into the rectum. A crooked probe-pointed bistoury is then to be inserted into the fistula, and pushed against the finger in the rectum; the instrument is now brought downwards, the sphincter of the anus divided, and the sinus thus laid open. When the fistula is occult, it is necessary to make an artificial opening, previous to the passing of the bistoury. After the sinus or sinuses have thus been laid open, pledgets of lint or soft linen spread with simple ointment, are to be gently insinuated into the wound, and a compress of soft linen applied over the surface, and kept there by bandage. The dressings during the cure are to be often renewed, at least once in twenty-four hours.

Abscess will sometimes form slowly in the rectum, and discharge its contents without any fistulous ulcers following. In these cases, after the discharge of the matter, much advantage is often found in the use, for some time, of astringent and detergent injections, such as of lime-water: which the patient himself, by means of a syringe contrived for the purpose, may with ease and safety inject.

Explanation of the Plates.

Fig. 1. A lancet and canula for discharging the contents of an abscess by means of a seton.

Fig. 2. A director for guiding the knife in discharging the contents of an abscess, &c.

Fig. 3. A pair of forceps for extracting polypi

Fig. 4. A slit probe for conducting a ligature to the root of a polypus.

Fig. 5. A ring probe for assisting in securing a ligature upon the root of a polypus.

Fig. 6. A double canula for fixing a ligature upon the root of a polypus.

Fig. 7. A bandage for making compression after performing the operation of arteriotomy at the temples.

Fig. 8. A seton needle.

Fig. 9. *a*, *b*, Two pins of different forms used in the twisted or hare-lip suture. The first commonly made of silver, with a moveable steel point; the other of gold.

Fig. 10. The tourniquet now most generally used.

Fig. 11. The tenaculum used in drawing out the mouths of bleeding vessels for the purpose of securing them by ligature.

Fig. 12. A blunt-pointed bistoury.

Fig. 13. A raspatory for removing the pericranium in the operation of the trepan.

Fig. 14. The trephine, with all its parts connected and ready for use. *a*, The centre-pin, which can be raised or depressed by the slider *b*. *c*, The part where the saw is united to the handle by means of the spring *d*.

Fig. 15. A brush for cleaning the teeth of the saw.

Fig. 16. Forceps for removing the piece of bone when nearly cut through by the trephine or the trepan.

Fig. 17. A levator also employed in removing the piece of bone.

Fig. 18. A lenticular for smoothing the ragged edge of the perforated bone.

Fig. 19. A speculum used for keeping the eye-lids separated, and the eye fixed, in performing various operations upon that organ.

Fig. 20. A flat curved hook for elevating the upper eye-lid, and fixing the eye, in performing various minute operations upon its surface.

Fig. 21. A couching-needle.

Fig. 22. A couching-needle for the right eye, fitted for the operator's right hand.

Fig. 23. A knife for extracting the cataract.

Fig. 24. A flat probe for scratching the capsule in extracting the crystalline lens.

Fig. 25. A flat probe or scoop for assisting in removing the cataract.

Fig. 26. A knife for extracting the cataract from the right eye.

Fig. 27. One of Anel's probes for removing obstructions of the lachrymal ducts.

Fig. 28. A syringe and pipe (by the same) for injecting a liquid into the lachrymal ducts.

Fig. 29. A crooked pipe which fits the syringe.

Fig. 30. A trocar and canula for perforating the os unguis in the operation for the fistula lachrymalis.

Figs. 31, 32, 33. Instruments employed by Mr. Peltier in the operation for fistula lachrymalis. Fig. 31. a conductor for clearing the nasal duct. Fig. 32. a conical tube to be left in the duct. Fig. 33. a compressor for fixing the tube in its place.

Fig. 34. A trocar for making an artificial parotid duct.

Fig. 35. Pins used in the operation for hare-lip, represented as they are usually inserted into the part.

Fig. 36. A gum-lancet.

Fig. 37. A trocar for perforating the antrum maxillare.

Fig. 38. Mr. Cheselden's needle, with an eye near the point, for tying a knot on scirrhous tonsils.

Fig. 39. An instrument for perforating the lobes of the ear.

Fig. 40. An instrument recommended by Mr. B. Bell for supporting the head after the operation for wry neck.

Fig. 41. An instrument invented by Dr. Monro for fixing the canula after the operation of bronchotomy.

Fig. 42. A spring-truss for an inguinal or femoral hernia of one side only.

Fig. 43. A silver canula for carrying off pus collected in the thorax.

Fig. 44. A spring-truss for an umbilical hernia.

Fig. 45. A spring-truss for an inguinal or femoral hernia existing on both sides.

Fig. 46. Mr. Andre's trocar for evacuating the contents of an encysted hydrocele.

Fig. 47. Mr. B. Bell's trocar for operating in the hydrocele.

Fig. 48. A bag of resina elastica, with a stop-cock and short pipe, which fits the canula of the trocars figs. 77, 78, for the purpose of injecting the cavity of the tunica vaginalis, in the case of hydrocele.

Fig. 49. A straight-edged bistoury, sharp-pointed.

Fig. 50. A sound used in searching for the stone.

Fig. 51. A grooved staff for the operation of lithotomy.

Fig. 52. A cutting gorget.

Fig. 53. Extracting forceps.

Fig. 54. A scoop.

Fig. 55. A catheter for a male.

Fig. 56. A catheter for a female.

Fig. 57. A bistoury used in the operation for phymosis.

Fig. 58. A silver canula for conducting the urine after amputation of the penis.

Fig. 59. A bistoury, with a probe of flexible silver joined to it, to be used in the operation for fistula in ano.

Fig 60. A bistoury, which has been lately used by some practitioners in the operation for fistula in ano.

Fig. 61. A wire of silver or lead, with a tube of the same metal, for laying open a fistula in ano.

Fig. 62. A bandage for supporting the end of the rectum in cases of prolapsus ani.

Fig. 63. Represents a fractured limb dressed with an eighteen-tailed bandage, and placed in the manner recommended by Mr. Pott.

Fig. 64. Mr. Gooch's machine, improved by Dr. Aikin, for keeping a fractured thigh-bone properly extended. The upper circular bandage goes round the waist, the under one fixes immediately above the knee.

Fig. 65. A bandage for a fractured patella.

Fig. 66. A leather splint for a fractured leg.

Fig. 67. Mr. James's machine, which is an improvement upon one invented some years ago by Mr. White, of Manchester, for retaining fractured thighs, or bones of the leg, in their natural situation.

Fig. 68. The common collar used in distortions of the spine.

Fig. 69. Stays recommended by Mr. Jones for distortions of the spine.

Fig. 70. An apparatus for a distortion of the leg.

Fig. 71. An amputating-knife.

Fig. 72. A retractor of cloth or leather, used in amputating the larger extremities.

Fig. 73. Iron retractors recommended by Dr. Monro, in amputation of the larger extremities.

Fig. 74. The amputating-saw now most generally used.

Fig. 75. Pincers for nipping off any points of bone which may remain after the saw has been used.

Fig. 76. A catline used in an amputation of the leg.

Fig. 77. An apparatus invented by the late Dr. Monro for the cure of a rupture of the tendo Achillis.

Fig. 78. A pair of spring forceps, for laying hold of the extremities of arteries, &c.

SURIANA, a genus of the decandria pentagynia class of plants, the corolla of which consists of five petals, obversely ovated, patent, and of the length of the cup: there is no pericarpium except the crusts of the seeds, which are five in number, and roundish. It is a native of South America. There is but one species.

SUR-REBUTTER, a second rebutter.

SUR-REJOINDER. As a rejoinder is the defendant's answer to the replication of the plaintiff, so a sur-rejoinder is the plaintiff's answer to the defendant's rejoinder. Wood's Inst. 586.

SURRENDER, a deed or instrument, testifying that the particular tenant of lands or tenements for life, or years, does sufficiently consent and agree, that he who has the next or immediate remainder or reversion thereof, shall also have the present estate of the same in possession; and that he yields and gives up the same to him; for every surrenderer ought forthwith to give possession of the things surrendered. West. Sym.

SURROGATE, one who is substituted or appointed in the room of another; as the bishop or chancellor's surrogate.

SURSOLID, or SURDESOLID, in arithmetic and algebra, the fifth power, or fourth multiplication of any number or quantity considered as a root.

SURSOLID PROBLEM, in mathematics, is that which cannot be resolved but by curves of a higher nature than a conic section, *e. gr.* in order to describe a regular endecagon, or figure of eleven sides in a circle, it is required to describe an isosceles triangle on a right line given, whose angles at the base shall be quintuple to that at the vertex; which may easily be done by the intersection of a quadratrix, or any other curve of the second gender.

SURVEYING OF LAND. Surveying, or the measuring of land, is by some supposed to have had its origin in Egypt, and that, more especially, on the banks of the Nile; the inundations of which are said to have obscured the landmarks which the land-owners yearly made between their neighbours' property and their own; and to avoid this annual inconvenience, it was found necessary to devise some plans of form and dimensions which they could employ after every inundation. Such was the opinion of Herodotus, Proclus, and others, which has been continued down to the present age: but it is not our intention to justify such opinion, and we are rather disposed to countenance a position laid down by a modern traveller (Mr. Brown) who has spent much time on the borders of the Nile. He tells us, in Upper Egypt the river is confined by high banks, which prevent any inundation of the adjacent country: and so also in Lower Egypt, except at the extremities of the Delta, where the water of the Nile is never more than a few feet below the surface of the land, and where, of course, the inundations take place; here, however, the country is, as may be expected, without inhabitants.—But wherever the origin of this science might have been, the usefulness thereof is, now-a-days, well known and appreciated.

Geometry is the foundation of land-measuring; and we shall proceed to the most practical rules for finding the areas of such geometrical figures as occur in surveying.

Square. The area of this figure is found by squaring the length of either of its sides, or by multiplying the base side by its perpendicular: as in Plate Surveying, fig 1, AB^2 is therefore = the area. So also, $AB \times BC$ = the area.

Parallelogram, rectangled. The area hereof is found by multiplying the length by the breadth; as $AB \times AD$ = the area. See fig. 2.

Rhombus, or Rhomboides. Multiply the base by the perpendicular height: thus, in fig. 3, $AB \times ED$ = the area.

Also, when two sides and their included angle are given, the product of those sides multiplied by the natural sine of the angle = area: that is, $AB \times AC \times$ nat. *s.* $\angle A$ = area.

*** The angles of a regular rhombus are each 60°; those of a rhomboides may be more or less.

Triangle. Multiply the base by a perpendicular demitted from the opposite angle; half the product is the area; $\frac{AB \times PC}{2}$ = area. (Fig. 4.)

Also, when all the sides are given, from half the sum of the three sides subtract each side severally: multiply the half sum and the three remainders continually together; the square-root of the last product will be the area; that is,

$$\sqrt{\frac{a+b+c}{2} \times \overline{\frac{a+b+c}{2}-a} \times \overline{\frac{a+b+c}{2}-b} \times \overline{\frac{a+b+c}{2}-c}} = \text{the area,}$$

where a, b, and c, denote the three sides.

Otherwise, when two sides and their included angle are given, multiply the two sides together, and that product by the natural sine of the angle; half this last product = the area: that is, $\frac{AB \times AC \text{ nat. } s. \text{ of } \angle A}{2}$ = area.

Tropezium. Divide it into two parts by a diagonal line; demit perpendiculars from the other angles. Multiply the diagonal by the sum of the two perpendiculars: half the product = area; (fig. 5.) that is, $\frac{AC \times De + Bf}{2}$ = area.

Otherwise, where two diagonals and the angle of their intersection are given, multiply the product of the diagonals by the nat. *s.* of the angle of intersection, and half this product will be area (fig. 6;) that is, $\frac{AC \times DB \times \text{nat. } s. \angle E}{2}$.

Or, when it can be inscribed in a circle, and the sides are given; from half the sum of the sides subtract each side severally; multiply the four remainders continually together, and the square-root of the last product will be = area; (fig. 7), that is,

$$\sqrt{\overline{\frac{a+b+c+d}{2}-a} \times \overline{\frac{a+b+c+d}{2}-b} \times \overline{\frac{a+b+c+d}{2}-c} \times \overline{\frac{a+b+c+d}{2}-d}}$$

= area.

Trapezoid. Multiply half the sum of the parallel sides by the distance between them; and the product = area: (fig. 8.)

$$\frac{AD + BC}{2} \times AB = \text{area.}$$

Regular Polygon. When a side and a perpendicular demitted from the centre are given, half the perimeter multiplied by the perpendicular = area: (fig. 9.)

$$\frac{AB + BD + DE + EF + FA}{2} \times G = \text{area.}$$

When a side only is given, the square of the side multiplied by the tabular number or multiplier below = area.

That is, $AB^2 \times$ tab. num. = area.

POLYGON TABLE.

No of Sides.	NAMES.	Tabular Multiplier.
3	Equilateral Triangle	0.433013
4	Square - -	1.000000
5	Pentagon - -	1.720477
6	Hexagon - -	2.598076
7	Heptagon - -	3.633912
8	Octagon - -	4.828427
9	Nonagon - -	6.181824
10	Decagon - -	7.694209
11	Undecagon - -	9.365641
12	Duodecagon - -	11.196152

Circle. The square of the diameter multiplied by .7854 = area; (fig. 10.) *i. e.* $AB^2 \times .7854 =$

area; or, half the circumference multiplied by the radius = area; viz. $AaB \times Ab$ = area.

Circular Ring. Between two concentric circles multiply the sum of the diameters by their difference, and that product by .7854, and the half product = area: (fig. 11.)

$$\overline{AC + DB} \times \overline{AC - DB} \times .7854 = \text{area.}$$

Segment of a Circle, or other *curvilineal figure.* Divide the line OP (fig. 12.) into any even number of equal parts, as O*a*, *ab*, *bc*, &c.; and let perpendiculars be raised from these points. Put B for the sum of *a*2, *c*4, and other even ordinates, and C for the sum of the others; then four times B × twice C, × the common distance between the ordinates, = three times the area: that is, $\frac{4B + 2C}{3} \times D$ (the common distance) = area.

A mean breadth may readily be found, by dividing the whole measure of the ordinates by the number of them, accounting the ends parts of such number; which mean breadth multiplied by the length, will be = area.

Ellipse. Multiply continually together the two axes and the decimal .7854, and the product = area; viz. AC × BD × .7854 = area. (fig. 13.)

All pieces of land are found to be of some one of the forms before described, or composed of two or more of them; and the general rule for finding the content of any such compounded figure is, to divide it into as many of the foregoing simple figures as the case requires; to measure such lines and angles in the field as may be necessary to determine the content of each single figure; and the sum of the whole will be = area.

The Chain. The most general instrument which a land-surveyor employs, is the chain.—Chains of sundry lengths and dimensions were invented in former days; but that which was most approved of, and is now in general use, was invented by the Rev. *Edmund Gunter*, about 180 years since, and is composed of 100 links of strong iron wire, each link 7.92 inches; consequently the whole chain is 22 yards, or 4 poles in length. Hence it appears to be peculiarly well adapted to the measuring of land; as 10 square chains (that is, 10 chains in length and 1 in breadth, or 5 in length and 2 in breadth, or of any other dimensions in such proportion), are exactly an acre.

The accompaniments to the measuring-chain are a staff or rod, of the tenth part of a chain, called an off-set staff, divided into ten parts, answering to ten links of the chain, by which short distances are measured; to which staff a rectangular cross may be affixed, to set off the direction of lines perpendicular to a general line. Picket staves to set up in the angles of fields are necessary; and ten arrows of strong wire, which are employed by the measurer's assistant at each chain's length.

The dimensions of all lines on the land are taken in chains, or, rather, the links of a chain; and the contents are found in square acres, roods, and perches. The acre, we have before observed, contains 4 square roods; a rood contains 40 square perches. In one square acre are 100,000 square links; in a square rood are 25,000 square links; and in a square perch are 625 square links.

By an ordinance of the 35th of Edw. I., as well as by a statute of the 34th of Hen. VIII., it is ordered, that the perch should be $16\frac{1}{2}$ feet; but custom, however, permits perches of different lengths to prevail, in sundry parts of the kingdom: for instance, in Lancashire the customary perch is 21 feet in length; in Cheshire and Staffordshire, 24 feet; in Dorsetshire, $15\frac{1}{2}$ feet; in Somerset and Devon, 15 feet; and in Cornwall the customary perch is 18 feet.

To reduce the statute measure to either of the customary measures, the following rules will apply:—first, if the customary is smaller than the statute, as the Devonshire for instance, say, as the square of 15 is to an acre, or number of statute acres, so is the square of 16.5 to the number of customary acres:—secondly, if the customary is the larger measure, as the Cheshire for instance, say, as the square of 24 is to an acre, or number of acres, so is the square of $16\frac{1}{4}$ to the number of acres customary.

Before a measurer begins his work in the field, he should consider what lines are necessary to be measured for obtaining the content; taking such as require the least walking forward and backward.

Having carefully measured such lines as will reduce the field to some of the simple figures before-mentioned, with such of their measuring lines as may be necessary, he will be enabled to find the content of each part, by the rules laid down in the former part of this article.

We would observe, that a measurer may divide the same field different ways, and obtain the content thereof by each. For instance, the field ABCDE (fig. 14), may be divided into a trapezium ABCD, and a triangle ADE.

Or, it may be divided into four triangles, as in fig. 15.

It may also be divided into four triangles AE*a*, ED*b*, C*de*, and B*cd*, and two trapezoids D*bde*, and AB*ac*; as in fig. 16.

Or, into three triangles AE*a*, EBC, BC*c*, and one trapezoid A*a*B*c*; as in fig. 17.

Land-measurers are much in the practice of taking such lines only in the field as will enable them to draw a geometrical plot thereof by some scale of equal parts; and by taking such measure-lines on the plot, by the same scale, they calculate the content with less trouble than by taking all such measure-lines in the field, as may be necessary to reduce the same to triangles, trapezia, or other simple figures.

The calculations for the quantity of land in the same field, by the four respective methods of taking the dimensions, will stand as follow:

Fig. 14.

$$\text{Trapezium ABCD} = \frac{\overline{Bb + Dc} \times AC}{2}$$

$$= \frac{\overline{460 + 440} \times 1020}{2} = 459000$$

$$\text{Triangle ADE} = \frac{AD \times Ea}{2} =$$

$$\frac{780 \times 251}{2} = 97890$$

5.56890

2.2756

11.024

5 acr. 2 rds. 11 per. for the answer.

It is unnecessary to divide the square links of each small part by 2; as the double content may be carried on, and the aggregate, from thence arising, be divided by 2, once for all.

Fig. 15.

$$\text{Trapezium AEDC} = \overline{Dc + Aa} \times EC$$

$$= \overline{292 + 330} \times 1020 = 634440$$

$$\text{Triangle ABC} = AC \times Bb =$$

$$1020 \times 470 = 479400$$

2)1113840

5.56920

2.2768

11.072

5 acr. 2 rds. 11 perches, the answer, as before.

Fig. 16.

$$\text{Triangle AE}a = Aa \times Ea = 260 \times 180 = 46800$$

$$\text{Triangle ED}b = Db \times Eb = 450 \times 330 = 148500$$

$$\text{Triangle CD}c = dc \times Cc = 470 \times 50 = 23500$$

$$\text{Triangle B}cd = Bc \times cd = 320 \times 60 = 19200$$

$$\text{Trapezoid D}bde = \overline{Db + dc} \times bd = \overline{450 + 470} \times 560 = 515200$$

$$\text{Trapezoid A}a\text{B}c = \overline{Aa + Bc} \times ac = \overline{260 + 320} \times 622 = 360760$$

)1113900

5.56950

2.2780

11.120

5 acr. 2 rds. 11 perches, as before.

Fig. 17.

$$\text{Triangle AE}a = Aa \times Ea = 330 \times 70 = 23100$$

$$\text{Triangle EDC} = EC \times Db = 1020 \times 292 = 297840$$

$$\text{Triangle BC}c = Bc \times Cc = 624 \times 390 = 243460$$

$$\text{Trapezoid AB}ca = \overline{Aa + Bc} \times ac = \overline{634 + 330} \times 570 = 549480$$

)1113880

5.56940

2.27760

11.1040

5 acr. 2 rds. 11 perches, as before.

We have hitherto confined our consideration to such figures only, whose few sides are straight lines of considerable length; but, as the general boundaries of many pieces of land consist of short indentations, it is necessary to avoid the tediousness of computing the contents of a multitude of small triangles and trapezoids; to find such equalizing lines as shall constitute a triangle, or other figure, of equal area with the sum of all such triangles and trapezoids combined.

Suppose, then, that an irregular boundary of a field is of the form of fig. 18, composed of two triangles and four trapezoids.

Draw the line AB, and at A erect a perpendicular AC.—Lay a parallel ruler from A to *e*, the third point. Move the upper part of the rule to *b*, and note where it cuts the perpendicular, as at 1.—From this point 1, lay the ruler to *d*; bring its lower part down to *c*, and note where it cuts the perpendicular, at 2. From 2 lay the rule to *e*, and move it upwards to *d*, and mark the perpendicular at 3.—From thence lay the rule to *f*, and bring it down to *e*, and mark the perpendicular at 4.—From this point lay the rule to B, and raise it to *f*, and mark the perpendicular at 5.—From 5 draw the line 5B; then will the triangle, AB5, be equal in area to the aggregate of the two triangles and four trapezoids.

Example. Suppose that, on some well graduated scale, the base of the triangle A*gb*, was found to be 185, and perpendicular, *gb*, 110; the base, *gh*, of the adjoining trapezoid 250, and sum of its perpendiculars 160; the base, *hi*, of the next trapezoid is 120, and its perpendiculars 180; the base *ik* 325, and the perpendiculars of that trapezoid 190; the base *kl* of the next trapezoid 300, and the perpendiculars thereof 349; the base of the latter triangle, *l*B, 630, and its perpendicular, *lf*, 289; and that the content of the whole is required.

Suppose also, the content of the triangle ABC, whose base AB, by the same scale, is 1810, and perpendicular AC, is 238, is required.

First. The double of the

Triangle	*Agb*	$= 185 \times 110 =$	20350
Trapezoid	*ghcb*	$= 250 \times 160 =$	40000
Do.	*bidc*	$= 120 \times 180 =$	21600
Do.	*iked*	$= 325 \times 190 =$	61750
Do.	*klfe*	$= 300 \times 349 =$	104700
Triangle	*lBf*	$= 630 \times 289 =$	182070
			2)430470
			2.15235
			.60940
Content, 2 acr. 0 rds. 24 perches.			24.3760

Secondly. The double of the triangle ABC = AB × AC = 1810 × 238 = 2)430780

2.1539

.6156

24.624

Content, 2 acr. 0 rds. 24 perches, as before.

From whence it appears, that the content of the new triangle is the same as the aggregate contents of all the original triangles and trapezoids, to within the decimal of a perch.

In working with a chain and its off-set staff, a measurer does well in making a rough sketch in his field-book, large enough to admit his writing down the lengths of all the necessary lines, whether for planning, or for casting off the content without a plan.

Where there is a general base line, with several perpendiculars raised thereon, it may be best to continue the reckoning throughout that line: and, by subtraction, find the intermediate distances between one perpendicular and another.

Example. Suppose from the sketch and dimensions of fig. 19, a true plan and the content of the field were required.

Beginning at A, draw a line towards the tree at the upper end, and thereon prick off the distances, as in the sketch.

At the proper points erect the perpendiculars, according to their respective lengths; and the true figure will be as fig. 20. The whole content may be found, by seeking the separate content of each triangle and trapezoid, from the dimensions given in fig. 19, thus:

The double content of the triangle a =	$350 \times 100 =$	35000
of the trapez. b =	$\overline{350 + 260} \times 200 =$	122000
——— c =	$\overline{260 + 400} \times 60 =$	39600
——— d =	$\overline{400 + 350} \times 490 =$	367500
——— e =	$\overline{350 + 200} \times 250 =$	137500
——— f =	$\overline{300 + 200} \times 400 =$	220000
——— g =	$\overline{250 + 400} \times 500 =$	325000
of the triangle b =	$200 \times 400 =$	80000
		2)1326600
		6.63300
		4
		2.532
		40
The content 6 ac. 2 rds. 21 perches.		21.28

Hitherto we have supposed all the measuring-lines to be taken within the fields; but a measurer may sometimes meet with fields so circumstanced, by woody ground, meres of water, &c. as not to admit of the necessary internal lines being taken. Such pieces of land may, however, be measured, by taking surrounding lines, making one or more right angles with each other, and raising perpendiculars from those lines to the angular points of the fields; by which a true plan may be constructed, and from thence the content found, either by equalizing the sides by the parallel ruler, or by deducting the contents of the small parts without, from the general content of the trapezium or surrounding figure: see fig. 21.

Example. A plan of the piece of woody ground 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, and 13, being drawn by a 6-chain scale, the content thereof is required.

The ∠ A being (by the cross) made a right one, and the sides BA and AD being measured, the diagonal BD is readily found by construction; or else, by extracting the root of AB × AD.

This diagonal being a base to the triangle BCD, and the other sides BC and CD measured, that triangle also is readily constructed, and the trapezium completed.

The off-sets being made on the lines of the trapezium, the figure of the piece of wood may be correctly drawn.

Its content may then be obtained, either by equalizing (with the parallel ruler, or otherwise) the lines of the wood, and thus reducing it to a trapezium; or by deducting the content of all the small trapezoids without, from the general content of the outer trapezium, fig 22.

First, by reducing the figure to the trapezium, EFGH.

The lines being straightened, as before directed, the diagonal of this new trapezium, found by the scale, will be 1070, and the sum of the perpendiculars, 1065.

Then, $\frac{\text{EG} \times \overline{\text{EK} + \text{HI}}}{2} = \frac{1032 \times 1060}{2} = 516 \times 1060 = 546910 = $ 5 acres, 1 rood, 34 perches, for the answer.

Secondly, by finding the content of the surrounding trapezium, (fig. 21,) and from thence deducting the aggregate of the outer trapezoids.

To find the triangle ABD, we have, $\frac{\text{AB} \times \text{AD}}{2} = \frac{910 \times 930}{2} = 455 \times 930 = 423150.$

The diagonal $\text{BD} = \sqrt{\text{AB}^2 + \text{AD}^2} = \sqrt{910^2 + 930^2} = 1301.$

Then, the triangle BCD is found thus: $\sqrt{s \times \overline{s-d} \times \overline{s-b} \times \overline{s-c}}$, where a, b, c, stand for the sides, and s for the half sum of those sides.

$a = 1301$
$b = 970$
$c = 830$

2)3101

$1550 = s$, the half sum of the sides.
$s - a = 249$
$s - b = 580$
$s - c = 720$

Then, $\sqrt{1550 \times 249 \times 580 \times 720} = \sqrt{161172720000} = 401463.$

The triangle ABD = 423150
The triangle BCD = 401463

824613 = surrounding trapezium ABCD.

	Sum of perpend.		Lengths.	
The trapezoid, No. 1	= 129	×	250	= 30000
2	= 110	×	520	= 57200
3	= 100	×	160	= 16000
4	= 210	×	250	= 52500
5	= 160	×	210	= 33600
6	= 130	×	320	= 41600
7	= 80	×	50	= 4000
8	= 150	×	380	= 57000
9	= 160	×	280	= 44800
10	= 250	×	160	= 40000
11	= 410	×	110	= 45100
12	= 150	×	460	= 69000
13	= 380	×	170	= 69600
				2)556400
				278200

= the aggregate of all the small trapezoids; which taken from 824613 (the content of the surrounding trapezium), leaves 546410, = 5 acres, 1 rood, 34 perches, the content, as before.

Thus far we have applied ourselves to single fields only; but we will now proceed to the measuring of two or more, lying contiguously to each other

Example. From the dimensions given in the sketch, fig. 23, the contents of the fields A and B are required.

Field A $\frac{620 \times \overline{290 \times 1060}}{2} = 482300 = 4$ acres, 3 roods, 11 perches, for the measure thereof.

Field B. $\frac{740 \times 500}{2} = 185000 = 1$ acre, 3 roods, 16 perches, for the content of that field.

As in measuring single fields, various methods are pursued for obtaining the contents; such as general lines with normals, or triangles combined with normals, &c.; so also may the content of each respective field, contained in an estate, be found by like means.

The estate, fig. 24, may be measured by a general line, with normals erected thereon, in manner following; viz.

Beginning at the southern end, a measurer takes his principal line from A towards the tree on the northern limits of his work; and at every necessary point in that line, he sets off such perpendiculars as will lead him to the corners of each field, as in the figure. The dimensions taken in each field being as here given, the content of each may be found in manner following:

DIMENSIONS TAKEN.

Bases.	Normals.	Operations.	Double Areas.
I. *Aa* ×	*a*1	= 740 × 25 =	14800
Aa ×	$\overline{Ab + a2}$	= 360 × 80 =	28800
Ab ×	$\overline{Aa + bo}$	= 790 × 1500 =	1185000
ac ×	$\overline{a2 + cf}$	= 490 × 120 =	58800
bo ×	bc	= 760 × 60 =	45600
			2)1333000
			6.665
			2.66
			26.
II. *cf* ×	$\overline{cd + cf}$	= 850 × 860 =	731000
dc ×	*d*4	= 488 × 130 =	62400
*c*6 ×	$\overline{cb + 6,2}$	= 350 × 90 =	31500
6*f* ×	6,2	= 500 × 40 =	20000
fe ×	*eq*	= 470 × 40 =	18800
			2)863700
			4.3185
			1.274
			10.96
III. *lm* ×	4*l*	= 820 × 40 =	32800
gh ×	$\overline{gm + hk}$	= 590 × 1290 =	761100.
ik ×	*rk*	= 770 × 30 =	23100
gb ×	$\overline{hi + gl}$	= 590 × 270 =	159300
			)976300
			4.8815
			3.5260
			21.04.

IV. cf	×	$\overline{c7 + ft}$	= 490 × 1570	=	769300
c7	×	7,o	= 780 × 55	=	62900
dq	×	cd	= 510 × 45	=	22950
de	×	$\overline{dq + en}$	= 230 × 1010	=	232300
ef	×	$\overline{eo + fp}$	= 215 × 750	=	161250
fp	×	fg	= 370 × 70	=	25900
fz	×	$\overline{fg + zv}$	= 230 × 200	=	46000
zr	×	$\overline{zu + rw}$	= 300 × 270	=	81000
rs	×	rw	= 40 × 200	=	8000
st	×	sx	= 230 × 50	=	11500
					)1421100
					7.1055
					.4220
					16.88

V. hu	×	gh	= 210 × 70	=	14700
hk	×	$\overline{hu + kb}$	= 770 × 370	=	284900
kb	×	kl	= 140 × 50	=	7000
lc	×	cd	= 260 × 70	=	18200
il	×	$\overline{cl + ai}$	= 330 × 550	=	181500
gi	×	$\overline{ai + yg}$	= 560 × 700	=	392000
yg	×	yp	= 350 × 70	=	24500
					)922800
					4.614
					2.456
					18.24

VI. el	×	$\overline{eu + lb}$	= 750 × 700	=	525000
ef	×	$\overline{ex + ft}$	= 260 × 280	=	72800
eg	×	$\overline{ef + gh}$	= 210 × 520	=	109200
gi	×	$\overline{gh + ik}$	= 90 × 660	=	59400
il	×	$\overline{ik + lm}$	= 350 × 820	=	287000
lm	×	ln	= 820 × 120	=	98400
					)1152800
					5.764
					3.056
					2.

Respective Contents.

			acr.	rds.	per.
Field I.	-	-	6	2	26
II.	-	-	4	1	10
III.	-	-	4	3	21
IV.	-	-	7	0	16
V.	-	-	4	2	18
VI.	-	-	5	3	2
Total			33	1	13

Notwithstanding some land-measurers have adopted the foregoing method, of normal lines, for their mode of practice, in making plans of estates, yet the following (by triangles, &c.) seems preferable; being less subject to error, and more facile in operation.

Let us suppose that the small estate, fig. 25, was to be measured, by means of a general triangle, and necessary off-sets; the measurer beginning at A, and measuring towards B, from thence to C, and returning to A, making all necessary off-sets as he goes on; required the true plan, and the measure of each field?

From the following dimensions, to plan the estate:

Az	=	250	*a*1	=	60
1X	=	60	Xz	=	60
A*b*	=	500	*b*2	=	320
A*c*	=	730	*c*3	=	70
A*d*	=	810	*d*4	=	140
A*e*	=	940	*e*5	=	100
AB	=	1500	B*k*	=	210
B*o*	=	250	*o*6	=	120
B*f*	=	320	*f*7	=	100
B*g*	=	390	*g*8	=	70
B*b*	=	480			
B*i*	=	300			
BC	=	1600	*ib*	=	350
C*l*	=	600	*l*9	=	250
C12	=	710			
C*m*	=	800	*m*10	=	160
C*n*	=	950	*n*2	=	370
C*o*	=	1380	*o*14	=	580
CA	=	1400			

The plan of the estate being obtained by these dimensions, other lines must now be drawn in each field, dividing it into such geometrical figures as will most readily give the content; as in fig. 26.

By dividing the fields as here directed, the content of each may be found as follows:

HOME PADDOCK.

					Double areas.
Triangle	*a* = 1040	×	315	=	364000
Do.	*b* = 630	×	565	=	355950
Trapezoid	*c* = 270	×	$\overline{565 + 230}$	=	217350
Triangle	*d* = 140	×	230	=	32200
					2)641900
					3.2095

GARDEN.

Trapezium *e* = 680 × $\overline{250 + 180}$ = 2)292400

1.462

RIVER MEAD.

Triangle *f* (the lower irregular boundary being reduced by the Rule, p. 755, *col.* 3.)	= 1865	×	860	=	1603900
Triangle *g*	= 160	×	115	=	18400
Trapezoid *b*	= 320	×	$\overline{115 + 440}$	=	177600
Triangle *i*	= 1275	×	440	=	561000
Do. *k*	= 275	×	110	=	30250
Trapezoid *l*	= 60	×	$\overline{110 + 100}$	=	8600
Do. *m*	= 70	×	$\overline{100 + 65}$	=	11550
Triangle *n*	= 70	×	65	=	4550
					2)2415850
					12.07925

Respective Contents.

			acr.	rds.	per.
Home Paddock	3.2095	=	3	0	33
Garden -	1.462	=	1	1	33
River Mead	12.07925	=	12	0	12
Total - -			17	2	38

THE PLANE TABLE.

Land-measuring may, in some instances, be expedited by instruments which set off lines in their relative positions, and the angles of their inclination one to another; the most convenient instruments for these purposes, are the Plane-table and the Theodolite.

The Plane, or Plain-table, is composed of a smooth rectangular board, commonly of about 15 inches by 12; around which is a frame, that not only serves to keep the paper smooth on which the plan is to be drawn, but, being graduated into degrees, answering to a central point in the board, the angular bearing of any two lines, issuing from the station where the instrument is placed, may readily be ascertained; or the angle itself may be drawn on the paper.—A magnetic needle and compass-box is fixed to one side of the board, which serves to point out the bearing of any line to the magnetic meridian.—There is, also, a brass index-rule, having sundry scales thereon, and also perpendicular sights at the end used herewith. The whole is supported on a three-legged stand, &c. moveable on a brass ball and socket.

A land-measurer having planted his Plane-table at A, one of the inner angles of the field ABCDE, fig. 27, and from any assumed point on the paper (which may be considered as his station-point on the land) directed his sight along the boundary to B, and also to C, to D, and to E; and, by measuring these lines on the ground, finding them to be as follow, viz.: AB = 665, AC 885, AD 1030, and AE 580; he may make a correct plan of the field and from thence, by drawing other lines on the plan, as heretofore directed, he may calculate the content thereof.

If the other sides of the same field, viz. BC, CD, and DE, &c. (fig. 27), had been measured, either on the ground, or on the plot, the content may be found by Rule 2. for the triangle.

A measurer may take his observations from a point about the middle of a field, as at A, (fig. 28,) and take his angles of bearing to all the corners of the field, and measure the links to each corner, and from thence find the content; for, suppose the ∠ BAC = 105° 0′

∠ CAD = 59 30

∠ DAE = 129 0

∠ EAB = 66 30

And that the line AB = 480

AC = 550

AD = 665

AE = 730, he will have two sides of each triangle, and their included angle, given from whence he may make his plan; and by Rule 3. of triangles, find the content.

A measurer may take two stations in a field, as at A and B, (fig. 29, the distance between which must be carefully measured); he must then from each station direct his sight to the corner of the field, and draw dotted lines till they intersect each other. From the intersections of these dotted lines he must draw the boundary lines to make his plan; in which he must draw such measuring-lines as are necessary to find the content by the scale.

A measurer may take four or more stations in a field, as *abeg*, (fig. 30,) and set up such perpendiculars as are necessary for perfecting the boundary *lmdfbk*; the plan being laid down, the content of the field may be found by scaling.

THE THEODOLITE.

The Theodolite is a circular instrument made of brass, graduated into degrees, &c. on which is an index-limb for taking horizontal angles, surmounted with an arch for vertical angles, and a telescopic sight. It has, usually, spirit-levels to adjust it by; and a compass, for angular bearings, checking the observations by the limb: the whole placed on three legs, and a ball and socket, or half-ball and parallel plates, to set it level.

In all cases of land-measuring, where angles are required to be taken, whether horizontal or vertical, no instrument is so well adapted thereto as the theodolite; its accuracy and dispatch far exceeding all other instruments used for that purpose, especially on large estates, where varieties of boundary, as well as inequality of surface, are met with.

In a single piece of land, the angular observations may all be made from one spot in a field.

In this case, the theodolite being set at the station A, fig. 31, and properly adjusted (as hereafter described), the first observation to the picket-staff at *a*, was = 62° 20′, from the north towards the east, and the length of the line A*a* = 660 links.

The second observation, to *b*, between the south and east, = 152° 0′, and the length of the line A*b* = 960 links.

The third, to *c*, between the south and the west, = 200° 0′, the length 730.

And the fourth observation, to *d*, from the north towards the west, 329° 50′, and the length 599.

From hence, with the help of a protractor, the plan may be drawn.

It is evident, that if from the observation *b*, that of a is subducted, the $\angle\, aAb$ will be found $= 89^\circ\ 40'$.

That if from the observation c, that of b is subducted, the $\angle\, bAc$ will be found $= 48^\circ\ 0'$.

That if from the observation d, that of c is subducted, the $\angle\, cAd$ will be found $= 129^\circ\ 50'$.

And also, that if the circular complement of the observation d (which is $360^\circ - 329^\circ\ 50' = 30^\circ\ 10'$) is added to the observation a, the $\angle\, dAa$ will be found $= 92^\circ\ 30'$.

The whole together making (as it ought) the complete circle 360°.

The content may now be computed by Rule 3 of triangles.

A measurer may take the angle at each corner of a piece of ground, and measure the sides as he goes on, thus:—having set the needle to its 360°, and the limb to its 360°, he found by observation at ⊖ 1, that looking to his picket at ⊖ 2, the limb cut 304°, from the north towards the west, and his needle 124°.—At ⊖ 2, having directed the theodolite to the back station, his observation forward was, on the limb, 45° 30′ from south to west, and on the needle 45° 30′ also. At ⊖ 3, the limb was at 126° 0′, from south to east, and the needle at 306° 0′.—And at ⊖ 4, the limb and needle both were at 216° 0′, from the north to the eastward.

Supposing the lines were found to be 1000 links, 800 links, 1100 links, and 800 links, the plan may be made, and the content found by the scale.

In extensive concerns, where all the fields in an estate or manor are to be measured, large circuits must be taken with the theodolite, and the proceedings carefully noted down in the field-book, the pages of which are divided into three parts; the middle column being for inserting the angular observations, and the progressive distances from station to station, and the points where it may be necessary to set off (with the ten link staff) such short lines as the flexures or angles of boundaries may require. The sides of the page are employed in noting down such off-sets and remarks, on either hand, as may be found necessary, and also in making sketches of side boundaries, where any deviations from a straight line occur. For the more readily sketching such side boundaries, it is necessary to begin at the bottom of the page, and write upwards.

For an example to exemplify the mode of practice with this excellent instrument, we will take the estate, fig. 33, and suppose the measurer to plant his instrument in the road at ⊖ 1, and having duly adjusted it, by setting the head thereof truly horizontal by the spirit levels and adjusting screws; and setting the index part of the limb exactly at 360°, by moving the whole head about until the 360 in the compass-box comes to the line in the north end of the needle, the instrument will thus be completely adjusted: here he is to lock all fast by the screw under the head between the legs.

The instrument thus adjusted, the measurer sends one of his assistants forward, as far as he can conveniently measure a straight line, as at ⊖ 2. Taking then his angle of observation by his telescope, he finds it to be 69° 0′ from the north towards the east, which he enters in his field-book, noting it with N. E. as a memorandum on which side of the meridian it lies. He must now fix his limb to the other part of the head, by a screw for that purpose. His chain-men having laid the chain in a direction to the picket at ⊖ 2, he proceeds to measure this line, making such off-sets to the right and left as may be necessary. At his station he finds, by measuring, on the right, with his off-set staff, that he has the general line of the road-fence at 30 links, and also a corner of 40 links more, and 30 broad: on the left of his station he has an off-set of 10 links. The chain-men proceeding on their line to 300, he finds 25 on the right to be the breadth on that side of the road, where is a gate, and on the left 20, which will determine the breadth of the road at that spot. At 400 he will find 10 on the right, and 20 on the left, to be the breadth. At 760 (the end of that line) he will find 35 on the right, and 15 on the left, to be the breadth; where also he will find a small road branch off to the right. Thus is the first station-line finished.

To this spot (which is his second station) he brings his theodolite, and after setting it level, unlocks the under screw and turns the whole head about, until, through the telescope, he sees the back picket or station-staff. Here again, locking the head of his theodolite, he must unscrew the limb, and turn it about until, through the telescope, he has a view of the picket at ⊖ 3; the angle to which he will find to be 253° 10′ from the north to the eastward, which he will enter in his field-book. Measuring on from ⊖ 2 to ⊖ 3, he will find, at 130 links, that he is come to a turnpike-gate, where the breadths on the right and left are 30 and 15. At 200 he has an off-set of 15 on the left; and a break-off at the right of another road, at 25 from his line, with two other off-sets, as expressed in the field-book. Whereto this road leads, must be noted. At 265 he has off-sets of 30 on the left, and 20 on the right; which ends this station line.

Bringing now his instrument to ⊖ 3, he is to adjust it in the manner we have directed him to do at ⊖ 2, and turning the limb about towards the picket forward, he will find the angle of bearing to be 57° 45′, still from the north to the eastward. At 20 he will find himself opposite to a cross hedge on the left, belonging to the estate he is surveying. At 293 he ends his line of this station; where the off-sets are 5 and 35, as noted in the field-book.

Coming now to ⊖ 4, and having adjusted his theodolite, he finds his next angle = 226° 0′ N. E. At 20 his off-sets are 20 and 15. At 410 they are 15 and 30, where, on the left, is a cross hedge of a backward direction. At 480 his off-sets are 5 and 25, where is another cross hedge. At 750 is a break-in of the fence, and the off-sets are 30 + 15 on the left, and 10 on the right. At 1050 the off-sets are 20 on each hand, and another cross hedge on the left. At 1150 are off-sets on the right of 20 and 20, where stands a house. At 1300 the off-set of 30 on the right terminates the house; and at 5 on the left is a cross hedge of a backward direction:—1350 ends this line, where roads diverge to the right and left.

At ⊖ 5 the instrument being adjusted, the angle is 284° 50′, nearly W. At 50 the off-set to the hedge is 15; at 220 it is also 15, where is a cross hedge, which is the same as was noted at 1050 in the last line. At 320 the off-set is 25. At 350 is the end of this station, where the distance from the fence is 15.

At ⊖ 6 the bearing is 305° 35′ N. W. At 130 the off-set is 30; where a cross hedge goes off to the point noticed at 750 in the line from ⊖ 4 to ⊖ 5. At 160 the line is nearly close to the fence. 210 ends this line.

At ⊖ 7 the angle forward is 106° 25′ N. W. The line is 143 long, with an off-set at the end of 15.

At ⊖ 8 the bearing is 269° 20′ N. W. At 100 and 300 the off-sets are 15 and 10.

The bearing at ⊖ 9 is 70° 45′ S. W. At 30 the measurer finds it expedient to cross the fence, and to proceed within the bounds of the estate. At 90 he has an off-set of 30 to the right, where he crosses a hedge. At 880 he crosses another hedge, having there an off-set of 20. At 940 he has an off-set of 50. At 990 he again crosses the hedge. At 1020 he has an off-set of 20 to the left. At 1040 he again crosses the hedge. At 1080 he comes to the corner of the farm-house; and 1165 ends his line, where is a small curve at the right.

At ⊖ 10 the bearing is 204° 0′ S. W. At 70 is an off-set of 5 on the right At 200 is 15 on the left, and a cross hedge. At 600 is 25 on the left, and 20 + 15 on the right. 690 ends the line, having an off-set of 15 on the right, and the like on the left, where is a cross hedge.

The bearing at ⊖ 11 is 355° 30′ S. E. At 280 is an off-set of 30 on the right, and 10 with a cross hedge on the left. At 400 is an off-set of 30, and a cross hedge at the left; and 470 ends the line, with off-sets of 10 and 20 on the right and left.

At ⊖ 12 the bearing is 155° 0′ S. E. At 60 is a cross hedge. At 219 the off-sets are 10 and 15: and at 229 the measurer comes to a close at ⊖ 1, where he began.

Having thus taken a circuit of this estate, the measurer must proceed to plot off the same by some convenient scale in manner following:

PLOTTING.

The plotting, or making a draught of an estate, from a field-book or other memoranda taken in the field, is thus performed:

The paper, or vellum, on which the plan is to be drawn, must be smoothly laid down on a drawing-board: a line is to be drawn from the bottom to the top, to represent the magnetic meridian.

About the middle part of this line a point is to be made, on which point the centre of the circular protractor is to be laid, the straight edge so placed as to coincide with the meridian line: round, at the edge of the protractor, draw a pencil line. [The protractor is a circular piece of brass, having its edge divided into degrees &c. answerable to the circumference of the theodolite, so that whatever horizontal observation is made with the latter, it may be laid down on paper with the help of this instrument.]

The protractor thus placed, being steadily fixed in that position by pins, or by a lead weight, look in the field-book for the quantity of the ∠ at ⊖ 1, which, in the present case, is stated to be 69° 0′ north-easterly. Look for this degree, on the circular edge of the protractor, and on the paper make a mark, with a fine plotting-pin, at that number; mark it 1, denoting ⊖ 1.

Look in the field-book for the ∠ at ⊖ 2, which, in this case, = 253° 10′, where make a mark, as before.

Thus do with all the other ∠s, until you come to the last station previous to a close on some former part of the work.

All the angles being thus pricked off, remove the protractor.

Consider whereabout the beginning of the work should be placed, so that the whole may come within the compass of the paper laid down; and there make a mark, noting it as ⊖ 1, the beginning of the plot.

Lay the fore edge of the parallel ruler from the central point where the protractor lay, to the mark on the pencilled circle denoted ⊖ 1. Move the fore edge of the parallel ruler until it touches the point determined on for the beginning of the plot.—From thence draw an obscure or pencil line (in the direction mentioned, i. e. in this case, from the north to the eastward) about the length of the whole line of this ⊖, = 760.

Apply a feather-edge scale to this obscure line, the 0 division thereof at the beginning; and prick off every progressive number where any off-sets have been made; as at 300, 400, and 760.

Turn the scale across the line (by some cross division), and prick off the off-sets on each side o the station-line. At 0, or ⊖ 1, the field-book informs us, that on the left hand, at 10 links, is the boundary-line of that side; where is also a small road branching off. On the right hand, the off-set is 30, which, with + 40, goes to the extent of a small nook, that is 40 links broad also. At 300, on the left, is an off-set of 20, and, on the right, another of 25; where also is a gate to be noticed.—At 760 is an off-set on the left of 15; and, on the right, one of 35, where a small road-way branches off. All which off-sets are to be pricked off as you go on. Draw the boundary-lines through these off-set points; and thus the first station will be completed.

Lay, now, the parallel ruler from the centre to the angular point of ⊖ 2: move the limb of the parallel ruler, until it touches the end of the last station; from whence draw another obscure line, from the north, easterly, as noted in the field-book.

Apply the edge of the scale as before, and prick off the numbers 30, 200, and 265.—At 30 links is a toll-gate, where the off-sets are 15 and 30.—At 200, the off-sets are 15 and 25; where, on the right hand, is a short line of hedge of 30 links, and also a lane of 30 links broad, going off at an acute angle.—At 265, the end of this station, the off-sets are 30 and 10.

Lay off the line from ⊖ 3, as before directed, north-easterly.—Prick off the numbers 20 and 293. Opposite 20 is a hedge branching off to the left.—At 293 the off-sets are 35 and 5.

From ⊖ 4 lay off the line north-easterly, and prick off the numbers on that line, as they appear in the field-book, and make the off-sets as follow, viz. At 120 set off 15 and 20. At 410 are 30 and 15, where two hedges branch off nearly in the direction of the side sketches. At 480 the off-sets are 25 and 5, where is a cross hedge on the left. At 150, on the left, is 30 + 15 with a cross hedge; on the right is 10. At 1050, on the left, is 20 with a cross hedge, and 20 on the right. At 1150, on the right, is 20 + 20, where stands a house. At 1300, on the left, is 5 with a cross hedge; on the right is 30 with a road branching from thence.—1350 completes this line.

At ⊖ 5 the work takes another direction, and goes backwards towards the west. Lay the ruler from the centre to this station, and draw the obscure line in the direction mentioned. Prick off the distances and off-sets as in the field-book. Here we have off-sets on one side only, not being now in a road-way.

At ⊖s 6, 7, and 8, set off the lines south-westerly, and prick off the distances and off-sets, as in the field-book.

At 30, in ⊖ 9, a hedge was crossed; as also at 990 and 1040.

Station 10 still bears west of the south; at the end of which we again come into a road-way.

But at ⊖ 11, the direction of the line bears above the south, towards the east; as does that also of ⊖ 12.

At the end of this station, the work comes to a close at ⊖ 1.

After having thus plotted his work, the measurer will have to draw another line, for the true meridian, to the eastward of the former, according to the variation of the magnetic needle, where the estate lies.—On this true meridian line he must place a *fleur de lis*, or some other device, as a north point.—He will also have to give a title to his map; to draw a scale of the proportion he has plotted by; and to give the whole a border.

After this circuit is plotted off, the measurer must fill up the interior by measuring with the chain, and lay each field down in its proper situation and dimensions on the plan.

Having thus a prototype of the estate on paper, he may draw such measuring-lines on his plan as will enable him to calculate the content of each field separately.

SURVIVORSHIP. See LIFE ANNUITIES.

SUS, *hog*, a genus of quadrupeds, of the order belluæ. The generic character is, front teeth in the upper jaw four, converging, in the lower jaw six, projecting; canine teeth, or tusks, in the upper jaw two, rather short; in the lower jaw two, long, exserted; snout truncated, prominent, moveable; feet cloven. This genus is in some points of an ambiguous nature, being allied to the pecora, by its cloven hoofs, and to the feræ, in some degree, by its teeth; yet differing widely from both in many respects. The internal structure of the feet also approaches to that of the digitated quadrupeds, while that of some other parts is peculiar to this genus alone. It may, therefore, be allowed to form at once a link between the cloven-footed, the whole-hoofed, and the digitated quadrupeds.

1. Sus scrofa, common hog. The wild boar, the stock or original of the common domestic hog, is a native of almost all the temperate parts both of Europe and Asia, and is also found in the upper parts of Africa. It is a stranger to the arctic regions, and is not indigenous to the British isles.

The wild boar inhabits woods, living on various kinds of vegetables, viz. roots, mast, acorns, &c. &c. It also occasionally devours animal food. It is, in general, considerably smaller than the domestic hog, and is of a dark brinded grey colour, sometimes blackish; but when only a year or two old, is of a pale rufous or dull yellowish brown cast; and when quite young, is marked by alternate dusky and pale stripes disposed longitudinally on each side the body. Between the bristles, next the skin, is a finer or softer hair, of a kind of woolly or curling nature. The snout is somewhat longer in proportion than that of the domestic animal; but the principal difference is in the superior length and size of the tusks, which are often several inches long, and are capable of inflicting the most severe and fatal wounds.

The hunting of the wild boar forms one of the amusements of the great in some parts of Germany, Poland, &c. and is a chace of some difficulty and danger; not on account of the swiftness, but the ferocity of the animal.

As the wild boar advances in age, after the period of three or four years, he becomes less dangerous, on account of the growth of his tusks, which turn up, or make so large a curve or flexure, as often rather to impede than assist his intentions of wounding with them.

To describe particularly the common or domestic hog would be superfluous. It may be sufficient to observe, that this animal principally differs from the wild boar in size, in having smaller tusks, and larger ears, which are also somewhat pendant, and of a more pointed form. Of all quadrupeds the hog is the most gross in his manners, and has therefore been pretty uniformly considered in all nations as the emblem of impurity. The Jews were strictly enjoined not to eat its flesh; and in many parts of the world, a similar prohibition is still in force; since the Mahometans agree in this respect with the Mosaic institution. In most parts of Europe, on the contrary, it constitutes a principal part of the food of mankind. This animal is of a remarkably prolific nature, being sometimes known to produce as many as twenty at a birth.

The hog was unknown in America, on the discovery of that continent; but since its introduction, appears to flourish there as much as in the old world. The varieties into which the hog occasionally runs, chiefly relate to size and colour. That called the Chinese hog is of a very small size, with a remarkably pendulous belly: its colour is commonly black, and the skin often nearly bare, or less hairy than in the European kinds.

The variety called the Guinea hog is distinguished by having a smaller head than the common hog, with long, slender, sharp-pointed ears, and naked tail reaching to the ground. Its colour is rufous, and its hair softer, shorter, and finer than in other kinds. It is said to be most common in Guinea, and is considered by Linnæus as a distinct species, under the title of sus porcus.

But the most remarkable variety of the hog is that in which the hoofs are entire and undivided. This is a mere accidental variety, which is, however, observed to be more common in some countries than in others, and is, according to Linnæus, not unfrequent in the neighbourhood of Upsal in Sweden. It has been noticed by Aristotle and Pliny, and is said by the former to have been most common in Illyria and Pæonia.

The age of the domestic hog is said to extend from fifteen to twenty-five years, or even more.

2. Sus Æthiopicus, Æthiopian hog. This animal is very much allied in its general appearance to the common hog, but is distinguished by a pair of large, flat, semicircular lobes or wattles, placed beneath the eyes: the snout is also of a much broader form, and is very strong and callous: the ears are large, and very slightly pointed: the tusks in the lower jaw are rather small; but those in the upper jaw are large, sharp, curved, and in the old animal bend upwards in a semicircular manner towards the forehead: there are no fore teeth; their place being supplied by very hard gums: the skin of the face, immediately below the eyes, or above the broad lobes before-mentioned, is loose and wrinkled, and on each side the corners of the mouth is a callous protuberance. The body is of a strong form; the tail slender, slightly flattened, and thinly covered with scattered hairs. The general colour of the whole animal is a dusky or blackish brown.

This species is a native of the hotter parts of Africa, occurring from Sierra Leona to Congo, and to within about two hundred leagues of the Cape of Good Hope. It also occurs in the island of Madagascar.

It is a fierce and dangerous animal, and is said to reside principally in subterraneous recesses which it digs with its nose and hoofs. When attacked or pursued, it rushes on its adversary with great force; and strikes, like the common boar, with its tusks, which are capable of inflicting the most tremendous wounds.

3. Sus Africanus, Cape Verd hog. The Cape Verd hog has been generally confounded with the former animal, from which, however, it appears to differ very considerably; having a head of a much longer and slenderer form, with the upper jaw extending beyond the lower. In the upper jaw are also two cutting teeth, and six in the lower: the tusks are very large and thick, but those of the lower jaw much larger than those of the upper: the ears are rather narrow, pointed, and tufted

with long bristles or hairs: the whole body is also covered with long, weak, or fine bristles, of which those on the shoulders, belly, and thighs, are much longer than on other parts: the tail is thin, and terminates in a longish tuft. The colour of this animal is a palish brown. Its general size is that of a common hog, but it is said sometimes to be found far larger. It is a native of Africa extending from Cape Verd to the Cape of Good Hope. See Plate Nat. Hist. fig. 383.

4. Sus babyroussa. The babyroussa is nearly of the size of a common hog, but of a somewhat longer form, and with more slender limbs, and is covered, instead of bristles, with fine, short, and somewhat woolly hair, of a deep-brown or blackish colour, interspersed with a few bristles on the upper and hinder part of the back. It is also distinguished by the very extraordinary position and form of the upper tusks, which, instead of being situated internally on the edge of the jaw, as in other animals, are placed externally, perforating the skin of the snout, and turning upwards toward the forehead; and as the animal advances in age, become so extremely long and curved as to touch the forehead and continue their curvature downwards, by which means they must of necessity lose their power as offensive weapons: the tusks of the lower jaw are formed as in the rest of the genus, and are also very long, sharp, and curved; but not of equal magnitude with those of the upper. The upper tusks are of a fine hard grain, like that of ivory: the eyes are small; the ears somewhat erect, and pointed: the tail rather long, slender, and tufted at the head with long hairs.

The babyroussa is a gregarious animal, and is found in large herds in many parts of Java, Amboina, and some other Indian islands. Their food is entirely of a vegetable nature, and they often feed on the leaves of trees. When sleeping or resting themselves in a standing posture, they are said often to hook or support themselves by placing the upper tusks across the lower branches of the trees. When pursued they will often plunge into a river, or even into the sea, if near, and can swim with great vigour and facility, and to a vast distance. The voice of the babyroussa is said to resemble that of the common hog, but it occasionally utters also a strong or loud growling note. It is sometimes tamed by the inhabitants of the Indian islands, and the flesh is considered as a wholesome food. See Plate Nat. Hist. fig. 385.

5. Sus tajassu, pecary. The pecary is the only animal of this genus that is a native of the new world, where it is chiefly found in the hottest regions. Its size is considerably smaller than that of a common hog, and it is of a short compact form. The whole animal is thickly covered, on the upper parts, with very strong dark-brown or blackish bristles, each marked by several yellowish-white rings; so that the colour of the whole appears mottled with minute freckles or specks, and round the neck is generally a whitish band or collar. The head is rather large; the snout long; the ears short and upright; the belly nearly naked: there is no tail, and at the lower part of the back, or at some little distance beyond the rump, is a glandular orifice surrounded by strong bristles in a somewhat radiated direction. From the orifice exsudes a strong-scented fluid, and this part has been vulgarly supposed to be the navel of the animal: the tusks in this species are not very large.

The pecary is a gregarious animal, and in its wild state is fierce and dangerous; sometimes attacking the hunters with great vigour, and often destroying the dogs which are employed in its pursuit. It feeds not only on vegetable substances, but occasionally on animals of various kinds, and is particularly an enemy to snakes and other reptiles; attacking and destroying even the rattlesnake, without the least dread or inconvenience, and dexterously skinning it, by holding it between its feet, while it performs that operation with its teeth. It is also remarkable that the common hog, when translated to America, will attack and destroy the rattlesnake. The pecary is considered as an agreeable food; but the dorsal gland must be cut away as soon as the animal is killed: otherwise the whole flesh would be infected with an unpleasant flavour. See Plate Nat. Hist. fig. 386.

SUSPENSION, or Points of Suspension, in mechanics, are those points in the axis or beam of a balance, wherein the weights are applied, or from which they are suspended.

In a law sense, suspension is a species of censure, whereby ecclesiastical persons are forbidden to exercise their office, or to take the profits of their benefices; or when they are prohibited in both of them for a certain time, either in whole or in part. Suspension is also said to relate to the laity, viz. suspensio ab ingressu ecclesiæ, *i. e.* from hearing divine service.

SUTURE. See Surgery.

SWARTZIA, a genus of the class and order polyadelphia polyandria. The calyx is four-leaved; petals single, lateral, flat; legumen one-celled, two-valved; seeds arillated. There are six species, trees of the West Indies.

SWEARING, an offence punishable by several statutes: thus stat. 6 and 7 Will. III. cap. 11. ordains, that if any person shall profanely swear, if he is a labourer, servant, or common soldier, he shall forfeit 1s. to the poor, for the first offence, 2s. for the second, &c.; and any person not a servant, &c. forfeits 2s. for the first offence, 4s. for the second, 6s. for the third, &c. to be levied by distress of goods.

SWEAT. See Perspiration.

Sweating-Sickness, a disease which appeared first in England, in the year 1483. It seized different patients in different manners; for in some it first appeared with a pain in the neck, scapula, legs, or arms; whilst others perceived only a kind of warm vapour, or flatulence, running through those parts. And these symptoms were suddenly succeeded by a profuse sweat, which the patient could not account for. The internal parts became first warm, and were soon after seized with an incredible heat, which thence diffused itself to the extremities of the body. An intolerable thirst, restlessness, and indisposition of the heart, liver, and stomach, were the next symptoms, which were succeeded by an excessive head-ache; a delirium, in which the patient was very talkative; and after these, a kind of extenuation of the body, and an irresistible necessity of sleeping. For preventing this disease, temperance was ordered, and the choice of salutary aliments and drinks, and no crude pot-herbs nor sallads to be used.

SWEEP, in the sea-language, is that part of the mould of a ship, where she begins to compass in at the rung-heads: also, when the hawser is dragged along the bottom of the sea, to recover any thing that is sunk, they call this action sweeping for it.

SWEETS, in the wine trade, denotes any vegetable juice, whether obtained by means of sugar, raisins, or other foreign or domestic fruit, which is added to wines, with a design to improve them.

SWERTIA, *marsh gentian*, a genus of plants belonging to the class of pentandria, and to the order of digynia; and in the natural system ranging under the 20th order, rotaceæ. The corolla is wheel-shaped. There are nectariferous pores at the bases of the segments of the corolla. The capsule is unilocular and bivalve. There are six species. The perennis is a native of England. It is distinguished by radical oval leaves. It flowers in August.

SWIETENIA, *mahogany*, a genus of plants belonging to the class of decandria, and to the order of monogynia; and in the natural system arranged under the 54th order, miscellaneæ. The calyx is quinquefid. There are five petals; the nectarium is cylindrical, supporting the antheræ with its mouth. The capsule is five-celled, woody, and opening at the mouth. The seeds are imbricated and winged. There are three species: the mahogani, which is the principal, is a native of the warmest parts of America, and grows also in the island of Cuba, Jamaica, Hispaniola, and the Bahama islands. It abounded formerly in the low lands of Jamaica, but is now found only on high hills and places difficult of access.

It thrives in most soils, but varies in texture and grain according to the nature of the soil. On rocks it is of a smaller size, but very hard and weighty, of a close grain, and beautifully shaded; while the produce of the low and richer lands is observed to be more light and porous, of a paler colour, and open grain; and that of mixed soils to hold a medium between both. The tree grows very tall and straight, and is usually four feet in diameter; the flowers are of a reddish or saffron colour, and the fruit of an oval form, and about the size of a turkey's egg.

The wood is generally hard, takes a fine polish, and is found to answer better than any other sort in all kinds of cabinet-ware. It is now universally esteemed, and sells at a good price. It is a very strong timber, and answers very well in beams, joists, plank, boards, and shingles; and has been frequently put to those uses in Jamaica in former times. It is said to be used sometimes in ship-building; a purpose for which it is remarkably adapted, if not too costly, being very durable, capable of resisting gun-shots, and burying the shots without splintering.

The seed-vessels are of a curious form, consisting of a large cone splitting into five parts, and disclosing its winged seeds, disposed in the regular manner of those of an apocynum. The seeds being winged, are dispersed on the surface of the ground, where some falling into the chinks of the rocks, strike root; then creep out on the surface, and seek another chink, into which they creep and swell uch a size and strength, that at length the k splits, and is forced to admit of the root's per penetration; and with this little nutri-it the tree increases to a stupendous size few years.

WIMMING, the act of sustaining the y in water, and of moving in it, in which on the air-bladder and fins of fishes bear a considerable part. See AIR-BLAD-R, and FISHES.

WIMMING, as applied to human beings, he art of balancing the body on or near surface of the water, and of making a gress through it; an art so useful, we might so necessary, that every young person ht to be instructed in it; and as it is also holesome and pleasant exercise, it ought e regularly taught at schools, as well as other athletic exercises.

The art of swimming is so antient, that we e no accounts of its origin in the history of nation; nor are there any nations so bar-ous but that swimming is known and prac-l among them, and that in greater perfec-than among civilized people. It is pro-e, therefore, that the art, though not ab-tely natural, will always be acquired by ple in a savage state from imitating the te animals, most of whom swim naturally. eed so much does this appear to be the case, very expert swimmers have recommended those who wished to learn, to imitate the ions of the frog in moving through the ele-it of water.

he art of swimming depends entirely n keeping the body in a proper balance, this is easily and almost insensibly ac-ed. The great obstacle is the natural ad which people have of being drowned; this it is impossible to overcome by any g but accustoming ourselves to go into water. With regard to the real danger of g drowned, it is but little; and on innu-able occasions arises entirely from the ter-above mentioned, as will appear from the wing observations by Dr. Franklin:

1st, That though the legs, arms, and head, human body, being solid parts, are spe-ally somewhat heavier than fresh water, the trunk, particularly the upper part, its hollowness, is so much lighter than er, that the whole of the body, taken to-her, is too light to sink wholly under water, some part will remain above until the lungs ome filled with water; which happens from ving water into them instead of air, when rson in the fright attempts breathing while mouth and nostrils are under water.

2dly, That the legs and arms are speci-lly lighter than salt water, and will be sup-ed by it; so that a human body would sink in salt water though the lungs were d as above, but from the greater specific vity of the head.

dly, That therefore a person throwing him-on his back in salt water, and extending arms, may easily lie so as to keep his mouth nostrils free for breathing; and by a small ion of his hands may prevent turning, if he ld perceive any tendency to it.

4thly, That in fresh water, if any man ws himself on his back near the surface, cannot long continue in that situation, but proper action of his hands on the water. e uses no such action, the legs and lower of the body will gradually sink till he comes into an upright position; in which he will continue suspended, the hollow of the breast keeping the head uppermost.

"5thly, But if in this erect position the head is kept upright above the shoulders, as when we stand on the ground, the immersion will, by the weight of that part of the head that is out of the water, reach above the mouth and nostrils, perhaps a little above the eyes; so that a man cannot long remain sus-pended in water with its head in that posi-tion.

"6thly, The body continued suspended as before, and upright, if the head is leaned quite back, so that the face looks upwards, all the back part of the head being then under water, and its weight consequently in a great mea-sure supported by it, the face will remain above water quite free for breathing, will rise an inch higher every inspiration, and sink as much every expiration, but never so low that the water may come over the mouth

"7thly, If therefore a person unacquainted with swimming, and falling accidentally into water, could have presence of mind sufficient to avoid struggling and plunging, and to let the body take this natural position, he might continue long safe from drowning, till per-haps help would come; for as to the clothes, their additional weight while immersed is very inconsiderable, the water supporting it; though when he comes out of the water, he would find them very heavy indeed."

The method of learning to swim is as fol-lows: The person must walk into water so deep that it will reach to the breast. He is then to lie down gently on the belly, keep-ing the head and neck perfectly upright, the breast advancing forward, the thorax inflated, and the back bent; then withdrawing the legs from the bottom, and stretching them out, strike the arms forwards in unison with the legs. Swimming on the back is somewhat similar to that on the belly, but with this dif-ference; that the legs are here chiefly em-ployed to move the body forwards, and the arms are often unemployed, for the progres-sive motion is derived from the movement of the legs. In diving, after the plunge, a per-son uses the same action as in swimming, only the head is bent downwards; and whenever he chooses to return to his former situation, he has nothing to do but bend back his head, and he will immediately return to the sur-face.

It is very common for novices in the art of swimming to make use of corks or bladders to assist in keeping the body above water. Some have utterly condemned the use of these; Dr. Franklin, however, allows that they may be of service for supporting the body while one is learning what is called the stroke, or that manner of drawing in and striking out the hands and feet that is necessary to pro-duce progressive motion. "But (says he) you will be no swimmer till you can place con-fidence in the power of the water to support you: I would therefore advise the acquiring of that confidence in the first place, especially as I have known several who by a little of the practice necessary for that purpose, have insen-sibly acquired the stroke, taught in a manner by nature.

"The practice I mean is this: choosing a place where the water deepens gradually, walk coolly into it till it is up to your breast: then turn round your face to the shore, and throw an egg into the water, between you and the shore; it will sink to the bottom, and be easily seen there if the water is clear. It must lie in the water so deep that you can-not reach it to take it up but by diving for it. To encourage yourself in order to do this, reflect that your progress will be from deeper to shallower water; and that at any time you may, by bringing your legs under you, and standing on the bottom, raise your head far above the water: then plunge under it with your eyes open, throwing yourself towards the egg, and endeavouring, by the action of your hands and feet against the water, to get forward till within reach of it. In this attempt you will find that the water buoys you up against your inclination; that it is not so easy a thing to sink as you imagined; that you cannot but by active force get down to the egg. Thus you feel the power of the water to sup-port you, and learn to confide in that power; while your endeavours to overcome it, and to reach the egg, teach you the manner of act-ing on the water with your feet and hands; which action is afterwards used in swimming to support your head higher above water, or to go forward through it."

SWINE-STONE, in mineralogy. The texture of this substance is often earthy; frac-ture splintery; specific gravity 2.7.; colour grey, of various shades. When scraped or pounded, it emits an urinous or garlic smell.

SWORD, a weapon used either in cut-ting or thrusting; the usual weapon of fights hand to hand. It also signifies, figuratively, destruction by war; as fire and sword.

SWORD, *broad*. An original weapon of Scotland: it is sometimes called a back sword, as having but one edge: it is basket-handled, and three feet two inches long.

SWORD, *regulation*. The sword which is worn by British officers may be properly called a long cut-and-thrust. It is a manifest imita-tion of the Austrian sword, and has been lately introduced. It is not, however, so conveniently used by us as it is by the Aus-trians. The latter have it girted round their waists, so that it hangs without any embarrass-ment to the wearer close to the left hip or thigh; whereas with us, it is suspended in an aukward diagonal manner from a cross belt over the loins.

SWORD, *position of, at open order*. When an officer stands or marches in front of his company, &c. the position of the sword is di-agonal across the chest. At close order, or when the officer is on the flank of his com-pany, &c. the hilt is close to the right thigh, and the blade in the hollow of the right shoul-der. When mounted, he carries it diagonally across the bridle-hand.

When troops or squadrons of cavalry ad-vance, in the walk, the sword is carried with the blade resting on the right arm; in the trot and gallop, the right hand must be stea-died on the right thigh, the point of the sword rather inclining forward; and in the charge, the hand is lifted, and the sword is carried ra-ther forward, and crossways in front of the head, with the edge outwards.

SYENA, a genus of the class and order triandria monogynia. The calyx is three-leaved; petals three; anthers oblong; cap-sules one-celled, three-valved. There is one species, a mossy plant of Guiana.

SYLLOGISM, συλλογισμος, in logic, an argument or term of reasoning, consisting of three propositions; the two first of which are called premises, and the last the conclusion. See Logic, Mode, &c.

SYMPHONIA, a genus of plants of the class of monadelphia, and order of pentandria. There is one pistil. The corolla is globular, and the berry five-celled. There is only one species yet discovered; the globulifera, a tree of Surinam.

SYMPHONY, in music, properly denotes a consonance or concert of several sounds agreeable to the ear, whether vocal or instrumental, called also harmony.

SYMPHYSIS, in anatomy, one of the kinds of junctures of articulation of the bones. See Anatomy.

SYMPHYTUM, *comfrey*, a genus of plants of the class of pentandria, and order of monogynia; and in the natural system ranging under the 41st order, asperifoliæ. The limb of the corolla is tubular and ventricose, and the throat is shut with awl-shaped rays. There are three species; the officinale, tuberosum, and orientale. The officinale is a British plant. The stem is about two feet high, round, branched, green, and rough. The radical leaves are very large and rough; those on the stalk are decurrent, and alternate. The flowers grow on loose spikes, and are either of a yellowish or purple colour. It grows on the banks of rivers, and flowers from May to October.

SYMPLOCOS, a genus of plants of the class of polyadelphia, and the order of polyandria; and in the natural system ranging under those the order of which has not been determined. The calyx is quinquefid and inferior: the corolla is pentapetalous: the stamina are attached to the tube of the corolla in a fourfold series. Only one species, the martinicensis, is mentioned by Linnæus; but l'Heritier of the academy of sciences at Paris has added three more, the ciponima, arechea, and octopetala, all trees of the West Indies.

SYNCOPE, *fainting*. See Medicine.

Syncope, in grammar, an elision or retrenchment of a letter or syllable out of the middle of a word, as *caldus* for *calidus*, *aspris* for *asperis*, &c.

SYNGENESIA. See Botany.

SYNGNATHUS, pipefish, a genus of fishes of the order nantes: the generic character is, snout subcylindric, with terminal mouth; body lengthened, jointed, mailed; ventral fins none.

1. Syngnathus acus, great pipefish. The fishes of the present genus are inhabitants of the sea, and are observed to frequent the shallower parts near the shore, feeding on the smaller worms and insects: they are easily distinguished by their slender habit, and angular jointed body. The syngnathus acus or great pipefish is usually seen of the length of twelve or fifteen inches, but is sometimes found, especially in the northern seas, of far greater extent, measuring from two to three feet: it is of an extremely slender form, gradually tapering towards the extremity, and is of a pale yellowish-brown colour, varied throughout its whole length with broad alternate zones of a deeper or olive brown, with a few smaller variegations intermixed: the shields or laminæ with which the joints of the body are covered, appear, if narrowly inspected, to be finely radiated from the centre by numerous lines or streaks: the dorsal fin is placed rather nearer the head than the tail, and is thin, tender, shallow, and of no great extent; the pectoral fins small, and slightly rounded, and the tail of similar shape and size. In spring, as in others of this genus, the ova are found lying in a longitudinal channel or division at the lower part of the abdomen, and are large in proportion to the size of the animal: from these are hatched the young, completely formed. Native of the European seas.

2. Syngnathus hippocampus, sea-horse pipefish. A fish of a highly singular appearance: general length from six to ten inches: body much compressed; colour greenish brown, varied with darker and lighter specks: head large, thickish, and beset on the upper part, as well as along some of the first joints of the body, with several small, weak, lengthened spines or cirrhi, which are sometimes slightly ramified: snout slender: neck contracting suddenly beyond the head: body rather short, and contracting suddenly towards the tail, which is long, quadrangular, and terminates in a naked or finless tip. In its dry or contracted state this animal exhibits the fancied resemblance from which it takes its name, but in the living fish this appearance is somewhat less striking, the head and tail being carried nearly straight. It is a native of the Mediterranean, Northern, and Atlantic seas. See Plate Nat. Hist. fig. 387.

3. Syngnathus foliatus, foliated pipefish. A most extraordinary species; far exceeding all the rest of the genus in the singularity of its appearance, which is such as at first view rather to suggest the idea of some production of fancy than of any real existence. In its general shape it is greatly allied to the preceding species, but is considerably longer in proportion, or of a more slender habit: these appendages are situated on very strong, rough, square spines or processes; and was it not for the perfect regularity of their respective proportions, might be mistaken for the leaves of some kind of fucus adhering to the spines. The colour of the whole animal is a dusky or blackish olive, thickly sprinkled on all parts, except on the appendages, with small round whitish specks, and accompanied by a kind of metallic gloss on the abdomen. There are seven species.

SYNOCHUS, *synocha*. See Medicine.

SYNODENDRON, a genus of insects of the order coleoptera. The generic character is, antennæ clavate; the club lamellate; thorax gibbous, muricate, or unequal; lip filiform; horny palpigerous at the tip. There are four species.

SYNOVIA. See Sinovia.

SYNTAGMA, the disposing or placing of things in an orderly manner.

SYNTAX, in grammar, the proper construction, or due disposition, of the words of a language, into sentences.

SYREN. See Siren.

SYRINGIA, the lilac, a genus of plants of the class of diandria, and order of monogynia; and in the natural system ranging under the 44th order, sepiariæ. The corolla is quadrifid, and the capsule is bilocular. There are three species, the vulgaris, persica, and suspensa. The two first are natives of Persia, and the last of Japan. The vulgaris, which is distinguish[ed] by ovate heart-shaped leaves, was cultivat[ed] in Britain about the year 1597 by Mr. Jo[hn] Gerard. The persica, which has lanceola[te] leaves, was cultivated in 1658; but how lo[ng] both species might have been introduced in Britain before these dates, it is perhaps impo[s]sible to ascertain.

SYRINGE, an instrument serving to i[m]bibe a quantity of any fluid, and to squirt [or] expel the same with violence. See Su[r]gery.

The syringe is made of a hollow cylind[er] ABCD, Plate Miscel. fig. 224, furnished wit[h a] little tube at the bottom, EF. In this cylind[er] is an embolus or piston K, made, or at lea[st] covered, with leather, or some other matt[er] that easily imbibes moisture, and so filli[ng] the cavity of the cylinder, as that no air [or] water may pass between the one and t[he] other. If then the little end of the tube is put into water, and the embolus drawn u[p] the water will ascend into the cavity left [by] the embolus; and upon thrusting back t[he] embolus, it will be violently expelled ag[ain] through the tube EF.

This ascent of the water, the antients, wh[o] supposed a plenum, attributed to nature[’s] abhorrence of a vacuum; but the modern[s] from repeated experiments, have found it [to] be owing to the pressure of the atmosphe[re] upon the fluid; for by drawing up the e[m]bolus, the air left in the cavity of the cyli[n]der will be exceedingly rarified, so th[at] being no longer a counterbalance to the [air] incumbent on the surface of the fluid, th[is] prevails and forces the water through t[he] little tube into the body of the syringe. S[ee] Pneumatics, &c.

SYRINGOTON, the name of an instr[u]ment to lay open the fistula.

SYRUP. See Pharmacy, and Sugar.

SYSTEM, in music, an interval compoun[d]ed, or supposed to be compounded, of seve[ral] lesser intervals, as the fourth, the fifth, t[he] sixth, the octave, &c. the components [of] which, considered as the elements of the s[ys]tem, are called diastems. A system is a[lso] a method of calculation to determine the [re]lations of sounds, or an order of signs [es]tablished to express them: and lastly, a s[ys]tem is the code of harmonic rules dra[wn] from those common principles by which th[ey] are computed.

There is an infinity of different interva[ls] and consequently an infinity also of possi[ble] systems. Any interval between the terms [of] which one or more sounds intervened, [was] by the antients called a system: E, G, [for] example, constituted the system of a mi[nor] third; E, A, of a fourth; E, B, of a fif[th], &c.

Systems were divided into general and p[ar]ticular. The particular systems were th[ose] which were composed of at least two int[er]vals. The general systems, or diagra[ms,] were formed of the sum of all the particu[lar] systems, and consequently contained all [the] sounds in music.

The whole system of the Greeks was o[ri]ginally composed only of four sounds [at] most, which formed the concord of their ly[re] or cithara. These four sounds, according [to] some authors, were by conjoint degrees: [ac]cording to others, they were not diatoni[c;] but the two extremes were at the distance [of] an octave, and the two intermediate ones ed it into a fourth on each side, and a tone he middle. This system did not, howr, continue long confined to so few nds. Chorebus, son of Athis, king of dia, as Boetius informs us, added a fifth rd; Hyagnis a sixth; Serpander a seventh, equal the number of the planets; and chaon an eighth. But Pliny gives a different account of the progression of the annt system: according to that writer, Terider added three chords to the tetrachord, l was the first who used the cithara with en chords; Simonides joined to it an eighth, l Timotheus a ninth.

Whichever of these accounts may be the true one, it seems pretty certain that the system of the Greeks was gradually extended, both upward and downward; and that it attained and even exceeded the limits of the bis-diapason, or double octave, an extent which they called systema perfectum, maximum, immestatum, the great system, the perfect system.

This entire system was composed of four tetrachords, three conjoint and one disjoint, and the chord called proslambanomenos, which was added below these tetrachords to complete the double octave.

This general system of the Greeks remained nearly in this state till the eleventh century, when Guido made a considerable change, by adding a new chord below, which he called hypoproslambanomenos; also a fifth tetrachord above, or tetrachord of the sur-sharp; and substituting hexachords in the place of the antient tetrachords. Since the time of Guido, the general system has again been greatly extended, and divided into octaves; which has long been adopted throughout Europe, and which the ear certainly recognises as the most natural of all possible partitions of the great scale of sounds.

SYSTOLE. See ANATOMY.

SYZYGY. See ASTRONOMY.

T.

T the nineteenth letter of our alphabet.

In abbreviations, amongst the Roman writs, T. stands for Titus, Titius, &c. Tab. for abularius; Tab. P. H. C. Tabularius proncis Hispaniæ citerioris; Tar. Tarquinius; i. Tiberius; Ti. F. Tiberii filius; Ti. L. iberii libertus; Ti. N. Tiberii Nepos; T. A. V. P. V. D. tempora judicem arbiumve postulat ut det; T. M. P. terminum osuit; T M. D D. terminum dedicavit; r. trans, tribunus; Tr. M. or Mil. tribunus ilitum; T R. P L. D E S. tribunus plebis esignatus; T R. A E R. tribunus ærarii; R V. C AP. triumviri capitales; T. R. r TRIB. POT. tribunicia potestata; Tul. I. Tullus Hostilius.

Amongst the antients, T. as a numeral, ood for one hundred and sixty: and with a ash at top, thus T̄, it signified one hundred nd sixty thousand. In music, T stands for utti, all, or altogether.

TABANUS, a genus of insects of the order diptera. The generic character is, mouth ormed into a fleshy proboscis, terminated by wo lips; rostrum furnished with two pointed alpi, placed on each side of, and parallel o, the proboscis. There are 53 species.

The largest of the British species is the tabanus bovinus of Linnæus, having the appearance of a very large grey or pale-brown ly, often measuring near an inch in length, and marked down the back by a series of arge, whitish, triangular spots, pointing downwards; on each side also is an approach also to a similar appearance, though less distinct than that of the dorsal row. This insect, like the rest of the genus, is seen during the middle and the decline of summer; generally in the hottest part of the day. It is extremely troublesome to cattle, piercing their skin with the lancets of its trunk, and sucking its blood in such a manner as to cause considerable pain. It proceeds from a large dusky-yellowish larva, nearly resembling that of a tipula, and marked by transverse blackish streaks or rings; it resides under ground in moist meadows, &c. and changes to a cylindric brownish chrysalis, with a roundish or very slightly pointed extremity; out of which, in the space of a month, proceeds the perfect insect. See Plate Nat. Hist. fig. 388.

2. Tabanus tropicus is of a smaller size than the preceding, and of a brown colour, with the sides of the abdomen bright ferruginous. It is a less common species than the former.

3. Tabanus pluvialis is of the size of a window-fly, but of a somewhat longer shape in proportion; it is of a dull brown colour, with the wings of a similar cast, but marbled or variegated with very numerous whitish specks: this is a very troublesome insect during the latter part of summer, fastening on the legs, hands, &c. and causing considerable pain by the puncture of its proboscis: it is observed to be peculiarly teasing on the approach of rain.

4. Tabanus cæcutiens is an insect of singular beauty. It is of the size of a common window-fly, and of a yellowish-brown colour varied with back; the wings are transparent, and marked by large black bands or patches, and the eyes are of the most vivid or lucid green, marbled with black spots and streaks. It is by no means uncommon during the autumnal season.

TABBY, in commerce, a kind of rich silk, which has undergone the operation of tabbying. See the next article.

TABBYING, the passing a silk or stuff through a calender, the rolls of which are made of iron or copper, variously engraven; which bearing unequally on the stuff, renders the surface unequal, so as to reflect the rays of light differently, making the representation of waves thereon.

TABELLA, TABLET. See PHARMACY.

TABERNÆMONTANA, a genus of plants of the class of pentandria, and order of monogynia; and in the natural system arranged under the 30th order, contortæ. There are two horizontal folioles, and the seeds are immersed in pulp. There are 19 species, all of foreign growth.

TABES DORSALIS. See MEDICINE.

TABLE, in perspective, denotes a plane surface, supposed to be transparent, and perpendicular to the horizon. It is always imagined to be placed at a certain distance between the eye and the objects, for the objects to be represented thereon by means of the visual rays passing from every point thereof through the table to the eye; whence it is called perspective-plane.

TABLES, *laws of the twelve*, were the first laws of the Romans; thus called either because the Romans then wrote with a style on thin wooden tablets covered with wax, or rather, because they were engraven on tables, or plates of copper, to be exposed in the most noted part of the public forum. After the expulsion of the kings, as the Romans were then without any fixed or certain system of law, at least had none ample enough to comprehend the various cases that might fall between particular persons, it was resolved to adopt the best and wisest laws of the Greeks. One Hermodorus was first appointed to translate them, and the decemviri afterwards compiled and reduced them into ten tables. After much care and application, they were at length enacted and confirmed by the senate and an assembly of the people, in the year of Rome 303. The following year they found something wanting in them, which they supplied from the laws of the former kings of Rome, and from certain customs which long use had authorised; all these being engraven on two other tables made the law of the twelve tables, so famous in the Roman jurisprudence, the source and foundation of the civil or Roman law.

TABLE, among the jewellers. A table-diamond, or other precious stone, is that whose upper surface is quite flat, and only the sides cut in angles; in which sense a diamond cut tablewise, is used in opposition to a rose-diamond.

TABLE, in mathematics, systems of numbers calculated to be ready at hand for the expediting astronomical, geometrical, and other operations: thus we say tables of the stars; tables of sines, tangents, and secants; tables of logarithms, rhumbs, &c. sexagenary tables.

TACAMAHACA. See POPULUS, and RESINS.

TACCA, a genus of the class and order hexandria monogynia. The cal. is six-parted; cor. six-petalled, inserted into the cal.; stigma stellate; berry dry, hexangular, &c. There is one species, a herb of the East Indies.

TACHYGRAPHY, the art of writing fast or of short hand; of which authors have invented several methods. See STENOGRAPHY.

TACK, in a ship, a great rope having a wale-knot at one end, which is seized or fastened into the clew of the sail; so is reefed first through the chess-trees, and then is brought through a hole in the ship's side. Its use is to carry forward the clew of the sail, and to make it stand close by a wind: and whenever the sails are thus trimmed, the main-tack, the fore-tack, and mizen-tack, are brought close by the board, and haled as much forward on as they can be.

TACK-ABOUT, in the sea-language, is to turn the ship about, or bring her head about, so as to lie the contrary way.

TACKLE, or TACKLING, among seamen, denotes all the ropes or cordage of a ship, used in managing the sails, &c. In a more restrained sense, tackles are small ropes running in three parts, having at one end a pendant and a block; and at the other end a block and a hook, to hang goods upon that are to be heaved into the ship or out of it.

TACTICS, in the art of war, is the method of disposing forces to the best advantage in order of battle, and of performing the several military motions and evolutions. See WAR, *art of*.

TACTICS, in the military art, a word derived from the Greek, signifying order. Tactics consist of a knowledge of order, disposition, and formation, according to the exigency of circumstances in warlike operations.

General tactics are a combination or union of first orders, out of which others grow of a more extensive and complicated nature, to suit the particular kind of contest or battle which is to be given, or supported. Let it not, however, be inferred from this, that evolutions and tactics are one and the same. They are closely connected, but there is still a discernible difference between them.

Tactics may be comprehended under order and disposition; evolution is the movement which is made, and eventually leads to order. The higher branches of tactics should be thoroughly understood by all general officers; but it is sufficient for inferior officers and soldiers to be acquainted with evolutions. Not that the latter are beneath the notice of general officers; but that having already acquired a knowledge of them, they ought to direct their attention more immediately to the former, carefully retaining at the same time a clear apprehension of every species of military detail, and consequently obviating the many inconveniences and embarrassments which occur from orders being awkwardly expressed by the general, and of course ill understood by the inferior officer. It may be laid down as a certain rule, that unless a general officer makes himself acquainted with particular movements and dispositions, and preserves the necessary recollections, it is morally impossible for him to be clear and correct in his general arrangements. Of all mechanical operations, founded upon given principles, the art of war is certainly the most compendious, the most enlarged, and the most capable of improvement. Almost every other science and art are comprehended in it; and it should be the subject matter, the chief study, and the ultimate object, of a general's reflections. He must not be satisfied with a limited conception of its various branches; he should go deeply into all its parts, be aware of its manifold changes, and know how to adapt movements and positions to circumstances and places.

It will be of little use to a general to have formed vast projects, if, when they are to be executed, there should be a deficiency of ground; if the general movements of the army should be embarrassed by the irregularity of some particular corps, by their overlapping each other, &c.; and if, through the tardiness of a manœuvre, an enemy should have time to render his plan abortive by a more prompt evolution. A good general must be aware of all these contingencies, by making himself thoroughly master of tactics.

The Prussian tactics under Frederic the Great, had for their principal object to concentrate forces, and to attack the chief points of an enemy, not at one and the same time, but one after another: whereas the tactics which have been uniformly pursued by the French, since the commencement of their revolution, have been founded upon this principle; to attack all points with divided forces, at one and the same time. We thus see, that the principles of extension have been as much followed by the latter, as those of compression were studiously adhered to by the former.

Tactics of Europe. The following observations respecting the tactics of Europe, which we extract from a book entitled the Elementary Principles of Tactics, page 137, may not be uninteresting to our military readers:

In the time of the Romans, the Gauls and other nations on the continent fought in the phalanx order; it is this order which still prevails through all Europe, except that it is deficient in the advantages and utility which Polybius ascribes to it, and is injured and disgraced by defects unknown to the antient phalanx.

In Turenne's days, troops were ranged 8 deep, both in France and Germany. Thirty years after, in the time of Puysegur, the ranks were reduced to 5; in the last Flanders war to 4; and immediately after to 3; at present the ranks are reduced to 2.

This part of the progression from eight to three being known, we easily conceive how the files of the phalanx have been diminished from sixteen to eight in the ages preceding Turenne. It is to be presumed, that this depth was considered as superfluous; and it was judged necessary to curtail it, in order to extend the front. However, the motion is of very little consequence, since we are now reduced to three ranks; let us therefore endeavour to find out what qualities of the phalanx have been preserved, and what might have been added to it.

To shew that we have preserved the defects of the phalanx in Europe, we suppose two bodies of troops, one of eight thousand men, ranged as a phalanx, sixteen deep; the other a regiment of three battalions, consisting only of fifteen hundred men, drawn up in three lines after the same manner. These two bodies shall be perfectly equal and alike in extent of front, and shall differ in nothing but in the depth of their files; the inconveniences and defects, therefore, occasioned by the length of their fronts, are equal in both troops, though their numbers are very different; hence it follows, that in Europe, the essential defects of the phalanx are preserved, and its advantages lost.

Let the files of this body of eight thousand be afterwards divided, and let it be reduced to three in depth, its front will then be found five times more extensive, and its depth five times less; we may therefore conclude, that the defects of the phalanx are evidently multiplied in the discipline of Europe, at the expence of its advantages, which consisted in the depth of its files.

The progress which has taken place in the artillery, has contributed greatly to this revolution. As cannon multiplied, it was necessary to avoid its effects; and the only method of avoiding, or at least of lessening them, was doubtless to diminish the depth of the files.

The musquet, likewise, has a great share in the alteration; the half-pike was entirely laid aside for the bayonet; and in order to have no fire unemployed, it was thought necessary to put it in the power of every soldier to make use of his.

These are the two principal causes of the little solidity or depth given to our battalions.

We have now seen, that the defects of the phalanx were multiplied in the European discipline, and its advantages and perfection infinitely diminished. Our regulations are therefore, much inferior to the phalanx, and have nothing but the single effect of fire-arms to counterbalance all its advantages. The effect, however, of fire-arms, is an artificial power, and does not originally belong to the manner of disciplining troops, the sole aim of which should be to employ man's natural action. It is man, therefore, and not this fire, which is to be considered as the principal agent; and hence we may infer that this method is very much inferior to the phalanx, and still more to the Roman arrangement, which so far surpassed that of Greece.

The light troops of both these people were much heavier than our battalions, and had more power and solidity for a shock or conflict. However, the Roman discipline, notwithstanding its superiority, is not calculated for our times; because, as we are obliged to engage at a distance, ours, by its cannon, would destroy the Grecian order of battle in a very short time, and would be exposed to a loss much less considerable itself, supposing even the artillery was equal on both sides; we should then, in order to perfect our arrangements, endeavour to procure them all the advantageous qualities of the legionary regulations, as the only means of giving them the superiority.

Many people are of opinion, that we imitate the Romans, and that we give battle according to their system, because our troops are drawn up in lines, some of which are full, and others vacant. But it has been proved, that three battalions have the same front, and the same inconveniences, that eight thousand men, ranged in the phalanx order. Our lines are formed by brigades, regiments, or battalions, and the distance of one corps to the other is equal to the front of one of those corps: so that those lines, both full and vacant, are composed of detachments equal in front and in defects; each has a phalanx of six, eight, or twelve thousand men. Our orders of battle, consequently, can be no more at most than a kind of medium between those of Greece and Rome.

TACTICS, *maritime*, or manœuvres at sea. With respect to naval tactics, or the art of fighting at sea, it is confessedly less antient than tactics on shore, or what is generally called land-service. Mankind were accustomed to contend for the possession of territory long before they determined on, or even dreamed of, making the sea a theatre of war and bloodshed.

Setting aside the many fabulous accounts which are extant concerning naval tactics, we shall remain satisfied with what has been transmitted to us by the Roman writers of the fifth and sixth centuries of that republic. We shall there find specific details of the different manœuvres which were practised at sea during the Punic war. In those times naval armaments began to be regularly fitted out; ships of different forms and sizes were constructed; and certain offensive and defensive machines, that served as a species of artillery, were placed upon them. They had already been drawn out according to system; being divided into certain proportions which were then called divisions, but are now named squadrons; and the persons who commanded them, exerted all their skill and genius to gain advantages over their enemies, by opportunely getting to windward, by seizing the favourable occurrence of the tide, or by mooring in advantageous situations.

At the battle of Actium, Augustus, finding himself inferior to Mark Anthony in the number of his ships, had the sagacity to draw up his line of battle along the entrance of the gulph of Ambracia, and thereby to make up for his deficiency. This naval manœuvre, as well as that of getting to windward of the enemy, in order to bear down upon him with more certainty and effect, exists to the present day.

We act precisely upon the same principles in both cases, by which the antients were governed; with the additional advantage, in fighting to windward, of covering the enemy's line with smoke from the discharge of ordnance and fire-arms. The French call this being in possession of the closest line.

In those times, ships were boarded much sooner than they are at present. Most engagements at sea are now determined by cannon-shot. Among the antients, when two ships endeavoured to board each other, the rowers drew in their oars, to prevent them from being broken in the shock.

The manœuvre which was practised on this occasion, was for the ship that got to windward of its adversary, to run upon its side, with the prow; which being armed with a long sharp piece of iron, made so deep an impression in it, that the ship thus attacked, generally sunk. The voyages which were afterwards made on the ocean, rendered it necessary to construct ships that carried more sail, and were double-decked; and since the invention of gunpowder, tiers of guns have been substituted in the room of rows of oars.

On the decline and fall of the Roman empire, the Saracens got the ascendancy in naval tactics. They took advantage of this superiority, and extended their conquests on all sides. The whole extent of coast belonging to the Mediterranean, together with the adjacent islands, fell under their dominion. Mankind are indebted to them for considerable improvements in naval tactics.

It was only under Charlemagne, that the Europeans can be said to have paid any great attention to their navy. That monarch kept up a regular intercourse with the caliphs of the East; and having just grounds to apprehend an invasion from the Normans, he constructed vessels for the defence of his coasts.

During the reign of the first French kings belonging to the third race, naval tactics were little attended to, on account of the small extent of maritime coast which France possessed at that period. It was only in the days of Louis the Younger, and of Louis surnamed the Saint, that we discover any traces of a considerable fleet, especially during the crusades.

Under Charles the Fifth, and his successor Charles the Sixth, the French got possession of several sea-ports, and had command of a long line of coast. Yet neither they nor the English, with whom they were frequently at war, had at that period any thing like the fleets which are now fitted out.

The discovery of America by Columbus, and the more lucrative possession of the East Indies, induced the principal states of Europe to increase their naval establishments, for the purpose of settling colonies, and of bringing home, without the danger of molestation or piracy, the wealth and produce of the eastern and western worlds.

The French marine was far from being contemptible under Francis the First; but it grew into considerable reputation during the administration of cardinal Richelieu, in the reign of Louis the Thirteenth; and continued so until the battle of La Hogue, which was so gloriously won by the English, under William the Third. From that epoch it began to decline; while the English, on the other hand, not only kept up the reputation they had acquired under Cromwell and his predecessors, but rendered themselves so thoroughly skilled in naval tactics, that they have remained masters of the sea to this day. See WAR, *art of*.

TÆNIA, the TAPE-WORM, in zoology, a genus of animals belonging to the class of vermes, and order of intestina. The body is long, depressed, and jointed like a chain, and contains a mouth and viscera in each joint. According to Gmelin, there are ninety-two species; all which inhabit the intestines of various animals, particularly of quadrupeds.

Seven species of tænia are peculiar to man: 1. The visceralis, which is inclosed in a vesicle, broad in the fore part, and pointed in the hinder part; inhabits the liver, the placenta uterina, and the sac which contains the superfluous fluid of dropsical persons. 2. Cellulosa, which is inclosed in a cartilaginous vesicle, inhabiting the cellular substance of the muscles; is about an inch long, half an inch broad, and one-fourth of an inch thick, and is very tenacious of life. 3. The dentata, has a pointed head; the large joints are streaked transversely, and the small joints are all dilated; the osculum or opening in the middle of both margins is somewhat raised. It is narrow, ten or twelve feet long, and broad in the fore parts; its ovaria are not visible to the naked eye; and the head underneath resembles a heart in shape. It inhabits the intestines. 4. The lata, is white, with joints very short and knotty in the middle; the osculum is solitary. It is from eighteen to one hundred and twenty feet long; its joints are streaked transversely; its ovaria are disposed like the petals of a rose. 5. The vulgaris, has two lateral mouths in each joint; it attaches itself so firmly to the intestines, that it can scarcely be removed by the most violent medicines; it is slender, and has the appearance of being membranaceous; it is somewhat pellucid, from ten to sixteen feet long, and about four lines and a half broad at one end. 6. The truttæ, which chiefly inhabits the liver of the trout, but is also to be found in the intestines of the human species. 7. The solium, has a marginal mouth, one on each joint. 8. The ovilla, found in the liver and omentum of sheep. See Plate Nat. Hist. fig. 389.

The structure and physiology of the tænia are curious, and it may be amusing as well as instructive to consider it with attention. The tænia appears destined to feed upon such juices of animals as are already animalized; and is therefore most commonly found in the alimentary canal, and in the upper part, where there is the greatest abundance of chyle; for chyle seems to be the natural food of the tænia. As it is thus supported by food which is already digested, it is destitute of the complicated organs of digestion. As the tænia solium is most frequent in this country, it may be proper to describe it more particularly.

It is from three to thirty feet long, some say sixty feet. It is composed of a head in which are a mouth adapted to drink up fluids, and an apparatus for giving the head a fixed situation. The body is composed of a great number of distinct pieces articulated together, each joint having an organ by which it attaches itself to the neighbouring part of the inner coat of the intestine. The joints nearest the head are always small, and they become gradually enlarged as they are farther removed from it; but towards the tail a few of the last joints again become diminished in size. The extremity of the body is terminated by a small semicircular joint, which has no opening in it.

The head of this animal is composed of the same kind of materials as the other parts of its body; it has a rounded opening at its extremity, which is considered to be its mouth. This opening is continued by a short duct into two canals; these canals pass round every joint of the animal's body, and convey the aliment. Surrounding the opening of the mouth are placed a number of projecting radii, which are of a fibrous texture, whose direction is longitudinal. These radii appear to serve the purpose of tentacula for fixing the orifice of the mouth, as well as that of muscles to expand the cavity of the mouth, from their being inserted along the brim of that opening. After the rounded extremity or head has been narrowed into the neck, the lower part becomes flatted, and has two small tubercles placed upon each flatted side; the tubercles are concave in the middle, and appear destined to serve the purpose of suckers for attaching the head more effectually. The internal structure of the joints composing the body of this animal is partly vascular and partly cellular; the substance itself is white, and somewhat resembles in its texture the coagulated lymph of the human blood. The alimentary canal passes along each side of the animal, sending a cross canal over the bottom of each joint, which connects the two lateral canals together.

Mr. Carlisle injected with a coloured size, by a single push with a small syringe, three feet in length of these canals, in the direction from the mouth downwards. He tried the injection the contrary way, but it seemed to be stopped by valves. The alimentary canal is impervious at the extreme joint, where it terminates without any opening analogous to an anus. Each joint has a vascular joint occupying the middle part, which is composed of a longitudinal canal, from which a great number of lateral canals branch off at right angles. These canals contain a fluid like milk.

The tænia seems to be one of the simplest vascular animals in nature. The way in which it is nourished is singular; the food being taken in by the mouth, passes into the alimentary canal, and is thus made to visit in a general way the different parts of the animal. As it has no excretory ducts, it would appear that the whole of its alimentary fluid is fit for nourishment; the decayed parts probably dissolve into a fluid which transudes through the skin, which is extremely porous.

This animal has nothing resembling a brain or nerves, and seems to have no organs of sense but those of touch. It is most probably propagated by ova, which may easily pass along the circulating vessels of other animals. We cannot otherwise explain the phenomena of worms being found in the eggs of fowls, and in the intestines of a fœtus before birth, except by supposing their ova to have passed through the circulating vessels of the mother, and by this means been conveyed to the fœtus.

The chance of an ovum being placed in a situation where it will be hatched, and the young find convenient subsistence, must be very small; hence the necessity for their being very prolific. If they had the same powers of being prolific which they now have, and their ova were afterwards very readily hatched, then the multiplication of these animals would be immense, and become a nuisance to the other parts of the creation.

Another mode of increase allowed to tænia (if we may call it increase) is by an addition to the number of their joints. If we consider the individual joints as distinct beings, it is so; and when we reflect upon the power of generation given to each joint, it makes this conjecture the more probable. We can hardly suppose that an ovum of a tænia, which at its full growth is thirty feet long, and composed of 400 joints, contained a young tænia composed of this number of pieces; but we have seen young tæniæ not half a foot long, and not possessed of fifty joints, which still were entire worms. We have also many reasons to believe, that when a part of this animal is broken off from the rest, it is capable of forming a head for itself, and becomes an independant being. The simple construction of the head makes its regeneration a much more easy operation than that of the tails and feet of lizards, which are composed of bones and complicated vessels; but this last operation has been proved by the experiments of Spallanzani and many other naturalists.

When intestinal worms produce a diseased state of the animal's body which they inhabit, various remedies are advised for removing them; many of which are ineffectual, and others very injurious by the violence of their operation. Drastic purges seem to operate upon tæniæ, partly by irritating the external surface of their bodies, so as to make them quit their holds, and partly by the violent contractions produced in the intestine, which may sometimes divide the bodies of tænia, and even kill them by bruising. The most effectual remedy, however, has been found to be the digitalis in substance.

TAGETES, *French marigold*, a genus of plants of the class of syngensia, and order of polygamia superflua; and in the natural system ranging under the 49th order, compositæ. The receptacle is naked; the pappus consists of five erect awns or beards; the calyx is monophyllous, quinquedentate, and tubular; and there are four persistent florets of the ray. There are three species, the patula, erecta, and minuta; of which the two first have been cultivated in the British gardens, at least since the year 1596, for it is mentioned in Gerard's Herbal, which was published that year. They are both natives of Mexico.

The erecta, or African marigold, has a stem subdividing and spreading, and has formed itself into a great many varieties: 1. Pale yellow, or brimstone-colour, with single, double, and fistulous flowers. 2. Deep yellow, with single, double, and fistulous flowers. 3. Orange-coloured, with single, double, and fistulous flowers. 4. Middling African, with orange-coloured flowers. 5. Sweet-scented African. These are all very subject to vary; so that unless the seeds are very carefully saved from the finest flowers, they are apt to degenerate; nor should the same seeds be too long sown in the same garden, for the same reason; therefore those who are desirous to have these flowers in perfection, should exchange their seeds with some person of integrity at a distance, where the soil is of a different nature, at least every other year. If this is done, the varieties may be continued in perfection.

TAIL, or ESTATES TAIL, are either general or special. Tail general, is where lands and tenements are given to one and the heirs of his body begotten, which is called tail general; because, how often soever such donee may be married, his heirs, by every such marriage, are capable of inheriting the estate tail. Tenant in tail special, is where the gift is restrained to certain heirs of the grantee, and not to all in general, which may happen several ways. Estates tail are likewise diversified by the distinction of male and female, as if lands are given to a man and the heirs male of his body begotten; this is an estate in tail, male special: but if to a man and the heirs female of the body of his present wife begotten, this is an estate in tail, female special. So in case of a gift in tail male, the female line shall not inherit; and so e converso.

As the word heirs is necessary to create a fee, so the word body or some other words of procreation are necessary to make a fee tail, and ascertain to what heirs the estate is limited. Therefore, if the words of inheritance or procreation are omitted, although the others are inserted, this will not make an estate tail. As if an estate is granted to a man and the issue of his body, this is only an estate for life, the words of inheritance being wanting; and a grant to a man, and his heirs male or female, is an estate in fee simple, not in fee tail, as there are no words to ascertain the body from whence they shall issue. Though in wills, where greater latitude is given, an estate tail may be devised by the words, to a man and his heirs male, or other irregular modes of expression.

The incidents to a tenancy in tail are principally these:

1. A tenant in tail may commit waste on an estate without being impeached for the same.

2. That the wife shall have her dower of the estate tail.

3. That the husband of a female tenant in tail may be tenant by courtesy.

4. An estate tail may be barred or destroyed by a fine, a recovery, or lineal warranty, descending with assets to the heir.

And by stat. 26 Hen. VIII. c. 13. all estates tail (in common with all estates of inheritance) are forfeited to the king on conviction of high treason.

By stat. 32 Hen. VIII. c. 28. certain leases which do not tend to the prejudice of the heir are allowed to bind the issue in tail. A stat. of the same year, c. 36. declares a fine duly levied by a tenant in tail to be a complete bar to all persons claiming under such entail.

And lastly, by 33 Hen. VIII. c. 39. all estates tail are liable to be charged for debts to the king by record or special contract.

They are likewise subject to be sold for the debts contracted by a bankrupt; and by the construction put on stat. 43 Eliz. c. 4. an appointment by tenant in tail, of the lands entailed to a charitable use, is good without fine or recovery.

TAIL, in the Turkish customs, (bashaws of three tails, &c.) See TUG.

TALC. Though this term has often been a synonym of mica in mineralogy, it is adopted by the moderns, to denote a stony substance which differs from it, especially in an unctuosity sensible to the touch, and in the vitreous electricity which it communicates to sealing-wax by friction, whilst mica gives it the resinous electricity. Hauy enumerates four varieties of this stone; namely, the laminary talc, or Venice talc; the foliated talc, or chalk of Briançon; compact talc, as the lard-stone; these three first give the positive or vitreous electricity to sealing-wax. The fourth variety, or the steatites talc, communicates the negative or resinous electricity to it by friction.

The characters of this stone are, a specific gravity between 3.5834 and 2.9902; a texture easy to be scraped with the knife; a soft and unctuous surface; the primitive form of a right rhomboidal prism, its bases having angles of 120 degrees and 60 degrees, and in which sections parallel with these bases are easily obtained. Its integrant molecule has the same form.

Mr. Kirwan has found in this stone almost as much magnesia as silex, and only a twentieth part of alumina. Amongst the varieties of talc, which are sufficiently numerous, the mixed steatites, the serpentine, and pot stones, are not ranked.

The softness of the texture of the talcs, the fineness of their powder, their easy suspension in water (which they powerfully absorb), and the hardness which they contract by the action of a moderate heat, render them useful in a great number of the arts, or for domestic purposes.

A specimen analysed by Mr. Kirwan contained

Silex	5.0
Alumina	5
Magnesia	4.5
	100

TALENT, a money of account amongst the antients, equal to 342*l.* sterling. See Coin, and Money.

Amongst the Jews, a talent in weight was equal to 60 maneh, or 113 pounds, 10 ounces, 1 pennyweight, 10 and two-seventh grains.

TALES, is used in law for a supply of men impanelled on a jury, and not appearing, or on their appearance challenged and disallowed, when the judge upon motion orders a supply to be made by the sheriff of one or more such persons present in court, to make up a full jury.

TALIO, *lex talionis,* a species of punishment in the Mosaic law, whereby an evil is returned similar to that committed against us by another; hence that expression, eye for eye, tooth for tooth. This law was at first inserted in the twelve tables amongst the Romans; but afterwards set aside, and a power given to the prætor to fix upon a sum of money for the damages done.

TALLOW-TREE. See Croton.

TALLY, in law, a piece of wood cut in two parts, whereon accounts were antiently kept, by means of notches; one part of the tally being kept by the debtor, and the other by the creditor. As to the tallies or loans, one part thereof is kept in the exchequer, and the other part given to particular persons in lieu of an obligation for the moneys they have lent to the government on acts of parliament. This last part is called the stock, and the former the counter-stock, or counter-tail.

TALMUD, or Thalmud, among the Jews, a collection of the doctrines of their religion or morality. It is the corpus juris, or body of the laws and customs of the Jews, who esteem it equal to the scriptures themselves.

TALPA, mole, a genus of the quadrupeds of the order feræ. The generic character is, front teeth in the upper jaw six, unequal; in the lower jaw eight; canine teeth one on each side, the upper ones largest; grinders seven in the upper jaw, six in the lower.

The genus talpa or mole is readily distinguished by its peculiar shape, habit, or general appearance, even without an examination of the teeth; in which particular some species resemble the genus sorex, and were placed in that genus by Linnæus. There are 21 species; the most remarkable are:

1. Talpa Europæa, the common mole. The whole form of the mole is eminently calculated by nature for its obscure and subterraneous life. The body is thick and cylindric; the snout slender, but very strong and tendinous; the head not distinguished from the body by any appearance of neck; the legs so extremely short as scarcely to project perceptibly from the body; the skin is much thicker and tougher in proportion than in other quadrupeds, and the fur with which it is covered equally surpasses that of other animals in fineness and softness. The muscular strength of the mole is very great, and it is enabled to force itself into the ground with an extraordinary degree of celerity. The general length of the mole is about five inches and three quarters, exclusive of the tail, which measures one inch. This animal is supposed to possess the power of hearing in an exquisite degree; and if at any time it emerges from its subterraneous retreat, instantly disappears on the approach of any danger. When first taken, either by digging it out or otherwise, it utters a shrill scream, and prepares for defence by exerting the strength of its claws and teeth. According to the count de Buffon, so lively and reciprocal an attachment subsists between the male and female, that they seem to dread or disrelish all other society.

The mole is furnished with eyes so extremely small that it has been doubted whether they were intended by nature for distinct vision, or rather merely for giving the creature such a degree of notice of the approach of light as might sufficiently warn it of the danger of exposure. Galen, however, seems to have been of a different opinion, since he ventures to affirm that the eyes of the mole are furnished with the crystalline and vitreous humours, encompassed with their respective tunics; so accurate an anatomist was that great man, even unassisted by glasses.

The mole is reported to feed not only on worms, insects, &c. but also on the roots of vegetables; but it is certainly more carnivorus than frugivorous. It is even a very fierce and voracious animal in particular circumstances; and it is observed by sir Thomas Brown, that whatever these animals are contented with under ground, yet, when above it, they will sometimes tear and eat one another; and in a large glass case, wherein a mole, a toad, and a viper, were inclosed, we have known (says he) the mole to dispatch them, and to devour a good part of them both.

The mole is with difficulty kept alive in a state of confinement, unless constantly supplied with a provision of damp mould to reside in.

Like other animals of a black colour, the mole is sometimes found perfectly white, or cream-coloured, and sometimes spotted. In a memoir relative to the mole, published by M. de la Faille, it appears that four varieties may be reckoned, viz. the white mole, the rufous or tawny mole, the greenish-yellow or citron-coloured mole (found in some parts of Languedoc), and, lastly, the spotted mole, which is variegated either with white or tawny spots or patches. The mole brings four or five young.

The greatest misfortune that befals the mole is, the sudden overflowing of rivers, when they are said to be seen swimming in great numbers, and using every effort to obtain a more elevated situation; but a great many of them perish on such occasions, as well as the young, which remain in their holes.

Linnæus, in the twelfth edition of the Systema Naturæ, affirms that the mole hybernates, or passes the winter, in a state of torpidity; and the same observation is repeated in the Gmelinian edition of that work. This, however, is flatly contradicted by the count de Buffon, who observes, that the mole sleeps so little in winter, that she raises the earth in the same manner as in summer; and that the country people remark that the thaw approaches, because the moles make their hills. They endeavour to get into warm grounds, gardens, &c. during this season more than at others.

This animal is said to be unknown in Ireland. In Siberia it arrives at a larger size than in Europe. The fur is so soft and beautiful, that it would make the most elegant articles of dress, did not the difficulty of curing and dressing the skin deter from experiments of this nature.

2. Talpa radiata, radiated mole. This is somewhat smaller than the common mole, and is of a dusky or blackish colour. In general form it resembles the preceding species, having broad fore legs with long claws; the hind legs scaly and with much weaker claws; the nose long, and beset at the end with a circular series of radiated tendrils; the length from nose to tail is three inches and three quarters. It is an inhabitant of North America, forming subterraneous passages, in different directions, in uncultivated fields, and is said to feed on roots. This species is the sorex cristatus of Linnæus; being placed in that genus on account of its teeth, in despite of its appearance. It is, perhaps, in reality, no other than a variety of the former species, or a sexual difference.

TAMARINDUS, the *tamarind-tree,* a genus of plants arranged by Linnæus under the class of triandria and order of monogynia; but Woodville, Schreber, and other late botanists, have found that it belongs to the class of monadelphia, and order of triandria. In the natural system it is ranked under the lomantaceæ. There is only one species, the Indica, which is a native of both Indies, of America, of Arabia, and of Egypt, and was cultivated in Britain before the year 1633.

The tamarind-tree rises to the height of thirty or forty feet, sending off numerous large branches, which spread to a considerable extent, and have a beautiful appearance; the trunk is erect, and covered with rough bark, of a greyish or ash-colour; the leaves are small and pinnated, and of a yellowish green colour; the flowers resemble the papilionaceous kind, and grow in lateral clusters; the calyx consists of four leaves, and the corolla of three petals, which are of a yellowish hue, and are beautifully diversified with red veins; the fruit is a pod of a roundish compressed form, from three to five inches long, containing two, three, or four seeds, lodged in a dark pulpy matter. The tamarind is easily raised with us from the stones even of the preserved fruit, and is a beautiful stove plant, rising to the height of four or five feet.

The pulp of the tamarind, with the seeds connected together by numerous tough strings or fibres, are brought to us freed from the outer shell, and commonly preserved in syrup. According to Long, tamarinds are prepared for exportation at Jamaica in the following manner: "The fruit or pods are gathered (in June, July, and August) when full-ripe, which is known by their easy breaking on small pressure between the finger and thumb. The fruit, taken out of the pod, and cleared from the shelly fragments, is placed in layers in a cask, and boiling syrup, just before it begins to granulate, is poured in till the cask is filled; the syrup prevades every part quite down to the bottom, and when cool the cask is headed for sale." He observes, that the better mode of preserving this fruit is with sugar, well clarified with eggs, till a transparent syrup is formed, which gives the fruit a much pleasanter flavour; but as a principal medicinal purpose of the pulp depends upon its acidity, which is thus counteracted by the admixture of sugar, it would therefore be of more utility if always imported here in the pods. The fruit produced in the East Indies is more esteemed than that of the West, and easily to be distinguished by the greater length of the pods, and the pulp being drier and of a darker colour.

This fruit, the use of which was first learned of the Arabians, contains a larger proportion of acid, with the saccharine matter, than is usually found in the fructus acido-dulcis, and is therefore not only employed as a laxative, but also for abating thirst and heat in various inflammatory complaints, and for correcting putrid disorders, especially those of a bilious kind; in which the cathartic, antiseptic, and refrigerant qualities of the fruit have been found equally useful. When intended merely as a laxative, it may be of advantage to join it with manna, or purgatives of a sweet kind, by which its use is rendered more effectual. Three drachms of the pulp are usually sufficient to open the body; but to prove moderately cathartic, one or two ounces are required. It is an ingredient in electuarium e cassia, and electuarium e senna or lenitive electuary.

TAMARIX, the *tamarisk*, a genus of plants in the class of pentandria, and order of trigynia; and in the natural system ranging under the 13th order, succulentæ. The calyx is quinquepartite; the petals are five; the capsule is unilocular and trivalvular, and the seeds pappous. There are 4 species.

The bark and leaves of the tamarisk-tree are moderately astringent, but never prescribed in the present practice.

TAMBOUR, in fortification, is a kind of work formed of palisades, or pieces of wood, ten feet long and six inches thick, planted close together, and driven two or three feet into the ground; so that when finished it may have the appearance of a square redoubt cut in two. Loop-holes are made six feet from the ground, and three feet asunder, about eight inches long, two inches wide within, and six without. Behind is a scaffold two feet high, for the soldiers to stand upon. They are frequently made in the place of arms of the covert-way, at the salient angles, in the gorges, half-moons, and ravelins, &c.

TAMBOURS, in fortification, are also solid pieces of earth which are made in that part of the covert way that is joined to the parapet, and lies close to the traverses, being only three feet distant from them. They serve to prevent the covert way from being enfiladed, and obstruct the enemy's view towards the traverses When tambours are made in the covert way, they answer the same purposes that works en cremaillére would.

Tambour likewise means in fortification, a single or isolated traverse, which serves to close up that part of the covert way where a communication might have been made in the glacis for the purpose of going to some detached work.

It also signifies, both in French and English, a little box of timber-work covered with a cieling, withinside the porch of certain churches, both to prevent the view of persons passing by, and to keep off the wind, &c. by means of folding-doors. In many instances it is the same as porch.

TAMUS, *black briony*, a genus of plants of the class of diœcia, and order of hexandria, and in the natural system ranging under the 11th order, sarmentaceæ. The male and female flowers are both sexpartite; there is no corolla; the style is trifid; the berry is trilocular and inferior, and contains two seeds. There are only two species. The communis, or common black briony, is a native of England. It has a large root, which sends forth several long slender stems; the leaves are large, heart-shaped, dark green, and grow on long footstalks; the flowers are greenish, and the berry red. It flowers from May to August, and is frequent in hedges.

TAN, the bark of the oak, chopped and ground in a tanning-mill into a coarse powder, to be used in the tanning of leather.

Deyeux was, perhaps, the first chemist who ascertained the peculiar nature of tan, or tanning. He pointed it out in his analysis of nutgalls, as a peculiar resinous substance, but without assigning it any name. Seguin soon after engaged in a set of experiments on the art of tanning leather; during which he discovered that tan has the property of precipitating glue from its solutions in water, and of combining with the skins of animals. This led him to suppose it the essential constituent of the liquids employed for the purpose of tanning leather. Hence the names tannin and tanning principle given it by the French chemists. But it is to Mr. Proust that we are indebted for the investigation of the nature and properties of tan, and of the methods of obtaining it in a separate state. Much curious and important information has likewise been obtained by the experiments of Mr. Davy on the constituent parts of astringent vegetables, and on their operation in tanning.

Tan exists in a great number of vegetable substances; but it may be procured most readily and in the greatest purity from nutgalls and catechu.

Nutgalls are excrescences formed on the leaves of the oak by the puncture of an insect which deposits its eggs on them. The best are known by the name of Aleppo galls, imported in large quantities in this country for the use of the dyers, calico-printers, &c. They are hard like wood, round, often nodulated on the surface, of an olive-green colour, and an excessively disagreeable taste. They are in a great measure soluble in water; what remains behind is tasteless, and possesses the properties of the fibre of wood. A very great proportion of water is necessary to carry off every thing soluble. Deyeux found that a French pound of nutgalls required 96 French pints of water, applied in 20 different portions one after the other, and allowed to macerate each a considerable time. This, reduced to our standard, gives us about 150 English pints to a pound troy of nutgalls.

From the analyses of Deyeux and Davy, it follows that the soluble part of nutgalls consists chiefly of five ingredients; namely, tan, extract, mucilage, gallic acid, and gallat of lime. Mr. Davy found that 500 grains of Aleppo galls formed with water a solution which yielded by slow evaporation 185 grains of matter. This matter he found composed of

130	tan
31	gallic acid and extract
12	mucilage and extract
12	lime and saline matter
185.	

So that the tan constitutes rather more than two-thirds of the whole.

According to Mr. Davy, the strongest infusion of galls is of the specific gravity 1.068; and when evaporated at a temperature below 200°, yields a mass composed of $\frac{9}{10}$ tan, and $\frac{1}{10}$ gallic acid and extract. But at a boiling heat most of the gallic acid is dissipated or destroyed, and a portion of the extract is rendered insoluble in water.

Catechu, or terra japonica as it is also called, is a substance obtained by decoction and evaporation from a species of the mimosa which abounds in India. It has a reddish brown colour, and an astringent taste, leaving an impression of sweetness; it is not altered by exposure to the air. There are two varieties of it; one from Bombay, which has the lightest colour, and a specific gravity of 1.39; and one from Bengal, which is of the colour of chocolate; its specific gravity is 1.28. This substance was examined by Davy, and found to consist chiefly of tan combined with a peculiar species of extract.

Tan obtained from the infusion of nutgalls is a brittle substance, of a brown colour. It breaks with a vitreous fracture, and does not attract moisture from the air. Its taste is exceedingly astringent. It is very soluble in water. The solution is of a deep-brown colour, a very astringent and bitter taste, and has the odour which distinguishes a solution of nutgalls. It froths, when agitated, like a solution of soap; but does not feel unctuous. Tan is still more soluble in alcohol than in water. The solution has a deep-brown colour and an astringent taste.

When heated, it blackens, emits carbonic acid gas, and in the open air bursts, leaving always a small portion of lime.

From the experiments of Proust, Davy, and Deyeux, we learn, that it is capable of combining with oxygen; but at the same time it is either decomposed altogether, or its nature completely altered. Thus nitric acid converts it into a yellowish-brown matter soluble in alcohol, and similar in its properties to an extract. Oxymuriatic acid produces similar effects; and Mr. Proust has observed, that the peroxide of tin changes it also into an extract, perhaps by communicating oxygen.

The action of the metals upon tan does not seem to be great; but almost all the metallic oxides have an affinity for it, and are capable of combining with it; the compound is usually nearly insoluble in water. Hence the reason why the infusion of nutgalls precipitates metallic solutions so readily. These compounds have been hitherto in a great measure overlooked by chemists. The following observations contain the facts at present known.

When the peroxide of tin or zinc is boiled in the infusion of galls, it acquires a dull yellow colour, and abstracts all the constituents from the infusion, leaving behind only pure water. The oxides thus combined with tan, &c. are partly soluble in muriatic acid, and the solution indicates the presence of tan and gallic acid. When the peroxide of tin is allowed to act upon the cold infusion, it abstracts all its constituents in a few days. But Mr. Proust affirms, that in that case the gallic acid is mostly destroyed, and a portion of the tan brought to the state of extract.

When the metallic salts are mixed with the infusion of galls, the precipitate consists of the metallic oxide combined with the tan, the extract, and the acid of the infusion; and, according to Davy, it contains also a portion of the acid of the metallic salt.

Tan produces no change upon the solution of sulphat of iron; but when it is mixed with a solution of the oxysulphat of iron, a deep blue coloured precpitate immediately appears, consisting of the tan combined with the oxide. This precipitate, when dried, assumes a black colour. It is decomposed by acids.

When too great a proportion of oxysulphat of iron is poured into a solution of tan, the sulphuric acid, set at liberty by the combination of the iron and tan, is sufficient to re-dissolve the precipitate as it appears; but the precipitate may easily be obtained by cautiously saturating this excess of acid with potass. When the experiment is performed in this manner, all the oxysulphat of iron which remains in the solution undecomposed is converted into sulphat. Mr. Proust supposes that this change is produced by the tan absorbing oxygen from the iron. The same change takes place if oxide is mixed with a considerable excess of sulphuric acid, and diluted with water. Common writing-ink is a combination of gallat of iron and tannat of iron.

The alkalies combine readily with tan, and form with it a compound soluble in water. This was first observed by Deyeux, whose experiments have been verified by Mr. Davy. When potass or soda is added to the infusion of nutgalls, the liquid assumes a reddish-brown colour, and loses the property of precipitating gelatine, till alkali is saturated with an acid. When the alkalized infusion is evaporated to dryness, an olive-coloured mass remains of a faint alkaline taste, which deliquesces in the air. Ammonia produces the same effect upon the infusion of galls; but when the mixture is exposed to the heat of boiling water, part of the ammonia flies off, a precipitate falls, consisting of most of the tan and gallic acid, while the extract remains in solution.

All the earths hitherto tried have a strong affinity for tan, and form with it compounds for the most part insoluble in water, the properties of which have scarcely been examined by chemists.

One of the most important properties of tan is the insoluble compound which it forms with glue or gelatine, as this substance is termed by chemists. It is therefore employed to detect the presence of gelatine in animal fluids: and, on the other hand, solutions of gelatine are employed to detect the presence of tan in vegetable fluids, and to ascertain its quantity. Now, although the compound of gelatine and tan is insoluble in water, it is soluble both in the solution of tan and of gelatine when sufficiently diluted. It is necessary, therefore, that the solution of gelatine, used to detect tan, should be as concentrated as is consistent with its perfect fluidity; for glue, when gelatinous, does not act upon tan. It is necessary also that it should be employed quite fresh; for when in a state of putrefaction, it loses its property of precipitating tan. Mr. Davy has ascertained that the best proportion for use is a solution of 120 grains of isinglass in 20 ounces of water. Care must be taken not to add an excess of the solution to the liquid from which the tan is to be separated; because the compound of tan and gelatine is re-dissolved by the solution of gelatine. According to the analysis of Mr. Davy, this compound, when dried in the temperature of 150°, is composed of

54 gelatine
46 tan

100.

It appears, from the experiments of Mr. Davy and Mr. Chenevix, that tan is sometimes formed in vegetables by the action of heat. Thus no tan can be detected in the decoction of coffee-beans, unless they have been roasted; but in that case their decoction precipitates gelatine.

From the experiments of Mr. Davy, we learn that the affinities of the different classes of bodies capable of combining with tan are nearly in the following order:

Earths,	Acids,
Alkalies,	Neutral salts.
Gelatine,	

But the order of the individual substances belonging to each of these classes remains still to be ascertained.

Tan affects particularly the bark of trees: but it exists also in the sap and in the wood of a considerable number, and even in the leaves of many. It is very seldom that it exudes spontaneously; yet this seems to be the case with a variety of kino.

It has been ascertained by Mr. Biggin, that when the barks of trees are examined at different seasons, they vary in the quantity of tan. The quantity varies also with the age and size of the trees. The greatest proportion of tan is contained in the inner barks. The epidermis usually contains none.

The following table exhibits the proportion of solid matter extracted by water from different vegetable substances, and the quantity of tan contained in that solid matter, as ascertained by the experiments of Mr. Davy.

One Ounce of	Solid Matter. Grains.	Tan. Grains.
White inner bark of old oak	108	72
——— young oak	111	77
——— Spanish chesnut	89	63
——— Leicester willow	117	72
Coloured or middle bark of oak	43	19
——— Spanish chesnut	41	14
——— Leicester willow	34	16
Entire bark of oak	61	29
Entire bark of Spanish chesnut	53	21
——— Leicester willow	71	33
——— elm	—	13
——— common willow	—	11
Sicilian sumach	165	78
Malaga sumach	156	79
Souchong tea	—	48
Green tea	—	41
Bombay catechu	—	261
Bengal catechu	—	231
Nutgalls	180	127

TANACETUM, *tansy*, a genus of plants of the class of syngenesia, and order of polygamia superflua, and in the natural system ranging under the 49th order, compositæ. The receptacle is naked; the pappus somewhat emarginated; the calyx imbricated and hemispherical; the florets of the radius are trifid, and scarcely distinguishable. There are nine species; of which one only is a native of Britain, the vulgare, or common tansy. Of this species there is a variety with curled leaves, which is therefore called curled tansy. The tansy has a bitter taste, and an aromatic smell, disagreeable to many people. It is esteemed good for warming and strengthening the stomach; for which reason the young leaves have obtained a place among the culinary herbs, their juice being an ingredient in puddings, &c. It is rarely used in medicine, though extolled as a good emmenagogue. A drachm of the dried flowers has been found very beneficial in hysteric disorders arising from suppression. The seeds and leaves were formerly in considerable esteem for destroying worms in children, and are reckoned good in cholics and flatulencies.

TANÆCIUM, a genus of the angiospermia order, in the didynamia class of plants, and in the natural method ranking under the 25th order, putamineæ. The calyx is monophyllous, tubulated, truncated, and entire: the corolla long, monopetalous, and white; the tube cylindrical; the lymbi erect, spreading, and nearly equal; the fruit a berry, covered with a thick bark, large, oblong, internally divided into two parts; in the pulp are contained a number of seeds. There are only two species of this genus, the jaroba and parasiticum, both natives of Jamaica. They grow by the sides of rivers, and climb on trees and bushes.

TANAGRA, *tanager*, in ornithology, a genus of birds belonging to the order of passeres. The beak is conical, acuminated, emarginated, almost triangular at the base, and inclining a little towards the point. Dr. Latham has described 44 species, all of which are of foreign extraction. See Plate Nat. Hist. fig. 390.

TANGENT, in geometry, is defined, in general, to be a right line which touches any arch of a curve, in such a manner that no right line can be drawn betwixt the right line and the arch. See Plate Miscel. fig. 226.

The tangent of an arch is a right line drawn perpendicularly from the end of a diameter, passing to one extremity of the arch, and terminated by a right line drawn from the centre through the other end of the arch, and called the secant.

The tangent of a curve is a right line which only touches the curve in one point, but does not cut it.

In order to illustrate the method of drawing tangents to curves, let ACG (fig. 227) be a curve of any kind, and C the given point from whence the tangent is to be drawn. Then conceive a right line, mg, to be carried along uniformly, parallel to itself, from A towards Q; and let, at the same time, a point p so move in that line, as to describe the given curve ACG: also let mm, or Cn, express the fluxion of Am, or the velocity wherewith the line mg is carried; and let nS express the corresponding fluxion of mp, in the position mCg, or the velocity of the point p, in the line mg: moreover, through the point C let the right line SF be drawn, meeting the axis of the curve, AQ, in F.

Now it is evident, if the motion of p, along the line mg, was to become equable at C, the point p would be at S, when the line itself had got into the position mSg; because, by the hypothesis, Cn and nS express the distances that might be described by the two uniform motions in the same time. And if vsg is assumed to represent any other position of that line, and s the contemporary position of the point p, still supposing an equable velocity of p; then the distances Cv, and vs, gone over in the same time by the two motions, will always be to each other as the velocities, or as Cn to nS. Therefore, since Cv : vs :: Cn : nS (which is a known property of similar triangles), the point s will always fall in the right line FCS fig. 228; whence it appears, that if the motion of the point p along the line mg was to become uniform at C, that point would then move in the right line CS, instead of the curve-line CG. Now, seeing the motion of p, in the description of curves, must either be an accelerated or retarded one; let it be first considered as an accelerated one, in which case the arch CG will fall wholly above the right line CD, because the distance of the point p from the axis AQ, at the end of any given time, is greater than it would be if the acceleration was to cease at C; and if the acceleration had ceased at C, the point p would have been always found in the said right line FS. But if the motion of the point p is a retarded one, it will appear, by arguing in the same manner, that the arch CG will fall wholly below the right line CD, as in fig. 228.

This being the case, let the line mg, and the point p, along that line, be now supposed to move back again, towards A and m, in the same manner they proceeded from thence: then, since the velocity of p did before increase, it must now, on the contrary, decrease; and therefore as p, at the end of a given time, after repassing the point C, is not so near to AQ, as it would have been had the velocity continued the same as at C, the arch Cb (as well as CG) must fall wholly above the right line FCD: and by the same method of arguing, the arch Cb, in the second case, will fall wholly below FCD. Therefore FCD, in both cases, is a tangent to the curve at the point C: whence the triangles FmC and CnS being similar, it appears that the sub-tangent mF is always a fourth proportional to nS, the fluxion of the ordinate Cn, the fluxion of the absciss, and Cm the ordinate; that is, Sn : nC :: mC : mF. Hence, if the absciss Am $= x$, and the ordinate $mp = y$, we shall have $mF = \frac{y\dot{x}}{\dot{y}}$; by means of which general expression, and the equation expressing the relation between x and y, the ratio of the fluxions $\dot{x}$ and $\dot{y}$ will be found, and from thence the length of the sub-tangent mF, as in the following examples.

Example I. To draw a right line CT (fig. 229) a tangent to a given circle BCA, in a given point C. Let CS be perpendicular to the diameter AB, and put AB $= a$, BS $= x$, and SC $= y$. Then, by the property of the circle, y^2 ($=$ CS^2) $=$ BS $\times$ AS ($= x \times \overline{a - x}$) $= ax - x^2$; whereof the fluxion being taken, in order to determine the ratio of $\dot{x}$ and $\dot{y}$, we get $2y\dot{y} = a\dot{x} - 2x\dot{x}$; consequently $\frac{\dot{x}}{\dot{y}} = \frac{2y}{a - 2x} = \frac{y}{\frac{1}{2}a - x}$; which, multiplied by y, gives $\frac{y\dot{x}}{\dot{y}} = \frac{y^2}{\frac{1}{2}a - x} =$ the sub-tangent ST. Whence, O being supposed the centre, we have OS ($= \frac{1}{2}a - x$) : CS ($= y$) :: CS ($= y$) : ST; which is also found to be the case from other principles.

Example II. To draw a tangent to any given point C (fig. 230) of the conical parabola ACG. If the latus rectum of the curve is denoted by a, the ordinate MC by y, and its corresponding absciss AM by x; then the known equation expressing the relation of x and y, being $ax = y^2$, we have, in this case, the fluxion $a\dot{x} = 2y\dot{y}$; whence $\frac{\dot{x}}{\dot{y}} = \frac{2y}{a}$, and consequently $\frac{y\dot{x}}{\dot{y}} = \frac{2y^2}{a} = \frac{2ax}{a}, = 2x =$ MF. Therefore the sub-tangent is just the double of its corresponding absciss AM.

TANNING is the art of converting the raw skins of animals into leather. See TAN, and CUTIS.

In a preceding article (TAN), it was stated that gelatine with tannin, or the tanning principle of vegetables, formed a combination which is insoluble in water. Upon this depends the art of making leather; the gelatinous part of the skin combining with the tannin of the bark usually employed.

The process which has long been used in this country is as follows: The leather tanned in England consists chiefly of three sorts, known by the name of butts or backs, hides, and skins. Butts are generally made from the stoutest and heaviest ox-hides, and are managed as follows: after the horns are taken off, the hides are laid smooth in heaps for one or two days in the summer, and for five or six in the winter; they are then hung on poles in a close room, called a smoke-house, in which is kept a smouldering fire of wet tan; this occasions a small degree of putrefaction, by which means the hair is easily got off, by spreading the hide on a sort of wooden horse or beam, and scraping it with a crooked knife. The hair being taken off, the hide is thrown into a pit or pool of water, to cleanse it from the dirt, &c. which being done, the hide is again spread on the wooden beam, and the grease, loose flesh, extraneous filth, &c. carefully scrubbed out or taken off; the hides are then put into a pit of strong liquor, called ooze, prepared in pits kept for the purpose, by infusing ground bark in water; this is termed colouring; after which they are removed into another pit, called a scowering, which consists of water strongly impregnated with vitriolic acid, or with a vegetable acid prepared from rye or barley. This operation (which is called raising), by distending the pores of the hides, occasions them more readily to imbibe the ooze, the effect of which is to combine with the gelatinous part of the skin, and form with it leather. The hides are then taken out of the scowering, and spread smooth in a pit commonly filled with water, called a binder, with a quantity of ground bark strewed between each. After lying a month or six weeks, they are taken up; and the decayed bark and liquor being drawn out of the pit, it is filled again with strong ooze, when they are put in as before, with bark between each hide. They now lie two or three months, at the expiration of which the same operation is repeated; th y then remain four or five months, when they again undergo the same process, and after being three months in the last pit, are completely tanned; unless the hides are so remarkably stout as to want an additional pit or layer. The whole process requires from eleven to eighteen months, and sometimes two years, according to the substance of the hide, and discretion of the tanner. When taken out of the pit to be dried, they are hung on poles; and after being compressed by a steel pin, and beaten out smooth by wooden hammers, called battes, the operation is complete; and when thoroughly dry, they are fit for sale. Butts are chiefly used for the soles of stout shoes.

The leather which goes under the denomination of hides, is generally made of cow-hides, or the lighter ox-hides, which are thus managed: After the horns are taken off, and the hides washed, they are put into a pit of water, saturated with lime; where they remain a few days, when they are taken out, and the hair scraped off on a wooden beam, as before described; they are then washed in a pit or pool of water, and the loose flesh, &c. being taken off, they are removed into a pit of weak ooze, where they are taken up and put down (which is technically termed handling) two or three times a day, for the first week; every second or third day they are shifted into a pit of fresh ooze, somewhat stronger than the former, till at the end of a month or six weeks they are put into a strong ooze, in which they are handled once or twice a week with fresh bark for two or three months. They are then removed into another pit, called a layer, in which they are laid smooth, with bark ground very fine, strewed between each hide. After remaining here two or three months, they are generally taken up, when the ooze is drawn out, and the hides put in again with fresh ooze and fresh bark, where, after lying two or three months more, they are completely tanned; except a very few stout hides, which may require an extra layer: they are then taken out, and hung on poles, and being hammered and smoothed by a steel pin, are, when dry, fit for sale. These hides are called crop hides; they are from ten to eighteen months in tanning, and are used for the soles of shoes.

Skins is the general term for the skins of calves, seals, hogs, dogs, &c. These, after being washed in water, are put into lime-pits, as before mentioned, where they are taken up and put down every third or fourth day, for a fortnight or three weeks, in order to destroy the epidermis of the skin. The hair is then scraped off, and the excrescences being removed, they are put into a pit of water impregnated with pigeon-dung, called a grainer, forming an alkaline ley, which in a week or ten days soaking out the lime, grease, and saponaceous matter (during which period they are several times scraped over with a crooked knife, to work out the dirt and filth), softens the skins, and prepares them for the reception of the ooze. They are then put into a pit of weak ooze, in the same manner as the hides, and being frequently handled, are by degrees removed into a stronger, and still stronger liquor, for a month or six weeks; when they are put into a very strong ooze, with fresh bark ground very fine, and at the end of two or three months, according to their substances, are sufficiently tanned; when they are taken out, hung on poles, dried, and are fit for sale. These skins are afterwards dressed and blacked by the curriers, and are used for the upper leathers of shoes, boots, &c.

The lighter sort of hides, called dressing hides, as well as horse-hides, are managed nearly in the same manner as skins; and are used for coach-work, harness-work, &c. &c.

Much light has been thrown by modern chemists upon the theory of tanning, though it does not appear that any considerable improvements have been made in the practice of this art. M. Seguin, in France, has particularly distinguished himself by his researches on this subject.

In 1795, Mr. William Desmond obtained a patent for practising Seguin's method in England. He obtained the tanning principle by digesting oak-bark or other proper material in cold water, in an apparatus nearly similar to that used in the saltpetre-works. That is, the water which has remained upon the powdered bark for some time, in one vessel, is drawn off by a cock, and poured upon fresh tan. This is again to be drawn off, and poured upon other fresh tan; and in this way the process is to be continued to the fifth vessel. The liquor is then highly coloured, and marks from six to eight degrees upon the hydrometer for salts. This he calls the tanning lixivium.

The criterion for ascertaining its strength, is the quantity of the solution of gelatine which a given quantity of it will precipitate. Isinglass is used for this purpose, being entirely composed of gelatine. And here it may be observed, that this is the mode of ascertaining the quantity of tanning principle in any vegetable substance, and consequently how far each may be used as a substitute for oak-bark.

The hides, after being prepared in the usual way, are immersed for some hours in a weak tanning lixivium of only one or two degrees; to obtain which, the latter portions of the infusions are set apart, or else some of that which has been partly exhausted by use in tanning. The hides are then to be put into a stronger lixivium, where, in a few days, they will be brought to the same degree of saturation with the liquor in which they are immersed. The strength of the liquor will by this means be considerably diminished, and must therefore be renewed. When the hides are by this means completely saturated, that is, perfectly tanned, they are to be removed, and slowly dried in the shade.

It has been proposed to use the residuum of the tanning lixivium, or the exhausted ooze (which contains a portion of gallic acid, this forming a constituent part of astringent vegetables), for the purpose of taking off the hair; but this liquor seems to contain no substances capable of acting upon the epidermis, or of loosening the hair; and when skin is depilated by being exposed to it, the effect must really be owing to incipient putrefaction.

The length of time necessary to tan leather completely, according to the old process, is certainly a very great inconvenience; and there is no doubt that it may be much shortened by following the new method. It has been found, however, that the leather so tanned has not been so durable as that which has been formed by a slower process.

TANTALITE. This mineral has been found in Finland, in the parish of Kimito. It has been long known; but before the analysis of Ekeberg, was mistaken for an ore of tin. Found in irregular crystals, which seem to be octahedrons. Colour between bluish grey and blackish grey. Surface smooth, with some lustre. Lustre metallic. Fracture compact. Streak blackish grey, approaching brown. Very hard. Not magnetic. Specific gravity 7.953. Composed of the oxides of tantalium, iron, and manganese.

TANTALIUM. Mr. Ekeberg, a Swedish chemist of considerable eminence, has lately discovered a new metal constituting a component part of two minerals, found in the parish of Kimito in Finland. The first of these minerals, which he calls tantalite, has a bluish or blackish grey colour, crystallized confusedly, with a metallic lustre and compact fracture. It is very hard, and its specific gravity is 7.953. It has been long known, and mistaken for an ore of tin.

The other mineral, called yttro-tantalite, is found in small kidney-form masses. It is of a deep-grey colour, has a metallic lustre, and a granular fracture. It is not hard. Its specific gravity is 5.130.

From each of these minerals Mr. Ekeberg extracted, by a chemical analysis, a white powder, which he ascertained to be the oxide of a peculiar metal, to which he gave the name of tantalium.

When this white oxide of tantalium is strongly heated along with charcoal in a crucible, it yields a button moderately hard, which has the metallic lustre externally, but within is black and destitute of brilliancy. The acids convert it again into the state of white-coloured oxide.

This oxide does not alter its colour, though heated to redness. Its specific gravity is 6.500. It is not acted on by acids, nor is it soluble in any of them. It was this insolubility in acids which induced Ekeberg to give it the name of tantalium, from the fabled punishment of Tantalus.

This oxide combines with the alkalies except ammonia, and forms with them compounds soluble in water. When melted with phosphat of soda and borax, it forms with them glasses destitute of colour. Such are the only properties of this metal hitherto published.

The resemblance between the oxides of tantalium and columbium is striking. The only property in which they differ is, the insolubility of the first in acids; but we know not what acids Ekeberg tried, and Mr. Hatchett found the oxide of columbium insoluble in nitric acid.

TANTALUS, or Ibis, a genus of birds of the order grallæ. The generic character is, bill long, subulate, roundish subarched; face naked; nostrils oval; feet four-toed, palmate at the base. There are 23 species; the most remarkable are:

1. The loculator, or wood ibis: (1.) face bluish; bill reddish; legs, quill and tail feathers, black; body white. (2.) Head and neck white, varied with yellow; body black; belly cinereous. (3.) Wing-coverts white, with a black blotch in the middle. Inhabits New Holland, and the warmer parts of America. It is three feet long; is very slow in flight, and stupid; sits on trees, and feeds on herbs, seeds, fruits, fish, and reptiles. The flesh is very much esteemed.

2. The leucephalus, or white-headed ibis, inhabits India; and every year before the rainy season sets in, it sheds its rosy feathers.

3. The ibis, or Egyptian ibis, inhabits in vast numbers the lower part of Egypt, and is held sacred by the inhabitants for its use in clearing the land of reptiles and insects, which are left after the inundation of the Nile. It rests in an erect posture, and is said to destroy the young of the crocodile.

4. The melanocephalus, or black-headed ibis, is a very beautiful bird that inhabits India. See Plate Nat. Hist. fig. 391.

TANTALUS'S CUP. See HYDRAULICS.

TAPE-WORM. See TÆNIA.

TAPESTRY, a kind of woven hangings of wool and silk, frequently raised and enriched with gold and silver, representing figures of men, animals, landscapes, histories, &c.

The invention of tapestry seems to have come to us from the Levant; and this appears the more probable, as the workmen concerned in it were called, at least in France, sarrasins, or sorrasinois. It is supposed that the English and Flemish, who were the first that excelled in making tapestry, might bring the art with them from some of the crusades, or expeditions against the Saracens.

Tapestry-work is distinguished by the workmen into two kinds, viz. that of high, and that of low warp; though the difference is rather in the manner of working than in the work itself, which is in effect the same in both, only the looms, and consequently the warps, are differently situated: those of the low warp being placed flat and parallel to the horizon, and those, on the contrary, of the high warp, erected perpendicularly. The English antiently excelled all the world in the tapestry of the high warp.

The manufacture of tapestry of the high warp. The loom, whereon it is wrought, is placed perpendicularly. It consists of four principal pieces; two long planks or cheeks of wood, and two thick rollers or beams. The planks are set upright, and the beams across them, one at the top, and the other at the bottom, or about a foot distance from the ground. They have each their trunnions, by which they are suspended on the planks, and are turned with bars. In each roller is a groove from one end to the other, capable of containing a long round piece of wood, fastened therein with hooks. The use of it is to tie the ends of the warp to. The warp, which is a kind of worsted, or twisted woollen thread, is wound on the upper roller; and the work, as fast as woven, is wound on the lower. Withinside the planks, which are seven or eight feet high, 14 or 15 inches broad, and three or four thick, are holes pierced from top to bottom, in which are put thick pieces of iron, with hooks at one end, serving to sustain the coat-stave: these pieces of iron have also holes pierced, by putting a pin in which, the stave is drawn nearer or set further off; and thus the coats or threads are stretched or loosened at pleasure. The coat-stave is about three inches diameter, and runs all the length of the loom; on this are fixed the coats or threads, which make the threads of the warp cross each other. It has much the same effect here, as the spring-stave and treadles have in the common looms. The coats are little threads fastened to each thread of the warp with a kind of sliding knot, which forms a sort of mesh or ring. They serve to keep the warp open for the passage of broaches wound with silks, woollens, or other matters used in the piece of tapestry. In the last place, there are a number of little sticks of different lengths, but all about an inch in diameter, which the workman keeps by him in baskets, to serve to make the threads of the warp cross each other, by passing them across; and, that the threads thus crossed may retain their proper situation, a packthread is run among the threads, above the stick.

The loom being thus formed, and mounted with its warp, the first thing the workman does, is to draw on the threads of this warp, the principal lines and strokes of the design to be represented on the piece of tapestry; which is done by applying cartoons, made from the painting he intends to copy, to the side that is to be the wrong side of the piece, and then, with a black-lead pencil, following and tracing out the contours thereof on the thread of the right side, so that the strokes appear equally both before and behind.

As for the original design the work is to be finished by, it is hung up behind the workmen, and wound on a long staff, from which a piece is unrolled from time to time as the work proceeds.

Besides the loom, &c. here described, there are three other principal instruments required for working the silk or the wool of the woof within the threads of the warp; these are a broach, a reed, and an iron needle.

The broach is made of a hard wood, seven or eight inches long, and two-thirds of an inch thick, ending in a point with a little handle. This serves as a shuttle; the silks, woollens, gold, or silver, to be used in the work, being wound on it,

The reed or comb is also of wood, eight or nine inches long, and an inch thick on the back, whence it grows less and less to the extremity of the teeth, which are more or less apart, according to the greater or less degree of fineness of the intended work. Lastly, the needle is made in form of the common needle, only larger and longer. Its use is to press close the wool and silks when there is any line or colour that does not fit well.

All things being prepared for the work, and the workman ready to begin, he places himself on the wrong side of the piece, with his back towards the design; so that he works in a manner blindfold, seeing nothing of what he does, and being obliged to quit his post, and go to the other side of the loom, whenever he would view and examine the piece, to correct it with his pressing-needle. To put silk, &c. in the warp, he first turns and looks at the design; then, taking a broachful of the proper colour, he places it among the threads of the warp, which he brings cross each other with his fingers, by means of the coats or threads fastened to the staff; this he repeats every time he is to change his colour. Having placed the silk or wool, he beats it with his reed or comb; and when he has thus wrought in several rows over each other, he goes to see the effects they have, in order to reform the contours with his needle, if there should be occasion. As the work advances, it is rolled upon the lower beam, and they unrol as much warp from the upper beam as suffices them to continue the piece; the like they do of the design behind them. When the pieces are wide, several workmen may be employed at once.

We have two things to add: the first is, that the high-warp tapestry goes on much more slowly than the low-warp, and takes up almost twice the time and trouble. The second is, that all the difference that the eye can perceive between the two kinds, consists in this; that in the low warp there is a red fillet, about one-twelfth of an inch broad, running on each side from top to bottom, which is wanting in the high warp.

But, for the satisfaction of our readers, we shall here describe the principal parts of the loom for the manufacture of tapestry of the high warp, or that in a situation perpendicular to the horizon. The loom consists, 1. Of two strong upright posts fixed in the floor: these support (2.) two rollers, of which the upper end holds the chain, the lower holds the tapestry, which is rolled upon it according as the work goes forward: the threads are fastened at their ends to a dweet, or thick rod, which is lodged in a groove made on each roller. 3. The two tantoes, one called the great tantoe, for turning the upper roller; the other, the little tantoe, for turning the lower roller. 4. The pole of the leishes, which runs quite across the chain, takes up all the leishes, and brings them to the workman's hand. These leishes are little strings, tied by a slip-knot to each thread of the chain, to be raised up according as the chain sinks down: they serve to draw the particular thread which the weaver wants. He holds the thread separate from the rest, and passes a spindle of such a woof and colour as he thinks proper; then he lets the spindle hang down, and hinders the thread from running off by a slip-knot. After having taken one or two threads of the fore part of the chain by another leish, he brings the threads of the opposite side to him. By this alternative work he constantly makes them cross one another, to take in and secure the woof. In order to distinguish the threads of both sides, he is assisted by the cross rod, which is put between two rows of threads. 5. A long tract of dots formed by the ends of the leishes which take hold of the leishes of the chain by a slip-knot; and on the other hand encompass the pole of the leishes. 6. The cross-rod. 7. A little chain, each loop of which contains four or five threads of the warp, and keeps them perpendicular. 8. An iron hook, to support the pole of the leishes. 9, The broacher-quill, to pass the threads of the woof, which is wound on it. 10. The comb, to strike in the work. 11. The end of the dweet let into the roller, in a groove.

When the chain is mounted, the draughtsman traces the principal outlines of the picture, which is to be wrought with black chalk on the fore and back side of the chain. The weaver in the upright way having prepared a good stock of quills, filled with threads of all colours, goes to work, placed on the back part, as in the flat way, or in the manufacture of the low warp. He has behind him his drawings, on which he frequently looks, that he may from time to time see how his work succeeds on the right or fore side, which the other cannot do.

TAPIR, a genus of quadrupeds of the order belluæ. The generic character is, front teeth in both jaws, ten; canine teeth in both jaws, single, incurvated; grinders in both jaws, five on each side, very broad; feet with three hoofs, and a false hoof on the fore feet.

Tapir Americanus, American tapir. The tapir, with respect to the size of its body, may be considered as the largest of all the native quadrupeds of South America, except the lately discovered equus bisulcus of Molina. When full-grown it is nearly equal to a heifer. In its general form it bears some distant resemblance to the hippopotamus, and in the earlier editions of the Systema Naturæ was ranked by Linnæus in that genus, under the title of hippopotamus terrestris. By others it has been considered as more allied to the hog, and has been called sus aquaticus multisulcus, or water-hog with fingered hoof; but, in reality, the tapir cannot properly be associated, otherwise than by a distant general alliance, with any other quadruped, and forms a peculiar genus. It is of a gregarious nature, and inhabits the woods and rivers of the eastern parts of South America; occurring from the isthmus of Darien to the river Amazons; feeding chiefly by night, and eating sugar-canes, grasses, and various kinds of fruit. Its colour is an obscure brown, the skin itself being of that cast, and covered sparingly with somewhat short hair; the young animal is said to be commonly spotted with white. The male is distinguished by a kind of short proboscis or trunk, formed by the prolongation of the upper lip to some distance beyond the lower: this part is extensile, wrinkled at the sides, and in some degree resembles that of the elephant on a smaller scale, though not of the same tubular structure. The neck is very short, and furnished above with a rising mane; the body is thick and heavy; the back much arched; the legs short; the fore feet divided into four toes with pointed hoofs; the hind into three only; the tail is very short, thickish, and pointed. The female is said to be destitute of the proboscis.

In its manners this animal is perfectly harmless; endeavouring merely to save itself by flight when pursued, plunging into some river if at hand, and swimming with great readiness, and even continuing for a considerable time under water, in the manner of the hippopotamus. The young is easily tamed, and may be rendered domestic, as is said to be the case in some parts of Guiana. In feeding, the tapir makes use of the trunk in the same manner as the rhinoceros of its upper lip, to grasp the stems of plants, leaves, &c. Its most common attitude, when at rest, is sitting on its rump, in the manner of dog.

The tapir has been occasionally imported alive into Europe. The flesh is considered by the South Americans as a wholesome food, though not very pleasant or delicate, and the skin serves for various purposes where a strong leather is required. The Indians make shields of it, which are said to be so hard that an arrow cannot pierce them. This animal sleeps much by day in the retired parts of the woods, and is shot by the Indians with poisoned arrows. When attacked by dogs, it is said to make a very vigorous resistance. Its voice is a kind of whistle, which is easily imitated, and thus the animal is often deceived and trepanned. It is rather slow in its motions, and of a somewhat inactive disposition.

The tapir produces but one young at a birth, of which it is extremely careful; leading it early to the water, in order to instruct it in swimming, &c. See Plate Nat. Hist. fig. 392.

TAPPING. See Surgery.

TAR. See Pinus, Resins, and Bitumen.

TARANTULA. See Aranea.

TARCHONANTHUS, *flea-bane*, a genus of plants belonging to the class of syngenesia, and to the order of polygamia æqualis, and in the natural system ranging under the 49th order, compositæ. The receptacle is villous, and the pappus plumy; the calyx is monophyllous, turbinated, and half divided into seven segments. There are only three species known; the camphoratus, glaber, and ericoides.

TARE, is an allowance for the outside package, that contains such goods as cannot be unpacked without detriment; or for the papers, threads, bands, &c. that inclose or bind any goods imported loose; or, though imported in casks, chests, &c. yet cannot be unpacked and weighed net.

TARGIONIA, a genus of plants of the class of cryptogamia, and natural order of algæ. The calyx is bivalved, including a globular body. There is only one species; the hypophylla, which is a native of Great Britain.

TARGUM, a name whereby the Jews call the Chaldee paraphrases, or expositions of the Old Testament, in the Chaldee language.

TARIF, or Tariff, a table or catalogue, containing the names of different sorts of merchandize, with the duties to be paid, as settled by authority, amongst trading nations.

TARSUS. See Anatomy.

TARTAR, or, according to the new chemistry, Tartrat of Potass, is obtained in a state of impurity, incrusted on the bottom and sides of casks in which wine has been kept. It is afterwards purified by dissolving it in boiling water, and filtring it while hot. On cooling, it deposits the pure salt in very irregular crystals. In this state it is sold under the name of crystals or cream of tartar. This salt attracted the peculiar attention of chemists, probably in consequence of the extravagant encomiums and invectives bestowed on it by Paracelsus. It is called tartar, says he, because it produces the oil, water, tincture, and salt, which burn the patient as hell does. According to him, it is the principle of every disease, and every remedy, and all things contain the germ of it. This ridiculous theory was combated by Van Helmont, who gives a pretty accurate account of the formation of tartar in wine-casks. It was known to Van Helmont, and even to his predecessors, that potass could be obtained from tartar; but it was long a disputed point among chemists, whether the alkali existed in it ready-formed. Duhamel, Margraff, and Rouelle, at last established that point beyond a doubt; but the other component part of tartar was unknown, or very imperfectly known, till Scheele pointed out the method of extracting it.

The crystals of tartar are very small and irregular. According to Mantet, they are prisms, somewhat flat, and mostly with six sides. Tartar has an acid, and rather unpleasant taste. It is very brittle, and easily reduced to powder. Its specific gravity is 1.953. It is soluble in about 60 parts of cold water, and in about 30 parts of boiling water. It is not altered by exposure to the air; but when its solution in water is allowed to remain for some time, the salt is gradually decomposed, a mucous matter is deposited, and there remains in solution carbonat of potass coloured with a little oil. This decomposition was first accurately described by Berthollet in 1782.

When tartar is heated, it melts, swells, blackens, and the acid is entirely decomposed. The same changes take place when the salt is distilled in close vessels. The phenomena of this distillation have been described with great care, and its products very attentively examined, by chemists; because, before the discovery of the tartaric acid by Scheele, distillation was the only method thought of for obtaining any knowledge of the acid part of tartar. These products are an enormous quantity of gas, consisting of carbonic acid and carbureted hydrogen, an oil, and an acid; and, according to some chemists, carbonat of ammonia. The acid obtained was long considered as a peculiar body, and was denominated pyro-tartarous acid by the French chemists in 1787. But Fourcroy and Vauquelin have lately demonstrated, that it is no other than acetic acid contaminated with a little empyreumatic oil.

Tartar, according to Bergman, is composed of

	77 acid
	23 potass
	100.
Or - - -	56 tartrat of potass
	44 tartaric acid
	100.

According to the late analysis of Tenard, its component parts are

57 acid
33 potass
7 water

97.

TARTARIC ACID. Scheele was the first who obtained this acid in a separate state. He communicated his process for obtaining it to Retzius, who published it in the Stockholm Transactions for 1770. It consisted in boiling tartar with lime, and in decomposing the tartrat of lime thus formed by means of sulphuric acid.

1. The process employed at present for obtaining tartaric acid, which is the same with that of Scheele, is the following: Dissolve tartar in boiling water, and add to the solution powdered chalk till all effervescence ceases, and the liquid ceases to redden vegetable blues. Let the liquid cool, and then pass it through a filtre. A quantity of tartrat of lime (which is an insoluble white powder) remains upon the filtre. Put this tartrat, previously well washed, into a glass cucurbite, and pour on it a quantity of sulphuric acid equal to the weight of the chalk employed, which must be diluted with water. Allow it to digest for twelve hours, stirring it occasionally. The sulphuric acid displaces the tartaric; sulphat of lime remains at the bottom, while the tartaric acid is dissolved in the liquid part. Decant off this last, and try whether it contains any sulphuric acid. This is done by dropping in a little acetat of lead; a precipitate appears, which is insoluble in acetic acid if sulphuric acid is present, but soluble if it is absent. If sulphuric acid is present, the liquid must be digested again on some more tartrat of lime; if not, it is to be slowly evaporated, and about one-third part of the weight of the tartar employed is obtained of crystallized tartaric acid.

2. The form of its crystals is so irregular, that every chemist who has treated of this subject has given a different description of them. According to Bergman, they generally consist of divaricating lamellæ; according to Van Packen, they assume oftenest the form of long-pointed prisms; Spielman and Corvinus obtained them in groups, some of them lance-shaped, others needle-formed, others pyramidal. Morveau obtained them needle-form. Their specific gravity is 1.5962.

3. Crystallized tartaric acid does not experience any change in the open air, but heat decomposes it altogether: in the open fire it burns without leaving any other residuum than a spungy charcoal, which generally contains a little lime. When distilled in close vessels, it is converted into carbonic acid gas and carbureted hydrogen gas, a coloured oil, and a reddish acid liquor, which was formerly distinguished by the name of pyrotartarous acid, but which Fourcroy and Vauquelin have lately ascertained to be merely acetic acid impregnated with oil.

4. Tartaric acid dissolves readily in water. Bergman obtained a solution, the specific gravity of which was 1.230. Morveau observed, however, that crystals formed spontaneously in a solution, the specific gravity of which was 1.084. It is not liable to spontaneous decomposition when dissolved in water, unless the solution is considerably diluted.

5. Neither its action on oxygen gas nor on simple combustibles and incombustibles has been examined; but it is probable that it is not capable of producing any sensible change on them. It is capable of oxidizing iron and zinc, and even mercury; but it does not act

upon antimony, bismuth, tin, lead, copper, silver, gold, or platinum. Its action on the other metallic bodies has scarcely been examined.

6. It combines with alkalies, earths, and metallic oxides, and forms salts known by the name of tartrats.

7. The action of the greater part of the other acids on it is unknown. Hermstadt has ascertained, that it may be converted into oxalic acid by distilling it repeatedly with six times its weight of nitric acid. By this process he obtained 560 parts of oxalic acid from 360 parts of tartaric acid.

8. From this result, and from the products obtained when tartaric acid is distilled, it is evident that it is composed of oxygen, carbon, and hydrogen. Fourcroy informs us, that Vauquelin and he have ascertained that these ingredients are combined in it the following proportions:

70.5 oxygen
19.0 carbon
10.5 hydrogen

100.0

9. The affinities of this acid follow the same order as those of oxalic acid.

Tartaric acid, in a state of purity, has scarcely been put to any use; but some of the compounds into which it enters are much employed in medicine. This acid has the property of combining in two different proportions with a great number of bases. With potass, for instance, in one proportion, it forms a salt pretty soluble in water, called tartrat of potass; but when added in a greater proportion, it forms tartar, a salt very imperfectly soluble in water. By this property, the presence of tartaric acid, in any acid solution, may easily be detected. All that is necessary is, to drop in slowly a little solution of potass; if tartaric acid is present, tartar immediately precipitates in the form of a white gritty powder.

TARTRATS, salts formed with the tartaric acid.

TAURUS. See ASTRONOMY.

TAX. See REVENUE, CUSTOMS, &c.

TAXUS, the YEW-TREE, a genus of plants of the class of diœcia, and order of monadelphia; and in the natural system ranging under the 51st order, coniferæ. There is no male calyx or corolla; the stamina are numerous; the antheræ peltated and octofid. The female has no corolla nor style, and only one seed with a calycle resembling a berry very entire. There are four species; of which the baccata, or common yew-tree, is a native of Britain, France, Switzerland, &c. and of North America. It is distinguished from the other species by linear leaves which grow very close, and by the receptacles of the male flowers being subglobose. The wood is reddish, full of veins, and flexible, very hard and smooth, and almost incorruptible. Its hardness renders it very proper for turners and cabinet-makers. Its berries are often eaten by birds, and are therefore not poisonous; but it is a common opinion that the leaves are poisonous to cattle, and many facts are mentioned of horses and cows having eaten them. Others, however, deny these facts. It is of no great height, but the trunk grows to a large size. Mr. Pennant has taken notice of a very remarkable decayed one in Fortingal church-yard, the remains of which measured fifty-six feet and a half in circumference.

TEARS, and MUCUS. 1. That peculiar fluid which is employed in lubricating the eye, and which is emitted in considerable quantities when we express grief by weeping, is known by the name of tears. For an accurate analyis of this fluid, we are indebted to Messrs. Fourcroy and Vauquelin. Before their dissertation, which was published in 1791, appeared, scarcely was any thing known about the nature of tears.

The liquid called tears is transparent and colourless like water; it has scarcely any smell, but its taste is always perceptibly salt. Its specific gravity is somewhat greater than that of distilled water. It gives to paper, stained with the juice of the petals of mallows or violets, a permanently green colour, and therefore contains a fixed alkali. It unites with water, whether cold or hot, in all proportions. Alkalies unite with it readily, and render it more fluid. The mineral acids produce no apparent change upon it. Exposed to the air, this liquid gradually evaporates, and becomes thicker. When nearly reduced to a state of dryness, a number of cubic crystals form in the midst of a kind of mucilage. These crystals possess the properties of muriat of soda; but they tinge vegetable blues green, and therefore contain an excess of soda. The mucilaginous matter acquires a yellowish colour as it dries.

This liquid boils like water, excepting that a considerable froth collects on its surface. If it is kept a sufficient time at the boiling temperature, $\frac{96}{100}$ parts of it evaporate in water; and there remain about 0.4 parts of a yellowish matter, which by distillation in a strong heat yields water and a little oil; the residuum consists of different saline matters.

When alcohol is poured into this liquid, a mucilaginous matter is precipitated in the form of large white flakes. The alcohol leaves behind it, when evaporated, traces of muriat of soda, and soda. The residuum which remains behind, when inspissated tears are burnt in the open air, exhibits some traces of phosphat of lime and phosphat of soda.

Thus it appears that tears are composed of the following ingredients:

1. Water,	4. Soda,
2. Mucilage,	5. Phosphat of lime,
3. Muriat of soda,	6. Phosphat of soda.

The saline parts amount only to about 0.01 of the whole, or probably not so much.

The mucilage contained in the tears has the property of absorbing oxygen gradually from the atmosphere, and of becoming thick and viscid, and of a yellow colour. It is then insoluble in water, and remains long suspended in it without alteration. When a sufficient quantity of oxymuriatic acid is poured into tears, a yellow flaky precipitate appears, absolutely similar to this inspissated mucilage. The oxymuriatic acid loses its peculiar odour; hence it is evident that it has given out oxygen to the mucilage. The property which this mucilage has of absorbing oxygen, and of acquiring new qualities, explains the changes which take place in tears which are exposed for a long time to the action of the atmosphere, as is the case in those persons who labour under a fistula lachrymalis.

2. The mucus of the nose has also been examined by Fourcroy and Vauquelin. They found it composed of precisely the same ingredients with the tears. As this fluid is more exposed to the action of the air than the tears, in most cases its mucilage has undergone less or more of that change which is the consequence of the absorption of oxygen. See MUCUS.

TECTONA, a genus of the pentandria monogynia class and order. The corolla is five-cleft; stigma toothed; drupe dry, spungy within the inflated calyx; nect. three-celled. There is one species, the teck-wood, or Indian oak, a tree of the East Indies.

TELEGRAPH, an instrument by means of which information may be quickly conveyed to a considerable distance. The telegraph is by no means a modern invention. There is reason to believe that amongst the Greeks there was some sort of telegraph in use. A Greek play begins with a scene, in which a watchman descends from the top of a tower in Greece, and gives the information that Troy was taken. "I have been looking out these ten years (says he) to see when that would happen, and this night it is done." Of the antiquity of a mode of conveying intelligence quickly to a great distance, this is certainly a proof. The Chinese when they send couriers on the great canal, or when any great man travels there, make signals by fire from one day's journey to another, to have every thing prepared; and most of the barbarous nations used formerly to give the alarm of war by fires lighted on the hills or rising grounds.

In the year 1663, the marquis of Worcester, in his Century of Inventions, affirmed that he had discovered "a method by which, at a window, as far as eye can discover black from white, a man may hold discourse with his correspondent, without noise made or notice taken; being according to occasion given, or means afforded, ex re nata, and no need of provision beforehand; though much better if foreseen, and course taken by mutual consent of parties." This could be done only by means of a telegraph, which in the next sentence is declared to have been rendered so perfect, that by means of it the correspondence could be carried on "by night as well as by day, though as dark as pitch is black."

About forty years afterwards M. Amontons proposed a new telegraph. His method was this: Let there be people placed in several stations, at a certain distance from one another, that by the help of a telescope a man in one station may see a signal made in the next before him; he must immediately make the same signal, that it may be seen by persons in the station next after him, who are to communicate it to those in the following station, &c. These signals may be as letters of the alphabet, or as a cypher, understood only by the two persons who are in the distant places, and not by those who make the signals. The person in the second station making the signal to the person in the third the very moment he sees it in the first, the news may be carried to the greatest distance in as little time as is necessary to make the signals in the first station. The distance of the several stations, which must be as few as possible, is measured by the reach of a telescope. Amontons tried this method in a mall tract of land before several persons of the highest rank at the court of France.

It was not, however, till the French revolution, that the telegraph was applied generally to useful purposes. Whether M. Chappe, who is said to have invented the telegraph first used by the French about the end of 1793, knew any thing of Amontons' invention or not, it is impossible to say; but his telegraph was constructed on principles nearly similar. The manner of using this telegraph was as follows: At the first station, which was on the roof of the palace of the Louvre at Paris, M. Chappe, the inventor, received in writing, from the committee of public welfare, the words to be sent to Lisle, near which the French army at that time was. An upright post was erected on the Louvre, at the top of which were two transverse arms, moveable in all directions by a single piece of mechanism, and with inconceivable rapidity. He invented a number of positions for these arms, which stood as signs for the letters of the alphabet; and these, for the greater celerity and simplicity, he reduced in number as much as possible. The grammarian will easily conceive that sixteen signs may amply supply all the letters of the alphabet, since some letters may be omitted not only without detriment but with advantage. These signs, as they were arbitrary, could be changed every week; so that the sign of B for one day might be the sign of M the next; and it was only necessary that the persons at the extremities should know the key. The intermediate operators were only instructed generally in these sixteen signals; which were so distinct, so marked, so different the one from the other, that they were easily remembered. The construction of the machine was such, that each signal was uniformly given in precisely the same manner at all times; it did not depend on the operator's manual skill; and the position of the arm could never, for any one signal, be a degree higher or a degree lower, its movement being regulated mechanically.

M. Chappe, having received at the Louvre the sentence to be conveyed, gave a known signal to the second station, which was Mont Martre, to prepare. At each station there was a watch-tower, where telescopes were fixed, and the person on watch gave the signal of preparation which he had received, and this communicated successively through all the line, which brought them all into a state of readiness. The person at Mont Martre then received, letter by letter, the sentence from the Louvre, which he repeated with his own machine; and this was again repeated from the next height, with inconceivable rapidity, to the final station at Lisle.

The first description of the telegraph was brought from Paris to Franckfort on the Maine by a former member of the parliament of Bourdeaux, who had seen that which was erected on the mountain of Belville. As given by Dr. Hutton from some of the English papers, it is as follows: AA is a beam or mast of wood placed upright on a rising ground (Plate Miscel. fig. 231), which is about 15 or 16 feet high. BB is a beam or balance-beam moving upon the centre AA. This balance-beam may be placed vertically or horizontally, or any how inclined, by means of strong cords, which are fixed to the wheel D, on the edge of which is a double groove to receive the two cords. This balance is about eleven or twelve feet long, and nine inches broad, having at the ends two pieces of wood CC, which likewise turn upon angles by means of four other cords that pass through the axis of the main balance, otherwise the balance would derange the cords; the pieces C are each about three feet long, and may be placed either to the right or left, straight, or square with the balance-beam. By means of these three the combination of movement is very extensive, remarkably simple, and easy to perform. Below is a small wooden hut, in which a person is employed to observe the movements of the machine. On the eminence nearest to this, another person is to repeat these movements, and a third to write them down. The time taken up for each movement is twenty seconds; of which the motion alone is four seconds, the other sixteen the machine is stationary. Two working models of this instrument were executed at Frankfort, and sent by Mr. W. Playfair to the duke of York; and hence the plan and alphabet of the machine came to England.

Various experiments were in consequence tried upon telegraphs in this country; and one was soon after set up by government in a chain of stations from the admiralty-office to the sea-coast. It consists of six octagon-boards, each of which is poised upon an axis in a frame, in such a manner that it can be either placed vertically, so as to appear with its full size to the observer at the nearest station as in fig. 232, or it becomes invisible to him by being placed horizontally, as in fig. 233, so that the narrow edge alone is exposed, which narrow edge is from a distance invisible. Fig. 232 is a representation of this telegraph, with the parts all shut, and the machine ready to work. T, in the officer's cabin, is the telescope pointed to the next station. Fig. 233 is a representation of the machine not at work, and with the ports all open. The opening of the first port expresses *a*, the second *b*, the third *c*, the fourth *d*, the fifth *e*, and the sixth *f*, &c.

Six boards make 36 changes, by the most plain and simple mode of working; and they will make 27 more if more were necessary; but as the real superiority of the telegraph over all other modes of making signals consists in its making letters, we do not think that more changes than the letters of the alphabet, and the ten arithmetical cyphers, are necessary; but, on the contrary, that those who work the telegraphs should avoid communicate by words or signs agreed upon to express sentences; for that is the sure method never to become expert at sending unexpected intelligence accurately.

This telegraph is, without doubt, made up of the best number of combinations possible; five boards would be insufficient, and seven would be useless. It has been objected to it, however, that its form is too clumsy to admit of its being raised to any considerable height above the building on which it stands; and that it cannot be made to change its direction, and consequently cannot be seen but from one particular point.

Several other telegraphs have been proposed to remedy these defects, and perhaps others to which the instrument is still liable. The dial-plate of a clock would make an excellent telegraph, as it might exhibit 144 signs so as to be visible at a great distance. A telegraph on this principle, with only six divisions instead of twelve, would be simple and cheap, and might be raised twenty or thirty feet high above the building without any difficulty: it might be supported on one post, and therefore turn round, and the contrast of colours would always be the same.

We shall now conclude this article with a short idea of Mr. John Garnet's most simple and ingenious contrivance. This is merely a bar or plank turning upon a centre, like the sail of a windmill; and being moved into any position, the distant observer turns the tube of a telescope into the same position, by bringing a fixed wire within it to coincide with or parallel to the bar, which is a thing extremely easy to do. The centre of motion of the bar has a small circle about it, with letters and figures around the circumference, and an index moving round with the bar, pointing to any letter or mark that the operator wishes to set the bar to, or to communicate to the observer. The eye-end of the telescope without has a like index and circle, with the corresponding letters or other marks. The consequence is obvious; the telescope being turned round till its wire covers or becomes parallel to the bar, the index of the former necessarily points out the same letter or mark in its circle, as that of the latter, and the communication of sentiment is immediate and perfect. The use of this machine is so easy, that it has been put into the hands of two common labouring-men, who had never seen it before, and they have immediately held a quick and distant conversation together.

The more particular description and figure of this machine, are as follows. ABDE (fig. 234) is the telegraph, on whose centre of gravity C, about which it revolves, is a fixed pin, which goes through a hole or socket in the firm upright post G, and on the opposite side of which is fixed an index CI. Concentric to C, on the same post, is fixed a wooden or brass circle, of six or eight inches diameter, divided into forty-eight equal parts, twenty-four of which represent the letters of the alphabet, and between the letters, numbers; so that the index, by means of the arm AB, may be moved to any letter or number. The length of the arm should be $2\frac{1}{2}$ or 3 feet for every mile of distance. Two revolving lamps of different colours suspended occasionally at A and B, the ends of the arm, would serve equally at night.

Let *ss* (fig. 235) represent the section of the outward tube of a telescope perpendicular to its axis, and *xx* the like section of the sliding or adjusting tube, on which is fixed an index I I. On the part of the outward tube next to the observer, there is fixed a circle of letters and numbers, similarly divided and situated to the circle in fig. 234; then the index I I, by means of the sliding or adjusting tube, may be turned to any letter or number. Now there being a cross hair, or fine silver wire, *fg*, fixed in the focus of the eye-glass, in the same direction as the index II; so that when the arm AB (fig. 234) of the telegraph is viewed at a distance through the telescope, the cross hair may be turned, by means of the sliding tube, to the same direction of the arm AB; then the index I I (fig. 235) will point to the same letter or number on its own circle, as the index I (fig. 234) points to on the telegraphic circle.

If, instead of using the letters and numbers to form words at length, they are used as signals, three motions of the arm will give above a hundred thousand different signals.

TELEPHIUM, TRUE ORPINE; a genus of plants of the class of pentandria, and order of trigynia; and in the natural system ranking under the 54th order, miscellaneæ. The calyx is pentaphyllous; there are five petals, which are inserted into the receptacle; the capsule is unilocular and trivalvular. There are two species, the imperati and oppositifolium.

TELESCOPE. See OPTICS.

TELLER, an officer of the exchequer, in antient records called tallier; there are four of these officers, whose duty is to receive all sums due to the king, and to give the clerk of the pells a bill to charge him therewith. They likewise pay all money due from the king, by warrant from the auditor of the receipt; and make weekly and yearly books, both of their receipts and payments, which they deliver to the lord treasurer.

TELLINA, a genus of vermes testacea; the generic character is, the animal a tethys; shell bivalve, generally sloping on one side; in the fore-part of one valve a convex, of the other a concave fold; hinge with usually three teeth, the lateral ones smooth in one shell. There are about 100 species, divided into three sections: A ovate and thickish; B ovate and compressed; and C suborbicular. The tellina foliacea is of section B, having the shell oval, with rough pubes, the flattened sides serrate. It inhabits the Indian Ocean and is rare. See Pl. Nat. Hist. fig. 393.

TELLURIUM, a mineral found in Transylvania, which Muller of Reichenstein examined in 1782, and concluded, from his experiments, that the ore, which had been distinguished by the names of aurum problematicum, aurum paradoxicum, and aurum album, contains a new metal different from every other. Being still dissatisfied with his own conclusions, he sent a specimen of it to Bergman; but the specimen was too small to enable that illustrious chemist to decide the point. He ascertained, however, that the metal in question is not antimony. The experiments of Muller appeared so satisfactory, that they induced Mr. Kirwan, in the second edition of his Mineralogy, published in 1796, to give this metal a separate place, under the name of sylvanite. Klaproth published an analysis of the ore in 1798, and completely confirmed the conclusions of Muller. To the new metal, which constitutes 0.925 of the ore, he gave the name of tellurium; and this name has been generally adopted. Gmelin examined the ore in 1799; and his experiments coincide almost exactly with those of Muller and Klaproth. By these philosophers the following properties of tellurium have been ascertained:

Its colour is bluish-white, intermediate between that of zinc and lead; its texture is laminated like antimony; and its brilliancy is considerable. Its hardness has not been ascertained. Its specific gravity, according to Klaproth, is 6.1. It is very brittle, and may be easily reduced to powder. It melts when raised to a temperature somewhat higher than the fusing-point of lead. If the heat is increased a little, it boils and evaporates, and attaches itself in brilliant drops to the upper part of the retort in which the experiment is made. It is therefore, next to mercury and arsenic, the most volatile of all the metals. When cooled slowly, it crystallizes.

When exposed to the action of the blowpipe upon charcoal, it takes fire, and burns with a lively blue flame, the edges of which are green; and is completely volatilized in the form of a white smoke, which, according to Klaproth, has a smell not unlike that of radishes, but which Gmelin could not observe.

This white smoke is the oxide of tellurium, which may be obtained also by dissolving the metal in nitro-muriatic acid, and diluting the the solution with a great quantity of water. A white powder falls to the bottom, which is the oxide. It may be procured also by dissolving the metal in the nitric acid, and adding potass slowly till the oxide precipitates. This oxide is easily melted by heat into a straw-coloured mass of a radiated texture. When made into a paste with oil, and heated in charcoal, it is reduced to the metallic state so rapidly, that a kind of explosion is produced.

Tellurium may be combined with sulphur by fusion. This sulphuret has a leaden grey colour, and a radiated texture; on red-hot coals it burns with a blue flame.

Tellurium may be amalgamated with mercury by trituration. Its other properties have not yet been examined.

TELIFEROUS, in entomology, means such insects as are armed with a dart or sting.

TEMPERAMENT. See PHYSIOLOGY, Vol. II. p. 421.

TEMPERAMENT, in music, the accommodation or adjustment of the imperfect sounds by transferring a part of their defects to the more perfect ones, in order to remedy, in some degree, the false intervals of those instruments, the sounds of which are fixed; as the organ, harpsichord, piano-forte, &c.

Temperament is what the Italians call participatione, participato, or systema temperato, because it is founded on temperature; that is, on the diminution of some intervals and augmentation of others, by which it partakes of the diatonic and chromatic systems.

TEMPERATURE. See METEOROLOGY.

TEMPERING *of steel and iron,* the rendering of them either more compact and hard, or soft and pliant, according as the different uses for which they are wanted may require. See IRON, p. 33. Vol. II.

TEMPLARS, or TEMPLERS, a religious order instituted at Jerusalem, about the year 1118. Some religious gentlemen put themselves under the government of the patriarch of Jerusalem, renounced property, made the vow of celibacy and obedience, and lived like canons regular. King Baldwin assigned them an apartment in his palace. They had likewise lands given them by the king, the patriarch, and the nobility, for their maintenance. They took the name of knights templars, because their first house stood near the temple dedicated to our Saviour, at Jerusalem. This order, after having performed many great exploits against the infidels, became rich and powerful all over Europe; but the knights, abusing their wealth and credit, fell into great disorders and irregularities. Many crimes and enormities being alleged against them, they were prosecuted in France, Italy, and Spain; and at last, the pope, by his bull of the 22nd of May, 1312, given in the council of Vienna, pronounced the extinction of the order of Templars, and united their estates to the order of St. John of Jerusalem.

TEMPORALITIES *of bishops,* are such revenues, lands, and tenements, and lay fees, as have been added to bishops' sees, by kings and other great personages of this land, from time to time, as they are barons and lords of parliament. This revenue of the king, which was antiently very considerable, is now, by a customary indulgence, almost reduced to nothing; for at present, as soon as the new bishop is consecrated and confirmed, he usually receives from the king the restitution of his temporalities entire and untouched; and then and not sooner, he has a fee simple in his bishopric, and may maintain an action for the profits. 1 Black. 283.

TENACITY, a term applied to metals, by which is meant the power that a metallic wire of a given diameter has of resisting, without breaking, the action of a weight suspended from its extremity. Metals differ exceedingly from each other in tenacity. Iron wire, for instance, $\frac{1}{10}$th of an inch in diameter, will support without breaking, about 500lb. weight; whereas one made of lead of the same diameter will not support above 29lb.

TENAILLE. This word literally means shears. A military evolution which was performed in the times of the ancients. In page 206 of Observations on the Military Art, we have the following account of it:

A phalanx, attacked by a lozenge or triangular wedge, bent its right and left forward by a half-quarter conversion, each wing on their common centre; and when they found themselves opposite the sides of the enemy's arrangement, they each marched on their own side, right before them; by which means they both inclosed and attacked the enemy together, at the same time, while the head was engaged and at blows with the centre of the phalanx that had kept its ground. Such is the description authors have left us of the design and effects of this manœuvre.

The tenaille had considerable advantage over the triangular wedge; but, according to chevalier Folard, it was not equally efficacious against the column. The latter could alter the direction of its march, and fall upon one of the wings, whether in motion or not, or detach the section of the tail or rear to take its wings in flank, while it was occupied in making the quarter-conversion. The column and tenaille were formed for acting against each other, and could only be victorious over one another by the superior abilities of their commander. We fancy, however, the column was always exposed to less danger than the tenaille, for the latter could not pursue the column without changing its order; whereas the column must destroy, and in a manner annihilate the tenaille, in case it could once break it.

The tenaille is unquestionably an excellent manœuvre, and strictly conformable to a very wise maxim, which directs us to multiply our strength and efforts as much as possible against one point. We sometimes, indeed, make use of it in war without being sensible of its advantages. This, however, does not hinder the manœuvre from being well performed; for the nature of ground not being level like a sheet of paper, the commander, in ranging his troops, according to the advantages of the situation, does not form a perfect tenaille, such as may be drawn or sketched out, but one of an irregular kind, which produces the same effects; and this is what should be sought on all occasions.

Tenailles, in fortification, are low works made in the ditch before the curtains. There are three sorts; viz. the first are the faces of the bastions produced till they meet, but much lower; the second have faces, flanks, and a curtain; and the third have only faces and flanks.

Tenaille, *single*, a work whose front is advanced towards the country, having two faces, forming a re-entering angle; its two long sides terminate on the counterscarp, opposite to the angle of the shoulder.

Tenaille, *double*, is a work whose front, having four faces, forms two re-entering, and three salient angles; its long sides are likewise parallel, and terminate on the counterscarp, opposite to the angle of the shoulder. Both the single and double tenailles have this fault, viz. that they are not flanked or defended at the re-entering angle, because the height of the parapet hinders the soldiers from discovering before that angle. Therefore tenailles should only be made when there is not room enough to make horn-works. The ramparts, parapets, ditches, covert-way, and glacis of tenailles, are the same with other outworks.

Tenaille *of a place*, is what is comprehended between the points of two neighbouring bastions; as the faces, flanks, and curtains. Hence it is said, the enemy attacked the whole tenaille of a place, when they made two attacks on the faces of the two bastions.

TENANT, signifies one who holds or possesses lands or tenements by any kind of right, either in fee, for life, years, or at will.

TENCH. See Cyprinus.

TENDER, is an offer to pay a debt, or perform a duty. In every plea of tender, where money is the thing demanded by the action, and the debt or duty is not discharged by the tender and refusal, money may be brought in without leave of the court; but as other things as well as money may, where a tender is pleaded, be brought into court; this is with more propriety called bringing into court generally, than a bringing money into court. In all other cases, the leave of the court must be had before money can be brought into court. The rule under which this leave is granted, is, as in the case of an ejectment by a mortgagee, founded upon a particular act of parliament. In other cases, it is founded upon that discretionary power, which is, for the furtherance of justice, vested in the court. By the discretionary rule, it is sometimes ordered, that upon bringing money into court, all proceedings in an action shall be stayed. At other times it is ordered, that the money brought into court shall be struck out of the plaintiff's declaration, and that the plaintiff shall not, at the trial of the issue, be permitted to give any evidence as to this money. This rule, by which the money brought into court is ordered to be struck out of the declaration, is from its being more frequently granted, than that by which it is ordered, that the proceeding shall be stayed, called the common rule. 5 Bac. Abr. 1.

If bank notes have been offered, and no objection made on that account, it has been considered by the court of king's bench as a good tender. 3 Durnf and East, 554.

Tender, a small ship in the service of men of war, for carrying of men, provisions, or any thing else that is necessary.

TENDONS, are white, firm, and tenacious parts, continuous to the muscles, and usually forming their extremities.

TENEBRIO, a genus of insects of the order coleoptera. The generic character is, antennæ moniliform, with the last joint rounded; thorax plano-convex, margined; head exserted; wing-sheaths stiffish. In this genus, of which there are more than 100 species, the body is oblong-oval, and in most species somewhat pointed at the extremity: it may be observed also that several species are destitute of wings. Among the European tenebriones one of the most remarkable is the tenebrio mortisagus, a coal-black insect measuring about an inch in length, of rather slow motion, and distinguished by the remarkably pointed appearance of the wing-sheaths, which at their extremities project a little beyond the abdomen: they are also perfectly connate or undivided, forming a complete covering to the body, being carried over the sides to some distance beneath, and the insect is totally destitute of real or under wings. It is usually found in dark neglected places, beneath boards, in cellars, &c. and if handled, and especially if crushed, diffuses a highly unpleasant smell.

Tenebrio globosus is perhaps not a Linnæan species, unless it is the tenebrio gibbosus of that author. It is seen during the hottest part of the summer about walls and pathways, and is distinguished by the remarkably globular appearance of the body; it is totally black, the under parts having sometimes a slight violaceous cast, and the joints of the feet, which are remarkably broad, are of a dull brown: the whole insect is of a very smooth, but not polished, surface, and usually measures about three quarters of an inch in length: in this however it varies considerably, some specimens, probably the males, being considerably smaller. The antennæ in this insect are beautifully moniliform, all the joints being globular.

Tenebrio molitor is an insect often seen in houses: it is one of the smaller kinds, and is coal-black, of a lengthened shape, with longitudinally striated wing-shells, and proceeds from a larva commonly known by the name of the meal-worm, from its being so frequently found in flour, &c. It is of a yellowish white colour, about an inch long, slender-bodied, and of a highly polished surface, and is considerd as the favorite food of the nightingale when kept in a state of captivity: it is said to remain two years before it changes into a chrysalis.

The genus tenebrio is numerous, and some of the exotic species much resemble the general appearance of the first described, but are much larger. Many others are small insects, and the genus has received, by later discoveries, such accessions, that it has been divided into several distinct genera.

TENEMENT, in its common acceptation, is applied only to houses and other buildings; but in its original, proper, and legal sense, it signifies every thing that may be holden, provided it is of a permanent nature, whether it is of a substantial, or of an unsubstantial and ideal kind. Thus frank tenement, or freehold, is applicable not only to lands and other solid objects, but also to offices, rents, commons, &c. and as lands and houses are tenements, so is an advowson a tenement; and a franchise, or office, a right of common, a peerage, or other property of the like unsubstantial kind, are all of them, legally speaking, tenements. 2 Black. 17.

TENEMENTIS LEGATIS, a writ that lies to London, or any other corporation where the custom is, that men may demise tenements as well as goods and chattels by their last will, for the hearing any controversy touching the same, and for rectifying the wrong.

TENESMUS. See Medicine.

TENNIS, a play at which a ball is driven by a racket. As many persons would become players at tennis, provided they could easily understand the rudiments of the game, so as to form some judgment of the players, or at least to know who wins and who loses, we have here attempted to give so plain a description of it, that no one can be at a loss, if ever he should bet or play. As to the executive part, it requires great practice to make a good player, so that nothing can be done without it; all we presume to do is, to give an insight into the game, by which a person may not seem a total stranger to it when he happens to be in a tennis-court.

The game of tennis is played in most capital cities in Europe, particularly in France, whence we may venture to derive its origin. It is esteemed with many to be one of the most antient games in Christendom, and long before King Charles I.'s time it was played in England.

This game is as intricate as any game whatever; a person who is totally ignorant of it may look on for a month together, without being able to make out how the game is decided. We shall begin therefore by describing the court in which it is played.

The size of a tennis-court is generally about 96 or 97 feet by 33 or 34, there being no exact dimension ascribed to its proportion, a foot more or less in length or width being of no consequence. A line or net hangs exactly across the middle, over which the ball must be struck, either with a racket or board, to make the stroke good. Upon the entrance of a tennis-court, there is a long gallery which goes to the dedans, that is, a kind of front gallery, where spectators usually stand; into which whenever a ball is struck, it tells for a certain stroke. This long gallery is divided into different compartments or galleries, each of which has its particular name, as follows; from the line towards the dedans are the first gallery, door, second gallery, and the last gallery, which is called the service side. From the dedans to the last gallery are the figures 1, 2, 3, 4, 5, 6, at a yard distance each, by which the chaces are marked, and is one of the most essential parts of the game, as will appear in the following description.

On the other side of the line are also the first gallery, door, second gallery, and last gallery, which is called the hazard-side. Every ball struck into the last gallery on this side reckons for a certain stroke the same as the dedans. Between the second and this last gallery are the figures 1, 2, to mark the chaces on the hazard-side. Over this long galler , or these compartments, is a covering, ied the penthouse, on which they play the ll from the service-side, in order to begin a set of tennis, from which it is called a service. When they miss putting the ball (so as to rebound from the penthouse) over a certain line on the service-side, it is deemed a fault, two of which are reckoned for a stroke. If the ball rolls round the penthouse, on the opposite of the court, so as to fall beyond a certain line described for that purpose, it is called passe, reckons for nothing on either side, and the player must serve again.

On the right-hand side of the court from the dedans is what they call the tambour, a part of the wall which projects, and is so contrived in order to make a variety in the stroke, and render it more difficult to be returned by the adversary; for when a ball strikes the tambour, it varies its direction, and requires some extraordinary judgment to return it over the line. The last thing on the right-hand side is called the grill, wherein if the ball is struck, it is also 15, or a certain stroke.

The game of tennis is played by what they call sets; a set of tennis consists of six games: but if they play what is called an advantage-set, two above five games must be won on one side or the other successively, in order to decide; or, if it comes to six games all, two games must still be won on one side to conclude the set; so that an advantage-set may last a considerable time; for which kind of sets the court is paid more than for any other.

We must now describe the use of the chaces, and by what means these chaces decide or interfere so much in the game. When the player gives his service at the beginning of a set, his adversary is supposed to return the ball; and wherever it falls after the first rebound untouched, the chace is called accordingly; for example, if the ball falls at the figure 1, the chace is called at a yard, that is to say, at a yard from the dedans: this chace remains till a second service is given; and if the player on the service-side lets the ball go after his adversary returns it, and if the ball falls on or between any of these figures or chaces, they must change sides, there being two chaces; and he who then will be on the hazard-side, must play to win the first chace; which if he wins by striking the ball so as to fall, after its first rebound, nearer to the dedans than the figure 1, without his adversary's being able to return it from its first hop, he wins a stroke, and then proceeds in like manner to win the second chace, wherever it should happen to be. If a ball falls on the line with the first gallery door, second gallery, or last gallery, the chace is likewise called at such or such a place, naming the gallery-door, &c. When it is just put over the line, it is called a chace at the line. If the player on the service-side returns a ball with such force as to strike the wall on the hazard-side so as to rebound, after the first hop over the line, it is also called a chace at the line.

The chaces on the hazard-side proceed from the ball being returned either too hard or not quite hard enough; so that the ball after its first rebound falls on this side of the blue line, or line which describes the hazard-side chaces; in which case it is a chace at 1, 2, &c. provided there is no chace depending. When they change sides, the player, in order to win this chace, must put the ball over the line any where, so that his adversary does not return it. When there is no chace on the hazard-side, all balls put over the line from the service-side, without being returned, reckon for a stroke.

As the game depends chiefly upon the marking, it will be necessary to explain it, and to recommend those who play at tennis to have a good and unbiassed marker, for on him the whole set may depend: he can mark in favour of the one and against the other in such a manner, as will render it two to one at starting, though even players. Instead of which the marker should be very attentive to the chaces, and not be any way partial to either of the players.

This game is marked in a very singular manner, which makes it at first somewhat difficult to understand. The first stroke is called 15, the second 30, the third 40, and the fourth game, unless the players get four strokes each; in that case, instead of calling it 40 all, it is called deuce; after which, as soon as any stroke is got, it is called advantage; and in case the strokes become equal again, deuce again, till one or the other gets two strokes following, which win the game; and as the games are won, so they are marked and called; as one game love, two games to one, &c. towards the set, of which so many of these games it consists.

Although but one ball at a time is played with, a number of balls are made use of at this game to avoid trouble, and are handed to the players in baskets for that purpose; by which means they can play as long as they please, without ever having occasion to stoop for a ball.

As to the odds at tennis, they are by no means fixed, but are generally laid as follow:

Upon the first stroke being won between even players, that is, fifteen love, the odds are of the single game	7 to	4
Thirty love	4	1
Forty love	8	1
Thirty fifteen	2	1
Forty fifteen	5	1
Forty thirty	3	1
The odds of a four-game set when the first game is won, are	7	4
When two games love	4	1
Three games love	8	1
When two games to one	2	1
Three games to one	5	1
The odds of a six-game set when the first game is won, are	3	2
When two games love	2	1
Three games love	4	1
Four games love	10	1
Five games love	21	1
When two games to one	8	5
Three games to one	5	2
Four games to one	5	1
Five games to one	15	1
When three games to two	7	4
Four games to two	4	1
Five games to two	10	1
When four games to three	2	1
Five games to three	5	1
The odds of an advantage-set when the first game is won, are	5	4
When two games love	7	4
Three games love	3	1
Four games love	5	1
Five games love	15	1
When two games to one	4	3
Three games to one	2	1
Four games to one	7	2
Five games to one	10	1
When three games to two	3	2
Four games to two	3	1
Five games to two	8	1
When four games to three	8	5
Five games to three	3	1
When five games to four	2	1
When six games to five	5	2

The foregoing odds, as beforesaid, are generally laid, but the chaces interfering make the odds very precarious; for example, when there is a chace at half a yard, and a set is five games all, and in every other respect equal, the odds are a good five to four; and if it were six games to five, and forty thirty with the same chace, the odds then would be a guinea to a shilling; so that it is plain that the odds at this game differ from those of any other; for one stroke will reduce a set, supposing the players to be five games all, from an even wager to three to two, and so on in proportion to the stage of the set.

There are various methods of giving odds at tennis, in order to make a match equal; and that they may be understood, we shall give the following list of them, with their meanings, so that any person may form a judgment of the advantage received or given.

The lowest odds that can be given, excepting the choice of the sides, is what they call a bisque, that is, a stroke to be taken or scored whenever the player, who receives the advantage, thinks proper: for instance, suppose a critical game of the set to be forty thirty, by taking the bisque, he who is forty becomes game, and so in respect of two bisques, &c.

The next greater odds are fifteen, that is, a certain stroke given at the beginning of each game.

After these half thirty, that is, fifteen one game, and thirty the next. Then follow the whole thirty, forty, &c.

There are also the following kind of odds which are given, viz.

Round services: those are services given round the penthouse, so as to render it easy for the striker-out (the player who is on the hazard-side) to return the ball.

Half-court, that is, being obliged or confined to play into the adversary's half-court; sometimes it is played straightwise, and at other times across; both which are great advantages given by him so confined, but the straight half-court is the greatest.

Touch-no-wall, that is, being obliged to play within the compass of the walls, or sides of the court. This is a considerable advantage to him who receives it; as all the balls must be played gently, and consequently they are much easier to take than those which are played hard, or according to the usual method of play.

Barring the hazards, that is, barring the dedans, tambour, grill, or the last gallery on the hazard-side, or any particular one or more of them.

These are the common kind of odds or advantages given; but there are many others, which are according to what is agreed by the players; such as playing with board against racket, cricket-bat against racket, &c.

The game of tennis is also played by four persons, two partners on each side. In this case, they are generally confined to their particular quarters, and one of each side appointed to serve and strike out; in every other respect, the game is played in the same manner as when two only play.

Any thing more to be said upon this subject would be needless, as nothing can be recommended, after reading this short account of tennis, but practice and attention, without which no one can become a proficient at the game.

TENON, in building, &c. the square end of a piece of wood, or metal, diminished by one-third of its thickness, to be received into a hole in another place, called a mortise, for jointing or fastening the two together. It is made in various forms, square, dove-tailed, for double mortises, &c.

TENOR, of writs, records, &c. is the substance or purport of them, or a transcript or copy.

Tenor, in music, the second of the four parts in harmonical composition, reckoning from the bass. The tenor is the part most accommodated to the common voice of man; from which circumstance it has sometimes, by way of preference, been called "the human voice." Its general compass extends from C above G gamut to G the treble-cliff note.

The tenor was formerly the plain-song, or principal part in a composition, and derived the name of tenor from the Latin word teneo, I hold; because it held or sustained the air, point, substance, or meaning, of the whole cantus, and every part superadded to it was considered but as its auxiliary. It appears that the contrary practice of giving the air to the soprano, or treble, had its rise in the theatre, and followed the introduction of evirati into musical performances; since which it has been universally adopted both in vocal and instrumental music.

Tenor-cliff, the name given to the C cliff when placed on the fourth line of the stave. See Cliff.

Tenor Violin, or *Viola*, a stringed instrument resembling the violin, but lower in its scale, having its lowest note in C above G gamut. In concert this instrument takes the part next above the bass.

TENSE, *time*, in grammar, an inflection of verbs, whereby they are made to signify or distinguish the circumstance of time, in what they affirm.

TENSION, the state of a thing stretched. Thus animals sustain and move themselves by the tension of their muscles and nerves. A chord or string gives an acuter or deeper sound, as it is in a greater or less degree of tension, that is, more or less stretched or tightened.

TENT, in surgery, a roll of lint worked into the shape of a nail, with a broad flat head. See Surgery.

TENTER, a railing used in the cloth-manufacture, to stretch out the pieces of cloth, stuff, &c. or only to make them even, and set them square. It is usually about four feet and a half high, and for length exceeds that of the longest piece of cloth. It consists of several long pieces of wood, placed so that the lower cross-piece of wood may be raised or lowered, as is found requisite, to be fixed at any height, by means of pins. Along the cross-pieces, both the upper and under one, are hooked nails, called tenter-hooks, driven in from space to space.

TENTHREDO, a genus of insects of the order hymenoptera: the generic character is, mouth with jaws, without proboscis; wings flat, swelled or slightly inflated; piercer consisting of two serrated and scarcely projecting laminæ; scutellum with two distant granules. The larvæ of the genus tenthredo are remarkable for their great resemblance to those of the order lepidoptera or real caterpillars, from which however they may in general be readily distinguished by their more numerous feet, which are never fewer than sixteen, exclusive of the three first or thoracic pairs. When disturbed or handled, they usually roll themselves into a flat spiral. They feed, like the caterpillars of the lepidoptera, on the leaves of plants, and undergo their chrysalis state in a strong gummy case or envelopement, prepared in autumn, out of which in the ensuing spring emerges the complete insect.

The tenthredines form a numerous genus, and may be divided into tribes or sections, according to the form of the antennæ, which are in some clavated, in others filiform, &c. Among the principal species may be numbered the tenthredo lutea of Linnæus, which proceeds from a large green larva, of a finely granulated surface, with a double row of black specks along each side, and a dusky dorsal line bounded on each by yellow: it feeds on various species of willow, &c. The parchment-like case in which it envelops itself in autumn is of a pale yellowish-brown colour, and the chrysalis, which is of a pale dusky or brownish cast, exhibits the limbs of the future fly, which is equal in size to a common wasp, and is of a yellow colour, barred with black: the antennæ rather short, and strongly clavated.

The tenthredo amerinæ of Linnæus is somewhat smaller than the preceding, and of a cinereous-brown colour, with the under part of the abdomen rufous or dull orange: like the former, its caterpillar is of a green colour, and of a finely roughened surface powdered with numerous whitish specks.

The larvæ of the smaller tenthredines are often very injurious to different kinds of esculent vegetables, as turnips, &c. &c. There are nearly 200 species of this insect.

TENTHS, that yearly portion or tribute which all ecclesiastical livings antiently paid to the king. See First Fruits.

TENURE, the manner whereby lands or tenements are holden, or the service that the tenant owes to his lord. Under the word tenure is included every holding of an inheritance; but the signification of this word, which is a very extensive one, is usually restrained by coupling other words with it: this is sometimes done by words which denote the duration of the tenant's estate; as if a man holds to himself and his heirs, it is called tenure in fee-simple. At other times the tenure is coupled with words pointing out the instrument by which an inheritance is held: thus, if the holding is by copy of court-roll, it is called tenure by copy of court-roll. At other times, this word is coupled with others that shew the principal service by which an inheritance is held: as where a man held by knight's service, it is called tenure by knight's service. 5 Bac. Abr. 34.

TERAMNUS, a genus of the diadelphia decandria class and order of plants: the keel is very small, concealed within the calyx; stamina alternate, five, barren; stigma sessile, headed. There are two species, creeping plants of Jamaica.

TEREBELLA, a genus of vermes mollusca. The generic character is, body oblong, creeping, naked, often enclosed in a tube furnished with lateral tufts and branchiæ; mouth placed before, furnished with lips, without teeth, and protending a clavate proboscis; feelers numerous, ciliate, capillary, seated round the mouth. There are eleven species.

TEREDO, in natural history, a genus of vermes belonging to the order of testacea. The animal is a terebella; there are two valves, calcareous, hemispherical, and cut off before, and two lanceolated. The shell is tapering, bending, and capable of penetrating wood. There are only three species, the navalis, utriculis, and clava. See Plate Nat. Hist. fig. 394.

The navalis, or ship-worm, which has a very slender smooth cylindrical shell, inhabits the Indian seas, whence it was imported into Europe. It penetrates easily into the stoutest oak-planks, and produces dreadful destruction to the ships by the holes it makes in their sides; and it is to avoid the effects of this insect that vessels require sheathing.

The head of this creature is well prepared by nature for the hard offices which it has to undergo, being coated with a strong armour, and furnished with a mouth like that of the leech, by which it pierces wood as that animal does the skin. A little above this it has two horns which seem a kind of continuation of the shell; the neck is as strongly provided for the service of the creature as the head, being furnished with several strong muscles; the rest of the body is only covered by a very thin and transparent skin, through which the motion of the intestines is plainly seen by the naked eye; and by means of the microscope several other very remarkable particulars become visible there. This creature is wonderfully minute when newly excluded from the egg; but it grows to the length of four or six inches, and sometimes more.

When the bottom of a vessel, or any piece of wood which is constantly under water, is inhabited by these worms, it is full of small holes; but no damage appears till the outer parts are cut away: then their shelly habitations come into view; in which there is a large space for inclosing the animal, and surrounding it with water. There is an evident care in these creatures never to injure one another's habitations, by which means each case or shell is preserved entire; and in such pieces of wood as have been found eaten by them into a sort of honeycomb, there never is seen a passage or communication between any two of the shells, though the woody matter between them often is not thicker than a piece of writing-paper. They penetrate some kinds of wood more easily than others.

They make their way most quickly into fir and alder, and grow to the greatest size. In the oak they make small progress, and appear small and feeble, and their shells much discoloured.

Since each of these animals is lodged in a solitary cell, and has no access to those of its own species, it has been matter of surprise how they should increase to so vast a multitude. Upon dissecting them, it appears that every individual has the parts of both sexes, and is therefore supposed to propagate by itself.

The sea-worms, which are pernicious to our shipping, appear to have the same office allotted to them in the waters which the termites have on the land (see TERMES). They will appear, on a very little consideration, to be most important beings in the great chain of creation, and pleasing demonstrations of that infinitely wise and gracious Power which formed, and still preserves, the whole in such wonderful order and beauty; for if it was not for the rapacity of these and such animals, tropical rivers, and indeed the ocean itself, would be choked with the bodies of trees which are annually carried down by the rapid torrents, as many of them would last for ages, and probably be productive of evils, of which, happily, we cannot in the present harmonious state of things form any idea; whereas now being consumed by these animals, they are more easily broken in pieces by the waves; and the fragments which are not devoured become specifically lighter, and are consequently more readily and more effectually thrown on shore, where the sun, wind, insects, and various other instruments, speedily promote their entire dissolution.

TERES. See ANATOMY.

TERM, in geometry, is the extreme of any magnitude, or that which bounds and limits its extent. So the terms of a line, are points; of a superficies, lines; of a solid, superficies.

TERMS, of an equation, or of any quantity, in Algebra, are the several names or members of which it is composed, separated from one another by the signs + or —. So, the quantity $ax + 2bc - 3ax^2$, consists of the three terms ax and $2bc$ and $3ax^2$.

In an equation, the terms are the parts which contain the several powers of the same unknown letter or quantity: for if the same unknown quantity is found in several members in the same degree or power, they shall pass but for one term, which is called a compound one, in distinction from a simple or single term. Thus, in the equation $x^3 + \overline{a - 3b} . x^2 - acx = b^3$ the four terms are x^3 and $\overline{a - 3b} . x^2$ and acx and b^3; of which the second term $\overline{a - 3b} . x^2$ is compound, and the other three are simple terms.

TERMS of a product, or of a fraction, or of a ratio, or of a proportion, &c. are the several quantities employed in forming or composing them. Thus, the terms

of the product ab, are a and b;
of the fraction $\frac{5}{8}$, are 5 and 8;
of the ratio 6 to 7, are 6 and 7;
of the proportion $a : b :: 5 : 9$, are a, b, 5, 9.

TERMS, are those spaces of time wherein the courts of justice are open for all that complain of wrongs or injuries, and seek their rights by course of law or action, in order to their redress; and during which, the courts in Westminster-hall sit and give judgments, &c. but the high court of parliament, the chancery, and inferior courts, do not observe the terms; only the courts of king's-bench, common-pleas, and exchequer, the highest courts at common law. Of these terms there are four in every year, viz. Hilary term, which begins the 23d of January, and ends the 12th of February, unless on Sundays, and then the day after; Easter term, which begins the Wednesday fortnight after Easter-day, and ends the Monday next after ascension-day; Trinity term, which begins the Friday after Trinity Sunday, and ends the Wednesday fortnight after; and Michaelmas term begins the 6th and ends the 28th of November.

There are in each of these terms stated days, called days in bank, that is, days of appearance in the court of common pleas, called usually bancum, or commune bancum, to distinguish it from bancum regis, or the court of king's-bench. They are generally at the distance of about a week from each other, and regulated by some festival of the church. On some of these days in bank, all original writs must be made returnable, and therefore they are generally called the returns of that term. 3 Black. 227.

The first return in every term is, properly speaking, the first day in that term; and thereon the court sits to take essoins, or excuses, for such as do not appear, according to the summons of this writ; wherefore this is usually called the essoin day of the term. But the person summoned has three days grace beyond the return of the writ, in which to make his appearance; and if he appears on the fourth day inclusive, quarto die post, it is sufficient. Therefore, at the beginning of each term, the court does not sit for dispatch of business till the fourth day, and in Trinity term, by stat. 32 H. VIII. c. 21, not till the sixth day. 3 Black. 227.

TERMS, *Oxford*. Hilary, or Lent term, begins on Jan. 14, and ends the Saturday before Palm Sunday. Easter term begins the tenth day after Easter, and ends the Thursday before Whit-Sunday. Trinity term begins the Wednesday after Trinity Sunday, and ends after the act, sooner or later, as the vice-chancellor and convocation please. Michaelmas term begins on Oct. 10, and ends Dec. 17.

TERMS, *Cambridge*. Lent term begins on Jan. 13, and ends the Friday before Palm Sunday. Easter term begins the Wednesday after Easter week, and ends the week before Whit Sunday. Trinity term begins the Wednesday after Trinity Sunday, and ends the Friday after the commencement. Michaelmas term begins Oct. 10, and ends Dec. 16.

TERMS, *Scottish*. In Scotland Candlemas term begins Jan. 23, and ends Feb. 12. Whitsuntide term begins May 25, and ends June 15. Lammas term begins July 20, and ends Aug. 8. Martinmas term begins Nov. 3, and ends Nov. 29.

TERMES, *the white ant*, a genus of insects of the order aptera: the generic character is, legs six, formed for running; eyes two; antennæ setaceous; mouth furnished with two jaws. The European species of termes are very small, compared with those of the warmer regions of Africa and America; and instead of assembling in multitudes, as in those climates, are usually observed single. The most common of these is the termes pulsatorius of Linnæus, a diminutive insect, of a whitish colour, and which, from its general resemblance to the insects of that genus, has by Derham and some other naturalists been distinguished by the title of pediculus pulsatorius. It is very frequent, during the summer months, in houses, particularly where the wainscot is in any degree decayed, and is remarkable for causing a long-continued sound, exactly resembling the ticking of a watch. It is a very common insect in collections of dried plants, &c. which it often injures greatly. It is of so tender a frame as to be easily destroyed by the slightest pressure, and is an animal of very quick motion. When magnified, the head appears large; the eyes remarkably conspicuous, of a most beautiful gold-colour, and divided, like those of most other insects, into innumerable hexagonal convexities; the antennæ long and setaceous; the palpi or feelers two in number, of moderate length, and terminating in a large club-shaped tip; the thorax rather narrow, and the abdomen obtusely oval; the thighs or first joints of the legs thick, the remaining ones slender, and the feet furnished with very small claws: the whole animal is beset with small, scattered hairs. According to the observations of the celebrated Derham, this insect, at its first hatching from the egg, which is white, oval, and extremely small, bears a complete resemblance to a common mite, being furnished with eight legs, and beset with long hairs. After a certain time it casts its skin, and appears in the very different form above-described. Some individuals of this species become winged when arrived at their full growth; the wings, which are four in number, being very large, of a slightly iridescent appearance, and variegated with blackish and brown clouds or spots. It is in the beginning of July that this change takes place, and at this time several may be seen with the wings half-grown; in a few days they seem to obtain their full size.

Mr. Derham imagines the ticking sound which these animals produce, to be analogous to the call of birds to their mates during the breeding-season; and there seems to be no reason for calling in question the truth of this observation. We may add, that this sound, as well as that produced by the ptinus fatidicus, or death-watch, seems to afford a convincing proof of the faculty of hearing in insects, which some naturalists have been inclined to deny.

Of the exotic termites the most remarkable seems to be the termes bellicosus, whose history is described by Mr. Smeathman in the Philosophical Transactions.

With the good order of their subterraneous cities, they will appear foremost on the list of the wonders of the creation, as most closely imitating mankind in provident industry and regular government.

The termites are represented by Linnæus as the greatest plagues of both Indies, and are indeed every way between the tropics so deemed. These insects have generally obtained the names of ants, it may be presumed, rom the similarity in their manner of living, which is in large communities that erect very extraordinary nests, for the most part on the surface of the ground, whence their excursions are made through subterraneous passages or covered galleries, which they build whenever necessity obliges, or plunder induces, them to march above ground; and at a great distance from their habitations carry on a business of depredation and destruction, scarcely credible but to those who have seen it.

The termites resemble the ants also in their provident and diligent labour, but surpass them as well as the bees, wasps, beavers, and all other animals, in the arts of building, as much as the Europeans excel the least cultivated savages. It is more than probable they excel them as much in sagacity and the arts of government; it is certain they shew more substantial instances of their ingenuity and industry than any other animals; and do in fact lay up vast magazines of provisions and other stores; a degree of prudence which has of late years been denied, perhaps without reason, to the ants.

Their communities consist of one male and one female (who are generally the common parents of the whole, or greater part, of the rest); and of three order of insects, apparently of very different species, but really the same, which together compose great commonwealths, or rather monarchies, if we may be allowed the term.

The different species of this genus resemble each other in form, in their manner of living, and in their good and bad qualities, but differ as much as birds in the manner of building their habitations or nests, and in the choice of the materials of which they compose them.

There are some species which build upon the surface of the ground, or part above and part beneath; and one or two species, perhaps more, that build on the stems or branches of trees, sometimes aloft at a vast height.

Of every species there are three orders; first, the working insects, which, for brevity, we shall generally call labourers; next the fighting ones, or soldiers, which do no kind of labour; and, last of all, the winged ones, or perfect insects, which are male and female, and capable of propagation.

The nests of the termes bellicosus are so numerous all over the island of Bananas, and the adjacent continent of Africa, that it is scarcely possible to stand upon any open place, such as a rice-plantation, or other clear spot, where one of these buildings is not to be seen within fifty paces, and frequently two or three are to be seen almost close to each other. In some parts near Senegal, as mentioned by Mons. Adanson, their number, magnitude, and closeness of situation, make them appear like the villages of the natives.

These buildings are usually termed hills, by natives as well as strangers, from their outward appearance, which is that of little hills more or less conical, generally pretty much in the form of sugar-loaves, and about ten or twelve feet in perpendicular height above the common surface of the ground.

These hills continue quite bare until they are six or eight feet high; but in time the dead barren clay, of which they are composed, becomes fertilized by the genial power of the elements in these prolific climates, and the addition of vegetable and other matters brought by the wind; and in the second or third year, the hillock, if not over-shaded by trees, becomes, like the rest of the earth, almost covered with grass and other plants; and in the dry season, when the herbage is burnt up by the rays of the sun, it is not much unlike a very large hay-cock.

Every one of these buildings consists of two distinct parts, the exterior and the interior. The exterior is one large shell in the manner of a dome, large and strong enough to inclose and shelter the interior from the vicissitudes of the weather, and the inhabitants from the attacks of natural or accidental enemies. It is always, therefore, much stronger than the interior building, which is the habitable part, divided with a wonderful kind of regularity and contrivance into an amazing number of apartments for the residence of the king and queen, and the nursing of their numerous progeny; or for magazines, which are always found well filled with stores and provisions.

From these habitations, galleries again ascend, and lead out horizontally on every side, and are carried under ground near to the surface a vast distance: for if you destroy all the nests within one hundred yards of your house, the inhabitants of those which are left unmolested farther off, will nevertheless carry on their subterraneous galleries, and invade the goods and merchandizes contained in it by sap and mine, and do great mischief if you are not very circumspect.

It has been observed, that there are of every species of termites three orders; of these orders the working insects or labourers are always the most numerous; in the termes bellicosus there seems to be at the least one hundred labourers to one of the fighting insects or soldiers. They are in this state about one-fourth of an inch long, and twenty-five of them weigh about a grain; so that they are not so large as some of our ants. The second order, or soldiers, have a very different form from the labourers, and have been by some authors supposed to be the males, and the former neuters; but they are, in fact, the same insects, only they have undergone a change of form, and approached one degree nearer to the perfect state. They are now much larger, being half an inch long, and equal in bulk to fifteen of the labourers. There is now likewise a most remarkable circumstance in the form of the head and mouth; for in the former state the mouth is evidently calculated for gnawing and holding bodies; but in this state, the jaws being shaped just like two very sharp awls, a little jagged, they are incapable of any thing but piercing or wounding, for which purposes they are very effectual, being as hard as a crab's claw, and placed in a strong horny head, which is of a nut-brown colour, and larger than all the rest of the body together, which seems to labour under great difficulty in carrying it; on which account perhaps the animal is incapable of climbing up perpendicular surfaces. The third order, or the insect in its perfect state, varies its form still more than ever. The head, thorax, and abdomen, differ almost entirely from the same parts in the labourers and soldiers; and, besides this, the animal is now furnished with four fine large brownish, transparent, wings, with which it is at the time of emigration to wing its way in search of a new settlement. We may open twenty nests without finding one winged insect, for those are to be found only just before the commencement of the rainy season, when they undergo the last change, which is preparative to their colonization.

In the winged state they have also much altered their size as well as form. Their bodies now measure between six and seven tenths of an inch in length, and their wings above two inches and a half from tip to tip, and they are equal in bulk to about thirty labourers, or two soldiers. They are now also furnished with two large eyes placed on each side of the head, and very conspicuous: if they have any before, they are not easily to be distinguished. Probably in the two first states, their eyes, if they have any, may be small, like those of moles: for as they live, like these animals, always under ground, they have as little occasion for these organs, and it is not to be wondered at that we do not discover them; but the case is much altered when they arrive at the winged state in which they are to roam, though but for a few hours, through the wide air, and explore new and distant regions. In this form the animal comes abroad during, or soon after, the first tornado, which, at the latter end of the dry season, proclaims the approach of the ensuing rains, and seldom waits for a second or third shower, if the first, as is generally the case, happens in the night, and brings much wet after it.

The quantities that are to be found the next morning all over the surface of the earth, but particularly on the waters, are astonishing; for their wings are only calculated to carry them a few hours, and after the rising of the sun not one in a thousand is to be found with four wings, unless the morning continues rainy, when here and there a solitary being is seen winging its way from one place to another, as if solicitous only to avoid its numerous enemies, particularly various species of ants which are hunting on every spray, on every leaf, and in every possible place, for this unhappy race, of which probably not a pair in many millions get into a place of safety, fulfil the first law of nature, and lay the foundation of a new community.

The termites arborum, those which build in trees, frequently establish their nests within the roofs and other parts of houses, to which they do considerable damage, if not timely extirpated. The large species are not only much the most destructive, but more difficult to be guarded against, since they make their approaches chiefly under ground, descending below the foundations of houses and stores at several feet from the surface, and rising again either in the floors, or entering at the bottoms of the posts, of which the sides of the buildings are composed, bore quite through them, following the course of the fibres to the top, or making lateral perforations and cavities here and there as they proceed.

While some are employed in gutting the posts, others ascend from them, entering a rafter or some other part of the roof. If they once find the thatch, which seems to be a favourite food, they soon bring up wet clay, and build their pipes or galleries through the roof in various directions, as long as it will support them; sometimes eating the palm-tree leaves and branches of which it is composed, and, perhaps (for variety seems very pleasing to them) the rattan, or other running plant, which is used as a cord to tie the various parts of the roof together, and that to the posts which support it; thus, with the assistance of the rats, who during the rainy season are apt to shelter themselves there, and to burrow through it, they very soon ruin the house by weakening the fastenings, and exposing it to the wet. In the mean time the posts will be perforated in every direction, as full of holes as that timber in the bottoms of ships which has been bored by the worms; the fibres and knotty parts, which are the hardest, being left to the last.

They sometimes, in carrying on this business, seem to find that the post has some weight to support, and then if it is a convenient track to the roof, or is itself a kind of wood agreeable to them, they bring their mortar, and fill all or most of the cavities, leaving the necessary roads through it, and as fast as they take away the wood, replace the vacancy with that material; which being worked together by them closer and more compactly than human strength or art could ram it, when the house is pulled to pieces, in order to examine if any of the posts are fit to be used again, those of the softer kinds are often reduced almost to a shell, and all or a greater part transformed from wood to clay, as solid and as hard as many kinds of free-stone used for building in England. It is much the same when the termites bellicosi get into a chest or trunk containing clothes and other things; if the weight above is great, or they are afraid of ants or other enemies, and have time, they carry their pipes through, and replace a great part with clay, running their galleries in various directions. The tree termites indeed, when they get within a box, often make a nest there, and being once in possession, destroy it at their leisure.

When the termites attack trees and branches in the open air, they sometimes vary their manner of doing it. If a stake in a hedge has not taken root and vegetated, it becomes their business to destroy it. If it has a good sound bark round it, they will enter at the bottom, and eat all but the bark, which will remain, and exhibit the appearance of a solid stick (which some vagrant colony of ants or other insects often shelter in till the winds disperse it); but if they cannot trust the bark, they cover the whole stick with their mortar, and then it looks as if it had been dipped into thick mud that had been dried on. Under this covering they work, leaving no more of the stick and bark than is barely sufficient to support it, and frequently not the smallest particle; so that upon a very small tap with your walking-stick, the whole stake, though apparently as thick as your arm, and five or six feet long, loses its form, and disappearing like a shadow, falls in small fragments at your feet.

The first object of admiration which strikes one upon opening their hills, is the behaviour of the soldiers. If you make a breach in a slight part of the building, and do it quickly with a strong hoe, or pick-axe, in the space of a few seconds a soldier will run out, and walk about the breach, as if to see whether the enemy is gone, or to examine what is the cause of the attack. He will sometimes go again, as if to give the alarm; but most frequently, in a short time, is followed by a large body, who rush out as fast as the breach will permit them; and so they proceed, the number increasing, as long as any one continues battering their building. It is not easy to describe the rage and fury they shew. In their hurry they frequently miss their hold, and tumble down the sides of the hill, but recover themselves as quickly as possible; and, being blind, bite every thing they run against, and thus make a crackling noise, while some of them beat repeatedly with their forceps upon the building, and make a small vibrating noise, something shriller and quicker than the ticking of a watch. If they get hold of any one, they will in an instant let out blood enough to weigh against their whole body; and if it is the leg they wound, you will see the stain upon the stocking extend an inch in width. They make their hooked jaws meet at the first stroke, and never quit their hold, but suffer themselves to be pulled away leg by leg, and piece after piece, without the least attempt to escape. On the other hand, keep out of their way, and give them no interruption, and they will in less than half an hour retire into the nest, as if they supposed the wonderful monster that damaged their castle to be gone beyond their reach. Before they are all got in you will see the labourers in motion, and hastening in various directions toward the breach, every one with a burthen of mortar in his mouth ready-tempered. This they stick upon the breach as fast as they come up, and do it with so much dispatch and facility, that although there are thousands, or rather millions, of them, they never stop or embarrass one another; and you are most agreeably deceived, when, after an apparent scene of hurry and confusion, a regular wall arises, gradually filling up the chasm. While they are thus employed, almost all the soldiers are retired quite out of sight.

A renewal of the attack, however, instantly changes the scene. At every stroke we hear a loud hiss; and on the first the labourers run into the many pipes and galleries with which the building is perforated, which they do so quickly that they seem to vanish, for in a few seconds all are gone, and the soldiers rush out as numerous and as vindictive as before.

Previously to breeding, a very surprising change takes place in the body of the queen or breeding animal. The abdomen of this female, in the termes bellicosus especially, begins gradually to extend and enlarge to such an enormous size, that an old queen will have it increased so as to be fifteen hundred or two thousand times the bulk of the rest of her body, and twenty or thirty thousand times the bulk of a labourer. Mr. Smeethman conjectures the animal is upwards of two years old when the abdomen is increased to three inches in length, and has sometimes found them of near twice that size. The abdomen is now of an irregular oblong shape, being contracted by the muscles of every segment, and is become one vast matrix full of eggs, which make long circumvolutions through an innumerable quantity of very minute vessels that circulate round the inside in a serpentine manner, which would exercise the ingenuity of a skilful anatomist to dissect and develope. This singular matrix is not more remarkable for its amazing extension and size, than for its peristaltic motion, which resembles the undulating of waves, and continues incessantly without any apparent effort of the animal; so that one part or other alternately is rising and sinking in perpetual succession, and the matrix seems never at rest, but is always protruding eggs to the amount of sixty in a minute, or eighty thousand and upward in one day of twenty-four hours. These eggs are instantly taken from her body by her attendants (of whom there are always, in the royal chamber and the galleries adjacent, a sufficient number in waiting) and carried to the nurseries, which in a great nest may some of them be four or five feet distant in a straight line, and consequently much farther by their winding galleries. Here, after they are hatched, the young are attended and provided with every thing necessary until they are able to shift for themselves, and take their share of labour.

TERMINALIA, a genus of plants of the class of polygamia, and order of monœcia. The male calyx is quinquepartite; there is no corolla; the stamina are ten in number. The hermaphrodite flower is the same with that of the male; there is one style; the fruit, which is a drupe or plum, is below, and shaped like a boat. There are six species.

TERMINATOR, in astronomy, a name sometimes given to the circle of illumination, from its property of terminating the boundaries of light and darkness.

TERNSTROEMIA, a genus of the class and order polyandria monogynia. The calyx is five-parted; the corolla one-petalled, wheel-shaped; anthers thick at the top; berry two-celled. There are five species, trees of the East and West Indies.

TERRA PONDEROSA. See Barytes.

TERRÆ FILIUS, *son of the earth*, a student of the university of Oxford, formerly appointed, in public acts, to make jesting and satyrical speeches against the members thereof to tax them with any growing corruptions, &c.

TERRE-PLEIN, or Terre-plain, in fortification, the top, platform, or horizontal surface, of the rampart, upon which the cannon are placed, and where the defenders perform their office. It is so called because it lies level, having only a little slope outwardly to counteract the recoil of the cannon. Its breadth is from 24 to 30 feet; being terminated by the parapet on the outer side, and inwardly by the inner talus.

TERRELLA, or little earth, is a magnet turned of a spherical figure, and placed so that its poles, equator, &c. do exactly correspond with those of the world. It was so first called by Gilbert, as being a just representation of the great magnetic globe we inhabit. Such a terrella, it was supposed, if nicely poised, and hung in a meridian like a globe, would be turned round like the earth in 24 hours by the magnetic particles pervading it; but experience has shewn that this is a mistake.

TERRIER, a book or roll, wherein the several lands, either of a private person, or of a town, college, church, &c. are described. It should contain the number of acres, and the site, boundaries, tenant's names, &c. of each piece or parcel.

TESSELLATED PAVEMENTS, those of rich mosaic work, made of curious square marbles, bricks, or tiles, called tesselæ from their resembling dice.

TEST, a vessel used in metallurgy for absorbing the scoriæ of metallic bodies when melted. See Cupellation, Chemistry, and Metallurgy. Some of the German writers recommend, both for tests and cupels, a sort of friable opake stone, called white spath, which appears to be a species of gypsum, or of the stones from which plaister of Paris is prepared. The spath is directed to be calcined with a gentle fire, in a covered vessel, till the slight crackling, which happens at first, has ceased, and the stone has fallen in part into powder: the whole is then reduced into subtle powder, which is passed through a fine sieve, and moistened with so much of a weak solution of green vitriol as is sufficient for making it hold together. Gellert, however, finds, that if the stone is of the proper kind, which can be known only by trials, calcination is not necessary. Scheffer observes, that these kind of tests are liable to soften or fall asunder in the fire, and that this inconvenience may be remedied by mixing with the uncalcined stone somewhat less than equal its weight, as eight-ninths, of such as has been already used and is penetrated by the scoria of the lead, taking only that part of the old test which appears of a green-grey colour, and rejecting the red crust on the top. Tests or cupels made of the spath are said not to require so much caution in nealing and heating them as the common ones; it appears, however, from Scheffer's account, that they are less durable than those made of the ashes of bones, though greatly superior to those of wood-ashes. Vegetable ashes, which stand pretty well the testing of silver, can scarcely bear any great quantity of gold, this metal requiring a considerably stronger fire than the other; but bone-ashes answer so effectually, and are among us so easily procurable, that it is not needful for the refiner to search for any other materials; though those who work off large quantities of lead, in order to gain a little silver or gold contained in it, may possibly, in places remote from populous cities, avail themselves of substances similar to the spath above mentioned.

The test, for its greater security, is fixed in the mould in which it was formed; which is sometimes a shallow vessel made of crucible-earth or cast iron; more commonly an iron hoop, with three bars arched downwards across the bottom, about two inches deep, and of different widths, from three or four inches to fifteen or more, according to the quantity of metal to be tested at once. The ashes or earthy powder, moistened as for making cupels, are pressed down in the mould so as to completely fill it, or rise a little above the sides; with care to make the mass equally solid, and to put in at once, or at least after the bottom has been pressed close, as much of the matter as will be sufficient for the whole; for any additional quantity will not unite thoroughly with the rest, but be apt to part from it in the fire. The edges are pared smooth, and a portion cut out from the middle with a bent knife, so as to leave a proper cavity; which is smoothed by strewing some dry powder on the surface, and rolling on it a wooden, or rather a glass ball.

The process of testing is often performed in the same manner as that of cupellation: but where great quantities of base metal are to be worked off from a little gold, recourse is had to a more expeditious method, that of testing before the bellows.

An oval test is placed in a cavity, made in a hearth of a convenient height, and some moistened sand or ashes pressed round it to keep it steady: the nose of a bellows is directed along its surface, in such a manner, that if ashes are sprinkled in the cavity of the test, the bellows may blow them completely out: some have an iron plate fixed before the bellows, to direct the blast downwards. To keep the surface of the test from being injured in putting in the metal, some cloths or pieces of paper are interposed. The fuel consists of billets of barked oak laid on the sides of the test, with others laid crosswise on these: the bellows impel the flame on the metal, clear the surface of ashes or sparks of coal, hasten the scorification of the lead, and blow off the scoria, as fast as it forms, to one end of the test, where it runs out through a notch made for that purpose. About two-thirds of the scorified lead may thus be collected; the rest being partly absorbed by the test, and partly dissipated by the action of the bellows. Care must be taken not to urge the blast too strongly, lest some portion of the gold should be carried away by the fumes impetuously forced off from the lead, and some minute particles of it entangled and blown off with the scoriæ.

Test-act, a statute 25 Car. II. cap. 2. which requires all officers, both civil and military, to take the oaths and test, viz. the sacrament, according to the rites and ceremonies of the church of England; for the neglect whereof, a person executing any office, mentioned in that statute, forfeits the sum of 500*l*. recoverable by action of debt.

TESTACEA, in the Linnæan system of natural history, the third order of vermes. This order comprehends all shell-fish, arranged by Linnæus under thirty-six genera. Shell-fish are animals with a soft body, covered by or inclosed in a firm, hard, and stony habitation, composed, according to their three separate orders, 1. Of many parts which are ranged under the name of multivalves; 2. Of two parts, which are called bivalves; 3. Of one part or piece only, which we call univalves. These parts, pieces, or valves, are more or less moveable at the animal's pleasure. The animals included in these hard habitations have most of them the characters of one or other of the genera vermium, and might be reduced under the same genera with the mollusca: but as these characters are few, and the shells very numerous, and different in their form and structure, it will tend more to make this part of natural history easy, to arrange the subjects according to the distinctions of the shells themselves. There is this farther consideration in favour of this arrangement, viz. that the animals themselves are rarely seen, and never can be preserved in cabinets; whereas the shells make a figure in them, and great numbers have been met with empty of the animal. The genera classed under the several divisions of this order are,

A. Multivalves; chiton, lepas, phloas. B. Bivalves; mya, solen, tellina, cardium mactra, donax, venus, spondylus, chama, arca, ostrea, anomia, mytillus, pinna. C. Univalves with a regular spire; argonauta, nautilus, conus, cypræa, bulla, voluta, buccinum, strombus, murex, trochus, turbo, helix, nerita, haliotis. D. Univalves without a regular spire; patella, dentalium, serpula, teredo, sabella.

TESTAMENT, in law, a solemn and authentic act, whereby a person declares his will, as to the disposal of his estate, effects, burial, &c. See Will.

TESTATUM, in law, a writ in personal actions, where, if the defendant cannot be arrested on a capias, in the county where the action is laid, but is returned non est inventus by the sheriff, this writ shall be sent into any other county, where such person is thought to be, or have wherewithal to satisfy the demand. It is called testatum, because the sheriff has, before, testified that the defendant was not to be found in his bailiwick.

TESTE, in law, a word generally used in the conclusion of every writ, wherein the date is contained, and begins with teste meipso, &c. in case it is an original writ; or, if only judical, then with teste, naming the chief justice of the bench whence the writ issues.

TESTES. See Anatomy.

TESTUDO, tortoise, a genus of amphibia, of the order reptiles. The generic character is, body defended by a bony covering coated by a horny, scaly, or coriaceous integument; mouth without distinct or proper teeth, the upper mandible closing over the lower.

In no branch of natural history have more errors prevailed than in the attempt to discriminate with precision the several species of tortoises; the general similarity being very great, and the individuals occasionally varying much in size, colours, &c. according to the different periods of their growth. On the whole, the animals are best distinguished by the shape, pattern, and colours of the shell, the form of the head, &c. There are 35 species, of which the most remarkable are:

Of land and fresh-water tortoises.

1. Testudo græca, common tortoise. The common or Greek tortoise is supposed to be a native of almost all the countries bordering on the Mediterranean sea; and is thought to be more frequent in Greece than in other regions. It is found in the scattered European islands of the Archipelago, and in Corsica and Sardinia. It occurs likewise in many parts of Africa. In Greece, according to Forskal, "it forms an article of food; and the inhabitants often swallow the blood recent, and eat the eggs boiled, which are about the size of those of a pigeon, four or five in number, and of a white colour. In September the animal hides itself under ground, and again emerges in February; laying its eggs in June, in a small hole, which it scratches in some sunny spot, out of which, after the first rains of September, the young are hatched, which are about the size of a walnut. The males of this species are said to fight often, butting at each other with such force as to be heard at a considerable distance."

The general length of the shell of this species is from six to eight inches, which latter measure it rarely exceeds: the weight of the full-grown animal is about forty-eight ounces. The shell is of an oval form, extremely convex on the upper part, and composed, as in most others, of thirteen middle pieces, and about twenty-five marginal ones. The head is rather small than large; the eyes small and black; the mouth not extending beyond the eyes; the upper part of the head covered with somewhat irregular, tough scales, and the neck with smaller granulations, so as to be flexible at the pleasure of the animal. The legs are short, and the feet moderately broad, covered with strong ovate scales, and commonly furnished with four moderately stout claws on each; but this is a circumstance which cannot be allowed to constitute a part of the specific character, since in different individuals, either from age, or other circumstances, these parts are found to vary in number, there being sometimes five claws instead of four on the fore feet. The tail is about the same length with the legs, or rather shorter, and is covered with small scales, and terminates in a naked horny pointed tip or process.

This animal lives to a most extraordinary age; several well attested examples being adduced of its having considerably exceeded the period of a century. One of the most remarkable instances is that of a tortoise introduced into the archiepiscopal garden at Lambeth, in the time of archbishop Laud, and as near as can be collected from its history, about the year 1633, which continued to live there till the year 1753, when it was supposed to have perished rather from accidental neglect on the part of the gardener, than from the mere effect of age. This tortoise has had the honour of being commemorated by Derham, and many other writers, and its shell is preserved in the library of the palace at Lambeth.

The general manners of the tortoise, in a state of domestication in this country, are very agreeably detailed by Mr. White, in his history of Selbourn. "A land-tortoise," says Mr. White, "which has been kept thirty years in a little walled court, retires under ground about the middle of November, and comes forth again about the middle of April. When it first appears in the spring, it discovers very little inclination for food, but in the height of summer grows voracious; and then, as the summer declines, its appetite declines; so that for the last weeks in autumn it hardly eats at all. Milky plants, such as lettuces, dandelions, sowthistles, &c. are its principal food. On the first of November, 1771, I remarked that the tortoise began to dig the ground, in order to form its hybernaculum, which it had fixed on just beside a great tuft of hepaticas. It scrapes out the ground with its fore feet, and throws it up over its back with its hind, but the motion of its legs is ridiculously slow, little exceeding the hour-hand of a clock. Nothing can be more assiduous than this creature, night and day, in scooping the earth, and forcing its great body into the cavity; but as the noons of that season proved unusually warm and sunny, it was continually interrupted, and called forth by the heat in the middle of the day; and though I continued there till the thirteenth of November, yet the work remained unfinished. Harsher weather, and frosty mornings, would have quickened its operations. No part of its behaviour ever struck me more than the extreme timidity it always expresses with regard to rain; for though it has a shell that would secure it against the wheel of a loaded cart, yet does it discover as much solicitude about rain as a lady dressed in all her best attire, shuffling away on the first sprinklings, and running its head up in a corner. If attended to, it becomes an excellent weather-glass; for as sure as it walks elate, and in a manner on tip-toe, feeding with great earnestness, in a morning, so sure will it rain before night. It is totally a diurnal animal, and never pretends to stir after it becomes dark.

"The tortoise," adds Mr. White, "like other reptiles, has an arbitrary stomach, as well as lungs, and can refrain from eating, as well as breathing, for a great part of the year. I was much taken with its sagacity, in discerning those that do it kind offices: for as soon as the good old lady comes in sight who has waited on it for more than thirty years, it hobbles towards its benefactress with awkward alacrity; but remains inattentive to strangers. Thus, not only "the ox knoweth his owner, and the ass his master's crib," but the most abject and torpid of beings distinguishes the hand that feeds it, and is touched with the feelings of gratitude. This creature not only goes under the earth from the middle of November to the middle of April, but sleeps great part of the summer: for it goes to bed in the longest days at four in the afternoon, and often does not stir in the morning till late. Besides, it retires to rest for every shower, and does not move at all in wet days. When one reflects on the state of this strange being, it is a matter of wonder Providence should bestow such a seeming waste of longevity on a reptile that appears to relish it so little as to squander away more than two-thirds of its existence in a joyless stupor, and be lost to all sensation for months together in the profoundest of all slumbers! Though he loves warm weather, he avoids the hot sun; because his thick shell, when once heated, would, as the poet says of solid armour, 'scald with safety.' He therefore spends the more sultry hours under the umbrella of a large cabbage-leaf, or amidst the waving forests of an asparagus-bed. But as he avoids heat in the summer, so in the decline of the year, he improves the faint autumnal beams, by getting within the reflection of a fruit-tree wall; and though he has never read that planes inclining to the horizon receive a greater share of warmth, he inclines his shell by tilting it against the wall, to collect and admit every feeble ray."

2. Testudo marginata, marginated tortoise. The general colour of this animal is a dark or blackish bay; the middle or convex part of the pieces composing the disk, being more or less dashed or varied, in an irregular manner, with yellow: the marginal pieces are also variegated with the same colour, which predominates chiefly on the hindermost or widest divisions, which are pretty distinctly striated or furrowed, and from their peculiar width or dilatation form the chief part of the specific character. The under shell is of a pale yellow colour, each division being marked on its upper commissure by a transverse blackish band, running into a pair of pointed or subtriangular processes, extending nearly to the next or inferior division. The outline of the shell, if viewed from above, will be found to be much longer in proportion than that of the testudo græca, accompanied by a slight contraction or sinking in on each side.

The true native country of the animal seems not very distinctly known. Mr. Schoepf is inclined to think it an American species.

3. Testudo Indica, Indian tortoise. This very large terrestrial species, which is omitted by Linnæus in the twelfth edition of the Systema Naturæ, was first described by Perrault in the History of Animals published by the Royal Academy of France. The specimen was taken on the coast of Coromandel, and measured four feet and a half from the tip of the nose to the tail; and its height or convexity was fourteen inches: the shell itself was three feet long and two broad, and, like every other part of the animal, was of a dull-brown colour: the shield consisted of a large and dissimilar piece, and the edge on the fore part was rather reflected, for the easier motion of the animal's head: the head was seven inches long; the mandibles serrated, and furnished with an additional internal row of denticulations: the fore legs were nine inches long: the fore feet undivided, thick, and armed with five blunt claws: the hind legs were eleven inches long; the feet tetradactylous, and armed with four claws: the tail six inches thick at the base, fourteen inches long, and terminated by a horny curved process.

4. Testudo lutaria, mud-tortoise. This, which is supposed by the count de Cepede to be the testudo lutaria of Linnæus, is said to be extremely common in many parts of Europe, as well as Asia, being found in India, Japan, &c. It is, in general, not more than seven or eight inches long from the tip of the nose to that of the tail, and about three or four inches in breadth: the disk consists of thirteen pieces, which are striated and slightly punctuated in the centre, and along the middle range runs a longitudinal carina: the margin consists of twenty-three pieces, bordered with slight striæ: the colour of the shell is blackish, more or less deep in different specimens, and the general colour of the skin itself is similar: the feet are webbed, and there are five toes before, and four behind. Like other tortoises, it sometimes utters a kind of broken or interrupted hiss. This animal is, according to Cepede, no where more common than in France, and is particularly plentiful in Languedoc, and in many parts of Provence; and in a lake of about half a league wide, situated in the plain of Durance, were found such vast quantities, that the neighbouring peasantry were in a manner supported by them for more than three months together.

Though this species is aquatic, it always lays its eggs on land; digging for that purpose a hollow in the ground, and covering the eggs with the mould: the shell is less soft than those of the sea-tortoises or turtles, and the colour less uniform. When the young are first hatched they measure about six lines in diameter. This animal walks much quicker than the land-tortoise, especially when on even ground. It grows for a long time, and has been known to live more than twenty-four years. The taste which it has for small snails, and such kind of wingless insects as frequent the neighbourhood of the waters it inhabits, makes it useful in a garden, which it delivers from noxious animals, without doing any mischief itself. Like other tortoises, it may be rendered domestic, and may be kept in a bason or receptacle of water, so contrived on the edges as to give a ready egress to it when it wishes to wander about for prey. The count de Cepede adds, that though useful in gardens, it is found to be a very troublesome inmate in fish-ponds; attacking and destroying the fish: biting them in such a manner that they become enfeebled by loss of blood, and then dragging them to the bottom and devouring them; leaving only the bones and some of the cartilaginous parts of the head, and sometimes the air-bladder also, which floating on the surface, give notice of the en mies with which the pond is infested.

5. Testudo picta, painted tortoise. The remarkable colours of the shield of this species are sufficient to distinguish it from all others: the shell is of a smooth surface, of a flattened or but slightly convex form, and of a chesnut-brown colour, paler or darker in different individuals, and consisting, as usual, of thirteen segments, each of which is of a form approaching to square, and pretty deeply edged or bordered with pale yellow: a stripe of the same colour also runs down the middle of the dorsal segments, while the marginal pieces, which are twenty-five in number, are each marked by a semi-oval spot of the same colour at the edge, surrounded by two, or sometimes by three yellow bands, following the direction of the first-mentioned spot, and thus forming so many semi-elliptic yellow zones or stripes on each piece. The neatness and accuracy of these, as well as of the yellow borders on the large or middle segments of the shell, vary, as may be supposed, on different individuals, and in general seem most distinctly expressed on the smallest specimens. This may be considered as one of the middle-sized tortoises: the shell measuring from four to six inches in length, or somewhat more: the head is moderately small, and covered with a smooth skin; blackish above, but yellow on the sides and under part, and very elegantly streaked in a longitudinal direction, with several double rows of black streaks: the legs are blackish, and marked with two longitudinal yellow stripes: the claws are sharp and long, those on the fore feet five in number, and those on the hind feet four. The tail is blackish, scaly, moderately sharp-pointed, and marked on each side with yellow streaks. It is a fresh-water species, and inhabits slow and deep rivers in North America. In clear sunny weather these animals are said to assemble in multitudes, sitting on the fallen trunks of trees, stones, &c. and immediately plunging into the water on the least disturbance. They are said to swim very swiftly, but to walk slowly; to be able to continue many hours entirely beneath the water, but not to survive many days if kept out of their favourite element. They are very voracious, destroying ducklings, &c. which they seize by the feet, and drag under water. They are sometimes used as a food. The colour, as has been above observed, varies; being sometimes of a blackish brown, at other times of a reddish chesnut: the yellow markings are also either pale or deep in different individuals, and sometimes whitish: the inferior or under edges of the upper shell, as well as the upper edges or commissures of the lower, are elegantly streaked with black, as if artificially painted, and this variegation is continued over the skin of the sides of the body.

6. Testudo elegans, elegant tortoise. The animal described and figured by Seba, under the title of testudo terrestris ceilonica elegans minor, is a small land tortoise, with the shell nearly circular in its outline, and about two inches in length: its colour is a bright yellow, its surface apparently smooth, and at each of the commissures or joinings of the pieces composing the disk is a large oval, or rather leaf-shaped, black or dark-brown transverse spot; the pattern forming three rows of transverse spots down the disk; and at the upper junctures, or those where the ultimate pieces of the disk join those of the margin, is a broad spot of a more fasciated form: there are also two rather irregular or slightly flexuous black lists running down the shell, between the rows of spots: the marginal pieces are each marked by a transverse black belt or zone, thus forming a spotted edge round the whole: the head appears to be short and thick, and covered with small scales: the feet short, strong, scaly, and unwebbed, as in other land-tortoises, and furnished with five claws on each: the tail very short. Nothing particular seems to be known of its history.

7. Testudo tricarinata, tricarinated tortoise. This agrees as to shape and other particulars with Linnæus's description of his T. orbicularis. Its size scarce exceeds that of a large walnut; its colour is blackish; the shell consisting of thirteen scutella, each row marked on the middle by a longitudinal carina, and wrinkled with several lateral furrows and roughish points; the marginal pieces are twenty-three in number; the head is large, and of a brown colour, variegated on the sides with white: the legs short, strong, and covered with a scaly skin: on the fore feet are five distinct toes, connected to the very tips by a web, and terminated by so many sharp, crooked claws: the hind feet have only four toes, with sharp claws, and connected also by a web, with the appearance of a small unarmed fifth or spurious toe: the tail is short, conical, scaly, pointed, and but little exceeding the margin of the shell in length: the under shell is yellowish, spotted, and varied with brown. See Plate Nat. Hist. fig. 398.

8. Testudo scabra, rough tortoise. The shell of the species quoted by Linnæus in his description of T. scabra is figured in its natural size in the work of Seba, who affirms that it never grows larger than represented in his figure; measuring about two inches and a half in length, and near two inches in breadth; being of a cordated figure, or somewhat pointed at the bottom. Its colour, according to Seba, is light reddish, prettily variegated on the head and shell with white lines and spots, in a kind of flamy or wavy pattern: the feet are marked with red specks, and have each five toes with sharp claws: the head is very prominent, and the eyes small: down the back of the disk are represented in Seba's engraving three very conspicuous white lines or carinæ; so that the title of tricarinata would apply to this, as well as to the species so denominated by Mr. Schoepf.

9. Testudo ferox, fierce tortoise. This remarkable species is distinguished by the unusual nature of its shield, which is hard or osseous on the middle part only, while the edges gradually degenerate into a flexile coriaceous verge: this shield is obscurely marked with five or six transvere bands, and granulated with small warts or prominences, which gradually enlarge as they approach the leathery or flexible edge: the head is rather small, and of an unusual shape, being somewhat trigonal, with the snout very much lengthened, and the upper part drawn out into a subcylindric form, terminated by the nostrils, and projecting much beyond the lower mandible: the neck, when retracted, appears very thick, and surrounded by many wreaths or folds of skin; but when exerted, is of very great length, so as nearly to equal that of the whole shell: the legs are short, thick, and covered with a wreathed skin: the feet are all furnished with strong and broad webs, connecting the three last toes of each; the three first on each foot are furnished with pretty strong claws, but the remaining ones are unarmed; and besides the real or proper toes, there are two spurious or additional ones on the hind, and one on the fore feet, serving to strengthen and expand the web to a greater degree: the tail is short, pointed, and curving inwards: the eyes are very small and round. The colour of this animal on the upper parts is a deep-brownish olive, and on the under parts white; the shell being marked beneath in a very elegant manner, with ramifications of vessels disposed upon it.

This species is found in Pennsylvania, Carolina, &c. &c. and, contrary to the nature of most others of the tr e, is possessed of very considerable vigour and swiftness of motion, springing forwards towards its assailant, when disturbed or attacked, with great fierceness and alacrity. Its length is about a foot and half, or more, and its breadth about fifteen inches. It was first described by Dr. Garden, who communicated it to Mr. Pennant, by whom it was introduced into the Philosophical Transactions. A specimen examined by Dr. Garden weighed twenty-five pounds, but it is said to grow so large as to seventy pounds. The individual mentioned by Dr. Garden laid fifteen eggs during the time it was kept, which were exactly spherical, more than an inch in diameter, and fifteen more were found on dissection. Its flesh is said to be extremely delicate, being equal, if not superior, even to that of the green turtle.

The great soft-billed turtle, described by Mr. Bartram in his Travels, appears to be the same with this. It is said by Mr. Bartram to be of a flat form, two feet and a half long, and a foot and a half broad: the shield soft and cartilaginous on each side, and this part sometimes becomes gelatinous on boiling: the fore and hind part of the shield is beset with round horny warts or tubercles: the sternum or under shell semicartilaginous, except on the middle, where it is bony: the head large and clubbed, and of an oval form: the nose extended, truncated in the manner of a hog's snout: the eyes large, and seated at its base: mouth wide; the edges tumid and wrinkled, and bearded by several long pointed warts or processes, which are extensile at the pleasure of the animal, and give it an ugly and forbidding aspect. Mr. Bartram's figure also represents the throat and part of the neck as furnished with similar warts. Mr. Bartram adds, that it is fond of the muddy parts of rivers, &c. hiding itself among the roots and leaves of water-plants, and thence springing on its prey, stretching out its neck to an incredible length, and seizing with wonderful celerity young birds, &c. &c. It is found in all the rivers, lakes, and pools, of East Florida, weighing from thirty to forty pounds. The warts or processes on each side the neck may constitute perhaps a sexual difference in this species, since they are not to be found in that described by Dr. Garden and Mr. Pennant. See Plate Nat. Hist. fig. 396.

10. Testudo serpentina, snake tortoise. This species, first described by Linnæus, appears to have been very obscurely known;

having been figured in no work of natural history till it was introduced into Mr. Schoepf's publication. It is a native of North America, where it inhabits stagnant waters, growing to the weight of fifteen or twenty pounds, and even more, and preying on fish, ducklings, &c. &c. seizing its prey with great force, stretching out its neck and hissing at the same time. Whatever it seizes in its mouth it holds with great force, and will suffer itself to be raised up by a stick rather than quit its hold. The head is large, depressed, triangular, and covered with a scaly and warty skin: the orbits of the eyes are oblique; the mouth wide; the mandibles sharp; the neck covered by scaly warts, and appearing short and thick when the animal is at rest, but when in the act of springing on its prey, is stretched out to a third part of the length of the shell: the toes of all the feet are distinct, but connected by a web; and are five in number on the fore feet, and four on the hind; all armed with claws longer than the toes themselves: the tail is straight, and about two-thirds the length of the shell; it is compressed, attenuated, and crested on the upper part with sharp bony scales directed backwards and gradually decreasing to the tip, while the sides and under part are covered with smaller scales: the under part of the body is covered by a loose, wrinkled skin, beset with smallish soft scales and granules: the shell is slightly depressed, of an oval form, and consists of thirteen pieces in the disk, each of which rises behind into a kind of projection or obtuse point, and is pretty strongly radiated and furrowed in different directions; the general colour of the whole is a dull chesnut-brown, lighter or paler beneath.

This animal conceals itself in muddy waters in such a manner as to leave out only a part of its back, like a stone or other inanimate object, by which means it the more easily obtains its prey. Mr. Pennant, in the supplement to his Arctic Zoology, mentions this as a new species, under the name of serrated tortoise. In New York it is known by the title of the snapping tortoise. Linnæus seems to have been mistaken in supposing it a native of China.

Sea-tortoises, or turtles.

The marine tortoises, or turtles as they are commonly called, are distinguished from those of the preceding division by their very large and long fin-shaped feet, in which are inclosed the bones of the toes; the first and second alone on each foot being furnished with visible or projecting claws, the others not appearing beyond the edge. The shield, as in the land-tortoises, consists of a strong bony covering, in which are imbedded the ribs, and which is coated externally by hard horny plates, in one or two species much thicker or stronger than those of the land-tortoises.

1. Testudo coriacea, coriaceous turtle. Of all the marine tortoises this appears to grow to the largest size, having been sometimes seen of the length of eight feet, and of the weight of a thousand pounds. It differs from the rest of its tribe in the form of its body, which is longer in proportion, and still more in its external covering, which, instead of being of a horny nature, as in others, is of a substance resembling strong leather, marked over the whole surface into small, obscurely subhexagonal and pentagonal subdivisions or lineations, which do not take away from the general smoothness of the surface. Along the whole length of this covering or leathery shield run five distinct, strongly prominent, tuberculated ribs or ridges; and indeed if those which border the sides are taken into the account, we may say there are seven ridges on the shield. There is no under or thoracic shell, so that the animal might form a distinct genus from the rest of the tortoise tribe. The head is large, and the upper mandible notched at the tip in such a manner as to give the appearance of two large teeth or processes, between which, when the mouth is closed, is received the tip of the lower mandible. The fins or legs are large and long, and covered with a tough leathery skin: the tail is rather short and sharp-pointed. The general colour of the whole animal is dusky brown, paler beneath. This singular species is a native of the Mediterranean sea, and has at different periods been taken on the coasts both of France and England. In the month of August, in the year 1729, a specimen was taken about three leagues from Nantz, not far from the mouth of the river Loire, and which measured seven feet one inch in length, three feet seven inches in breadth, and two feet in thickness. It is said to have uttered a hideous noise when taken, so that it might be heard to the distance of a quarter of a league; its mouth at the same time foaming with rage, and exhaling a noisome vapour. In the year 1778, a specimen was taken on the coast of Languedoc, which measured seven feet five inches in length. In July, 1756, one was taken on the coast of Cornwall, which, according to Dr. Borlace, "measured six feet nine inches from the tip of the nose to the end of the shell; ten feet four inches from the extremities of the fore fins extended; and was adjudged to weigh eight hundred pounds weight." The fine specimen lately in the Leverian Museum was of similar weight, and was taken on the coast of Dorsetshire.

This species is found not only in the European seas, but in those of South America also, and occasionally appears about some of the African coasts.

According to Cepede, the coriaceous tortoise is one of those with which the Greeks were well acquainted, and he supposes it to have been the species particularly used in the construction of the antient lyre or harp, which was at first composed by attaching the strings or wires to the shell of some marine tortoise. We may add, that the ribs or prominences on the back of the shell bear an obscure resemblance to the strings of a harp, and may have suggested the name of luth or lyre, by which it is called among the French, exclusive of the use to which the shell was antiently applied.

The coriaceous tortoise, says Mr. Pennant, is reputed to be extremely fat, but the flesh coarse and bad: the Carthusians, however, will eat no other species.

It may be added, that the small sea-tortoise described by Mr. Pennant, in the Philosophical Transactions for the year 1771, is evidently no other than the young of this animal. See Plate Nat. Hist. fig. 395.

2. Testudo mydas. The green turtle, so named, not on account of its being externally of that colour, but from the green tinge which its fat frequently exhibits when the animal is taken in its highest state of perfection, may be considered as one of the largest of this genus, often measuring above five feet in length, and weighing more than five or six hundred pounds. Its shell is of a somewhat heart-shaped form, or pointed at the extremity, and consists of thirteen dorsal segments or divisions surrounded by twenty-five marginal pieces. Its colour is a dull palish-brown, more or less variegated with deeper undulations, but not exhibiting those strong and beautiful colours which so peculiarly distiguish that of the T. imbricata, or hawk's-bill turtle, which affords the tortoise-shell used for ornamental purposes and in various manufactures, having neither sufficient strength nor beauty; but so much is the flesh esteemed, that the inhabitants of the West Indian islands have long considered it as one of the most excellent articles of food, and have gradually succeeded in introducing a similar taste among some of the European nations. In our own country in particular it is in the highest estimation, and is regularly imported in considerable quantities to supply the luxury of the metropolis. The introduction of the green turtle as an article of luxury into England is of no very distant date, and perhaps can hardly be traced much farther than about fifty or sixty years backward. In reality, so little was the nature of the sea-tortoises understood by the Europeans before that period, that the different kinds were in general confounded by navigators, whose accounts relative to their character as a food varied according to the species which they happened to take for that purpose; some insisting that the turtle was a coarse and unpalatable diet, while others considered it as of the highest degree of excellence.

"Of the sea-turtles," says Catesby, "the most in request is the green turtle, which is esteemed a most wholesome and delicious food. It receives its name from the fat, which is of a green colour. Sir Hans Sloane informs us, in his History of Jamaica, that forty sloops are employed by the inhabitants of Port Royal, in Jamaica, for the catching them. The markets are there supplied with turtle as ours are with butcher's meat. The Bahamians carry many of them to Carolina, where they turn to good account; not because that plentiful country wants provisions, but they are esteemed there as a rarity, and for the delicacy of their flesh. They feed on a kind of grass, growing at the bottom of the sea, commonly called turtle-grass. The inhabitants of the Bahama islands, by often practice, are very expert at catching turtles, particularly the green turle. In April they go, in little boats, to Cuba and other neighbouring islands, where, in the evening, especially in moonlight nights, they watch the going and returning of the turtle to and from their nests, at which time they turn them on their backs, where they leave them, and proceed on, turning all they meet; for they cannot get on their feet again when once turned. Some are so large that it requires three men to turn one of them. The way by which the turtle are most commonly taken at the Bahama islands is by striking them with a small iron peg of two inches long, put in a socket, at the end of a staff of twelve feet long. Two men usually set out for this work in a little light boat or canoe, one to row gently and steer the boat, while the other stands at the head with his striker. The turtle are sometimes discovered by their swimming with their head and back out of the water, but they are often discovered lying at the bottom, a fathom or more deep. If a turtle perceives he is discovered, he starts up to make his escape: the men in the boat pursuing him, endeavour to keep sight of him, which they often lose, and recover again by the turtle putting his nose out of the water to breathe: thus they pursue him, one padding or rowing, while the other stands ready with his striker. It is sometimes half an hour before he is tired: then he sinks at once to the bottom, which gives them an opportunity of striking him; which is by piercing him with an iron peg, which slips out of the socket, but is fastened with a string to the pole. If he is spent and tired by being long pursued, he tamely submits, when struck, to be taken into the boat or hauled ashore. There are men who by diving will get on their backs, and by pressing down their hind parts, and raising the fore-part of them by force, bring them to the top of the water, while another slips a noose about their necks."

Though the green turtle is a native of the West Indian seas, yet it is sometimes driven by storms out of its usual residence, and instances have occurred in which it has been taken on the coasts of Europe. An occurrence of this kind is said by the count de Cepede to have happened in France, a turtle having been taken at Dieppe in the year 1752, which weighed between eight and nine hundred pounds, and was almost six feet in length, and four wide. It may, however, be doubted whether this animal was not rather a caretta or loggerhead, than a green turtle. Another, of still larger size, is also said to have been taken on the coast of France, about two years afterwards.

"The sea-tortoises, or turtles in general," says Catesby, "never go on shore but to lay their eggs, which they do in April: they then crawl up from the sea above the flowing of high water, and dig a hole above two feet deep in the sand, into which they drop in one night above a hundred eggs, at which time they are so intent upon nature's work, that they regard none that approach them; but will drop their eggs into a hat, if held under them; but if they are disturbed before they begin to lay, they will forsake the place, and seek another. They lay their eggs at three, and sometimes at four different times; there being fourteen days between every time; so that they hatch and creep from their holes into the sea at different times also. When they have laid their complement of eggs, they fill the hole with sand, and leave them to be hatched by the heat of the sun, which is usually performed in about three weeks." It may be proper to add, that the eggs are about the size of tennis-balls, round, white, and covered with a smooth parchment-like skin. See Plate Nat. Hist. fig. 399.

3. Testudo caretta, loggerhead turtle. This species exceeds in size every other yet known, except perhaps the coriacea. In its general appearance it most resembles the mydas or green turtle, but is distinguished by the superior size of the head, the proportional breadth of the shell, and by its deeper and more variegated colours, resembling those of the T. imbricata, or hawk's-bill; but its principal mark of distinction consists in the number of dorsal segments or scutella of the shell, which instead of thirteen, as in other species, amount to fifteen; the lateral as well as the middle range containing five pieces, of which the two superior are considerably smaller than the rest. The fore feet are very large and long; the hind feet much shorter, though broad. This animal inhabits the same seas with the green turtle, but is also diffused into very remote latitudes, being often found in the Mediterranean, and in particular about the coasts of Italy and Sicily. Considered in a commercial view, it is of little or no value; the flesh being coarse and rank, and the laminæ or plates of the shell too thin for general use. It is said, however, to afford a good quantity of oil, which may be used for lamps, &c. The loggerhead turtle is a very strong and fierce animal, and is even dangerous; defending itself with great vigour with its legs, and being able to break the strongest shells and other substances with its mouth. Aldrovandus assures us, that on offering a thick walking-stick to one which he saw publicly exhibited at Bologna, the animal bit it in two in an instant.

"The loggerhead turtles," says Catesby, "are the boldest and most voracious of all turtles; their flesh is rank, and therefore little sought for, which occasions them to be more numerous than any other kind. They range the ocean over, an instance of which, among many others that I have known, happened on the 20th of April, 1725, in lat. 30 degrees north; when our boat was hoisted out, and a loggerhead turtle struck as it was sleeping on the surface of the water: this by our reckoning, appeared to be the midway between the Azores and the Bahama islands; either of which places being the nearest land it could come from, or that they are known to frequent; there being none on the north continent of America, farther north than Florida. It being amphibious, and yet at so great a distance from land in the breeding-time, makes it the more remarkable. They feed mostly on shell-fish, the great strength of their beaks enabling them to break very large shells, as the large buccinums and trochi."

4. Testudo imbricata, the hawk's-bill turtle. The testudo imbricata is so named from the peculiar disposition of its scales or laminæ, which commonly lap over each other at their extremities in the manner of tiles on the roof of a building. The outline of the shell, viewed from above, is more heart-shaped than in other sea-tortoises, and terminates more acutely: each of the middle row of scales on the back is also of a sharpened form at the tip, more especially in the young or half-grown animal, and has a ridge or carina down the middle: the head is smaller in proportion than in other turtles; the neck longer; and the beak narrower, sharper, and more curved, so as to bear no inconsiderable resemblance to the bill of a hawk, from which circumstance the animal derives its common or popular name of the hawk's-bill turtle. The fore legs are longer than in the rest of the tribe, and it is said that when turned or laid on its back, the animal is enabled by their assistance, to reach the ground in such a manner as to recover its former situation, which no other turtle can do. In old specimens the neatness of the shell, and the well-defined outline of the scales, are occasionally impaired, and this seems to be one principal reason of its having been sometimes confounded with the caretta, or loggerhead turtle. The hawk's-bill turtle is a native of the Asiatic and American seas, and is sometimes, though less frequently, found in the Mediterranean. Its general length seems to be about three feet, from the tip of the bill to the end of the shell; but it has been known to measure five feet in length, and to weigh five or six hundred pounds. In the Indian ocean in particular, specimens are said to have occurred of prodigious magnitude.

The shell of this animal was anciently used for a shield, and still serves for that purpose among barbarous nations. The flesh is in no estimation as a food; the lamellæ or plates of the shell, which are far stronger, thicker, and clearer than in any other kind, constituting the sole value of the animal, and affording the substance particularly known by the name of tortoise-shell: they are semitransparent, and most elegantly variegated with whitish, yellowish, reddish, and dark-brown clouds and undulations, so as to constitute, when properly prepared and polished, one of the most elegant articles for ornamental purposes. See Tortoise-shell.

The natural or general number of the dorsal pieces is thirteen; the marginal row consisting of twenty-five smaller pieces. This external coating is raised or separated from the bony part, which it covers, by placing fire beneath the shell; the heat soon causing the plates to start, so as to be easily detached from the bone. These plates vary in thickness, according to the age and size of the animal, and measure from an eighth to a quarter of an inch in thickness. A large turtle is said to afford about eight pounds of tortoise-shell.

In order to bring tortoise-shell into the particular form required on the part of the artist, it is steeped in boiling water, till it has acquired a proper degree of softness, and immediately afterwards committed to the pressure of a strong metallic mould of the figure required; and where it is necessary that pieces should be joined, so as to compose a surface of considerable extent, the edges of the respective pieces are first scraped or thinned, and being laid over each other during their heated state, are committed to a strong press, by which means they are effectually joined or agglutinated. These are the methods also by which the various ornaments of gold, silver, &c. are occasionally affixed to the tortoise-shell.

The Greeks and Romans appear to have been peculiarly partial to this elegant ornamental article, with which it was customary to decorate the doors and pillars of their houses, their beds, &c. &c. In the reign of Augustus this species of luxury seems to have been at its height in Rome.

"The Egyptians," says Mr. Bruce, in the supplement to his Travels, "dealt very largely with the Romans in this elegant article of commerce. Pliny tells us the cutting them for fineering or inlaying was first practised by Carvilius Pollio, from which we should presume, that the Romans were ignorant of the art of separating the laminæ by fire placed in the inside of the shell, when the meat is taken out: for these scales, though they appear perfectly distinct and separate, do yet adhere, and oftener break than split, where the mark of separation may be seen distinctly. Martial says that beds were inlaid with it. Juvenal, and Apuleius in his tenth book, mention that the Indian bed was all over shining with tortoise-shell on the outside, and swelling with stuffing of down within. The immense use made of it in Rome may be guessed at by what we learn from Velleius Paterculus, who says, that when Alexandria was taken by Julius Cæsar, the magazines or warehouses were so full of this article, that he proposed to have made it the principal ornament of his triumph, as he did ivory afterwards, when triumphing for having happily finished the African war. This too, in more modern times, was a great article in the trade to China."

It may be doubted however, whether the species described and figured by Mr. Bruce, and said to inhabit the Red Sea, is the real T. imbricata; since it appears to differ in some respects from the usual character of this animal, and particularly in not having imbricated scales.

Testudo, in the military art of the antients, was a kind of cover or screen which the soldiers, *e. gr.* a whole company, made themselves of their bucklers, by holding them up over their heads, and standing close to each other. This expedient served to shelter them from darts, stones, &c. thrown upon them, especially those thrown from above, when they went to the assault.

Testudo was also a kind of large wooden tower which moved on several wheels, and was covered with bullocks'-hides, serving to shelter the soldiers when they approached the walls to mine them, or to batter them with rams.

TETHYS, a genus of insects belonging to the class of vermes, and order of mollusca. The body is oblong, fleshy, and without feet; the mouth consists of a cylindrical proboscis under the duplicature of a lip; and there are two foramina at the left side of the neck. The species are two, both inhabitants of the ocean.

TETRACERA, a genus of plants of the class polyandria, and order tetragynia, and in the natural system ranging under the doubtful. The calyx is hexaphyllous, and the capsules four. There are 12 species, shrubs of South America.

TETRACHORD, in music, (from the Greek,) a concord in the music of the antients consisting of three degrees, or intervals, and four terms, or sounds; called by the Greeks also diatessaron, and by us a fourth. In this system the extremes were fixed, but the middle sounds were varied according to the mode.

In the antient music, all the primitive or chief divisions were confined to four chords, so that the great scale consisted of replicates, and all the upper tetrachords were considered only as repetitions of the first or lowest.

TETRADIAPASON, the Greek appellation of the quadruple octave, which we also call the 29th. The system of the antients not extending to this interval, they only knew it in imagination, or by name.

TETRADYNAMIA (τεσσαρες, four, and δυναμις, power), four powers; the name of the 15th class in Linnæus's sexual system. See Botany.

TETRAEDRON, or Tetrahedron, in geometry, is one of the five Platonic or regular bodies or solids, comprehended under four equilateral and equal triangles. Or it is a triangular pyramid of four equal and equilateral faces.

It is demonstrated in geometry, that the side of a tetraedron is to the diameter of its circumscribing sphere, as $\sqrt{2}$ to $\sqrt{3}$; consequently they are incommensurable.

If a denotes the linear edge or side of a tetraedron, b its whole superficies, c its solidity, r the radius of its inscribed sphere, and R the radius of its circumscribing sphere; then the general relation among all these is expressed by the following equations, viz.

$$a = 2r\sqrt{6} = \tfrac{2}{3}R\tfrac{1}{3}\sqrt{6} = \sqrt{\tfrac{1}{3}b\sqrt{3}} = \sqrt[3]{6c\sqrt{2}}.$$

$$b = 24r^2\sqrt{3} = \tfrac{8}{3}R^2\sqrt{3} = a^2\sqrt{3} = 6\sqrt[3]{c^2\sqrt{3}}.$$

$$c = 8r^3\sqrt{3} = \tfrac{8}{27}R^3\sqrt{3} = \tfrac{1}{12}a^3\sqrt{2} = b\sqrt{2b\sqrt{3}}.$$

$$R = 3r = \tfrac{1}{4}a\sqrt{6} = \tfrac{1}{4}\sqrt{2b\sqrt{3}} = \tfrac{3}{2}\sqrt[3]{\tfrac{1}{3}c\sqrt{3}}.$$

$$r = \tfrac{1}{3}R = \tfrac{1}{12}a\sqrt{6} = \tfrac{1}{32}\sqrt{2b\sqrt{3}} = \tfrac{1}{2}\sqrt[3]{\tfrac{1}{3}c\sqrt{3}}.$$

TETRAGONIA, a genus of plants of the class of icosandria, and order monogynia; and in the natural system ranging under the 13th order, succulentæ. The calyx is divided into three, four, or five parts. There is no corolla; the drupe is beneath, and the nut three or eight-celled. There are eight species; the puticosa, decumbens, herbacea, echinata, expansa, crystallina, hirsuta, and spicata, chiefly natives of the Cape.

TETRAGYNIA (τεσσαρες, four, and γυνη, a woman), the name of an order, or secondary division, in the 4th, 5th, 6th, 8th, and 13th classes in the sexual system. See Botany.

TETRALOMA, a genus of insects of the coleoptera order. The generic character is, antennæ clavate, the club perfoliate, less rounded, entire; feelers thickish, unequal; shells as long as the abdomen. There are two species of this insect, viz. the T. fungorum, and the T. ancora.

TETRANDRIA (τεσσαρες, four, and ανηρ, a man or husband), the name of the fourth class in Linnæus's sexual system. See Botany.

TETRANTHUS, a genus of the syngenesia polygamia segregata class and order of plants. The calyx is common, four-flowered; perianthium proper, one-leafed; seeds crowned. There is one species, an annual of Hispaniola.

TETRAO, in ornithology, a genus of birds belonging to the order of gallinæ, and thus characterised by Linnæus: there is a spot near the eyes naked or papillose, or covered, though more rarely, with feathers. Gmelin has enumerated about 66 species. The genus tetrao comprehends both the grouse, partridge, and quail; but Dr. Latham, with great judgment and propriety, has made two genera of them, under the names of tetrao, comprehending the grouse; and perdix, comprehending the partridge and quail. Dr. Latham thus distinguishes the genus tetrao: the bill is like a crooked cone, with a naked scarlet skin above each eye, and the feet feathered to the toes. The perdix he characterizes by a bill convex, strong, and short; the nostrils are covered above with a callous prominent rim; the orbits are papillose; the feet naked, and most of the species are furnished with spurs. He reckons twenty species under the tetrao, and forty-eight under the perdix.

I. Tetrao. Of this genus the following species are found in Britain: 1. The urogallus, or cock of the wood, inhabits woody and mountainous countries; in particular, forests of pines, birch-trees, and junipers; feeding on the tops of the former, and berries of the latter; the first often infects the flesh with such a taste as to render it scarcely eatable. In the spring it calls the females to its haunts with a loud and shrill voice; and is at that time so very inattentive to its safety, as to be very easily shot. It stands perched on a tree, and descends to the females on their first appearance. They lay from eight to sixteen eggs; eight at the first, and more as they advance in age.

This bird is common to Scandinavia, Germany, France, and several parts of the Alps. It is found in no other part of Great Britain than the Highlands of Scotland, north of Inverness; and is very rare even in those parts.

The length of the male is two feet nine inches; its weight sometimes fourteen pounds. The female is much less, the length being only twenty-six inches. The sexes differ also greatly in colours. The bill of the male is of a pale yellow; the head, neck, and back, are elegantly marked, slender lines of grey and black running transversely. The upper part of the breast is of a rich glossy green; the rest of the breast and belly black, mixed with some white feathers; the sides are marked like the neck; the coverts of the wings crossed with undulated lines of black and reddish brown; the exterior webs of the greater quill-feathers are black: the tail consists of eighteen feathers, the middle of which is the longest; these are black, marked on each side with a few white spots. The legs are very strong, and covered with brown feathers; the edges of the toes are pectinated. Of the female, the bill is dusky; the throat red; the head, neck, and back, are marked with transverse bars of red and black: the breast has some white spots on it, and the lower part is of a plain orange-colour; the belly is barred with pale-orange and black; the tips of the feathers are white. The tail is of a deep rust-colour, barred with black, tipped with white, and consists of sixteen feathers.

2. The tetrix, black grouse, or black-cock, like the former species, is fond of woody and mountainous situations; feeding on the vaccinum, and other mountain-fruits, and in the winter on the tops of the heath. In the summer they frequently descend from the hills to feed on corn. They never pair: but in the spring the male gets upon some eminence, crows and claps his wings; on which signal all the females within hearing resort to him. The hen lays seldom more than six or seven eggs. When the female is obliged, during the time of incubation, to leave her eggs in quest of food, she covers them up so artfully with moss or dry leaves, that it is very difficult to discover them. On this occasion she is extremely tame and tranquil, however wild and timorous at other times. She often keeps

her nest though strangers attempt to drag
r away. As soon as the young ones are
tched, they are seen running with extreme
ility after the mother, though sometimes
ey are not entirely disengaged from the
ell. The hen leads them forwards for the
st time into the woods, to show them ants'
gs and the wild mountain-berries, which,
hile young, are their only food. As they
ow older their appetites grow stronger, and
ey then feed upon the tops of heath and
e cones of the pine-tree. In this manner
ey soon come to perfection; they are hardy
rds, their food lies every where before
em, and it would seem that they should in-
ease in great abundance. But this is not
e case; their numbers are thinned by rapa-
ous birds and beasts of every kind, and still
ore by their own salacious contests. As
on as the hatching is over, which the female
erforms in the manner of a hen, the whole
ood follows the mother for about a month
two; at the end of which the young males
tirely forsake her, and keep in great harmo-
y together till the beginning of spring. At
is season they begin to consider each other
rivals. They fight like game-cocks; and
that time are so inattentive to their own
fety, that it often happens that two or three
them are killed at a shot.

An old black cock is in length twenty-two
ches, and weighs near four pounds. The
ll is dusky; and the plumage of the whole
dy black, glossed over the neck and rump
ith a shining blue. The coverts of the
ings are of a dusky brown; the inner co-
erts white; the thighs and legs are covered
ith dark-brown feathers; the toes resemble
ose of the former species. The female
eighs only two pounds, and its length is one
ot six inches. The head and neck are
arked with alternate bars of dull red and
ack; the breast with dusky black and white;
t the last predominates. The back, co-
erts of the wings, and tail, are of the same
lours as the neck, but the red is deeper.
he tail is slightly forked. The feathers un-
r the tail are white, marked with a few bars
black and orange. This bird hatches its
ung late in the summer. It lays from six
eight eggs, of a dull yellowish-white co-
ur, marked with numbers of very small fer-
ginous specks; and towards the smaller
d with some blotches of the same hue. See
late Nat. Hist. fig. 400.

3. The scoticus, red game, or moor-fowl,
peculiar to the British islands. The male
eighs abont nineteen ounces; and is in
ngth $15\frac{1}{2}$ inches. The plumage on the head
d neck is of a light tawny red; each fea-
er is marked with several transverse bars of
ack. The back and scapular feathers are
a deeper red; and on the middle of each
ather is a large black spot; the breast and
lly are of a dull purplish brown, crossed
th numerous narrow dusky lines; the legs
d feet are clothed to the very claws with
ick soft white feathers. The claws are
itish, very broad and strong. The female
eighs only fifteen ounces. The colours in
neral are duller than those of the male.
hese birds pair in the spring, and lay from
to ten eggs. The young brood follow the
n the whole summer; in the winter they
in in flocks of forty or fifty, and become re-
arkably shy and wild; they always keep on
the tops of the hills, are scarcely ever found on the sides, and never descend into the valleys. Their food is the mountain-berries and tops of the heath.

4. The lagopus, white game, or ptarmigan, is fifteen inches in length, and weighs nineteen ounces. Its plumage is of a pale brown or ash-colour, elegantly crossed or mottled with small dusky spots and minute bars; the head and neck with broad bars of black, rust-colour, and white: the belly and wings are white, but the shafts of the greater quill-feathers black. In the male, the grey colour predominates, except on the head and neck, where there is a great mixture of red, with bars of white. The females and young birds have a great deal of rust-colour in them. The tail consists of sixteen feathers; the two middle of which are ash-coloured, mottled with black, and tipped with white; the two next black, slightly marked with white at their ends, the rest wholly black: the feathers incumbent on the tail are white, and almost entirely cover it.

Ptarmigans are found in these kingdoms only on the summit of the highest hills of the Highlands of Scotland, of the Hebrides and Orkneys; and a few still inhabit the lofty hills near Keswick in Cumberland, as well as the mountains of Wales. They live amidst the rocks, perching on the grey stones, the general colour of the strata in those exalted situations. They are very silly birds; so tame as to bear driving like poultry; and, if provoked to rise, take very short flights, making a great circuit like pigeons. Like the grouse, they keep in small packs; but never, like those birds, take shelter in the heath, but beneath loose stones. To the taste they scarcely differ from a grouse.

II. Perdix, comprehends both the partridge and quail.

In England the partridge is a favourite delicacy at the tables of the rich; and the desire of keeping it to themselves has induced them to make laws for its preservation, no way harmonising with the general spirit of English legislation.

The partridge seems to be a bird well known over all the old continent. Their manners resemble those of poultry in general; but their cunning and instinct seem superior to those of the larger kinds. Perhaps, as they live in the very neighbourhood of their enemies, they have more frequent occasion to put their little arts in practice, and learn by habit the means of evasion or safety. Whenever therefore a dog or other formidable animal approaches their nest, the female uses every means to draw him away. She keeps just before him, pretends to be incapable of flying, just hops up, and then falls down before him, but never goes off so far as to discourage her pursuer. At length, when she has drawn him entirely away from her secret treasure, she at once takes wing, and fairly leaves him to gaze after her in despair. After the danger is over, and the dog withdrawn, she then calls her young, who assemble at once at her cry, and follow where she leads them. There are generally from ten to fifteen in a covey; and, if unmolested, they live from fifteen to seventeen years.

2. The coturnix, or common quail, is not above half the size of the partridge. The feathers of the head are black, edged with rusty brown; the breast is of a pale yellowish red, spotted with black; the feathers on the back are marked with lines of pale yellow, and the legs are of a pale hue. Except in the colours thus described, and the size, it every way resembles a partridge in shape, and, except that it is a bird of passage, it is like all others of the poultry kind in its habits and nature.

The quail seems to spread entirely throughout the old world, but does not inhabit the new. It is observed to shift its quarters according to the season, coming northward in spring, and departing south in autumn, and in vast flocks, like other migrating birds. Twice in a year it comes in such vast quantities in Capri, that the bishop of the island draws the chief part of his revenue from them; hence he is called the quail-bishop. But this does not stand alone; almost all the islands in the Archipelago, on the opposite coasts, are at times covered with these birds, and some of them obtain a name from this circumstance. On the west coast of the kingdom of Naples, within the space of four or five miles, a hundred thousand have been taken in a day, which have been sold for eight livres per hundred to dealers who carry them for sale to Rome. Great quantities also sometimes alight in spring on the coasts of Provence, especially in the diocese of the bishop of Frejus, which is near the sea, and appear, at their first landing, so much fatigued that they are often taken by the hand.

With us they may be said not to be plenty at any time. They breed with us, and the major part migrate south in autumn; the rest only shift their quarters, as they have been met with on the coasts of Essex, and in Hampshire, in the winter season, retiring thence in October.

It feeds like the partridge, and, like that bird, makes no nest, except a few dry leaves or stalks scraped together may be called so, and sometimes a hollow on the bare ground suffices. In this the female lays her eggs to the number of six or seven, of a whitish colour, marked with irregular rust-coloured spots: the young follow the mother as soon as hatched, like young partridges. They have but one brood in a year.

Quail-fighting was a favourite amusement among the Athenians. They abstained from the flesh of this bird, deeming it unwholesome, as supposing that it fed upon the white hellebore: but they reared great numbers of them for the pleasure of seeing them fight; and staked sums of money, as we do with cocks, upon the success of the combat. Fashion, however, has at present changed with regard to this bird: we take no pleasure in its courage, but its flesh is considered as a very great delicacy. Quails are easily caught by a call: the fowler early in the morning having spread his net, hides himself under it among the corn; he then imitates the voice of the female with his quail-pipe, which the cock hearing, approaches with the utmost assiduity; when he has got under the net, the fowler then discovers himself, and terrifies the quail, who attempting to get away, entangles himself the more in the net, and is taken.

TETRODON, a genus of fishes of the order nantes. The generic character is, jaws bony, divided at the tip; body roughened beneath; ventral fins wanting.

1. Tetrodon lagocephalus, hare tetrodon. The fishes of this genus, of which there are 14 species, like the diodons, have the power of inflating their body at pleasure, by means of an internal membrane for that purpose, and during the time of inflation the small spines dispersed over their sides and abdomen are raised in such a manner as to operate as a defence against their enemies: they are chiefly natives of the tropical seas, though sometimes seen in the higher northern and southern latitudes, and are supposed to live principally on the crustaceous and testaceous animals.

The present species grows to the length of about twelve inches, and is of a thick form in front, the hinder parts tapering suddenly towards the tail: the colour is yellowish brown above, and whitish with a slight silvery cast beneath. This species occasionally strays into the northern latitudes, and has been taken, according to Mr. Pennant, about the British coasts, viz. near Penzance in Cornwall. It has the power of inflating the abdomen to a vast size: the Linnæan title seems to have been given from a fancied resemblance which the fore part of the head bears to that of a hare.

2. Tetrodon lineatus, lineated tetrodon. Length ten or twelve inches: shape somewhat square, but when inflated resembling that of the T. lagocephalus: whole body beset with numerous small spines: colour grey on the abdomen, with numerous, longitudinal, deep-brown streaks: fins and tail as in the preceding species. Native of the Mediterranean and American seas: sometimes found in the river Nile, where Hasselquist was assured by the fishermen that on being taken the hands were stung in the same manner as with nettles.

3. Tetrodon testudineus, tortoise-shell tetrodon. Length two feet; shape lengthened; colour rufous-brown above, marked by numerous round, pale-blue spots; beneath blueish or ash-coloured, beautifully varied by longitudinal brown streaks: fins and tail bright ferruginous: the whole abdomen is furnished with numerous small spines, which, when the animal is in a quiet state, are imbedded in so many corresponding cavities in the skin; but are elevated when the fish, on any alarm, distends its body. Native of the Indian seas. The Linnæan name of this fish is supposed to have been given from its tortoise-like beak, but perhaps, with more propriety, from its variegated skin.

4. Tetrodon ocellatus, ocellated tetrodon. Length six or eight inches: shape thick, ovate, contracting suddenly towards the tail; mouth slightly produced: colour deep-green above, gradually growing paler on the sides and abdomen, which are whitish. Native of the Indian seas, and sometimes of the adjoining rivers, particularly those of China and Japan. It is of an extremely poisonous nature, if eaten without the greatest care in properly cleaning it before dressing, and is said sometimes to have proved fatal in the short space of two hours. The symptoms, according to Rumphius, may be cured by the timely administration of a vegetable which he calls rex amaroris. The emperor of Japan prohibits his soldiers, under very severe penalties, from eating this fish: the rest of his subjects may, as Mr. Pennant observes, run the risk of being poisoned with impunity.

TEUCRIUM, *germander*, a genus of plants of the class didynamia, and order gymnospermia; and in the natural system ranging under the 42d order, verticillatæ. The corolla has the upper lip divided into two parts beyond the base, and divaricated where the stamina issue out. There are 69 species, of which the scorodonia, scordium, and chamædrys, are natives of Great Britain. 1. The scorodonia, wood sage, or germander, is distinguished by leaves which are heart-shaped, serrated, and petiolated; by racemi, which are lateral and ranged in one row; and by an erect stem. The flowers are straw-coloured, and the filaments red. The plant has a bitter taste, and smells like hops with a little mixture of garlic. It is used in brewing in the isle of Jersey instead of hops. 2. The scordium, or common water-germander, has creeping perennial roots, sending up many square, procumbent, or trailing stalks, branching diffusely, and small reddish flowers. This plant was formerly considered as medicinal, but has now fallen into disuse. It grows naturally in marshy places, in the isle of Ely and other parts of England, and most parts of Europe; and is sometimes admitted into gardens, in moist places, for variety, and as a medical plant. 3. The chamædrys, or smaller creeping germander, has reddish flowers, growing almost in a verticillus, or whorls, round the stalk, three on each peduncle: appearing in June and July. There are also some foreign species, ornamental as greenhouse plants.

TEUTHIS, a genus of fishes of the abdominal order. The generic character is, head truncate on the fore part; gill-membrane five-rayed; teeth equal, rigid, approximate in a single row. There are two species, 1. The hepatus, that inhabits Carolina and Amboina. 2. The jarva, that takes its name from the place where it is found.

TEUTONIC ORDER, a military order of kights, established towards the close of the twelfth century, and thus called as consisting chiefly of Germans or Teutons. The origin, &c. of the Teutonic order is said to be this: The Christians, under Guy of Lusignan, laying siege to Acre, a city of Syria, on the borders of the Holy Land, some Germans of Bremen and Lubec, touched with compassion for the sick and wounded of the army, who wanted common necessaries, set on foot a kind of hospital under a tent, which they made of a ship's sail, and here betook themselves to a charitable attendance on them. This excited a thought of establishing a third military order, in imitation of the templars and hospitalers. The design was approved of by the patriarch of Jerusalem, the archbishops and bishops of the neighbouring places, the king of Jerusalem, the masters of the temple and hospital, and the German lords and prelates then in the Holy Land, and pope Calixtus III. confirmed it by his bull, and the new order was called the order of Teutonic knights of the house of St. Mary at Jerusalem. The pope granted them all the privileges of the templars and hospitalers of St. John, excepting that they were to be subject to the patriarchs and other prelates, and that they should pay tythe of what they possessed. The officers of the Teutonic order, while in its splendour, were the grand master, who resided at Marienburg; under him were the grand commander; the grand marshal, who had his residence at Koningsberg; the grand hospitaler, who resided at Elbing; the draper, who took care to furnish the habits; the treasurer, who lived at the court of the grand master; and several commanders, as those of Thorn, Culme, Brandenburg, Koningsberg, Elbing, &c. They had also their commanders of particular castles and fortresses, advocates, proveditors, intendants of mills, provisions, &c. This order is now little more than the shadow of what it formerly was, having only three or four commanderies, scarcely sufficient for the ordinary subsistence of the grand master and his knights.

THALIA, a genus of plants of the class monandria, and order monogynia; and in the natural system ranging under the eighth order, scitamineæ. The corolla is pentapetalous and undulated; and the drupe has a unilocular kernel. There are two species, the geniculata and cannæformis.

THALICTRUM, *meadow rue*, a genus of plants of the class polyandria, and order polygynia; and in the natural system ranging under the 26th order, multisiliquæ. There is no calyx; the petals are four or five in number, and the seeds are naked and without a tail. There are 22 species; three of which are indigenous, the flavum, minus, and alpinum. 1. The flavum, or common meadow-rue, has a leafy furrowed stalk, and a manifold erect panicle. It has commonly 24 stamina, and from ten to sixteen pistils. The root and leaves of this plant dye a yellow colour, and cattle are fond of it. It grows on the banks of some rivers. 2. The minus, or small meadow-rue, has sexpartite leaves, and bending flowers. This plant is frequent in sandy soils and mountainous pastures. 3. The alpinum, or alpine meadow-rue, has a very simple stalk, and almost naked; and a racemus simple and terminal. It is frequent on the sides of rivulets.

THALLITE, a stone found in the fissures of mountains in Dauphiny, and of Chamouni, in the Alps. It is sometimes amorphous, and sometimes crystallized. The primitive form of its crystals is a rectangular prism, whose bases are rhombs with angles of 114° 37′, and 65° 23′. The most usual variety is an elongated four-sided prism (often flattened), terminated by four-sided incomplete pyramids; sometimes it occurs in regular six-sided prisms. The crystals are often very slender.

Its texture appears fibrous. Lustre 2. Glassy. Causes single refraction. Brittle. Specific gravity 3.45 to 3.46. Colour dark green. Powder white or yellowish green, and feels dry. It does not become electric by heat. Before the blowpipe, froths, and melts into a black slag. With borax melts into a green bead.

A specimen of thallite, analysed by Mr. Descotils, contained

37	silica
27	alumina
17	oxide of iron
14	lime
1.5	oxide of manganese
96.5	

THASPIA, the deadly carrot, a genus of plants of the class pentandria, and order diynia; and in the natural system ranging under the 45th order, umbellatæ. The fruit is oblong, and girt with a membrane. There are six species; the villosa, fœtida, asclepium, garganica, trifoliata, and polygami. The roots of the fœtida were formerly ordered in medicine, but are now entirely disused; a small dose operating with extreme violence both upwards and downwards.

THEA, the tea-tree, in botany, a genus of the class and order polyandria monogynia. The corolla is six or nine-petalled; the calyx five or six-leaved; the capsule tricoccous. There are two species, or at least principal varieties; the viridis or green, and the bohea, which again admit of various subdivisions or varieties. There is, however, much uncertainty on this point. The country of which the tea plant is a native, is hidden from the exploring eye of the philosopher; it is jealous of Europeans, and seldom gives them an opportunity of studying its productions.

The tea plant is a native of Japan, China, and Tonquin, and has not, as far as we can learn, been found growing spontaneously in any other part of the world. Sir Charles Thunberg, one of the most distinguished pupils of Linnæus, who resided sixteen months in Batavia and Japan, has given a full botanical description of the tea plant; and having classed it in the same manner as his master, says expressly that it has only one style. Several of the British botanists, on the other hand, refer it to the order of trigynia; deriving their authority from a plant in the duke of Northumberland's garden at Sionhouse, which had three styles.

Linnæus says that there are two species of the tea plant; the bohea, the corolla of which has six petals; and the viridis, or green tea, which has nine petals. Thunberg makes only one species, the bohea, consisting of two varieties: the one with broad and the other with narrow leaves. This botanist's authority is decisive respecting the Japanese tea plants; but as China has not yet been explored, we cannot determine what number of species there are in that country. The tea-tree, however, is now common in the botanical gardens in this country; and it is evident that there are two species, or, at least, permanent varieties of it: one with a much longer leaf than the other, which our gardeners call the green tea; and the other with shorter leaves, which they call the bohea. The green is by much the hardiest plant, and with very little protection will bear the rigour of our winters. Messrs. Loddridges, of Hackney, have now several large plants of it in the open ground, which they only cover with mats in hard frost. It is chiefly propagated in this country by layers. See Plate Nat. Hist. fig. 400.

This plant delights in valleys, and is frequent on the sloping sides of mountains and the banks of rivers, where it enjoys a southern exposure. It flourishes in the northern latitudes of Pekin as well as round Canton; but attains the greatest perfection in the mild temperate regions of Nankin. It is said only to be found between the 30th and 45th degree of north latitude. In Japan it is planted round the borders of fields, without regard to the soil; but as it is an important article of commerce with the Chinese, whole fields are covered with it, and it is by them cultivated with care. The abbé Rochen says, it grows equally well in a poor as in a rich soil; but that there are certain places where it is of a better quality. The tea which grows in rocky ground is superior to that which grows in a light soil; and the worst kind is that which is produced in a clay soil. It is propagated by seeds; from six to twelve are put into a hole about five inches deep, at certain distances from each other. The reason why so many seeds are sown in the same hole is said to be, that only a fifth part vegetate. Being thus sown, they grow without any other care. Some, however, manure the land, and remove the weeds; for the Chinese are as fond of good tea, and take as much pains to procure it of an excellent quality, as the Europeans do to procure excellent wine.

The leaves are not fit for being plucked till the shrub is of three years' growth. In seven years it rises to a man's height; but as it then bears but few leaves, it is cut down to the stem, and this produces a new crop of fresh shoots the following summer, every one of which bears nearly as many leaves as a whole shrub. Sometimes the plants are not cut down till they are ten years old. We are informed by Kæmpfer, that there are three seasons in which the leaves are collected in the isles of Japan, from which the tea derives different degrees of perfection.

The first gathering commences at the end of February or beginning of March. The leaves are then small, tender, and unfolded, and not above three or four days old: these are called ficki-tsiaa, or "tea in powder," because it is pulverised; it is also called imperial tea, being generally reserved for the court and people of rank; and sometimes also it is named bloom tea. It is sold in China for 20*d.* or 2*s.* per pound. The labourers employed in collecting it do not pull the leaves by handfuls, but pick them up one by one, and take every precaution that they may not break them. However long and tedious this labour may appear, they gather from four to ten or fifteen pounds a day.

The second crop is gathered about the end of March or beginning of April. At this season part of their leaves have attained their full growth, and the rest are not above half their size. This difference does not, however, prevent them from being all gathered indiscriminately. They are afterwards picked and assorted into different parcels, according to their age and size. The youngest, which are carefully separated from the rest, are often sold for leaves of the first crops, or for imperial tea. Tea gathered at this season is called too-tsiaa, or "Chinese tea," because the people of Japan infuse it, and drink it after the Chinese manner.

The third crop is gathered in the end of May, or in the month of June. The leaves are then very numerous and thick, and have acquired their full growth. This kind of tea, which is called ben-tsiaa, is the coarsest of all, and is reserved for the common people. Some of the Japanese collect their tea only at two seasons of the year, which correspond to the second and third already mentioned: others confine themselves to one general gathering of their crop, towards the month of June: however, they always form afterwards different assortments of their leaves.

An infusion of tea is the common drink of the Chinese; and indeed, when we consider one circumstance in their situation, we must acknowledge that Providence has displayed much goodness in scattering this plant with so much profusion in the empire of China. The water is said to be unwholesome and nauseous, and would therefore, perhaps, without some corrective, be unfit for the purposes of life. The Chinese pour boiling water over their tea, and leave it to infuse, as we do in Europe; but they drink it without any mixture, and even without sugar. The people of Japan reduce theirs to a fine powder, which they dilute with warm water until it has acquired the consistence of thin soup. Their manner of serving tea is as follows: They place before the company the tea-equipage, and the box in which this powder is contained; they fill the cups with warm water, and taking from the box as much powder as the point of a knife can contain, throw it into each of the cups, and stir it with a tooth-pick until the liquor begins to foam; it is then presented to the company, who sip it while it is warm. According to Du Halde, this method is not peculiar to the Japanese; it is also used in some of the provinces of China.

The first European writer who mentions tea is Giovanni Botero, an eminent Italian author, who published a treatise about the year 1590, of the causes of the magnificence and greatness of cities. He does not indeed mention its name, but describes it in such a manner that it is impossible to mistake it. "The Chinese (says he) have a herb out of which they press a delicate juice, which serves them for drink instead of wine; it also preserves their health, and frees them from all those evils which the immoderate use of wine produces among us."

Tea was introduced into Europe in the year 1610 by the Dutch East India company. It is generally said, that it was first imported from Holland into England, in 1666, by the lords Arlington and Ossory, who brought it into fashion among people of quality. But it was used in coffee-houses before this period, as appears from an act of parliament made in 1660, in which a duty of 8*d.* was laid on every gallon of the infusion sold in these places. In 1666 it was sold in London for 60*s.* per pound, though it did not cost more than 2*s.* 6*d.* or 3*s.* 6*d.* at Batavia. It continued at this price till 1707. In 1715 green tea began to be used; and as great quantities were then imported, the price was lessened, and the practice of drinking tea descended to the lower ranks. In 1720 the French began to send it to us by a clandestine commerce. Since that period the demand has been increasing yearly, and it has become almost a necessary of life in several parts of Europe, and among the lowest as well as the highest ranks:

The following table will give an idea of the quantity of tea imported annually into Great Britain and Ireland since 1717:

From	1717 to 1726	-	700,000 lb.
	1732 to 1742	-	1,200,000
	1755 near	-	4,000,000
	1766	-	6,000,000
	1785 about	-	12,000,000
	1794 from		16 to 20,000,000

Besides these immense quantities imported into Britain and Ireland, much has been brought to Europe by other nations. In

1766 the whole tea imported into Europe from China amounted to 17 millions of pounds; in 1785 it was computed to be about 19 millions of pounds.

In this country teas are generally divided into three kinds of green, and five of bohea: the former are, 1. Imperial or bloom tea, with a large loose leaf, light-green colour, and a faint delicate smell. 2. Hyson, so called from the name of the merchant who first imported it; the leaves of which are closely curled and small, of a green colour, verging to a blue: 3. Singlo tea, from the name of the place where it is cultivated. The boheas are, 1. Souchong, which imparts a yellow-green colour by infusion. 2. Camho, so called from the place where it is made; a fragrant tea, with a violet smell; its infusion pale. 3. Congo, which has a larger leaf than the preceding, and its infusion somewhat deeper, resembling common bohea in the colour of the leaf. 4. Pekoe tea; this is known by the appearance of small white flowers mixed with it. 5. Common bohea, whose leaves are of one colour. There are other varieties, particularly a kind of green tea, done up in roundish balls, called gunpowder tea.

THEATINES, a religious order in the Romish church, so called from their principal founder John Peter Caraffa, then bishop of Theate, or Chieti, in the kingdom of Naples, and afterwards pope, under the name of Paul IV.

THEFT, in law, an unlawful felonious taking away another man's moveable and personal goods, against the owner's will, with intent to steal them. It is divided into theft or larceny, properly so called, and petit theft, or petit larceny; the former whereof is of goods above the value of 12*d.* and is deemed felony; the other, which is of goods under that value, is not felony. See the articles FELONY and LARCENY.

THEFTBOTE, the receiving a man's goods again from a thief, or other amends, by way of composition, and to prevent prosecution, that the felon may escape unpunished; the punishment whereof is fine and imprisonment.

THELIGONUM, a genus of plants of the class monœcia, and order polyandria; and in the natural system ranging under the 53d order, scabridæ. The male calyx is bifid; there is no corolla; the stamina are generally 12. The female calyx is also bifid; there is no corolla; only one pistil; the capsule is coriaceous unilocular, and monospermous. There is only one species, the cynocrambe, which is indigenous in the south of Europe.

THEOBROMA, a genus of plants of the class polyadelphia, and order decandria; and in the natural system ranging under the 37th order, columniferæ. The calyx is triphyllous; the petals, which are five in number, are vaulted and two-horned; the nectarium is pentaphyllous and regular; the stamina grow from the nectarium, each having five antheræ, see Plate Nat. Hist. fig. 402. There is one species, viz.

The cacao, or chocolate-tree, which we shall describe in the words of Dr. Wright: "In all the French and Spanish islands and settlements in the warmer parts of America, the chocolate-tree is carefully cultivated. This was formerly the case also in Jamaica but at present we have only a few straggling trees left as monuments of our indolence and bad policy. This tree delights in shady places and deep valleys. It is seldom above 20 feet high. The leaves are oblong, large, and pointed. The flowers spring from the trunk and large branches; they are small, and pale red. The pods are oval and pointed. The seeds or nuts are numerous, and curiously stowed in a white pithy substance. The cocoa-nuts being gently parched in an iron pot over the fire, the external covering separates easily. The kernel is levigated on a smooth stone; a little arnotto is added, and with a few drops of water is reduced to a mass, and formed into rolls of one pound each. This simple preparation of chocolate is the most natural, and the best. It is in daily use in most families in Jamaica, and seems well adapted for rearing of children."

THEODOLITE, a mathematical instrument much used in surveying, for the taking of angles, distances, &c.

It is made variously, several persons having their several ways of contriving it, each supposed to be more simple and portable, or more accurate and expeditious, than others.

The following is a description of one of the most useful, and for a more particular account of some of its peculiar parts we refer to the article LEVEL: The three staves, see Plate Miscel. fig. 236, whereby it is supported, screw into bell-metal joints by brass ferules at top, which are moveable between brass pillars fixed in a strong brass plate; in which, round the centre, is fixed a socket with a ball moveable in it, and upon which the four screws press that set the limb horizontal. Next above is such another plate, through which the said screws pass, and on which round the centre is fixed a frustum of a cone of bell-metal, whose axis, being connected with the centre of the ball, is always perpendicular to the limb, by means of a conical brass ferule fitted to it, whereon is fixed the compass-box, and on it the limb, which is a strong bell-metal ring, whereon are moveable three brass indexes, in whose plate are fixed four brass pillars, that joining at top, hold the centre-pin of the bell-metal double sextant, whose double index is fixed in the centre of the same plate. Within the double sextant is fixed the spirit level, and over it the telescope.

The telescope is a little shorter than the diameter of the limb, that a fall may not hurt it; yet it will magnify as much, and shew a distinct object as perfect, as most of treble its length: in its focus are very fine cross wires, whose intersection is in the plane of the double sextant; this was a whole circle, and turned in a lathe to a true plane, and is fixed at right angles to the limb; so that whenever the limb is set horizontal (which is readily done by making the spirit-tube level over two screws, and the like over the other two) the double sextant and telescope are moveable in a vertical plane, and then every angle taken on the limb (though the telescope is never so much elevated or depressed) will be an angle in the plane of the horizon, and this is absolutely necessary in plotting an horizontal plane.

THEOPHRASTA, in botany, a genus of the pentandria monogynia class of plants, with a monopetalous campanulated petal, semiquinquefid at the limb: the fruit is a large, globose, unilocular capsule, containing a great many roundish seeds. There are two species, shrubs of the West Indies.

THEOREM, a proposition which terminates in theory, and which considers the properties of things already made or done. Or a theorem is a speculative proposition, deduced from several definitions compared together. Thus, if a triangle is compared with a parallelogram standing on the same base, and of the same altitude; and partly from their immediate definitions, and partly from other of their properties already determined, it is inferred that the parallelogram is double the triangle; that proposition is a theorem.

Theorem stands contradistinguished from problem, which denotes something to be done or constructed, as a theorem proposes something to be proved or demonstrated.

There are two things to be chiefly regarded in every theorem, viz. the proposition and the demonstration. In the first is expressed what agrees to some certain thing, under certain conditions, and what does not. In the latter, the reasons are laid down by which the understanding comes to conceive that it does or does not agree to it.

Theorems are of various kinds; as,

Universal theorem, is that which extends to any quantity without restriction, universally, as this; that the rectangle or product of the sum and difference of any two quantities, is equal to the difference of their squares.

Particular theorem, is that which extends only to a particular quantity, as this; in an equilateral rectilinear triangle, each angle is equal to 60 degrees.

Negative theorem, is that which expresses the impossibility of any assertion, as that the sum of two biquadrate numbers cannot make a square number.

Local theorem, is that which relates to a surface, as that triangles of the same base and altitude are equal.

Plane theorem, is that which relates to a surface that is either rectilinear, or bounded by the circumference of a circle; as that all angles in the same segment of a circle are equal.

Solid theorem, is that which considers a space terminated by a solid line; that is, by any of the three conic sections; as this: that if a right line cuts two asymptotic parabolas, its two parts terminated by them shall be equal.

Reciprocal theorem, is one whose converse is true; as that if a triangle has two sides equal, it has also two angles equal: the converse of which is likewise true, viz. that if the triangle has two angles equal, it has also two equal sides.

THERMOMETER. A glass vessel filled to a certain degree with a liquid, for the purpose of shewing the expansions of that liquid in different temperatures, or for the purpose of shewing the temperature by the corresponding expansion of that liquid, is called a thermometer; *i. e.* a measure of the temperature.

The fluids mostly used for thermometers, are either mercury or spirit of wine; the latter of which is generally tinged red, by means of cochineal, or Brazil wood, &c. for the purpose of rendering it more visible; hence they are denominated the mercurial thermometer, and the spirit thermometer. Other fluids, on account of their clamminess, or of their great irregularity of expansion, are not useful for thermometers.

The most proper and the most useful shape for thermometers, is that of a long tube with a narrow bore, and with a globular cavity at one extremity (see Plate Miscel. fig. 237.). The cavity of the bulb C, and part of the tube, as far, for instance, as A, are filled with the fluid: the rest of the tube is either partly, or quite, exhausted of air; and the end B of the tube is hermetically sealed; viz. perfectly closed by melting the extremity of the tube at the flame of a candle or lamp, urged by means of a blowpipe.

When the bulb C is heated, the mercury, or the spirit of wine, is expanded; and not being able to extend itself any other way, all the increment of bulk is manifested in the tube, viz. the surface A of the fluid will rise considerably into the tube. On the other hand, when the bulb C is cooled, the fluid contracts, and its surface A descends. It is evident, that, cæteris paribus, the larger the bulb is, in proportion to the diameter of the cavity of the tube, or the narrower the latter is in proportion to the former, the greater will the motion of the surface A be in the tube. But it must be observed, that when the bulb is very large, the thermometer will not easily arrive at the precise temperature of any place, wherein it may be situated. Some persons, in order to give the bulb a greater surface, and of course to render it more capable of readily attaining a given temperature, have made it not globular, but cylindrical (which shape was adopted by Fahrenheit), or flat, or bell-like, &c.; but those shapes are improper, because they are liable to be altered by the varying gravity of the atmosphere, consequently those thermometers cannot be accurate.

If a thermometer is heated suddenly, as when the bulb C is immerged in hot water, the surface A of the fluid in it will be seen to descend a little, and instantly after will be seen to rise; the reason of which is, that the heat of the water enlarges the glass first, and is then communicated to the fluid, &c. On the contrary, if the bulb of a thermometer is cooled suddenly, the surface A of the fluid will first rise a little, and then will descend; because the cold contracts the glass alone at first, and afterwards contracts the fluid.

Ice is melted by a certain invariable degree of temperature; and water freezes at about the same temperature; therefore, if the bulb C of a mercurial thermometer is placed in melting ice, or melting snow, and a mark is made on the outside of the tube, even with the surface of the fluid, as at D; that mark is called the freezing-point, though in fact it is the melting-point of ice; the freezing-point of water being not so constant. If the bulb of the thermometer is placed in boiling water, and a mark is made on the glass tube, even with the surface of the fluid within, as at E, that mark is called the boiling-point; for in an open vessel, and under the same atmospherical pressure, which is indicated by the barometer, water constantly boils at the same temperature, and an increased fire will force it to evaporate faster, but will not raise its temperature. Those points being ascertained, if the length of the tube from D to E is divided into any number of equal parts, those parts will be the degrees of the thermometer, or the degrees of heat, indicated by the corresponding expansions of the fluid within the thermometer. And the same degrees, or equal divisions, may be continued below D and above E, in order to shew the degrees of temperature below the freezing, and above the boiling, point.

Those two unalterable points of temperature, viz. the former where ice becomes water, and the second where water becomes vapour, have been universally adopted by the various constructors of thermometers for the graduation of those instruments; but the space between them has been divided differently by different persons, and this difference gives the different names of thermometers, or rather of their graduations; such as Reaumur's thermometer, Fahrenheit's thermometer, &c. Reaumur divides the space between the abovementioned two points, into 80 equal parts or degrees; placing the 0 at freezing, and the 80th degree at the boiling point. Fahrenheit divides it into 180 degrees or equal parts, but he places the 0 thirty-two degrees below the freezing-point D; so that the freezing-point is at 32, and the boiling-point E is at 212 degrees.

Other persons have adopted other divisions, which have been suggested by supposed advantages or fanciful ideas.

Most of those graduations are at present out of use, but they are to be met with in various, not very recent, publications; we have therefore thought it necessary to set them down in the following table, which contains: 1st. The name of the person or society that has used each particular division; 2dly. The degree which has been placed, by each of them, against the freezing-point; 3dly. The degree which has been placed against the boiling-point; and, 4thly. The number of degrees lying between those two points.

	Freezing-point.	Boiling-point.	Deg. between the preceding two points.
Fahrenheit's, which is generally used in Great Britain. It is also used throughout this work, unless some other is mentioned - - -	32	212	180
Reaumur's, which is generally used in France and other parts of the Continent - -	0	80	80
Celsius's, which has been used chiefly in Sweden, hence it is also called the Swedish thermometer. It has been lately adopted by the French chemists, under the name of centigrade thermometer	0	100	100
The Florentine thermometers, which were made and used by the members of the famous academy *del' Cimento*, being some of the first instruments of the sort, were vaguely graduated, some having a great many more degrees than others. But two of their most common graduations seem to be	20	174	154
	$13\frac{1}{2}$	$81\frac{2}{3}$	$68\frac{1}{6}$
The Parisian thermometer, viz. the *ancienne thermometre* of the Academy of Sciences, seems to have been graduated nearly thus, - -	25	239	214
De la Hire's thermometer, which stood in the observatory at Paris above 60 years, was graduated thus, - -	28	$199\frac{1}{3}$	$171\frac{1}{3}$
Amanton's - -	$51\frac{1}{2}$	73	$21\frac{1}{2}$
Poleni's - - -	$47\frac{3}{10}$	$62\frac{9}{10}$	$15\frac{6}{10}$
De L'Isle's thermometer is graduated in an inverted order - -	150	0	150
Sir Isaac Newton's -	0	34	34
Hales's - - -	0	163	163
The Edinburgh thermometer, formerly used, seems to have been graduated thus, - -	$8\frac{1}{5}$	47	$38\frac{4}{5}$

These are the chief thermometers that have been used in Europe; and the temperatures indicated by the principal of them may be reduced into the corresponding degrees on any of the others, by means of the following simple theorems; in which R signifies the degrees on the scale of Reaumur, F those of Fahrenheit, and S those of the Swedish thermometer.

1. To convert the degrees of Reaumur into those of Fahrenheit; $\frac{R \times 9}{4} + 32 = F$.

2. To convert the degrees of Fahrenheit into those of Reaumur; $\frac{(F - 32) \times 4}{9} = R$.

3. To convert the Swedish degrees into those of Fahrenheit; $\frac{S \times 9}{5} + 32 = F$.

4. To convert Fahrenheit's into Swedish; $\frac{(F - 32) \times 5}{9} = S$.

5. To convert Swedish degrees into those of Reaumur; $\frac{S \times 4}{5} = R$.

6. To convert Reaumur's degrees into Swedish; $\frac{R \times 5}{4} = S$.

To such readers as are unacquainted with the algebraic expression of arithmetical formulæ, it will be sufficient to express one or two of these in words, to explain their use: 1. Multiply the degree of Reaumur by 9, divide the product by 4, and to the quotient add 32, the sum expresses the degree on the scale of Fahrenheit. 2. From the degree of Fahrenheit subtract 32, multiply the remainder by 4, and divide the product by 9, the quotient is the degree according to the scale of Reaumur, &c.

Thermometers have been made of a great variety of shapes and sizes, suitable to the different purposes for which they were intended.

Thermometers for shewing the temperature of the atmosphere, need not have their scales much extended; it is more than sufficient if they go as high as 120°. The lower degrees may be carried down as low as may be necessary for the cold of any particular climate. The mercurial thermometer needs not to be graduated lower than 40° below 0, because at about that degree mercury ceases to be a fluid.

The spirit thermometer may be graduated lower if necessary. We shall here just mention, that, for reasons which will be noticed hereafter, if a mercurial thermometer and a spirit thermometer are both graduated according to the above-mentioned directions, the two thermometers will not, in their usual indications of the same temperatures, point to the same degrees.

The degrees of thermometers may be delineated on metal, or wood, or paper, or ivory, &c. but such substances should be preferred for the scales of thermometers, as are not apt to be bent or shortened, or otherwise altered by the weather, especially when the instruments are not defended by a glass case, or by a box with a glass face.

The bulb of the thermometer must be clean and colourless; since coloured surfaces are apt to be partially heated by a strong light. The ball of the thermometer ought not to be in contact with the substance of the scale, lest it should be influenced by the temperature of that substance.

Thermometers which are to be situated in the open air out of the house, must be at some distance (at least a foot) from the wall, and where the light of the sun may not fall directly upon them. Fig. 238 represents a thermometer of the most usual shape independant of the case.

For chemical purposes, the bulb and part of the tube of the thermometer, must project some way below the scales, in order that they may be placed in liquids, mixtures, &c.

For other purposes, as for botanical observations, hot-houses, brewing-manufactories, baths, &c. the thermometers must be made longer, or shorter, or narrower, or particular directions must be added to the scales, &c.; but we shall not take any farther notice of those fluctuating varieties of shape only.

It is necessary, however, to describe a sort of thermometers which have been constructed for a particular purpose; namely, for shewing the highest degree of heat or of cold which has taken place during the absence of the observer; as for instance, in the course of the night, or in the hottest part of the day, or even during a whole season.

Thermometers for this purpose have been contrived differently by various ingenious persons, as by Bernouilli, Kroft, lord Charles Cavendish, &c. but the best of them, which however is not without faults, and of course is in need of improvements, was contrived by Mr. James Six, and is described in the 72nd vol. of the Philosophical Transactions. Fig. 239 exhibits this instrument, but divested of the scale and frame; *ab* is a tube of thin glass, about 16 inches long, and $\frac{5}{16}$ of an inch in diameter; *cdefgh*, a smaller tube with the inner diameter, about $\frac{1}{40}$, joined to the larger at the upper end *b*, and bent down, first on the left side, and then, after descending two inches below *ab*, upwards again on the right, in the several directions *cde*, *fgh*, parallel to, and one inch distant from it. On the end of the same tube at *h*, the inner diameter is enlarged to half an inch from *h* to *i*, which is two inches in length. This glass is filled with highly rectified spirit of wine, to within half an inch of the end *i*, excepting that part of the small tube from *d* to *g*, which is filled with mercury. From a view of the instrument in this state, it will readily be conceived, that when the spirit in the large tube, which is the bulb of the thermometer, is expanded by heat, the mercury in the small tube on the left side will be pressed down, and consequently cause that on the right side to rise; on the contrary, when the spirit is condensed by cold, the reverse will happen, the mercury on the left side will rise as that on the right side descends. The scale, therefore, which is Fahrenheit's, beginning with 0, at the top of the left side, has the degrees numbered downwards, while that at the right side, beginning with 0 at the bottom, ascends. The divisions are ascertained, by placing this thermometer with a good standard mercurial one in water, gradually heating or cooling, and marking the divisions of the new scale at every 5°. The method of shewing how high the mercury had risen in the observer's absence, is effected in the following manner: Within the small tube of the thermometer, above the surface of the mercury on either side, immersed in the spirit of wine, is placed a small index, so fitted as to pass up and down as occasion may require; that surface of the mercury which rises, carries up the index with it, which index does not return with the mercury when it descends; but, by remaining fixed, shews distinctly, and very accurately, how high the mercury had risen, and consequently what degree of heat or cold had happened. Fig. 240 represents these indexes drawn larger than the real ones, to render it more distinct; *a* is a small glass tube $\frac{3}{4}$ of an inch long, hermetically sealed at each end, inclosing a piece of steel wire, nearly of the same length; at each end *c d*, is fixed a short piece of a tube of black glass, of such a diameter as to pass freely up and down within the small tube of the thermometer. The lower end, floating on the surface of the mercury, is carried up with it when it rises; while the piece at the upper end, being of the same diameter, keeps the body of the index parallel to the sides of the thermometrical tube. From the upper end of the body of the index at 0, is drawn a spring of glass to the fineness of a hair, about $\frac{2}{3}$ of an inch in length, which being set a little oblique, presses lightly against the inner surface of the tube, and prevents the index from following the mercury when it descends, or being moved by the spirit passing up or down, or by any sudden motion given to the instrument by the hand or otherwise; but at the same time the pressure is so adjusted, as to permit this index to be readily carried up by the surface of the rising mercury, and downwards whenever the instrument is to be rectified for observation. To prevent the spirit from evaporating, the tube at the end *i* is closely sealed.

This instrument in its frame must be secured against the wall out of doors, to prevent its being shaken by violent winds. "Towards evening," says Mr. Six, "I usually visit my thermometer, and see at one view, by the index on the left side, the cold of the preceding night; and by that on the right, the heat of the day. These I minute down, and then apply a small magnet to that part of the tube against which the indexes rest, and move each of them down to the surface of the mercury; thus, without heating, cooling, separating, or at all disturbing the mercury, or moving the instrument, may this thermometer, without a touch, be immediately rectified for another observation."

The common contrivance for a self-registering thermometer, now sold in most of the London shops, consists simply of two thermometers, one mercurial and the other of alcohol (fig. 243), having their stems horizontal; the former has for its index a small bit of magnetical steel wire, and the latter a minute thread of glass, having its two ends formed into small knobs by fusion in the flame of a candle.

The magnetical bit of wire lies in the vacant space of the mercurial thermometer, and is pushed forward by the mercury whenever the temperature rises, and pushes that fluid against it; but when the temperature falls and the fluid retires, this index is left behind, and consequently shews the maximum. The other index, or bit of glass, lies in the tube of the spirit thermometer immersed in the alcohol; and when the spirit retires by depression of temperature, the index is carried along with it in apparent contact with its interior surface; but on increase of temperature the spirit goes forward and leaves the index, which therefore shews the minimum of temperature since it was set. As these indexes merely lie in the tubes, their resistance to motion is altogether inconsiderable. The steel index is brought to the mercury by applying a magnet on the outside of the tube, and the other is duly placed at the end of the column of alcohol by inclining the whole instrument.

The operation of this instrument has been thus explained: When the surface of the column of spirit is viewed by a magnifier, it is seen to have the form of a concave hemisphere, which shews that the liquid is attracted by the glass. The glass in that place is consequently attracted in the opposite direction, by a force equal to that which is so employed in maintaining that concave figure; and if it was at liberty to move, it would be drawn back till the flat surface was restored. Let us suppose a small stick or piece of glass to be loose within the tube, and to protrude into the vacant space beyond the surface of the alcohol. The fluid will be attracted also by the glass, and form a concave between its surface, and that of the bore of the tube. But the small interior piece being quite at liberty to move, will be drawn towards the spirit so long as the attractive force possesses any activity; that is, so long as any additional fluid hangs round the glass; or, in other words, until the end of the stick of glass is even with the surface. Whence it is seen that the small piece of glass will be resisted, in any action that may tend to protrude it beyond the surface of the fluid; and if this resistance is greater than the force required to slide it along in the tube (as in fact it is), the piece must be slided along as the alcohol contracts; so as always to keep the piece within the fluid. And this fact is accordingly observed to take place.

It might at first sight be imagined that equal increments of heat would cause fluids to expand equably; viz. that if the heat is increased gradually by one degree, two degrees, three degrees, &c. the fluid thus heated would expand its bulk by a certain quantity, then by twice that quantity, three times that quantity, and so on. But this is not the case, and every fluid seems to follow a particular law of expansion.

Mercury seems to expand more equably than any other fluid. Yet its increments of bulk are not quite proportional to the increments of heat. With other fluids the irregularity of expansion is very considerable.

One cubic inch of mercury, or one measure whatever of it, at 32° of temperature, when heated to the temperature of boiling water, viz. at 212°, will be found increased in bulk by the quantity 0.01836. This fluid metal boils and becomes a vapour at 600° of Fahrenheit's thermometer, and it becomes a solid at — 40°; viz. 72° below melting ice. Below that point, viz. — 40°, it contracts irregularly.

Spirit of wine boils at about 180° and the purest probably never freezes. When brandy, or a mixture of water and spirit, freezes, it is the water that becomes solid, but the spirit will be found collected together in one or more bubbles, in some part of the ice.

From all that has been said with respect to the expansion of fluids, it appears that, on account of the great irregularity of the rate of expansion, mercury and spirit of wine are the only two fluids which can be used for thermometers; observing that some compensation must be made in the scale of the spirit thermometer, in order to make it correspond with the scale of the mercurial thermometer. But the mercurial thermometer cannot indicate a temperature higher than 600. Hence various ingenious persons have endeavoured to contrive instruments capable of indicating the higher degrees of heat, which would be of great use in philosophy, chemistry, and various arts; but the only useful contrivance of this sort was made by the late Mr. Wedgewood. This ingenious gentleman applied to the measuring of high degrees of heat, a singular property of argillaceous bodies, a property which obtains more or less in every kind of them, as far as has been examined. This property is, that an argillaceous substance, when exposed to fire, is diminished in bulk by it, nor does the bulk increase again after cooling; and this diminution of bulk is proportionate to the degree of heat to which the substance has been exposed.

This property may seem to be a deviation from the general rule, viz. that heat expands all sorts of bodies, and that a diminution of heat enables them to contract their dimensions; but in this case it must be considered that the clay pieces contract and remain contracted, because some substance, viz. water and an aëriform fluid, is separated from them by the action of the fire.

Mr. Wedgewood's thermometer, or apparatus for measuring the high degrees of heat, consists of small pieces of clay of a determined length, which are to be placed in the furnace, crucible, &c. whose degree of heat is to be ascertained; and of a gauge to measure the contracted dimensions of the clay pieces, after they have been exposed to the fire.

Fig. 241 represents the gauge, which is either of brass or of porcelain. Fig. 242 represents a section of the same; and the letters refer to the like parts in both figures. EFGH is a smooth flat plate; AC, BD, are two rulers or flat pieces, a quarter of an inch thick, and fixed fast upon the plate, so as to form a converging canal ABCD, whose width at CD is three-fifths of the width at AB. The whole length of the canal from AB to CD, is divided into 240 equal parts, and the divisions are numbered from the wider end. It is evident that if a body, so adjusted as to fit exactly the wider end of this canal, is afterwards diminished in its bulk by the action of fire (as the thermometrical pieces which will be described in the next paragraph), it may then be passed further in the canal, and more so according as the diminution is greater.

The thermometrical pieces are small cylinders of clay, a little flattened on one side. They are nearly as much in diameter as they are in length. When one of these pieces is to be used, it is proper to measure it first by placing it in the gauge at AB; for sometimes the pieces are a few degrees larger or smaller than the distance AB, which excess or defect being ascertained, must afterwards be allowed for. P represents one of these pieces set in the gauge for measurement.

The piece is then placed in the furnace, or crucible; and if it is taken out either at the end of the operation, or at any period, and, when grown cold, is measured by sliding it as far as it will go, into the canal of the gauge, the number of divisions against the place where it stops will shew the contracted dimensions of the piece, and of course the degree of heat to which it has been exposed. It will be found that these pieces will go very little beyond 0 in the canal, if they have been exposed to a visible red heat; will go to 27° if they have been exposed to the heat in which copper melts; to about 90° if exposed to the welding-heat of iron; about 160° if exposed to the greatest heat that can be produced with charred pit-coal in a well constructed common air-furnace, &c.

The same thermometrical piece which has been used before, may be used again for higher degrees of heat, but not for lower degrees.

It is now necessary to shew the correspondence between the scale of this, and the scale of Fahrenheit's mercurial thermometer.

As the mercurial thermometer cannot shew a temperature higher than 600°, and Wedgewood's thermometer cannot shew a temperature lower than red heat, which is by several degrees higher than 600°, therefore it was necessary to contrive a measure for the intermediate degrees, and which might reach some degrees below 600°, and some degrees above the temperature of a red heat. Mr. Wedgewood chose a piece of silver, the expansion of which measured in a gauge made for the purpose, similar to the gauge fig. 241, might indicate the degrees of temperature between the two thermometers; with this instrument he first found the correspondence between the degrees of Fahrenheit's scale and the last-mentioned gauge, by placing them alternately in water of the temperature of 50°, and in boiling water. Then he found the correspondence between the degrees of the gauge of the silver piece, and that of the earthen thermometrical pieces, by placing them both at the same time in different and higher degrees of heat; lastly, by computation from those results, he determined the correspondence between the degrees of Fahrenheit's scale and those of his own thermometrical gauge.

It was found that one degree of Wedgewood's thermometer is equal to 130° of Fahrenheit's; and that the 0 of Wedgewood's coincides with the 1077,°5 of Fahrenheit's; from which data a comparison of the two thermometers may be made, or rather of the imaginary extensions of their two scales; for, in fact, Fahrenheit's thermometer cannot shew higher than 600°, and Wedgewood's cannot reach near so low. It is likewise to be observed that the degrees of Wedgewood's scale are supposed to shew equal increments of heat, whereas in truth we do not know whether the clay thermometrical pieces contract in proportion to the increments of heat; which shews that, though this is the best known thermometer for measuring the higher degrees of heat, yet an improvement of the same, or some other manageable and more accurate contrivance, is highly desirable.

Upon the whole it appears, that the spirit thermometer enables us to measure the degrees of heat as low as has ever been experienced, either naturally, or by artificial cooling: that the mercurial thermometer enables us to measure the heat from — 40° to 600°; and that Wedgewood's thermometer enables us to measure from a red heat up to the farther extent of that scale, viz. to its 240th degree, which is reckoned equivalent to 32277° of Fahrenheit's scale.

THESIUM, Base fluellin, a genus of plants of the class pentandria, and order monogynia. The calyx is monophyllous, with the stamina inserted into it; there is only one seed, which is inferior. There are nineteen species; one of which is a British plant, the linophyllum or bastard toad-flax. It has a foliaceous panicle with linear leaves, and flowers in June and July.

THLASPI, bastard-cress, or mithridate mustard, a genus of plants of the class tetradynamia, and order siliculosa; and in the natural system ranging under the 39th order, siliquosa. The pod is emarginated, obcordate, and polyspermous; the valves are boat-shaped, and marginated and carinated. There are 14 species; of which six only are natives of Britain. 1. The arvense, treacle-mustard, or penny-cress. It smells like garlic, and has a white flower. 2. The hirtum, or perennial mithridate mustard. 3. The campestre, or mithridate mustard. 4. The montanum, or mountain mithridate mustard. 5. The perfoliatum, or perfoliate treacle-mustard. 6. The bursa pastoris, or shepherd's purse. The seeds of some of these species have an acrid biting taste, approaching to that of the common mustard; with which they agree nearly in their pharmaceutic properties.

THIRD, in music, an interval so called because it contains three diatonic sounds. The Greeks not admitting the third as a consonance, it obtained no general name amongst them; but took that of the lesser or greater interval from which it was formed.

There are four species of thirds; two consonant, and two dissonant. The consonants are; first, the major third, called by the antients ditone, composed of two tones; secondly, the minor third, called hemitone, consisting of a tone and a half. The dissonant thirds are, first, the diminished third, composed of two major semitones; secondly, the superfluous third, composed of two tones and a half. This last interval, not having place in the same mode, or key, is never used either in harmony, or in melody. The Italians sometimes introduce the diminished third in airs, but it is never used in harmony.

The consonant thirds are the spirit of harmony, particularly the major third, which is sonorous and brilliant; the minor third is more tender, and even pathetic; a difference of character from which skilful composers derive some of the best and most poignant effects.

The old French theorists had almost as severe laws respecting the thirds as we now observe in regard to fifths and eighths. It was by them forbidden to have two in immediate succession even of different kinds, particularly in the same direction.

THIRTEENTH, *in music*, an interval forming the octave of the sixth, or the sixth of the octave. It contains twelve diatonic degrees, *i. e.* thirteen sounds.

THOA, a genus of the monoecia polyandria class and order of plants. There is no calyx or corolla; the male stamina are numerous; fem. germ. two; stigma three or four-cleft; seed in a brittle shell, covered with a bristly nect. There is one species.

THORACIC, a term applied to an order of fishes in the Linnean system; the character of this order of fishes is, that they have bony gills, and ventral fins placed directly under the thorax. Of this order there are 21 genera, viz. the

Cepola,	Pleuronectes,	Trachychthys,
Echineis,	Chætodon,	Gasterosteus,
Coryphæna,	Sparus,	Scomber,
Gobius,	Scarus,	Centrogaster,
Cottus,	Labrus,	Mullus,
Scorpæna,	Sciæna,	Trigla
Zeus,	Perca,	Lonchiurus.

THORACIC DUCT. See ANATOMY.

THORAX. See ANATOMY.

The thorax of insects is the back part of the breast. See ENTOMOLOGY.

THORNBACK. See RAIA.

THOUINIA, a genus of plants of the class diandria, and order monogynia. The corolla is quadripetalous, the calyx quadripartite, and the antheræ sessile. There is only one species, a tree of Madagascar.

THRASHING, or THRESHING, in agriculture, the art of beating the corn out of the ears.

THRASHING-MACHINES. The thrashing of corn by means of machinery, has been long in use in the northern districts of the kingdom, and mills of this sort are now becoming general in most parts of the country; and upon arable farms of considerable extent they cannot but be highly advantageous, as they save much labour and expence. In the making of those machines, attention should always be had to the size of the farms, or or rather the quantity of grain that may be grown on them, and the mill proportioned accordingly. They are mostly constructed on the principles of the flax-mill, and are moved either by water or horses, the first by far the best method where it can be had; the grain by these machines being, in a manner, swingled out of the ears by means of beaters which are attached to a cylinder that moves with very great velocity. Since the introduction of these machines, many improvements have been made on them; a screen has been added for the grain to pass through into a winnowing-machine, and a circular rake to remove the straw from it; as before this addition the straw was forced out from the beater upon the upper barn-floor, and required much time and labour in shaking and putting into order, which by this contrivance is saved. In working these mills, four persons are commonly necessary; one takes the sheaf from the stack, another places it ready for the third who is to feed the mill, and the fourth removes the straw to prevent its collecting in too large a quantity. It has been objected to these machines, that they do not thrash some sorts of grain clean; this has been particularly the case with barley. It is, however, observed by an intelligent writer, that the circumstance on which the good thrashing of this kind of grain depends, is the iron covering under which the beating-wheel, having six beaters, moves: in some machines this is fixed, while the beating-wheel is capable of being raised or depressed at pleasure; but a recent improvement is, to render the iron roof moveable, and the wheel fixed; and the iron is placed so near to the beaters that the grain is rubbed, as well as stricken out of the ear. In some machines of this sort, the heaters are a little rounded; but it is probably a better practice to have them of the common flat form.

In some large mills of this kind the rollers take in about three hundred inches of grain in a minute. The medium length of the straw being estimated at about thirty inches, and supposing half a sheaf to be introduced into the machine at a time, the whole sheaf will be equal to sixty inches, and the machine, when supplied with a middling quantity of water, will thrash five sheaves in a minute. But in respect to the performance of these mills much must depend on the attention with which they are fed, as a small neglect in this point will make a very considerable difference in the quantity of work done.

An excellent description of a mill of this nature is given in a late publication, in which it is remarked, that in such mills five people are commonly necessary to keep the work going on without embarrassment; but that this depends greatly on the construction of the machines, some of them being so contrived, that the work can be performed with much fewer hands. The manner in which these people are employed is this: One finds constant work in carrying the sheaves to the man who feeds or puts the unthrashed corn into the machine, and in loosing the bands; another is required to feed the machine; a third to carry off the straw; the fourth to attend the fanners, and lay aside the cleaned grain; and a fifth, where horses are made use of, to take care that they go regularly; and thus by means of five men and four horses they will thrash at the rate of five quarters in the hour on a medium, and when the crop is rich, and easily thrashed, considerably more: consequently if a thrashing-mill was to be employed for a whole day, or nine hours, it would thrash forty-five quarters; but in that case it would be necessary to employ two sets of horses. The expence is calculated in this manner:

	£.	s.	d.
Hire of eight horses, at 2*s.* 6*d.* each per day, -	1	0	0
Five men's wages, at 1*s.* 6*d.* each,	0	7	6
	£1	7	6

In this account the hire of the men and horses is, it is conceived, charged at the lowest rate, and that the expence of thrashing forty-five quarters of grain would cost about 1*l.* 7*s.* 6*d.* or about 7*d.* each quarter. But that taking the average expence of thrashing forty-five quarters of grain with the flail, throughout the whole kingdom, including an equal proportion of all kinds, it cannot be, it is supposed, estimated at less than 3*l.* 7*s.* 6*d.* or 1*s.* 6*d.* each quarter, which makes a difference of about 11*d.* each quarter. It is also farther observed, that since the introduction of these mills, the grain is thrashed by the ordinary servants on the farm, and without in any material degree obstructing the operations in the field; farmers in general employing their men and horses in this business in bad weather, when other operations cannot be carried on.

The whole expence of constructing a thrashing-mill, including the building of the shed for covering the great wheel, does not, in almost any case, exceed 100*l.* The ordinary annual repairs may, one year with another, amount to 5*l.*, which added to the interest of the prime cost, makes the yearly expence 10*l.*; a sum for which any quantity of grain, however great, that may be supposed to grow on one farm, can be thrashed, and that too in a manner much superior to what can be done by manual labour. The expence either of erecting these machines, or of keeping them afterwards in repair, must be considered by every intelligent occupier of a corn-farm as a secondary object, when compared with the advantages that are derived from them; such as the performing of the operation at less than half the ordinary price, and affording the farmer the means of securing his grain from being embezzled; besides, the saving, in regard to superior clean thrashing, as has been now well ascertained, is not only more than the annual expence of repairs, but so great as, on a farm of considerable extent, to reimburse the farmer for the whole of his expenditure in the course of a few years. Considering, therefore the increasing scarcity of labourers, and the recent great advance in the rate of labour in all the better cultivated parts of the kingdom, the introduction of thrashing-mills into common use cannot but be highly beneficial.

There is, however, one difficulty in the introduction of thrashing-mills into the southern parts of the kingdom, which arises from the manner of harvesting all kinds of grain, except wheat, which cannot probably be easily removed; as the corn, in order to be clean thrashed, should be put into the machine as straight and regular as possible. For while the sheaves, after being loosened and spread on the board, so as to be easily taken in by the feeding rollers, are passing between them, they keep the straw steady, by which means the strokes of the beaters or scutchers operate with more force and effect in separating the grain from the ears; whereas, if the unthrashed corn goes in sideways or irregularly, the thrashers can have but little power upon it. This would no doubt frequently happen in thrashing corn which has been mowed with the scythe, and which is harvested in every respect like hay; so that unless the unthrashed grain is put into the mill in small quantities, it is almost impossible that it can be completely separated from the straw.

But though, when the size of the machine is considerable, the expence of erecting it may be from eighty to one hundred pounds, according to situation and materials, smaller ones may be erected at much less, as from thirty to fifty pounds.

Some of this kind of mills have rollers or small mill-stones added to them, for the purpose of crushing and grinding grain for horses, swine, and other animals; and also instruments for cutting straw into chaff.

On the necessity of employing machines of this kind, it is remarked by an able writer, that it is the only method left for having the corn cleanly and properly thrashed. They are so quick in the work, that the whole may be done under the eye of the master, and the corn secured in the granary without the least pilfering. The saving, by this means of thrashing, in the extra quantity of corn procured, and the security against having the corn stolen in the chaff, it is asserted, amounts to an advantage in favour of the mills of about ten per cent on the corn-crops; in some cases, to one shilling a bushel on wheat, and very generally to twenty shillings an acre on the wheat-crops.

This machine has undoubtedly many advantages over the flail, as well as those of saving time and hands; as in thrashing damp corn, not capable of being fully accomplished in any other way, especially in wet seasons; and with smutty wheat, which is thrashed by it without any mischief being done to the sound grain, the smut not being crushed comes out whole, and is blown away with the chaff.

The principal objections that have been made to these machines, are the great expence of erecting and using them, their tendency to diminish the labour of the poor, and their affording too great a supply of straw at a time. These objections are, however, of little consequence, when the general utility and advantages of such machines are considered; besides the latter are either such as have nothing to be apprehended from them, or as may be readily obviated. The difficulty in regard to the straw may be easily removed, by having it properly stacked up or cut into chaff.

THRAVE, or THREAVE *of corn*, twenty-four sheaves, or four shocks of six sheaves to the shock, though, in some counties, they only reckon twelve shocks to the thrave.

THREAD, a small line made up of a number of fine fibres of any vegetable or animal substance, such as flax, cotton, or silk; from which it takes its name of linen, cotton, or silk thread.

Linen and cotton thread may be dyed of a durable and deep black by a solution of iron in sour beer, in which the linen is to be steeped for some time, and afterwards boiled in madder. See the article DYEING. Thread may be easily bleached by the oxymuriatic acid discovered by Mr. Scheele. This acid whitens cloth remarkably well, but it is still more advantageous for bleaching thread.

THREATENING LETTER. If any person shall send any letter threatening to accuse any other person of a crime punishable with death, transportation, pillory, or other infamous punishment, with a view to extort money from him, he shall be punished at the discretion of the court, with fine, imprisonment, pillory, whipping, or transportation. 80 G. II. c. 24. But if the writer of a threatening letter delivers it himself, and does not send it, he is guilty of felony under this act. Leach's Cro. Law, 351.

THRINAX, *small Jamaica fan-palm*; a genus of plants of the natural class of palmæ and order of flabellifoliæ. The calyx is sexdentate; there is no corolla; there are six stamina; the stigmas are emarginate, and the berry monospermous. This plant was brought from Jamaica to Kew gardens by Dr. William Wright.

THRIPS, a genus of the order hemiptera: the generic character is, snout inconspicuous; antennæ the length of thorax; body linear, abdomen reflexile upwards; wings four, straight, long, narrow, incumbent on the back, slightly crossed. This is a genus consisting of very small insects, which are principally found on flowers. The antennæ are submoniliform, and of the length of the thorax; the snout is obscure or inconspicuous, short, and placed beneath the neck or head; the body of a lengthened or sublinear shape, and the abdomen is at pleasure bent upwards or backwards; the wings are four in number, long, narrow, incumbent, and very slightly, or scarcely, crossed over each other.

The most familiar example of the genus is the thrips physapus of Linnæus, which is a very small slender insect, of a black colour, very frequently seen during the spring and summer on various flowers, more especially on what are termed the compound flowers, as dandelion, &c. It wanders about the petals of the flower, descending to the bottom of the florets, occasionally emerging at intervals, and often skipping from place to place, in performing which action it is observed suddenly to turn back its abdomen, so as nearly to touch the thorax with its tip. The wings are of a semitransparent white, narrow, and when properly magnified, are observed to be edged and tipped with hairs growing gradually longer as they approach the tips, where they are of considerable length: the lower wings are rather shorter than the upper, beneath which they are, in general, almost concealed; the antennæ consist of six joints, and the feet are tipped with an expansile and apparently vesicular process, enabling the little animal to adhere at pleasure with the greater security to any particular substance. All these particulars require a microscope for their investigation, the whole insect not exceeding the tenth of an inch in length. The larva in a great degree resembles the complete insect, but is destitute of wings; when very young it is white, and afterwards of a yellowish or reddish colour, and like the complete insect, is seen wandering about the petals of flowers.

The thrips physapus has been supposed to do much injury to wheat, rye, &c. by causing the young flowers to decay, thus preventing the growth of the embryo grain. This opinion, however, has by some been considered as erroneous; who have contended that the thrips does not attach itself to such of the cerealia as are in a perfect healthy state, but rather to such as are diseased by having the germina covered with the dust of a very minute fungus, often growing on wheat, &c. and belonging to the genus æcidium or lycoperdon, and which makes its appearance in the form of a flattish, smooth, irregular exsudation, of a yellow colour, on various parts of the plant. See TRITICUM. The ingenious Mr. Kirby, however, seems convinced that the thrips is in reality an insect highly injurious to corn, by deriving its nourishment from the embryo grains. There are eight species.

THRUSH. See TURDUS.

THRYALLIS, a genus of plants of the class decandria, and order monogynia; and in the natural system ranging under the 38th order, tricoccæ. The calyx is quinquepartite, there are five petals, and the capsule is tricoccous. There is only one species known, the brasiliensis, a shrub of Brasil.

THUJA, the *arbor vitæ*, a genus of plants of the class monadelphia, and order monœcia; and in the natural system ranging under the 51st order, coniferæ. There are four species known; the orientalis, occidentalis, articulata, and dolabrata; of which the two first are most remarkable. 1. The occidentalis or common arbor vitæ, grows naturally in Canada, Siberia, and other northern countries. In some of the English gardens a few of these trees are to be met with of a large size; it has a strong woody trunk, which rises to the height of 40 feet or more. The bark, while young, is smooth, and of a dark-brown colour; but as the trees advance, the bark becomes cracked, and less smooth. The branches are produced irregularly on every side, standing almost horizontal, and the young slender shoots frequently hang downward, thinly garnished with leaves; so that when the trees are grown large, they make but an indifferent appearance. The leaves of this tree have a rank oily scent when bruised. 2. The orientalis, or China arbor vitæ, grows naturally in the northern parts of China, where it rises to a considerable height; but this has not been long enough in Europe to have any trees of large size. The seeds of this sort were first sent to Paris by some of the missionaries; and there are several of the trees growing in the gardens of the curious there, which are more than twenty feet high. The branches of this sort grow closer together, and are much better adorned with leaves, which are of a brighter-green colour, so as to make a better appearance than the other; and being very hardy, it is esteemed preferable to most of the evergreen trees with small leaves, for ornament in gardens. These trees are propagated by seeds, layers, or cuttings.

THUMMERSTONE. This stone was first described by Mr. Schreber, who found it near Balme D'auris in Dauphiné, and gave it the name of shorl violé. It was afterwards found near Thum in Saxony, in consequence of which Werner called it thummerstone. It is sometimes amorphous, but more commonly crystallized. The primitive form of its crystals is a rectangular prism, whose bases are parallelograms with angles of 101° 32 and 78° 28. The most usual variety is a flat rhomboidal parallelopiped, with two of its opposite edges wanting, and a small face in place of each. The faces of the parallelopiped are generally streaked longitudinally.

The texture of thummerstone is foliated. Its fracture conchoidal. Glassy. Causes simple refraction. Specific gravity 3.2956. Colour clove-brown; sometimes inclining to red, green, grey, violet, or black. Before the blowpipe it froths like zeolite, and melts into a hard black enamel. With borax it exhibits the same phenomena, or even when the stone is simply heated at the end of a pincer.

A specimen of thummerstone, analysed by Klaproth, contained

52.7 silica
25.6 alumina
9.4 lime
9.6 oxide of iron, with a trace of manganese.

97.3.

A specimen, analysed by Vauquelin, contained

44 silica
18 alumina
19 lime
14 oxide of iron
4 oxide of manganese

99.

THUNDER. See ELECTRICITY.

THUNBERGIA, a genus of plants belonging to the class and order didynamia angiospermia. The calyx is double; the corolla bell-shaped; capsules beaked. There are 2 species.

THUS. See RESINS.

THYMBRA, a genus of the class and order didynamia angiospermia. The calyx is two-lipped; seeds semibifid. There are 3 species.

THYMUS, THYME, a genus of plants of the class didynamia, and order gymnospermia; and in the natural system ranging under the 42d order, verticillatæ. The calyx is bilabiate, and its throat closed with soft hairs. There are 22 species; of which only two are natives of Britain, the serpyllum and acinas. 1. The serpyllum, or mother of thyme, has pale red flowers growing on round heads, terminal; the stalks are procumbent, and the leaves plane, obtuse, and ciliated at the base. 2. The acinas, or wild basil, has flowers growing in whorls on single footstalks; the stalks are erect and branched; the leaves acute and serrated. The thymus vulgaris, or garden thyme, is a native of France, Spain, and Italy. The attachment of bees to this and other aromatic plants is well known. In the experiments made at Upsal, sheep and goats were observed to eat it, and swine to refuse it.

THYMUS, in anatomy, a gland, which in infants is very remarkable; it is situated in the upper part of the thorax, immediately under the sternum, and lies upon the pericardium, and on the trunk of the aorta and of the vena cava. See ANATOMY.

THYNNUS, a genus of the hymenoptera order of insects. The generic character is, mouth horny, with an incurved mandible; the jaw short and straight; lip longer than the jaw, membranaceous at the tip, and trifid, the middle divison emarginate; tongue very short, involute; feelers four, equal, filiform; antennæ cylindrical, the first joint thicker. There are four species, three inhabiting New Holland, and the fourth is found in Africa.

THYROID GLAND. See ANATOMY.

THYRSUS, in botany, a mode of flowering resembling the cone of a pine.

TIARELLA, a genus of plants of the class decandria, and order digynia, and in the natural system ranging under the 13th order, succulentæ. The calyx is quinquepartite; the corolla pentapetalous, and inserted into the calyx; the petals are entire; the capsule is unilocular and bivalve, one valve being less than the other. There are two species, the cordifolia and trifoliata, natives of North America.

TIBIA. See ANATOMY.

TIBIALIS, or TIBIÆUS. See ANATOMY.

TIDES. See ASTRONOMY.

TIDE-WAITERS, or *tidesmen*, are inferior officers belonging to the custom-house, whose employment it is to watch or attend upon ships, until the customs are paid; they get this name from going on board ships on their arrival in the mouth of the Thames or other port, and so coming up with the tide.

TIERCE, or TEIRCE, a measure of liquid things, as wine, oil, &c. containing the third part of a pipe, or forty-two gallons. See MEASURE.

TIGER. See FELIS.

TIGER-SHELL, a beautiful species of voluta, of a dusky-red colour, spotted all over with large irregular blotches of white: it is brought from the East Indies, and is about two inches and a half in length, and about an inch in diameter.

TILE, in building, a sort of thin brick, used on the roofs of houses; or more properly a kind of clayey earth, kneaded and moulded of a just thickness, dried and burnt in a kiln, like a brick, and used in the covering and paving of different kinds of military and other buildings. The best brick-earth only should be made into tiles.

The tiles for all sorts of uses may now be comprised under seven heads, viz. 1. The plain tile for covering of houses, which is flat and thin. 2. The plain tile for paving, which is also flat, but thicker; and its size 9, 10, or 12 inches. 3. The pan-tile, which is also used for covering of buildings, and is hollow, and crooked, or bent, somewhat in the manner of an S. 4. The Dutch glazed pan-tile. 5. The English glazed pan-tile. 6. The gutter-tile, which is made with a kind of wings. And 7. The hip or corner-tile.

TILES, *plain*, are best when they are firmest, soundest, and strongest. Some are duskier, and others ruddier, in colour. The dusky-coloured are generally the strongest. These tiles are not laid in mortar, but pointed only in the inside.

TILES, *paving*, are made of a more sandy earth than the common or plain tiles; the materials for these last must be absolute clay, but for the others a kind of loam is used. These are made thicker and larger than the common roof-tiles; and when care has been taken in the choice of the earth, and the management of the fire, they are very regular and beautiful.

TILES, *pan*, when of the best kind, are made of an earth not much unlike that of the paving-tiles, and often of the same; but the best sort of all is a pale-coloured loam that is less sandy; they have about the same degree of fire given them in the baking, and they come out nearly of the same colour. These tiles are laid in mortar, because the roof being very flat, and many of them warped in the burning, they will not cover the building so well that no water can pass between them.

TILES, *pan, Dutch glazed*, get the addition of glazing in the fire. Many kinds of earthy matter running into a glassy substance in great heat, is a great advantage to them; preserving them much longer than the common pan-tiles, so that they are very well worth the additional charge that attends the using them.

TILES, *pan, English glazed*, are in general not so good as the Dutch ones under that denomination, but the process is nearly the same.

TILES, *Dutch*, for chimneys, are of a kind very different from all the rest. They are made of a whitish earth, glazed and painted with various figures, such as birds, flowers, or landscapes, in blue or purple colour, and sometimes quite white; they are about 6.5 inches each way, and three quarters of an inch thick. They are seldom used at present.

TILES, *gutter*, are made of the same earth as the common pan-tiles, and only differ from them in shape; but it is advisable that particular care is taken in tempering and working the earth for these, for none are more liable to accidents. The edges of these tiles are turned up at the larger ends for about four inches. They are seldom used where lead is to be had.

TILES, *hip* or *corner*, are at first made flat, like pan-tiles of a quadrangular figure, whose two sides are right lines, and the ends arches of circles; the upper end concave, and the lower convex the latter being about seven times as broad as the other; they are about 10.5 inches long; but before they are burnt, are bent upon a mould in the form of a ridge tile, having a hole at the narrow end, to nail them on the hip-corner of the roof.

TILES, *ridge*, are used to cover the ridges of houses, and are made in the form of a semi-cylindrical surface, about 13 inches in length, and of the same thickness as plain tiles; their breadth at the outside measures about sixteen inches.

TILIA, *lime*, or *linden-tree*, a genus of plants of the class polyandria, and order monogynia, and in the natural system ranging under the columniferæ. The calyx is quinquepartite; the corolla pentapetalous; the caps. is dry, globose, quinquelocular, quinquevalve, and opening at the base. There are four species; the europæa, americana, pubescens, and alba. The europæa, or common lime-tree, is generally supposed to be a native of Britain; but we are informed by Mr. Coxe, that Mr. Pennant told him (on what authority is not mentioned) that it was imported into England before the year 1652. The wood is light, smooth, and of a spongy texture, used for making lasts and tables for shoemakers, &c. Ropes and bandages are made of the bark, and mats and rustic garments of the inner rind, in Carniola and some other countries. The lime-tree contains a gummy juice, which being repeatedly boiled and clarified, produces a substance like sugar.

TILLANDSIA, a genus of the hexandria monogynia class of plants, with a tubulated monopetalous flower, trifid at the limb; the fruit is a long, obtusely trigonal, and acuminated capsule, formed of three valves, and containing only one cell, with numerous seeds affixed to a long capillary plume. There are 16 species.

TILLER *of a ship*, a strong piece of wood fastened in the head of the rudder, and in small ships and boats called the helm.

In ships of war, and other large vessels, the tiller is fastened to the rudder in the gun-room; and to the other end there are ropes fastened, which pass upwards to the quarter-deck, where the ship is steered by means of a wheel.

TILLŒA, a genus of plants of the class tetrandria, and the order tetragynia, and in the natural system ranging under the 13th order, succulentæ. The calyx has three or four divisions; the petals are three or four, and equal; the capsules three or four, and polyspermous. There are eight species, of which one only, the muscosa, is a native of England. The muscosa, or procumbent tillœa, has prostrate stems, almost erect, generally red, and growing longer after flowering. The parts of fructification are always three. The leaves grow in pairs, and are fleshy. It is found on dry heaths in Norfolk and Suffolk, and flowers in May and June.

TILLAGE. See HUSBANDRY.

TILT-BOAT, a boat covered with a tilt, that is, a cloth or tarpawlin, sustained by hoops, for the sheltering of passengers.

TIMBER, includes all kinds of felled and seasoned woods. See ACER, BETULUS, FRAXINUS, QUERCUS, PINUS, PLATANUS, POPULUS, ULMUS, &c.

Of all the different kinds known in Europe, oak is the best for building, and even when it lies exposed to air and water, there is none equal to it. Fir-timber is however perhaps more generally useful than any other. It is used for flooring, wainscoting, and the ornamental parts of building within doors. Elm is the next in use, especially in England and France; it is very tough and pliable, and therefore easily worked; it does not readily split; and it bears driving of bolts and nails better than any other wood. Ash is chiefly used by wheelwrights and coachmakers, for shafts, naves, &c. Beech is also used for many purposes; it is very tough and white when young, and of great strength, but liable to warp very much when exposed to the weather, and to be worm-eaten when used within doors; its greatest use is for planks, bedsteads, chairs, and other household goods. Wild-chesnut timber is by many esteemed to be as good as oak, and seems to have been much used in old buildings; but whether these trees are more scarce at present than formerly, or have been found not to answer so well as was imagined, this timber is now but little used. Walnut-tree is excellent for the joiner's use, it being of a more curious brown colour than beech, and not so subject to the worms. The poplar, abel, and aspen-tree, which are very little different from each other, are sometimes used instead of fir, but mostly by turners, &c. The goodness of timber not only depends on the soil and situation in which it stands, but likewise on the season wherein it is felled. In this, people disagree very much; some are for having it felled as soon as its fruit is ripe, others in the spring, and many in the autumn. But as the sap and moisture of timber are certainly the causes that it perishes much sooner than it otherwise would do, it seems evident that timber should be felled when there is the least sap in it, viz. from the time that the leaves begin to fall, till the trees begin to bud. This work usually commences about the end of April in England, because the bark then rises most freely; for where a quantity of timber is to be felled, the statute requires it to be done then, for the advantage of tanning.

After timber has been felled and sawed, it must be seasoned; for which purpose some advise it to be laid up in a very dry airy place, yet out of the wind and sun, or at least free from the extremities of either; and that it may not decay, but dry evenly, they recommend it to be daubed over with cow-dung. It must not stand upright, but lie all along, one piece over another, only kept apart by short blocks interposed, to prevent a certain mouldiness which they are otherwise apt to contract in sweating on one another; from which arises frequently a kind of fungus, especially if there are any sappy parts remaining. Others advise the planks of timber to be laid for a few days in some pool or running stream, in order to extract the sap, and afterwards to dry them in the sun or air. By this means, it is said, they will be prevented from either chopping, casting, or cleaving, but against shrinking there is no remedy. Some again are for burying them in the earth, others in a heat; and some for scorching and seasoning them in fire, especially piles, posts, &c. which are to stand in water or earth. The Venetians first found out the method of seasoning by fire, which is done after this manner: they put the piece to be seasoned into a strong and violent flame, in which they continually turn it round by means of an engine, and take it out when it is every where covered with a black coaly crust; when the internal part of the wood is so hardened, that neither earth nor water can damage it for a long time afterwards.

After the planks of timber have been well seasoned and fixed in their places, care is to be taken to defend or preserve them; to which the smearing them with linseed-oil, tar, or other oleaginous matter, contributes much.

To measure round timber, let the mean circumference be found in feet and decimals of a foot; square it, multiply this square by the decimal 0.079577, and the product by the length. Ex. Let the mean circumference of a tree be 10.3 feet, and the length 24 feet. Then $10.3 \times 10.3 \times 0.079577 \times 24 = 202.615$, the number of cubical feet in the tree. The foundation of this rule is, that when the circumference of a circle is 1, the area is 0.0795774715, and that the areas of circles are as the squares of their circumferences.

But the common way used by artificers for measuring round timber, differs much from this rule. They call one-fourth part of the circumference the girt, which is by them reckoned the side of a square whose area is equal to the area of the section of the tree; they therefore square the girt, and then multiply by the length of the tree. According to their method, the tree of the last example would be computed at 159.13 cubical feet only.

For measuring hewn or square timber, the custom is to find the middle of the length of the tree, and there to measure its breadth, by clapping two rules to the sides of the tree, and measuring the distance betwixt them; in like manner they measure the breadth the other way. If the two are found unequal, they are added together, and half their sum is taken for the true side of the square.

TIMBER, *strength of.* "After spending much time," says Mr. Smart, "in making various experiments, and comparing the results with those of Buffon, Belidore, &c. the differences were so great, that it would be wasting time to enumerate them: I shall therefore only mention some useful observations necessary to be known by all those mechanics who use timber; and point out some evident errors in a table of Belidore's, supposed to be the result of the best set of experiments ever produced in transverse strains. He tells us, that a bar of wood, thirty-six inches long, and one inch square, supported at the ends by two props, will break with a weight of 187 pounds on the middle, if it is loose at the ends; but if the ends are firmly fixed, it will require 283 pounds to break it. "This appeared to me so great an error, that I was induced to put little or no confidence in many of his experiments; and, in consequence, I made two laths of fir, of the same dimensions, one with a strong shoulder at each end, to prevent its bending, which having firmly fixed in a frame, it carried a weight more than ten times greater than that which was loose."

The fibres of timber requiring so great a force to tear them asunder in a vertical direction, and being easily broken by a transverse strain, when compared to that of a rope carrying nearly an equal weight in all directions, opens a wide field for useful experiments. All timber-trees have their annual circles, or growths, which vary greatly according to the soil and exposure to the sun. The north-east side of the trees (being much smaller in the grain than the other parts, which are more exposed to the sun) is strongest for any column that has a weight to support in a vertical direction; because its hard circles, or tubes, are nearer each other, and the area contains a greater quantity of them; nor are they so liable to be compressed by the weight, or to slide past each other, as when they are at a greater distance. On the other hand, this part of the tree is not fit for a transverse strain; because the nearer the hard circles are to each other, the easier the beam will break, there being so little space between them, that one forms a fulcrum to break the other upon: but that part of a tree, the tubes of which are at a greater distance, or of larger grain, is more elastic, and requires a greater force to break it; because the outside fibre on the convex side; cannot snap till the next one is pressed upon it, which forms the fulcrum to break it on. It is generally observed in large timbers, such as masts, that the fracture is seldom on the convex, but usually on the concave side; which is owing to the fibres on the concave side being more readily forced past each other, and those on the convex being so difficult to be torn asunder, that they cannot snap, in consequence of the largeness of the segment of the circle they describe when on the strain. The curve described by the inner layers of the wood being so large, and indeed little less than a straight line, cannot form a fulcrum to break the outer ones upon; and as the convex side, or that on which the fibres are extended, ought to be always free from any mortise or incision on the outside, the strength decreases as it approaches the centre.

Figs. 6, 7, 8, 9, and 10, Plate Ship-building, describe the simple method invented by Mr. George Smart, of converting all timber that is straight, and intended for square beams, to great advantage in general use. Fig. 8 is a section of the but-end of a tree, two feet in diameter, sawn or chopped diagonally. Fig. 9 is the other end, sawn square, one foot each side: cut it exactly through the centre in two cross-cuts *ab*, *de*, it will produce four pieces; which are put together, as in figs. 6 and 7, with the centre turned outwards, the but-end of one piece with the small end of the other, and dowel or bolt them together as fig 10: you will then form a beam, whose section is shewn in figs. 6 and 7, regular from one end to the other, with the advantage of having the heart of the tree in the place where the hardness and strength are most wanted, viz. in the corners which form the abutments; whereas, the same tree squared into a parallel beam, would have been much smaller, and the soft or sappy parts of the wood exposed to the action of the air and moisture. In flush-framing it is observable, that the failure of all timber in old buildings has commenced much sooner than they otherwise would have done, owing to the sappy wood being at the corners of the principal beams, which soon decays, as its spongy quality attracts the moisture; whereas the heart, especially of oak, will be as sound as the first day it was used.

As all beams take their weight horizontally, or on any transverse bearing, have their principal strain on the upper and lower surface, every workman ought to guard against having sap in beams, because if they do not immediately decay, they shrink, so as to let loose all the framing, and soon cripple the building or machine: but on Mr. Smart's plan the sappy part of the wood is excluded from what would cause its decay, and the timber increased in quantity is considerably more than the extra labour and expence.

A tree of oak, forty feet long and two feet diameter at the but-end, and one foot at the top, when put together on this plan, will have its sides each 18 inches square, which contains 90 feet; whereas, on the old plan 40 would be the content of a square beam, cut from the same tree; 50 cubic feet would have been cut off as slabs, or chopped up for the fire. The expence of sawing and putting a beam of the above dimensions in London in the year 1802 would have been as follows:

	l.	*s.*	*d.*
Four outside cuts at 14 inches deep; Two breaking, cut at 18; Length 40 feet, 306 feet sawing at 7*s.* 6*d.*	1	3	0
120 12-inch dowels, at 1*d.* each	0	10	0
Boring 240 holes, and putting together - -	1	5	0
	2	18	0

Allowing the 50 feet saved to be worth 6*l.* then the proprietor would save 3*l.* 2*s.* in each beam so converted. The dowels ought not to go through, as that would weaken the timber. In an 18-inch beam the dowels should come within three inches of the outside; but where a mortise is cut in place of a dowel, it is proper to have an iron screw bolt to prevent the joint opening with the pressure of the tennon; and the work ought to be put together with screw clamps, for nails or hammers bruise the wood, and destroy he cohesion of its fibres for a considerable depth. The method we are here describing is included in Mr. Smart's patent for hollow masts described in our article SHIP; yet, as far as relates to lessening the consumption of English oak, and introducing the larch and firs of our own growth into general use, Mr. Smart has liberally granted licences to all who chose to apply to him for them, masts, yards, bowsprits, &c. excepted.

TIMBER TREES, in law, are properly oak, ash, and elm. In some particular countries, by local custom, other trees being commonly there made use of for building, are considered as timber. 2 Black. 28. Of these, being part of the freehold, larceny cannot be committed; but if they are severed at one time, and carried away at another, then the stealing of them is larceny. And by several late statues the stealing of them in the first instance is made felony, or incurs a pecuniary forfeiture. 4 Black. 233.

For the better preservation of roots, shrubs, and plants, it is by the 6 G. III. c. 48, enacted, that from and after the 24th day of June, 1766, every person convicted of damaging, destroying, or carrying away any timber tree or trees, or trees likely to become timber, without consent of the owner, &c. shall forfeit for the first offence not exceeding 20*l.* with the charges attending; and on non-payment shall be committed for not more than twelve, nor less than six, months; for the second offence, a sum not exceeding 30*l.* and on non-payment shall be committed for not more than eighteen, and not less than twelve, months; and for the third offence is to be transported for seven years. All oak, beech, chesnut, walnut, ash, elm, cedar, fir, asp, lime, sycamore, and birch, trees, shall be deemed and taken to be timber-trees within the intent of this act.

By the same act, the plucking or spoiling of roots, shrubs, or plants, is subject to a fine of 4*l.* for the first offence, and 5*l.* for the second, and transportation for the third. Justices of peace are to put this act in execution.

TIME, in music, is an affection of sound, by which we denominate it long or short, with regard to its continuauce.

Common, or double time, is of two species. 1. When every bar or measure is equal to a semibreve, or its value in any combination of notes of a lesser quantity. 2. When every bar is equal to a minim, or its value in lesser notes. The movements of this kind of measure are various, but there are three common distinctions; the first slow, signified by the mark C; the second brisk, signified by ₵; the third very quick, signified by ₵.

The old musicians were acquainted with no more than two sorts of time: one of three measures in a bar, which they called perfect; and the other of two, considered as imperfect. When the time was perfect, the breve was equal to three semibreves, which was expressed by an entire circle, barred or not barred, and sometimes also by this compound character $\frac{3}{1}$. When the time was imperfect, the breve was equal only to two semibreves, which was indicated by a semicircle, or C. Sometimes the C was reversed, as thus Ɔ, which signified a diminution, by one-half, of the powers of the notes; a particularity sometimes denoted in the more modern music by a perpendicular bar drawn through the character, as thus ₵. The time of the full C was generally called the major time, and that of the reversed Ɔ the minor time.

The moderns have added to the old music a combination of times; but still we may say that we have no more than two times, common and triple: since the time of nine crotchets, or nine quavers in a bar, is but a species of triple time; and that of six crotchets, or six quavers in a bar, though called a compound common time, being measured by two beats, one down and one up, is as absolutely common time as that of four crotchets in a bar.

With respect to the velocities of the different species of time, they are as various as the measures and modifications of music, and are generally expressed by some Italian word or phrase at the beginning of each movement, as larghetto (rather slow), presto (quick), &c. But when once the time of the improvement is determined, all the measures are to be perfectly equal, that is, every bar is to take up the same quantity of time, and the corresponding divisions of the bars are to be perfectly symmetrical with respect to each other.

TIME-KEEPERS, in a general sense, denote instruments adapted for measuring time. See CHRONOMETER.

In a more peculiar and definite sense, time-keeper is a term first applied by Mr. John Harrison to his watches constructed for determining the longitude at sea, and for whcih he received, at different times, the parliamentary reward of twenty thousand pounds. Several other artists have since received also considerable sums for their improvements of time-keepers, as Arnold, Mudge, &c. See LONGITUDE.

This appellation is now become common among artists, to distinguish such watches as are made with extraordinary care and accuracy for nautical or astronomical observations.

The principles of Mr. Harrison's time-keeper, as they were communicated by himself to the commissioners appointed to receive and publish the same in the year 1765, are as follow:

"In this time-keeper there is the greatest care taken to avoid friction, as much as can be, by the wheels moving on small pivots, and in ruby-holes, and high numbers in the wheels and pinions.

"The part which measures time goes but the eighth part of a minute without winding up; so that part is very simple, as this winding-up is performed at the wheel next to the balance-wheel, by which means there is always an equal force acting at that wheel, and all the rest of the work has no more to do in the measuring of time than the person that winds up once a day.

"There is a spring in the inside of the fusee, which I will call a secondary main spring. This spring is always kept stretched to a certain tension by the main spring; and during the time of winding up the time-keeper, at which time the main spring is not suffered to act, this secondary spring supplies its place.

"In common watches in general, the wheels have about one-third the dominion over the balance that the balance-spring has; that is, if the power which the balance-spring has over the balance is called three, that from ie wheel is one; but in this time-keeper the heels have only about one-eightieth part of ie power over the balance that the balance-pring has; and it must be allowed, the less ie wheels have to do with the balance, the etter. The wheels in a common watch aving this great dominion over the balance, iey can, when the watch is wound up, and ie balance at rest, set the watch a going; ut when my time-keeper's balance is at rest, nd the spring is wound up, the force of the heels can no more set it a going than the heels of a common regulator can, when the eight is wound up, set the pendulum a ibrating; nor will the force from the wheels iove the balance when at rest, to a greater ngle in proportion to the vibration that it is fetch, than the force of the wheels of a ommon regulator can move the pendulum om the perpendicular, when it is at rest.

"My time-keeper's balance is more than iree times the weight of a large-sized comion watch balance, and three times its diaieter; and a common watch balance goes irough about six inches of space in a second, ut mine goes through about twenty-four ıches in that time; so that had my time-eeper only these advantages over a common atch, a good performance might be expected from it. But my time-keeper is not affectd by the different degrees of heat and cold, or agitation of the ship; and the force from he wheels is applied to the balance in such a ianner, together with the shape of the baınce-spring, and, if I may be allowed the erm, an artificial cycloid, which acts at this pring; so that from these contrivances, let he balance vibrate more or less, all its vibraions are performed in the same time; and herefore if it goes at all, it must go true. So hat it is plain from this, that such a timeeeper goes entirely from principle, and not om chance."

We must refer those who may desire to see minute account of the construction of Mr. Iarrison's time-keeper, to the publication y order of the commissioners of longitude.

We shall here subjoin a short view of the nprovements in Mr. Harrison's watch, from he account presented to the board of longiude by Mr. Ludlam, one of the gentlemen o whom, by order of the commissioners, Mr. Iarrison discovered and explained the prineiple upon which his time-keeper is contructed. The defects in common watches which Mr. Harrison proposes to remedy, are hiefly these: 1. That the main spring acts ıot constantly with the same force upon the wheels, and through them upon the balance. 2. That the balance, either urged with an ınequal force, or meeting with a different reistance from the air, or the oil, or the fricion, vibrates through a greater or less arch. 3. That these unequal vibrations are not performed in equal times. And, 4. That the orce of the balance-spring is altered by a change of heat.

To remedy the first defect, Mr. Harrison ıas contrived that his watch shall be moved by a very tender spring, which never unrolls tself more than one-eighth part of a turn, and acts upon the balance through one wheel only. But such a spring cannot keep the watch in motion a long time. He has, therefore, joined another, whose office is to wind ip the first spring eight times in every minute, and which is itself wound up but once a day. To remedy the second defect, he uses a much stronger balance-spring than in a common watch. For if the force of this spring upon the balance remains the same, whilst the force of the other varies, the errors arising from that variation will be the less, as the fixed force is the greater. But a stronger spring will require either a heavier or a larger balance. A heavier balance would have a greater friction. Mr. Harrison, therefore, increases the diameter of it. In a common watch it is under an inch, but in Mr. Harrison's, two inches and two tenths. However, the methods already described only lessening the errors, and not removing them, Mr. Harrison uses two ways to make the times of the vibrations equal, though the arches may be unequal: one is to place a pin so that the balance-spring pressing against it, has its force increased, but increased less when the vibrations are larger; the other, to give the pallets such a shape, that the wheel may press them with less advantage when the vibrations are larger. To remedy the last defect, Mr. Harrison uses a bar compounded of two thin plates of brass and steel, about two inches in length, riveted in several places together, fastened at one end, and having two pins at the other, between which the balance-spring passes. If this bar is straight in temperate weather (brass changing its length by heat more than steel), the brass side becomes convex when it is heated, and the steel side when it is cold; and thus the pins lay hold of a different part of the spring in different degrees of heat, and lengthen or shorten it as the regulator does in a common watch.

The principles on which Mr. Arnold's time-keeper is constructed are these: The balance is unconnected with the wheel-work, except at the time it receives the impulse to make it continue its motion, which is only whilst it vibrates 10° out of 380°, which is the whole vibration; and during this small interval it has little or no friction, but what is on the pivots, which work in ruby holes on diamonds. It has but one pallet, which is a plane surface formed out of a ruby, and has no oil on it. Watches of this construction, says Mr. Lyons, go whilst they are wound up; they keep the same rate of going in every position, and are not affected by the different forces of the spring; and the compensation for heat and cold is absolutely adjustable.

TIN, a metal known to the antients: the Phenicians procured it from Spain and Britain, with which nations they carried on a very extensive and lucrative commerce. This metal has a fine white colour, like silver; a slight disagreeable taste, and emits a peculiar smell when rubbed. Its specific gravity is 729. It is very malleable. Tin-leaf or foil is about $\frac{1}{1000}$th part of an inch thick, and it might be reduced to half this thickness. It is very flexible, and produces a remarkable crackling noise when bended, and when heated to 442° it melts. When exposed to the air it very soon loses its lustre, and assumes a greyish-white colour, but undergoes no farther change. Neither is it sensibly altered by being kept under cold water; but when the stream of water is made to pass over redhot tin, it is decomposed, the tin is oxidated, and hydrogen gas is evolved.

When tin is melted in an open vessel, its surface becomes very soon covered with a grey powder, which is an oxide of the metal. If the heat is continued, the colour of the powder gradually changes, and at least it becomes yellow. In this state it is known by the name of putty, and employed in polishing glass and other hard bodies. When tin is heated very violently in an open vessel, it takes fire, and is converted into a fine white oxide, which may be obtained in crystals.

Tin is capable of combining with two different proportions of oxygen, and of forming two oxides; usually distinguished, on account of their colour, by the names of the yellow and the white oxide.

The protoxide may be obtained by exposing tin to a strong heat under a muffle, constantly stirring it with a rod. It may be procured also by dissolving tin in diluted nitric acid without the assistance of heat, and then precipitating the oxide by pure potass; but in that case it retains a little acid, and has a white colour. It is composed of about 20 parts of oxygen and 80 of tin.

The peroxide may be obtained by heating tin in concentrated nitric acid. A violent effervescence ensues, and the whole of the tin is converted into a white powder, which is deposited at the bottom of the vessel. It is composed of about 28 parts of oxygen and 72 of tin.

Tin combines with sulphur and phosphorus; but it has never been combined with carbon or hydrogen.

Sulphuret of tin may be formed by throwing bits of sulphur upon the metal melted in a crucible, or by fusing the two ingredients together. It is brittle, heavier than tin, and not so fusible. It is of a blueish colour and lamellated structure, and is capable of crystallizing. According to Bergman, it is composed of 80 parts of tin and 20 of sulphur; according to Pelletier, of 85 parts of tin and 15 of sulphur.

When equal parts of white oxide of tin and sulphur are mixed together and heated gradually in a retort, some sulphur and sulphurous acid are disengaged; and there remains a substance composed of 40 parts of sulphur and 60 of white oxide of tin, formerly called aurum musivum, musicum, or mosaicum, and now sulphureted oxide of tin. It consists of beautiful gold-coloured flakes, exceedingly light, which adhere to the skin. The process for making this substance was formerly very complicated. Pelletier first demonstrated its real composition, and was hence enabled to make many important improvements in the manner of manufacturing it.

Phosphuret of tin may be formed by melting in a crucible equal parts of filings of tin and phosphoric glass. Tin has a greater affinity for oxygen than phosphorus has. Part of the metal therefore combines with the oxygen of the glass during the fusion, and flies off in the state of an oxide, and the rest of the tin combines with the phosphorus. The phosphuret of tin may be cut with a knife; it extends under the hammer, but separates in laminæ. When newly cut, it has the colour of silver; its filings resemble those of lead. When these filings are thrown on burning coals, the phosphorus takes fire. This phosphuret may likewise be formed by dropping phosphorus gradually into melted tin. According to Pelletier, to whose experiments we are indebted for the knowledge of all the phosphurets, it is composed of about

85 parts of tin and 15 of phosphorus. Margraf also formed this phosphuret, but he was ignorant of its composition.

Tin does not combine with azote or muriatic acid; though the last substance converts it into an oxide.

Tin is capable of combining with most of the metals, and some of its alloys are much employed. The greater number of them are brittle. The older metallurgists considered it as a property of tin to render other metals brittle. Hence they called it diabolus metallorum.

1. It mixes readily with gold by fusion; but the proportions in which these metals combine chemically are still unknown. When one part of tin and twelve of gold are melted together, the alloy is brittle, hard, and bad-coloured. Twenty-four parts of gold and one of tin produce a pale-coloured alloy, harder than gold, but possessed of considerable ductility. Gold alloyed with no more than $\frac{1}{37}$ of tin is scarcely altered in its properties, according to Mr. Alchorne; but Mr. Tillet, who more lately examined this alloy, found, that whenever it was heated it broke into a number of pieces. It is very difficult to separate these metals from each other. The method is, to fuse the alloy with sulphuret of antimony.

2. The alloy of platinum and tin is very fusible and brittle, at least when these metals are mixed in equal proportions. Twelve parts of tin and one of platinum form an alloy possessed of considerable ductility, which becomes yellow when expo ed to the air.

3. The alloy of silver and tin is very brittle, hard, and durable. The two metals can scarcely be separated again by the usual processes. This alloy has been applied to no use.

4. Mercury dissolves tin very readily cold; and these metals may be combined in any proportion by pouring mercury into melted tin. The amalgam of tin, when composed of three parts of mercury and one of tin, crystallizes in the form of cubes, according to Daubenton; but, according to Sage, in grey brilliant square plates, thin towards the edges, and attached to each other so that the cavities between them are polygonal. It is used to silver the backs of glass mirrors. See FOLIATION *of looking-glasses*.

5. Tin unites very readily with copper, and forms an alloy exceedingly useful for a great variety of purposes. Of this alloy cannons are made; bell-metal; bronze; and the mirrors of telescopes, are formed of different proportions of the same metals. The addition of tin diminishes the ductility of copper, and increases its hardness, tenacity, fusibility, and sonorousness. The specific gravity of the alloy is greater than the mean density of the two metals. It appears, from the experiments of Mr. Briche, that this augmentation of density increases with the tin; and that the specific gravity, when the alloy contains 100 parts of copper and 16 of tin, is a maximum: it is 8.87. The specific gravity of equal parts of tin and copper is 8.79, but it ought only to be 8; consequently the density is increased 0.79. In order to mix the two metals exactly, they ought to be kept a long time in fusion, and constantly stirred, otherwise the greater part of the copper will sink to the bottom, and the greater part of the tin rise to the surface; and there will be formed two different alloys; one composed of a great proportion of copper combined with a small quantity of tin, the other of a great proportion of tin alloyed with a small quantity of copper.

Bronze and the metal of cannons are composed of from 6 to 12 parts of tin combined with 100 parts of copper. This alloy is brittle, yellow, heavier than copper, and has much more tenacity; it is much more fusible, and less liable to be altered by exposure to the air. It was this alloy which the antients used for sharp-edged instruments before the method of working iron was brought to perfection. The χαλκος of the Greeks, and perhaps the *æs* of the Romans, was nothing else. Even their copper coins contain a mixture of tin.

Bell-metal is usually composed of three parts of copper and one part of tin. Its colour is greyish-white; it is very hard, sonorous, and elastic. The greater part of the tin may be separated by melting the alloy, and then pouring a little water on it. The tin decomposes the water, is oxidated, and thrown upon the surface.

The mirrors of telescopes are formed by melting together three parts of tin and one part of copper. This alloy is very hard, of the colour of steel, and admits of a fine polish. But besides this there are many other compounds used for the same purpose.

Vessels of copper, especially when used as kitchen-utensils, are usually covered with a thin coat of tin, to prevent the copper from oxidating, and to preserve the food which is prepared in them from being mixed with any of that poisonous metal. These vessels are then said to be tinned. Their interior surface is scraped very clean with an iron instrument, and rubbed over with sal ammoniac. The vessel is then heated, and a little pitch thrown into it, and allowed to spread on the surface. Then a bit of tin is applied all over the hot copper, which instantly assumes a silvery whiteness. The intention of the previous steps of the process is, to have the surface of the copper perfectly pure and metallic; for tin will not combine with the oxide of copper. The coat of tin thus applied is exceedingly thin. Bayen ascertained, that a pan nine inches in diameter, and three inches three lines in depth, when tinned, only acquired an additional weight of 21 grains. Nor is there any method of making the coat thicker. More tin indeed may be applied; but a moderate heat melts it, and causes it to run off.

6. Tin does not combine readily with iron. An alloy, however, may be formed, by fusing them in a close crucible, completely covered from the external air. We are indebted to Bergman for the most precise experiments on this alloy. When the two metals were fused together, he always obtained two distinct alloys; the first composed of 21 parts of tin and one part of iron; the second of two parts of iron and one part of tin. The first was very malleable, harder than tin, and not so brilliant; the second but moderately malleable, and too hard to yield to the knife.

The formation of tin-plate is a sufficient proof of the affinity between these two metals. This very useful alloy is formed by dipping into melted tin thin plates of iron, thoroughly cleaned by rubbing them with sand, and then steeping them 24 hours in water acidulated by bran or sulphuric acid. The tin not only covers the surface of the iron, but penetrates it completely, and gives the whole a white colour. See TINNING.

The affinities of tin, and its oxides, are, according to Bergman, as follow:

TIN.	OXIDE OF TIN.
Zinc,	Tartaric acid,
Mercury,	Muriatic,
Copper,	Sulphuric,
Antimony,	Oxalic,
Gold,	Arsenic,
Silver,	Phosphoric,
Lead,	Nitric,
Iron,	Succinic,
Manganese,	Fluoric,
Nickel,	Saclactic,
Arsenic,	Citric,
Platinum,	Lactic,
Bismuth	Acetic,
Cobalt,	Boracic,
Sulphur.	Prussic.

TIN-*stone*, an ore of tin which occurs in masses, in rounded pieces, and crystallized. These crystals are very irregular. Colour dark brown; sometimes yellowish grey, and sometimes nearly white. Somewhat transparent when crystallized. Specific gravity 6.9 to 6.97. Before the blowpipe it decrepitates, and on charcoal is partly reduced. Tinges borax white. According to Klaproth it is composed of

77.50	tin
21.50	oxygen
.25	iron
.75	silica
100.00	

TINCTURE. See PHARMACY.

TINCTURE, in heraldry, the hue or colour of any thing in coat-armour. See HERALDRY.

TINEA. See MEDICINE.

TINNING. Tinning is the art of covering any metal with a thin coating of tin. Copper and iron are the metals most commonly tinned. The use of tinning these metals is, to prevent them from being corroded by rust; as tin is not so easily acted upon by the air or water, as iron and copper are.

What are commonly called tin-plates, or sheets, so much used for utensils of various kinds, are in fact iron plates coated with tin.

The principal circumstance in the art of tinning is, to have the surfaces of the metal to be tinned perfectly clean and free from rust, and also that the melted tin may be perfectly metallic, and not covered with any ashes or calx of tin.

Tinning of iron. When iron plates are to be tinned, they are first scoured, and then put into what is called a pickle, which is sulphuric acid diluted with water; this dissolves the rust or oxyde that was left after scouring, and renders the surface perfectly clean. They are then again washed and scoured. They are now dipped into a vessel full of melted tin, the surface of which is covered with fat or oil, to defend it from the action of the air. By this means, the iron coming into contact with the melted tin in a perfectly metallic state, it comes out completely coated.

When a small quantity of iron only is to be tinned, it is heated, and the tin rubbed on with a piece of cloth, or some tow, having first sprinkled the iron with some powdered resin, the use of which is to reduce the tin that may be oxydated. Any inflammable substance, as oil for instance, will have in some degree the same effect, which is owing to their attraction for oxygen.

Tinning of copper. Sheets of copper may be tinned in the same manner as iron. Copper boilers, saucepans, and other kitchen utensils, are tinned after they are made. They are first scoured, then made hot, and the tin rubbed on as before with resin. Nothing ought to be used for this purpose but pure grain tin; but lead is frequently mixed with the tin, both to adulterate its quality, and make it lie on more easily; but it is a very pernicious practice, and ought to be severely reprobated.

To whiten brass or copper by boiling. Put the brass or copper into a pipkin with some white tartar, alum, and grain tin, and boil them together. The articles will soon become covered with a coating of tin, which, when well polished, will look like silver. It is in this manner that pins, and many sorts of buttons, are whitened.

TINNITUS AURIUM, a noise or buzzing in the ear, when it seems to receive sounds which do not exist, or at least which are not produced by the motion of the external air; and the ear being filled with a certain species of sound, cannot admit other sounds, unless they are very violent. The tinnitus is of two kinds, the one proceeding from a distemperature of the organ of hearing, the other from a disorder of the brain.

TIPHIA, a genus of insects of the order Hymenoptera. The generic character is, mouth with a membranaceous rounded jaw; the mandible arched and acute; no tongue; feelers four, filiform, unequal, and inserted in the middle of the lip; antennæ filiform, short, convolute; sting concealed within the abdomen. There are 27 species.

TIPULA, a genus of insects of the order Diptera. The generic character is, mouth arched over by the upper jaw extended from the head; palpi two, recurved, longer than the head; proboscis recurved, very short.

The larger kinds of tipulæ are, in general, distinguished by their lengthened bodies, horizontally expanded wings, and the unusual length and slenderness of their legs, which are also remarkably fragile; it being difficult to handle the insect without breaking some of its limbs. The smaller kind have incumbent wings, and in habit or general appearance are much allied to gnats, and some are so very small as scarcely to exceed the tenth of an inch in length. The larvæ of this genus differ in habit, according to their different modes of life, some being terrestrial, and others aquatic. They feed on the softer kind of vegetable substances, as the fine fibres of roots, &c. &c.

The largest of the European tipulæ, is the tipula rivosa of Linnæus, often measuring more than an inch and a half in body; and is distinguished by its wings, which are transparent, with large dusky undulations intermixed with white towards the rib or upper edge. This insect proceeds from a dusky or greyish larva of a lengthened form, and destitute of legs. It is found beneath the roots of grass in meadows, gardens, &c. and in the months of July and August changes into a lengthened and pointed chrysalis of a dusky colour, out of which in September proceeds the complete animal. This is popularly known by the title of long-legs, and is frequently seen in houses during the autumnal evenings, when it is remarkable for the propensity, in common with many other insects, of flying towards the flame of candles, and in consequence, often perishing in the blaze.

Tipula hortorum, or the garden tipula, is of somewhat smaller size than the preceding, and is produced from a larva and chrysalis of similar appearance with those of the former kind, but of a darker or blacker colour. The larva is found under grass-roots, &c. The wings of this species are transparent, with obscurely marked whitish variegations.

Tipula oleracea is a very common species, of nearly similar size with the preceding, and with transparent wings with a dusky rib or upper edge. Its larva inhabits garden-grounds, where it commits ravages among various plants. In its appearance it resembles those of the former kinds. It may be added, that the chrysalis, in most of the terrestrial insects of this tribe is furnished at the upper part with a pair of short hornlike processes, perhaps operating as a kind of spiracula; this particularity is however still more striking in those which belong to the aquatic kinds.

The tipula cornicina is of middle size, and has transparent wings with a marginal dusky spot, and the body yellow, with three longitudinal dusky streaks. Its larva, which is found in meadows, &c. is brown, with a flattened or truncated tail, beset with a certain number of radiating soft spines or processes; and the chrysalis is slender, and furnished, as in most others, with minute spines about its segments, by the assistance of which it is enabled to elevate itself to the surface when the time of its ultimate change takes place.

Tipula crocata is one of the few insects of this genus adorned with lively colours. It is of a polished black, with yellow rings round the abdomen.

Of those in which the wings are generally incumbent, the tipula plumosa, so named from its plumed antennæ, may serve as an example. This insect is of the size of a gnat, which it so much resembles in its general appearance as to be frequently mistaken for one: its colour is a greenish brown. The larva is aquatic, bears a considerable resemblance to those of the genus culex, as does likewise the chrysalis or pupa; which, instead of lying dormant during this state, is locomotive, playing about in the water, like the larva, and, at the time of its change, springs to the surface in order to give birth to the complete insect.

Among the very small tipulæ, none is more familiar than the elegant species called by Linnæus tipula phalænoides. This minute fly is very frequently observed in great numbers on windows during the decline of summer, appearing principally in the evening. It has so little the appearance of a genuine tipula, that it would hardly be considered as belonging to this genus by a common spectator. Its general length is about the tenth of an inch; and the wings, which are very large in proportion to the insect, are of an oval shape, and of a grey colour, elegantly mottled or variegated with dusky specks; the edges are deeply fringed with hair, and the nerves beset with oblong scales or feathers, and the whole insect, microscopically examined, exhibits a highly elegant appearance.

Tipula hirta so much resembles the last, that it might perhaps be rather considered as a variety or sexual difference than truly distinct. It is, however, a trifle larger, and of a darker colour. There can be little doubt that the larvæ of these minute species are aquatic, but they seem to be hitherto undescribed. There are 123 species.

TITANIUM, a metal found in black sand, resembling gunpowder, in Cornwall, and upon examination it is found to possess the following properties:

Its colour is orange-red, and it has a good deal of lustre. As it has been only obtained in very small agglutinated grains, neither its hardness, specific gravity, nor malleability, has been ascertained. It is one of the most infusible of metals, requiring a greater heat to melt it than can be produced by any method at present known.

When heated in the open air, it combines readily with oxygen, and seems capable of forming three different oxides; namely, the blue or purple, the red, and the white.

The protoxide, which is of a blue or purple colour, is formed, when titanium is exposed hot to the open air, evidently in consequence of the absorption of oxygen.

The deutoxide or red oxide is found native. It is often crystallized in four-sided prisms. Its specific gravity is about 4.2; and it is hard enough to scratch glass. When heated it becomes brown, and when urged by a very violent fire some of it is volatilized. When heated sufficiently along with charcoal, it is reduced to the metallic state.

The peroxide or white oxide may be obtained by fusing the red oxide in a crucible with four times its weight of potass, and dissolving the whole in water. A white powder soon precipitates, which is the white oxide of titanium. Vauquelin and Hecht have shown that it is composed of 89 parts of red oxide and 11 parts of oxygen.

Titanium does not seem to be capable of combining with sulphur.

Phosphuret of titanium has been formed by Mr. Chenevix by the following process: He put a mixture of charcoal, phosphat of titanium (phosphoric acid combined with oxide of titanium), and a little borax, into a double crucible, well luted, and exposed it to the heat of a forge. A gentle heat was first applied, which was gradually raised for three quarters of an hour, and maintained for half an hour as high as possible. The phosphuret of titanium was found in the crucible in the form of a metallic button. It is of a white colour, brittle, and granular, and does not melt before the blowpipe.

Vauquelin and Hecht attempted to combine it with silver, copper, lead, and arsenic, but without success. But they combined it with iron, and formed an alloy of a grey colour, interspersed with yellow-coloured brilliant particles. This alloy they were not able to fuse.

The affinities of the oxides of titanium are, according to professor Lampadius, as follows:

Gallic acid,	Sulphuric,
Phosphoric,	Muriatic,
Arsenic,	Nitric,
Oxalic,	Acetic.

TITHES, are the tenth part of the increase yearly arising and renewing from the profits of lands, the stock upon lands, and the personal industry of the inhabitants. And hence they are usually divided into three kinds; prædial, mixed, and personal.

Prædial tithes are such as arise merely and immediately from the ground, as grain of all sorts, hay, wood, fruits, herbs; for a piece of land or ground, being called in Latin prædium, whether it is arable, meadow, or pasture, the fruit or produce thereof is called prædial, and consequently the tithe payable for such annual produce is called a prædial tithe.

Mixed tithes are those which arise not immediately from the ground, but from things immediately nourished from the ground; as by means of cattle depastured thereupon, or otherwise nourished with the fruits; as colts, calves, lambs, chickens, milk, cheese, eggs.

Personal tithes are such as arise from the labour and industry of man, employing himself in some personal work, artifice, or negotiation; being the tenth part of the clear gain, after charges deducted. Watts, c. 59. But this is seldom paid in England, except by especial custom.

Tithes with respect to value, are divided into great and small. Great tithes, are corn, hay, wood. Small tithes, are the prædial tithes of all other kinds, together with those that are mixed, and personal.

Tithes of common right belong to that church, within the precincts of whose parish they arise. But one person may prescribe to have tithes within the parish of another; and this is what is called a portion of tithes.

No tithe is due de jure of the produce of a mine, or of a quarry, because this is not a fruit of the earth, renewing annually; but is the substance of the earth, and has perhaps been so for a great number of years. 1 Rol. Abr. 637.

But in some places tithes are due by custom of the produce of mines. 2 Vern. 46.

No tithe is due of lime: the chalk of which this is made being part of the soil. 1 Rol. Abr. 637.

Tithe is not due of bricks, which are made from the earth itself. 2 Mod. 77.

Nor is tithe due of turf, or of gravel; because both these are part of the soil. 1 Mod. 35.

It has been held, that no tithe is due of salt, because this does not renew annually. 1 Rol. Abr. 642.

But every one of these, and all things of the like kind, may by custom become tithable. 1 Rol. Abr. 642.

Barren land converted into tillage: no tithe shall be paid for the first seven years; but if it is not barren in its own nature, as if it is woodland, grubbed and made fit for tillage, tithes shall be paid presently; for woodland is fertile, not barren. 1 Rol. Abr.

Glebe lands, in the hands of the parson, shall not pay tithe to the vicar, nor being in the hands of the vicar, shall they pay tithe to the parson, because the church shall not pay tithes to the church. But if the parson lets his rectory, reserving the glebe lands, he shall pay the tithes thereof to the lessee. Gibs. 661.

No tithes are due for houses; for tithes are only due of such things as renew from year to year. 11 Rep. 16. But houses in London are, by decree, which was confirmed by an act of parliament, made liable to the payment of tithes. 2 Inst. 659. There is likewise in most antient cities and boroughs, a custom to pay tithes for houses; without which there would be no maintenance in many parishes for the clergy. 11 Rep. 16.

As to mills, it is now settled by a decree of the house of lords, upon an appeal from a decree of the court of exchequer, that only personal tithes are due from the occupier of a corn-mill. 2 Pere Will. Rep. 463.

The occupier of a new-erected mill, is liable to tithes, although such mill is erected upon land discharged of tithes. Cro. Jac. 429

Agistment, agisting in the strict sense of the word, means the depasturing of a beast the property of a stranger; but this word is constantly used, in the books, for depasturing the beast of an occupier of land, as well as that of a stranger. 5 Bac. Abr. An occupier of land is not liable to pay tithe for the pasture of horses, or other beasts, which are used in husbandry in the parish in which they are depastured; because the tithe of corn is by their labour increased. 1 Roll. Abr. 646. But if horses or other beasts are used in husbandry out of the parish in which they are depastured, an agistment tithe is due for them. 7 Mod. 114 No tithe is due for the pasture of milk-cattle which are milked in the parish in which they are depastured; because tithe is paid of the milk of such cattle. Lord Raym. 130. No tithe is due for the pasture of a saddle-horse which an occupier of land keeps for himself or servants to ride upon. Cro. Jac. 430.

An occupier of land is liable to an agistment tithe for all such cattle as he keeps for sale. Cro. Eliz. 446. Milk-cattle which are reserved for calving, shall pay no tithe for their pasture whilst they are dry; but if they are afterwards sold, or milked in another parish, an agistment tithe is due for the time they were dry. Lord Raym. 130. No tithe is due from an occupier of land for the pasture of young cattle, reared to be used in husbandry or for the pail. Cro. Eliz. 476. But if young beasts are sold before they come to such perfection as to be fit for husbandry, or before they give milk, an agistment tithe must be paid for them. Het. 86. If cattle also, which have neither been used in husbandry, nor for the pail, are, after having been kept some time, killed, to be spent in the family of the occupier of the land on which they are depastured, no tithe is due for their pasture. Jenk. 281.

No tithe is due for the cattle, either of a stranger or an occupier, which are depastured in grounds that have in the same year paid tithe of hay. 2 Rol. Rep. 191. But it is generally true, that an agistment tithe is due for depasturing any sort of cattle the property of a stranger. Cro. Eliz. 276. No agistment tithe is due for such beasts, either of a stranger or an occupier, as are depastured on the headlands of ploughed fields; provided that these are not wider, than is sufficient to turn the plough and horses upon. 1 Rol. Rep. 646. No tithe is due for such cattle as are depastured upon land that has the same year paid tithe of corn. Mod. 216. If land, which has paid tithe of corn one year, is left unsown the next year, no agistment is due for such land; because by this lying fresh, the tithe of the next crop of corn is increased. 1 Rol. Rep. 642. But if suffered to lie fallow longer than by the course of husbandry is usual, an agistment tithe is due for the beasts depastured upon such land. Shep. Abr. 1008.

Sheep, after paying tithe of wool, had been fed upon turnips not severed, by which they were bettered to the value of five shillings each, and were then sold; it also appeared, that before the next shearing time, as many had been bought in as were sold, and that of these tithe of wool had been paid. It was insisted, that if an agistment was to be paid for the sheep sold, it would be a double tithing; but the court held that this was a new increase, and decreed the defendant to account for an agistment tithe. Gibs. Rep. in Equi. 231. But in a later case the court held, that no agistment tithe should be paid, because sheep are animalia fructuosa. Bunb. 278.

Corn. It is held that no tithe is due of the rakings of corn involuntarily scattered. Cro. Eliz. 178. But if more of any sort of corn is fraudulently scattered, than there would have been scattered if proper care had been taken, tithe is due of the rakings of such corn. Cro. Eliz. 475. No tithes are due of the stubbles left in corn-fields, after mowing or reaping of corn. 2 Inst. 261.

Tithe of *hay* is to be paid, though beasts of the plough or pail, or sheep, are to be foddered with such hay. 12 Mod. 197. But no tithe is due of hay upon the headlands of ploughed grounds, provided that such headlands are not wider than is sufficient to turn the plough and horses upon. 1 Rol. Abr. 646. It is laid down in an old case, that if a man cuts down grass, and while it is in the swath carry it away, and gives it to his plough-cattle, not having sufficient sustenance for them otherwise, no tithe is due thereof. 1 Rol. Abr. 645. And in a modern case, the court of exchequer was of opinion, that no tithe is due of vetches, or of clover, cut green and given to cattle in husbandry. Rumb. 279.

Wood. Tithe of wood is not due in common right, because wood does not renew annually; but it was in antient times paid in many places by custom. 2 Inst. 645. Faggot wood, however, pays tithe.

Exemptions from tithes are of two kinds; either to be wholly exempted from paying any tithes, or from paying tithes in kind. The former is called de non decimando; the latter de modo decimandi.

Prescription de non decimando, is to be free from the payment of tithes, without any recompence for the same. Concerning which the general rule is, that no layman can prescribe in non decimando; that is, to be discharged absolutely of the payment of tithes, and to pay nothing in lieu thereof; unless he begins his prescription in a religious or ecclesiastical person. But all spiritual persons, as bishops, deans, prebendaries, parsons, and vicars, may prescribe generally in non decimando. 1 Rol. Abr. 653.

A modus decimandi, usually called by the name of modus only, is where there is by custom a particular manner of tithing, different from the general laws of taking tithes in kind. This is sometimes a pecuniary compensation, as so much an acre for the tithe of land; sometimes a compensation in work and labour; as that the parson shall have only the twelfth cock of hay, and not the tenth, in consideration of the owner's making it for him; sometimes in lieu of a large quantity, when arrived to great maturity; as a couple of fowls in lieu of tithe-eggs, &c. Any means in short, whereby the general law of tithing is altered, and a new method of taking them is introduced, is called modus decimandi, or special method of tithing. 2 Black. 29.

In order to make a modus or prescription good, several qualifications are requisite. It must be supposed to have had a reasonable commencement; as that at the time of the composition, the modus was the real value of money, though now become much less. It must be something for the parson's benefit; therefore the finding straw for the body of the church, the finding a rope for a bell, the paying 5*s.* to the parish-clerk, have been adjudged not to be good. But it is a good modus to be discharged, that one has time out of mind been used to employ the profits for the repair of the chancel, for the parson has a benefit by that.

A modus must be certain; so a prescription to pay a penny or thereabouts, for every acre of land, is void for the uncertainty. And it has been held, that if a precise day of payment is not alleged, the modus will be ill; but now it is holden, that where an amenial modus has been paid, and no certain day for the payment thereof is limited, the same shall be due and payable on the last day of the year.

A modus must be antient; and therefore if it is any thing near the value of the tithe, it will be supposed to be of late commencement, and for that reason will be set aside.

A modus must be durable: for the tithe in kind, being an inheritance certain, the recompence for it should be as durable; therefore a certain sum, to be paid by the inhabitants of such a house, has been set aside, because the house may go down and none inhabit it.

And it must be constant and uninterrupted; for if there have been frequent interruptions, no custom or prescription can be obtained. But after it has been once duly obtained, a disturbance for ten or twenty years shall not destroy it.

When a common is divided and inclosed, a modus shall only extend to such tithes as the common yielded before inclosure; such as the tithes of wool, lambs, or agistment; but not to the tithes of hay and corn, which the common, whilst it was common, did never produce. Bur. 1735.

The parson cannot come himself and set out his tithe without the consent of the owner; but he may attend and see it set out; yet the owner is not obliged to give him notice when he intends to set it out, unless by special custom. Id. 1891. After it is set out, the care thereof as to wasting or spoiling, rests upon the parson, and not upon the owner of the land; but the parson may spread, dry, and prepare his corn, hay, or the like, in any convenient place upon the ground, till it is sufficiently weathered, and fit to be carried into the barn. And he may carry his tithes from the ground, either by the common way, or such other way as the owner of the land uses to carry away his nine parts. If the parson suffers his tithe to stay too long upon the land, the other may distrain the same as doing damage, or he may have an action on the case; but he cannot put in his cattle and destroy the corn or other tithe, for that would be to make himself judge what shall be deemed a convenient time for taking it away. Lord Raym. 189.

Payment of tithes. By 1 Geo. I. c. 6, all customary payments due to clergymen, the payment of tithes, &c. are enforced; and the prosecution in this case may be for any tithes or church-rates, or any customary or other rights, dues, or payments, belonging to any church or chapel, which of right by law and custom ought to be paid for the stipend or maintenance of any minister or curate, officiating in any church or chapel, provided that the same does not exceed 20*l.* But the time is not limited, within which the same shall become due.

And if any quaker shall refuse to pay or compound for the same, any parson, vicar, curate, farmer, or proprietor of such tithes, or any churchwarden, chapelwarden, or other person who ought to have, receive, or collect any such tithes, rates, dues, or payments, may make complaint to any two justices, other than such as is patron of the church or chapel, or interested in the tithes. The number of days is not limited between the time of refusal and the complaint; nor is it hereby required that such complaint shall be in writing. But it will be more conformable to the usual practice in like cases, if it is in writing. Upon which complaint, the said justices are required to summon in writing, under their hands and seals, by reasonable warning, such quaker, against whom such complaint shall be made. And after appearance, or on default of appearance (the warning or summons being proved before him upon oath), they may proceed to examine on oath the truth of the complaint, and to ascertain and state what is due and payable; and by order under their hands and seals, they may direct and appoint the payment thereof, so that the sum, ordered as aforesaid, does not exceed 10*l.*; and also such costs and charges, that upon the merits of the cause shall appear, not exceeding 10*s.*; and on refusal to pay, any one of the two next justices, by warrant under his hand and seal, may levy the same by distress and sale, rendering the overplus, the necessary charges of distraining being first deducted and allowed by the said justice, unless it is in the case of appeal, and then no warrant of distress shall be granted till the appeal shall be determined. Tithes under the value of 40*l.* may also be recovered by the same process from persons who are not quakers. As no time is limited for detaining the distress, nor charges allowed for keeping it, it may be sold immediately.

Any person who shall think himself aggrieved by the judgment of the two justices, may appeal to the next session; where if the judgment shall be affirmed, they shall decree the same by order of session, and give costs against the appellant, to be levied by distress and sale, as to them shall seem reasonable; and no proceeding herein shall be removed by certiorari, or otherwise, unless the title of such tithes shall be in question.

The withholding of tithes from the parson or vicar, whether the former is a clergyman or lay-appropriator, is among the pecuniary causes cognizable in the ecclesiastical court; but herein a distinction must be taken: for the ecclesiastical courts have no jurisdiction to try the right of tithes, unless between spiritual persons, between spiritual men and laymen, and are only to compel the payment of them when the right is not disputed. 2 Inst. 364.

Tithes, however, if of any considerable value, are generally sued for in the exchequer by English bill, except where the suit is founded on the statute of 2 and 3 Ed. VI. for double or treble value, &c.

TITHINGMEN. In the Saxon times, for the better conservation of peace, and the more easy administration of justice, every hundred was divided into ten districts or tithings, each tithing consisting of ten friborgs, each friborg of ten families; in which tithingmen, or civil deans, were to examine and determine all smaller differences between villages and neighbours, but to refer all greater matters to the superior courts, which had a jurisdiction over the whole hundred.

TITLE, in law, denotes any right which a person as to the possession of a thing; or an authentic instrument, whereby he can prove his right. See RIGHT, &c.

As to the titles of the clergy, they denote certain places wherein they may exercise their functions. There are several reasons why a church is called titulus; but that which seems to be the best, is because antiently the name of the saint to whom the church was dedicated, was engraved on the porch, as a sign that the saint had a title to that church; and thence the church itself was afterwards called titulus. In this sense a title signifies the church to which a clergyman was admitted, and where he is constantly to reside; and by the canons, none shall be ordained without a title. This is in order to keep out such from the ministry who, for want of maintenance, might bring a disgrace upon the church. Can. 31.

In short, according to some writers, such a title is an assurance of being preferred to an ecclesiastical benefice; that is to say, a certificate that the clerk is provided of some church or place, or where the bishop that ordains him, intends shortly to admit him to a benefice or curacy then void.

TITMOUSE. See PARUS.

TMESIS, in grammar, a figure whereby a compound word is separated into two parts, and one or more words placed between them: thus, for quæcunque, Virgil says, quæ me cunque vocant terræ, &c.

TOAD. See RANA.

TOBACCO. See NICOTIANA.

TODUS, the *tody*, in ornithology, a genus belonging to the order of picæ. The beak is slender, depressed, broad, and the base beset with bristles; the nostrils are small and oval; the toes are placed three before and one behind; the middle are connected to the outer. There are 15 species according to Dr. Latham. "Birds of this genus (says that eminent ornithologist) inhabit the warmer parts of America. They vary considerably in their bills as to breadth, but all of them have a certain flatness, or depression, which is peculiar. They have a great affinity to the flycatchers; and, indeed, to speak the truth, the two genera run much into one another. However, in one thing they differ materially; for in the tody, the outer and middle toes are much connected, whereas in the flycatcher genus they are divided to their origin."

TOLUIFERA, the *balsam* of *tolu-tree*, a genus of plants of the class decandria, and order monogynia. The calyx is five-toothed, bell-shaped; petals five, obcordate; style none. There is only one species, the balsamum. This tree grows to a considerable height: it sends off numerous large branches, and is covered with rough, thick, greyish bark; the leaves are elliptical or ovate, entire, pointed, alternate, of a light-green colour, and stand upon short strong footstalks; the flowers are numerous, and produced in lateral racemi.

It grows in Spanish America, in the province of Tolu, behind Carthagena, whence we are supplied with the balsam. This balsam is obtained by making incisions in the bark of the tree, and is collected into spoons, which are made of black wax, from which it is poured into proper vessels.

This balsam is of a reddish-yellow colour, transparent, in consistence thick and tenacious. By age it grows so hard and brittle, that it may be rubbed into a powder between the finger and thumb. Its smell is extremely fragrant, somewhat resembling that of lemons. Its taste is warm and sweetish, and on being chewed, it adheres to the teeth. See BALSAMS.

This balsam possesses the same general virtues with the balsam of Gilead, and that of Peru. It is, however, less heating and stimulating, and may therefore, be employed with more safety. It has been chiefly used as a pectoral, and is said to be an efficacious corroborant in gleets and seminal weaknesses. It is directed by the Pharmacopœias in the syrupus tolutanus, tinctura tolutana, and syrupus balsamicus.

TOMBAC, a metal composed of copper and arsenic. See ARSENIC.

TOMERS, a genus of the class and order dodecandria monogynia. The involute is four or five-leaved; calyx none; corolla five-petalled; nect. scales five; berry one-seeded. There are three species, of which the sabipere or tallow-tree of China is the most remarkable. The leaves and twigs of this tree abound in a viscid juice, and being bruised and macerated in water, render it glutinous, and it is used by the natives to work up their plaister. A great quantity of thick white oil is extracted from the berries, of which candles are made resembling wax or spermaceti.

TON weight, 20 hundred. See WEIGHT.

TONE, or TUNE, in music, a property of sound whereby it comes under the relation of grave and acute; or it is the degree of elevation any sound has, from the degree of swiftness of the vibrations of the parts of sonorous bodies. See SOUND,

Tone is more particularly used for a certain degree or interval of tune, whereby a sound may be either raised or lowered from one extreme of a concord to the other, so as still to produce true melody.

TONGUE. See ANATOMY.

TONNAGE, a custom or impost due for merchandize brought or carried in tons from or to other nations after a certain rate in every ton.

TONNAGE. The usual method of finding the tonnage of any ship is by the following rule:—Multiply the length of the keel by the breadth of the beam, and that product by half the breadth of the beam: and divide the last product by 94, and the quotient will be the tonnage.

Ship's keel 72 feet; breadth of beam 24 feet.

$$\frac{72 \times 24 \times 12}{94} = 120.6 \text{ tonnage.}$$

The tonnage of goods and store is taken sometimes by weight, and sometimes by measurement; and that method is allowed to the vessel which yields the most tonnage. In tonnage by weight, 20 cwt. make 1 ton. In tonnage by measurement, 40 cubic feet are equal to 1 ton. All carriages, or other stores to be measured by tonnage, are taken to pieces, and packed in the manner which will occupy the least room on board ship. All ordnance, whether brass or iron, is taken in tonnage by its actual weight. Musket-cartridges in barrels or boxes, all ammunition in boxes, and other articles of great weight, are taken in tonnage according to their actual weight.

The following is the tonnage allowed to the military officers of the ordnance embarked for foreign service, for their camp-equipage and baggage:

For a field officer	-	5 tons.
For a captain	-	3 do.
For a subaltern	-	1½ do.

TONSELLA, a genus of the class and order triandria monogynia. The calyx is five-parted; petals five; nect. pitcher-shaped; berry one-celled, four-seeded. There are two species, trees of the West Indies.

TONSILS. See ANATOMY.

TONSURE, in ecclesiastical history, a particular manner of shaving or clipping the hair of ecclesiastics or monks.

The antient tonsure of the clergy was nothing more than polling the head, and cutting the hair to a moderate degree, for the sake of decency and gravity; and the same observation is true, with respect to the tonsure of the antient monks. But the Romanists have carried the affair of tonsure much farther; the candidate for it kneeling before the bishop, who cuts his hair in five different parts of the head, viz. before, behind, on each side, and on the crown.

TONTINE, a species of increasing annuity on which money is sometimes borrowed, either for the service of the state, or for erecting bridges, churches, theatres, taverns, and other expensive buildings. It is usually divided into a certain number of shares, for each of which a life is nominated; and a certain annual sum being set apart for payment of interest on the money advanced, the same sum is to continue to be annually divided among the surviving nominees, by which means their annuities increase as the number of shares are reduced, till the whole are extinct.

The first attempt in this country to raise money for the public service on this uncertain kind of interest, was in 1693; but though in this instance the annuity was more determinate than in the generality of such plans, as the subscribers were certain of 10 per cent. for the first seven years, it did not succeed, only 108,100*l*. being advanced out of a million intended to be raised.

In 1757, an attempt was made to raise a loan by a tontine scheme; and in 1765, a tontine formed part of a project for funding navy and victualling bills; both these plans were unsuccessful; and the tontine formed in the year 1789, which was the last attempt to raise a public loan in this way, experienced a similar fate, as not half the proposed number of shares were disposed of.

A variety of tontine schemes for short periods of five or seven years, have of late been set on foot, to the delusion of those who have been induced to subscribe to them.

Mr. W. Morgan has shewn the folly of these speculations. He observes, that in the short term of seven years, the accumulation of money at simple and compound interest, is much the same, and the decrements of life are so inconsiderable, as to produce little or no effect in increasing this accumulation. A weekly payment of sixpence improved at 4 per cent. compound interest for seven years, will amount to 10*l*. 5*s*. 3*d*. but at simple interest it will amount to 10*l*. 3*s*. 10*d*., and at no interest at all, to 9*l*. 2*s*. The addition, therefore, to the principal from the mere operation of compound interest, is so inconsiderable, that were all the subscribers to live to the end of the term, each share would be increased by this means only 1*l*. 3*s*. 7*d*. With respect to the advantage arising from survivorship, let it be supposed that the number of subscribers to the tontine is 10,000, consisting of persons of all ages under 60 years. According to the table of probabilities of life at Northampton, 8647 of those persons will survive a term of seven years; so that if the whole 10,000 lived to make their last payment, and none of them died till just before the final distribution of the stock, the share of each survivor would be no more than 11*l*. 17*s*. 6*d*. But it is to be observed, that these lives will be continually dying from the time of the first subscription to the conclusion of the tontine; and that these deaths, by lessening the weekly contributions, will reduce the share of each survivor to 11*l*. 11*s*. nearly. When the expences of management are also deducted, and allowance is made for the loss which may be sustained by investing the money in the public funds, it is more than probable that the shares will fall greatly below the sum just stated, and that the surviving members will, at the end of seven years, have the mortification of finding that they barely receive the money they have paid, after having endangered the loss of the greatest part of it by dying in the mean time. In several of these schemes, which have lately expired, the division to the subscribers has been considerably less than the amount of their contributions.

TOOTH. See ANATOMY.

TOPASFELS. See ROCKS, *primitive*.

TOPAZ. The name topaz has been restricted by Mr. Hauy to the stones called by mineralogists occidental ruby, topaz, and sapphire; which, agreeing in their chrystallization and most of their properties, were arranged under one species by Mr. Romé de Lisle. The word topaz, derived from an island in the Red Sea, where the antients used to find topazes, was applied by them to a mineral very different from ours. One variety of our topaz they denominated chrysolite.

The topaz is found in Saxony, Bohemia, Siberia, and Brazil, mixed with other minerals in granite rocks.

It is commonly chrystallized. The primitive form of its crystals is a prism whose sides are rectangles, and bases rhombs, having their greatest angles 124° 22′, and the internal molecule has the same form; and the height of the prism is to a side of the rhomboidal bases as 3 to 2. The different varieties of topaz crystals hitherto observed, amount to 6. Five of these are eight-sided prisms, terminated by four-sided pyramids, or wedge-shaped summits, or by irregular figures of 7, 13, or 15 sides: the last variety is a twelve-sided prism, terminated by six-sided pyramids wanting the apex. For an accurate description and figure of these varieties, the reader is referred to Mr. Hauy.

The texture of the topaz is foliated. It causes a double refraction. Specific gravity from 3.46 to 3.56. The Siberian and Brazil topazes, when heated, become positively electrified on one side, and negatively on the other. It is infusible by the blowpipe. The yellow topaz of Brazil becomes red when exposed to a strong heat in a crucible; that of Saxony becomes white by the same process. This shews us that the colouring matter of these two stones is different.

The colour of the topaz is various, which has induced mineralogists to divide it into the following varieties:

1. Red topaz, of a red colour, inclining to yellow; called Brazilian or occidental ruby.

2. Yellow topaz, of a golden-yellow colour, and sometimes also nearly white; called occidental or Brazil topaz. The powder of this and the following variety, causes syrup of violets to assume a green colour.

3. Saxon topaz. It is of a pale wine yellow colour, and sometimes greyish white.

4. Aigue marini, of a bluish or pale-green colour.

5. Occidental sapphire, of a blue colour, and sometimes white.

A specimen of white Saxon topaz, analyzed by Vauquelin, contained

68	alumina
31	silica
99.	

TOPOGRAPHY, a description or draught of some particular place, or small tract of land, as that of a city or town, manor or tenement, field, garden, house, castle, &c. such as surveyors set out in their plots, or make draughts of, for the information and satisfaction of the proprietors.

TORDYLIUM, *hart-wort*, in botany, a genus of plants of the class pentandria, and order digynia, and in the natural system arranged under the 45th order, umbellatæ. The corollets are radiated, and all hermaphrodite; the fruit is roundish, and crenated on the margin; the involucra long and undivided. There are seven species; of which two are British, the maximum and officinale. 1. The maximum, or knotted parsley, has simple sessile umbels, the exterior seeds being rough. It grows in the borders of the corn-fields, and in dry stony places. 2. The officinale, officinal hart-wort, has partial involucra, as long as the flowers; leaflets oval and jagged; the seeds are large and flat, and their edges notched.

TORMENTILLA, Tormentil, a genus of plants of the class icosandria, and order polygynia, and in the natural system ranging under the 35th order, senticosæ. The calyx is octofid; the petals are four; the seeds round, naked, and affixed to a juiceless receptacle. There are two species, the erecta and repens, both indigenous. The erecta, common tormentil, or septoil, has a stalk somewhat erect, and sessile leaves. The roots consist of thick tubercles, an inch or more in diameter, replete with a red juice of an astringent quality. They are used in most of the Western Islands.

TORNADO, or Turnado, a sudden and vehement gust of wind from all points of the compass, frequent on the coast of Guinea.

A tornado seems to partake much of the nature of a whirlwind or perhaps of a water-spout, but is more violent in its effects. It commences very suddenly, several clouds being previously drawn together, when a spout of wind, proceeding from them, strikes the ground, in a round spot of a few rods or perches diameter, in the course of the wind of the day, and proceeds thus half a mile or a mile. The proneness of its descent makes it rebound from the earth, throwing such things as are moveable before it, but some sideways or in a lateral direction from it. A vapour, mist, or rain descends with it, by which the path of it is marked with wet.

The gentleman who furnishes the above general description, gives an account of one which happened a few years since at Leicester, about fifty miles from Boston, in New England. "It happened in July, on a hot day, about four o'clock in the afternoon. A few clouds having gathered westward, and coming overhead, a sudden motion of their running together in a point being observed, immediately a spout of wind struck the ground at the west end of a house, and instantly carried it away with a negro man in it, who was afterwards found dead in the path of it. Two men and a woman, by the breach of the floor, fell into the cellar; and one man was driven forcibly up into the chimney-corner. These were preserved, though much bruised; they were wet with a vapour or mist, as were the remains of the floor, and the whole path of the spout. This wind raised boards, timbers, &c. A joist was found on one end, driven near three feet into the ground. The spout probably took it in its elevated state, and drove it forcibly down. The tornado moved with the celerity of a middling wind, and constantly declined in strength till it entirely ceased."

TORPEDO. See Raia, and Electricity.

TORRICELLIAN experiment, a famous experiment made by Torricelli, a disciple of the great Galileo, which has been already explained under Barometer.

TORRID zone, among geographers, denotes that tract of the earth lying upon the equator, and on each side as far as the two tropics, or 23° 30′ of north and south latitude.

TORTOISE-shell, the shell of the testaceous animal called a tortoise; used in inlaying, and in various other works, as for snuff-boxes, combs, &c. Mr. Catesby observes, that the hard strong covering which incloses all sorts of tortoises, is very improperly called a shell; being of a perfect bony contexture, but covered on the outside with scales, or rather plates of a horny substance; which are what workmen call tortoise-shell. See Horn.

There are two general kinds of tortoises, viz. the land and sea tortoise, testudo terrestris and marina. The sea-tortoise, again, is of several kinds; but it is the testudo imbricata of Linnæus, alone which furnishes that beautiful shell so much admired in Europe. See Testudo.

The whole spoils of the tortoise consist in thirteen leaves or scales, eight of them flat, and five a little bent. Of the flat ones, there are four large ones, sometimes a foot long, and seven inches broad. The best tortoise-shell is thick, clear, transparent, of the colour of antimony, sprinkled with brown and white. When used in marquetry, &c. the workmen give it what colour they please by means of coloured leaves, which they put underneath it.

Working and joining of tortoise-shell.—Tortoise-shell and horn become soft in a moderate heat, as that of boiling water, so as to be pressed, in a mould, into any form, the shell or horn being previously cut into plates of a proper size. Plumier informs us, in his Art de Tourner, that two plates are likewise united into one by heating and pressing them; the edges being thoroughly cleaned, and made to fit close to one another. The tortoise-shell is conveniently heated for this purpose by applying a hot iron above and beneath the juncture, with the interposition of a wet cloth to prevent the shell from being scorched by the irons: these irons should be pretty thick, that they may not lose their heat before the union is effected. Both tortoise-shell and horns may be stained of a variety of colours, by means of the colouring drugs commonly used in dyeing, and by certain metallic solutions.

TOUCAN. See Ramphastos.

Toucan, in astronomy, a constellation of the southern hemisphere, consisting of eight small stars, and otherwise called anser americanus. See Astronomy.

TOUCH-needle, among assayers, refiners, &c. little bars of gold, silver, and copper, combined together in all the different proportions and degrees of mixture; the use of which is to discover the degree of purity of any piece of gold or silver, by comparing the mark it leaves on the touchstone, with those of the bars. The metals usually tried by the touchstone, are gold, silver, and copper, either pure, or mixed with one another in different degrees and proportions, by fusion. In order to find out the purity or quantity of baser metal in these various admixtures, when they are to be examined, they are compared with these needles, which are mixed in a known proportion, and prepared for this use. The metals of these needles, both pure and mixed, are all made into laminæ or plates, one-twelfth of an inch broad, and a fourth part of their breadth in thickness, and an inch and a half long; these being thus prepared, you are to engrave on each a mark indicating its purity, or the nature and quantity of the admixture in it. The black rough marbles, the basaltes, or other softer kinds of black pebbles, are the most proper for touchstones.

The method of using the needles and stone is this: The piece of metal to be tried, ought first to be wiped well with a clean towel, or piece of soft leather, that you may the better see its true colour; for from this alone an experienced person will, in some degree, judge beforehand what the principal metal is, and how and with what debased. Then chuse a convenient, not overlarge, part of the surface of the metal, and rub it several times very hardly and strongly against the touchstone; that in case a deceitful coat or crust should have been laid upon it, it may be worn off by that friction: this, however, is more readily done by a grindstone, or small file, if you have them at hand. Then wipe a flat and very clean part of the touchstone, and rub against it, over and over the surface of the piece of metal, till you have, on the flat surface of the stone, a thin metallic crust, an inch long, and about an eighth of an inch broad; this done, look out the needle that seems most like the metal under trial, wipe the lower part of this needle very clean, and then rub it against the touchstone as you did the metal, by the side of the other line, and in a direction parallel to it. When this is done, if you find no difference between the colours of the two marks made by your needle and the metal under trial, you may, with great probability, pronounce that metal and your needle to be of the same alloy, which is immediately known by the mark engraved on your needle. But if you find a difference between the colour of the mark given by the metal, and that by the needle you have tried, choose out another needle, either of a darker or lighter colour than the former, as the difference of the tinge on the touchstone directs; and by one or more trials of this kind you will be able to determine which of your needles the metal answers, and thence what alloy it is of, by the mark of the needle; or else you will find that the alloy is extraordinary, and not to be determined by the comparison of your needles.

TOURMALINE, in mineralogy, a species of siliceous earth. It has been found only in Ceylon, Brazil, and Tyrol. That of Ceylon is of a dark-brown or yellowish colour; its specific gravity 3.065, or 3.295; that of Brazil is green, blue, red, or yellow, and its specific gravity 3.075 or 3.180; that of Tyrol by reflected light is of a blackish brown, but by refracted light yellowish, or in thin pieces green; its specific gravity 3.050; mostly crystallised in polygonal prisms, but sometimes amorphous. The thickest parts are opake; the thin more or less transparent. See SHORL.

TOURNEFORTIA, a genus of the pentandria monogynia class of plants, the flower of which consists of a single petal, in form of an oval tube, longer than the calyx, divided into five slight segments somewhat broad and pointed, and spread open; the fruit is a globose berry, containing two cells: and the seeds are of an oval figure, two in number, and separated by the pulp. There are eleven species, shrubs of South America.

TOURNEQUET. See SURGERY.

TOURRETTIA, a genus of the didynamia angiospermia class and order. The cal. is two-lipped; cor. lower lip none; caps. echinate, four-celled, two-valved. There is one species, an annual of Peru.

TOWER, any high building raised above another, consisting of several stories, usually of a round form, though sometimes square or polygonal; a fortress, a citadel. Towers are built for fortresses, prisons, &c. as the tower of the Bastile, which was destroyed by the inhabitants of Paris in 1789.

The tower of London, commonly called The Tower, is a building with five small turrets at different angles above it, situated on the banks of the river Thames. The guards usually do duty in it. It is at present garrisoned by the invalids. The tower of London is not only a citadel to defend and command the city, river, &c. but it is also a royal palace, where the kings of England with their courts have sometimes lodged; a royal arsenal, wherein are stored arms and ammunition for sixty thousand soldiers; a treasury for the jewels and ornaments of the crown; a mint for coining money; the archives wherein are preserved all the antient records of the courts of Westminster, &c. and the chief prison for state delinquents. The officers belonging to the tower of London consist of

	per annum.		
1 Constable and chief governor, at	£1000	0	0
1 Lieutenant governor, at	700	0	0
1 Deputy lieutenant, at	365	0	0
1 Major, at	182	10	0
1 Chaplain, at	121	13	4
1 Gentleman porter, at	84	6	8
1 Gentleman gaoler, at	70	0	0
1 Physician, at	182	10	0
1 Surgeon, at	45	12	6
1 Apothecary, 1 yeoman porter.			

Tower-bastions, in fortification, are small towers made in the form of bastions, by M. Vauban, in his second and third method; with rooms or cellars underneath to place men and guns in them.

Towers, moveable, in antient military history, were three stories high, built with large beams: each tower was placed on four wheels or trucks, and towards the town covered with boiled leather, to guard it from fire, and to resist the darts; on each story one hundred archers were posted. They were pushed with the force of men towards to the city wall. From these the soldiers, placed in the different stages, made such vigorous discharges that none of the garrison dared to shew themselves on the rampart.

TOXICODENDRON, the *poison-wood*. See RHUS.

TOZZIA, a genus of the didynamia angiospermia class of plants, with a monopetalous ringent flower; the upper lip of which is bifid, and the lower one trifid; the fruit is a globose unilocular capsule, containing an ovated seed. One species.

TRACHEA. See ANATOMY.

TRACHELIUM, a genus of the pentandria monogynia class of plants, with a funnel-fashioned flower, divided into five segments at the limb; the fruit is a roundish obtusely trilobous capsule, containing a great number of very minute seeds. There are three species, herbs of the Levant.

TRACHICHTHYS, a genus of fishes of the order thoracici. The generic character is, head rounded in front; eyes large; mouth wide, toothless, descending; gill-membrane with eight rays, the four lowermost of which are rough on the edges; scales rough; abdomen cataphracted with large carinate scales. There is only a single species, viz. the australis, that inhabits New Holland, about five inches long, and two deep; body coated with scales so strongly and closely inserted, that it is not possible to detach one from the rest without bringing with it a portion of the skin.

TRACHINUS, WEEVER, a genus of fishes of the order jugulares: the generic character is, head slightly roughened, compressed; gill-membrane six-rayed; gill-covers serrated on the edge; body compressed, vent situated near the breast.

1. Trachinus draco, dragon weever. This fish is of a lengthened shape, much compressed on the sides, and covered with small and easily deciduous scales; the mouth is wide, and opens vertically, like that of the star-gazer; both jaws are armed with sharp teeth; the tongue is straight, smooth, and pointed; the eyes are seated on the upper part of the head, pretty near each other; the gill-covers are armed at their tips with a strong spine. The general colour of the weever is silvery, with a yellowish or dusky cast on the upper parts, while the sides are commonly varied by numerous obliquely transverse streaks of a similar colour; the scales are small and rounded; the first dorsal fin is of a deep black. The usual length of the fish is about ten or twelve inches.

This fish is an inhabitant of the Mediterranean and Northern seas, commonly frequenting the coasts, and frequently imbedding itself in the sand; in which situation, if accidentally trodden on, it strikes backwards with great violence, and endeavours to wound the aggressor with the spines of its first dorsal fin. So troublesome are the consequences arising from the punctures inflicted by this part, that a law is said to exist in France, obliging the fishermen to cut it away before the fish is exposed for sale. The usual symptoms attending the wound are, violent heat, pain, and inflammation; and it not unfrequently happens that when the hand is thus wounded, a sudden redness extends throughout the whole length of the arm, as far as the shoulder. The usual remedy among the English fishermen is, according to Mr. Pennant, sea-sand, well rubbed on the part: an application which one might at first suppose would rather aggravate than alleviate the complaint. Many other popular remedies are used in different countries. Notwithstanding the suspicious aspect of the above-mentioned black fin, it does not seem to have any thing in its conformation which can justify the idea of any poisonous fluid conveyed from it into the wound; the spines when microscopically examined shewing no appearance of a tubular structure.

The weever is considered as an excellent article of food, and is much esteemed in Holland, France, &c. It feeds principally on marine insects, worms, and small fishes; it is tenacious of life, and can exist many hours out of water; the skin is remarkably tough, and the animal may be excoriated with almost the same facility as an eel. See Plate Nat. Hist. fig. 403.

2. Trachinus osbeckii, osbeckian weever. Native of the Atlantic seas, and found about the isle of Ascension, &c. Colour white, spotted with black; both jaws of equal length, and furnished with several rows of long and pointed teeth, three of which, both above and below, are larger than the rest: some sharp teeth are also situated in the throat: each gill-cover is terminated by two spines of unequal length; tail even. Described by Osbeck in his Voyage to China. There are no other species.

TRADE, the practice of exchanging goods, wares, money, bills and other articles of value, with the view of advantage or profit. It is generally distinguished into foreign trade, or the export and import of commodities to and from other countries, and the internal or home trade, or that which is carried on within the country, which two branches, however, are rather distinct in appearance than reality; for a very considerable portion of the internal trade, arising from manufactures carried on to supply foreign markets, could not subsist without foreign commerce, while a large part of the returns for manufactures sent abroad, being articles for consumption or raw materials which are converted to use in the different manufactures, depends upon our internal trade, so that the one supports the other, and by their mutual connection and dependance, the foreign and the domestic trade of Great Britain have risen together to their present unparalleled height.

The extent and value of the principal branches of foreign trade have been stated under the article COMMERCE, and the following view of the present state of the principal manufactures will shew the vast importance of our internal or home trade; a general proof of the advancement of which, may be found in the great increase in the number of country banks, now spread all over the kingdom, deriving their profits chiefly from this part of its trade.

Manufactures may be defined the arts by which natural productions are brought into the state or form in which they are consumed or used. The principal manufactures are those which fabricate the various articles of clothing; as the woollen-manufacture, the leather-manufacture in part, the cotton-manufacture, the linen-manufacture, and the silk-manufacture; others supply articles of household furniture, as the manufactures of glass, porcelain, earthenware, and of most of the metals in part; the iron-manufacture furnishes implements of agriculture, and weapons of war; and the paper-manufacture supplies a material for communicating ideas and perpetuating knowledge.

The enhanced value of raw materials by manufacture has been illustrated by the following remarks: "One hundred pounds laid out in wool, and that wool manufactured into goods for the Turkey market, and raw silk brought home in return, and manufactured here, will increase that one hundred to five thousand pounds; which quantity of silk-manufactures being sent to New Spain, would return ten thousand pounds; which vast improvement of the first hundred pounds, becomes, in a few years, dispersed amongst all orders and degrees, from the prince to the peasant. Thus, again, a parcel of iron-stone, which when taken from its natural bed, was not worth five shillings, when made into iron and steel, and thence into various manufactures for foreign markets, may probably bring home to the value of ten thousand pounds; for steel may be made near three hundred times dearer than standard gold, weight for weight. Twenty acres of fine flax, when manufactured into the dearest and most proper goods for foreign markets, may, in return, bring what may be worth ten thousand pounds; for an ounce of the finest Flanders thread has been sold in London for four pounds, and such an ounce made in Flanders into the finest lace, may be here sold for forty pounds; which is above ten times the price of standard gold, weight for weight."

Manufactures had begun to flourish in different parts of Europe, long before they were attempted in Britain; the few articles of this description which were in request, being obtained in exchange for wool, hides, tin, and such other produce as the country in a very uncultivated state could supply. In 1337, it was enacted, that no more wool should be exported; that no one should wear any but English cloth; that no cloths made beyond seas should be imported; that foreign clothworkers might come into the king's dominions, and should have such franchises as might suffice them. Before this time, the English were little more than shepherds and wool-sellers.

The progress of improvement since the establishment of manufactures in this country, has in most instances been remarkably great, particularly of late years, in consequence of an increased knowledge of the properties of various materials, vast improvements in all kinds of machinery, and the great capitals invested in most of the different branches. The value of British manufactures exported to all countries, on an average of six years, ending with 1774, was 10,342,019*l.*; the American war suspended for a time an important market for several of our manufactures, in consequence of which the total amount exported had fallen in 1781 to 7,633,332*l.* and on an average of six years, ending with 1783, was 8,616,660*l.* During the peace which followed, the export trade rapidly revived, and, in the year preceding the war with France, had attained to a magnitude beyond all former example; it was checked a little by the mercantile embarrassments in 1793, but a few years after, the unsettled state of several of the principal European powers threw many additional branches of foreign trade into the hands of our merchants, and carried the export of our manufactures to its present important extent.

Official value of British produce and manufactures exported from Great Britain, for eighteen years, ending 5th January, 1806:

In 1788	£12,724,719
1789	13,779,506
1790	14,921,084
1791	16,810,018
1792	18,336,851
1793	13,892,268
In 1794	£.16,725,402
1795	13,338,213
1796	19,102,220
1797	16,903,103
1798	19,672,503
1799	24,084,213
1800	24,304,283
1801	25,699,809
1802	26,993,129
1803	22,252,027
1804	23,935,793
1805	25,003,308

The real value of British produce and manufactures exported, however, considerably exceeds the above official statement, and as far as it can be ascertained, under the ad valorem duties, or computed at the average current prices of the goods, it amounted in the year 1804 to 40,349,642*l.* and in 1805 to 41,068,942*l.* The commodities included under the term British produce, such as alum, bark, coals, cattle, fish, hops, metals, salt, and a few other articles, being united in these accounts with manufactured goods, the actual value of the latter cannot be derived from them; but in a comparative view they furnish a sufficiently accurate idea of the proportions exported at different periods.

The annual produce of the different manufactures of this country, and the employment created by them, has in several instances been greatly over-rated; for if the number of persons which the various branches have at different times been represented to employ, were added together, they would make the population of the country far exceed its known amount, without any allowance whatever for other occupations.

The woollen-manufacture, which is the most antient and important, has increased during the last twenty years, and appears to be still increasing, notwithstanding the high price of the material, and the precarious state of the foreign markets. On a late examination of the principal woollen-manufacturers, by a committee of the house of commons, Mr. W. Hustler estimated the quantity of wool grown in this country at 600,000 packs, of 240 pounds each, which at 11*l.* per pack makes the value of the whole 6,600,000*l.* He justly observed that it is difficult to ascertain how much the wool is increased in value by being manufactured; some sorts are increased rather more than double, some nine times or even more; but if the average is taken at only three times, which will be under the truth, the total value of the wool manufactured in the country will amount to 19,800,000*l.* It must be remarked, that this calculation is founded on a supposition that, in 1791, the number of sheep in the kingdom was 28,800,000, which, as far as any idea can be formed from the proportion of the consumption of the metropolis to that of the whole island, and the stock requisite for the supply, greatly exceeded the truth at that time; and it is the general opinion, particularly of persons in the wool-trade, that of late the number of sheep kept has been considerably reduced. The calculation is likewise made at an unusually high price of wool; for though during the year 1800, the average price was about eleven guineas, the average of the three or four preceding years was certainly not more than from ten pounds to ten guineas; upon the whole, the estimate, therefore, will be much less objectionable, if formed on 500,000 packs at 10*l.* 10*s.* per pack, which will make the value of the wool 5,250,000*l.*; to this must be added at least 500,000*l.* for the value of Spanish wool imported, and the manufactured value of the whole will be 17,250,000*l.* That the total value of the manufacture cannot exceed this sum will appear highly probable from the exports. The value of woollen goods exported from Great Britain in six years, was as follows:

In 1794	£.4,390,920
1795	5,172,884
1796	6,011,133
1797	4,936,355
1798	6,499,339
1799	6,876,939

The average is 5,647,928*l.* Most of the custom-house values of goods exported are greatly below their present value, but not so much so in this article as in some others; they are found, however, to be about thirty-eight per cent. below the actual value, and this addition being made to the average amount, the value of woollen goods exported will appear to be 7,794,140*l.* The value retained for home consumption may be nearly equal to the value exported, although in quantity the former may greatly exceed the latter, a very considerable proportion of which consists of superfine and second cloths, whereas the consumption of fine woollens in Great Britain has much diminished of late years, from the general use of Manchester manufactures of cotton in clothing, particularly for waistcoats and breeches. The whole value of the manufacture thus appears to be about 15,588,000*l.* and, as a medium between this sum and the amount before stated, it may be taken at 16,400,000*l.* Deducting from this amount at the rate of 10 per cent. on the cost of the goods for the profits of the manufacturer, including the interest of his capital, there remains 14,909,090*l.* consisting of the cost of the material, and the wages of labour; the value of all the wool employed, we have seen, is about 5,750,000*l.* and including the cost of some other necessary articles, the materials cannot be valued at less than this sum; the remainder therefore, or 9,159,090*l.* is the amount of workmanship, or the wages of all the persons employed in the manufacture. It is scarcely possible to assume with precision an average rate of wages, with respect to any manufacture, as they vary in different parts of the country, and the proportion of the different classes of persons employed is in no instance known with certainty. In the West, where the woollen-manufacture has been for some time past in a very depressed state, few workmen get above 14*s.* per week, and many much less from not being fully employed; in Yorkshire good workmen earn from 16*s.* to 18*s.* per week, children 3*s.* older children and women from 5*s.* to 6*s.* and old men from 9*s.* to 12*s.* If, on taking all classes together, 8*s.* per week is not thought too high, it will appear that the whole number of persons employed does not exceed 440,340.

The value of the leather-manufacture was, some years ago, stated at 10,500,000*l.* and from the state of the trade of late, particularly those branches of it which supply military accoutrements, harness, sadlery, carriages, &c. combined with the high price of skins of most kinds, it cannot be supposed less than that sum at present. Deducting 954,545*l.* for the profits of capital employed, and 3,500,000*l.* for the cost of the raw article, there remains 6,045,455*l.* for the wages of persons employed therein, which, at 25*l.* per annum for each person, makes the number employed 241,818.

The cotton-manufacture was formerly of little importance in this country, in comparison with its present state. The total quantity of cotton-wool imported into England, on an average of five years, ending with 1705, was 1,170,881 pounds, and even so late as the year 1781, it amounted to only 5,101,920 pounds. About that time, however, the British calicoes, which had been introduced some years before, had arrived at some degree of perfection, and the branch of muslins being added, in which great improvements were soon after made, the whole manufacture experienced such a rapid and great increase, that previous to the commencement of the war with France, the consumption of cotton-wool amounted to upwards of 30,000,000 pounds per annum. In the years 1793, 1794, and 1795, the import was considerably less, but during the succeeding five years was as follows:

In 1796	31,280,000 lb.
1797	23,175,000
1798	31,592,000
1799	35,689,000
1800	56,010,000

The average is 35,549,200 pounds, the value of which, when manufactured, cannot be less than 11,000,000*l.* allowing for a considerable quantity exported in a partially manufactured state. The total quantity of British calicoes and muslins printed in England and Wales in the year 1800 was 28,692,790 yards, and in Scotland 4,176,939 yards, the duty on the whole amounting to 479,350*l.* 4*s.* 3½*d.* Upon the supposition that the duty is one-tenth of the value, the value of this description of goods printed in 1800, will be 4,793,502*l.* The quantity of white calicoes and muslins made in Great Britain, is probably much greater than that of the printed; and though they do not incur the expence of printing and duty, yet as a greater proportion of them are fine goods, the value of them is probably rather above 3,500,000*l.* There are many other branches of manufacture which consume large quantities of cotton, though it is difficult to form an idea of the precise amount; thus the hosiery branch was stated some years ago to employ 1,500,000 pounds, and it has certainly since increased considerably; the same quantity was said to be required for candle-wicks, and it will probably be a very moderate estimate to value all the cotton that is manufactured in any other way than in muslins and calicoes at 2,800,000*l.* The total value of the manufacture will thus appear to be, as before stated, about 11,000,000*l.* Deducting from this sum 1,000,000*l.* for profits of capital at ten per cent. and 4,443,650*l.* for cost of the raw material at 2*s.* 6*d.* per pound, there remains 5,556,350*l.* for wages, which, if divided at the rate of only 16*l.* per annum for each person, on account of the large proportion of women and children employed, makes the whole number 347,271 persons.

The silk-manufacture was formerly of greater extent than at present, but has not experienced any very considerable fluctuation for some years past: the quantity of raw and thrown silk imported in three years preceding the 5th January 1797, was as follows:

In 1794	906,686 lb.
1795	985,659
1796	758,970

The average of these three years is 883,438 pounds; and though the quantity in 1797 was still less than in 1796, the importation has since been greater, and the usual quantity cannot be stated at less than 900,000 pounds, the value of which when manufactured is about 2,700,000*l.* The cost of the silk to the manufacturer, if raw and thrown are taken together at only 28*s.* per pound, amounts to 1,260,000*l.* and the profits of the manufacturer 245,454*l.* at the rate of ten per cent. on the cost when manufactured. It may be said that though this is the usual profit charged by the manufacturer in this and some other branches, in casting up the selling price of his goods, they are frequently sold much under this price; which must be admitted: but, as an advantage is taken on most of the component parts of the price before the ten per cent. is laid on, it is probably not less than this rate on the whole, in this and in most other manufactures. The number of persons employed in the silk-manufactory has been stated at 200,000 and upwards, but there appears no reason to believe that it exceeds 65,000 of all descriptions.

The linen-manufacture of Great Britain is chiefly confined to Scotland, though some branches of it are carried on in Manchester and other parts of England. The exportation of British-made linen duty-free, was allowed in 1717, but the bounties on exportation were not granted till 1743, in which year the export was 52,772 yards. On an average of seven years of peace from 1749 to 1755, the export of British-manufactured linens had increased to 576,373 yards; and it continued to increase greatly during the succeeding period of war, the average of seven years, ending with 1762, being 1,356,640 yards. The average of the next seven years was 2,423,378 yards; but in consequence of the commercial embarrassments of the year 1773, this manufacture declined very much, and in the beginning of 1774, it is said there were not much more than half the weavers employed throughout Scotland and the north of England. In the course of a few years it revived again, and in the year 1783 the export amounted to no less than 14,298,000 yards. The total quantity of British linen exported during three years ending with 1779, was as follows:

In 1797	14,533,000 yards.
1798	20,744,000
1799	21,204,000

The value, estimated at the current prices of linens exported, on an average of three years preceding 5th January 1799, was 1,278,734*l.*; therefore, if the quantity retained for home consumption is not greater than the export, the value of the whole must be upwards of 2,500,000*l.*; and it probably will not exceed the truth if the yearly value of the whole of this manufacture in Great Britain, with the thread, and other branches of the flax trade, is stated at 3,000,000*l.* That it is not of less extent, may be presumed from the following account of the quantities of ugh flax and linen-yarn imported on an verage of five years, ending the 5th of January in the years stated, viz.

	Flax.	Linen-yarn.
1776	254,141 cwt.	7,847,157 lbs.
1787	245,636	8,873,866
1792	232,564	9,781,275
1799	290,754	8,148,936

The returns of the quantity and value of nen-cloth stamped for sale in Scotland, furish much information respecting the state of his manufacture; and were in three years nding with 1800, as follows:

	Yards.	Value.		
1 1798	21,297,059	£. 850,903	9	9
1799	24,506,007	1,116,022	4	7
1800	24,235,633	1,047,598	10	10

The linens which most of the families in cotland make for their own use, are not tamped, and consequently are not included n these returns, which must therefore be less han the quantity actually manufactured by everal millions of yards; and the value stated s certainly much below the actual selling rices. There is no account kept of the linenmanufacture in England; and as it is considered as an object of subordinate importance, ts annual value is probably under 1,000,000*l*. ut even if it is somewhat less than this mount, it will appear that the total value of he manufacture, rated at the current prices, annot be less than the sum before stated, or ,000,000*l*. The number of persons employed in it is probably not less than 95,000.

The hemp-manufacture at present exceeds ,600,000*l*. per annum, but is less in time of peace; the persons employed in it are probably about 35,000.

The paper-manufacture has been greatly advanced of late. A hundred years ago scarcely any paper was made in this country but the coarse wrapping papers; and for a ong time most of the superior kinds continued to be imported; the export is, however, at present considerable. The annual value of the manufacture, at the present high prices of the article, cannot be less than 900,000*l*. and the number of persons employed in it 30,000.

The glass-manufacture was much improved in the course of the last century, particularly in the article of plate-glass, and it has greatly increased of late years; it may now amount to 1,500,000*l*. per annum, and the persons employed in it to about 36,000.

The potteries, and manufactures of earthenware and porcelain, advanced rapidly during the last century in consequence of the great improvements made in them, and the introduction of many new and beautiful wares both for our own use and foreign markets. The article of queen's-ware was invented in 1763, by Mr. J. Wedgewood, to whom the public are also indebted for most of those elegant species of earthenware and porcelain which, moulded into a thousand different forms for ornament or use, now constitute the most valuable part of this manufacture. The annual value will probably not be overrated at 2,000,000*l*. and the number of persons employed at 45,000.

The iron-manufacture is supplied partly by the produce of our own mines, and partly by those of other countries; with respect to the first, it appears, that the total produce of pig-iron in Britain, is at least 100,000 tons; and reckoning on an average, that 33 cwt. of crude iron produce one ton of bars, and that the manufacture of malleable iron amounts to 35,000 tons per annum, this branch will require 57,750 tons of crude iron; and the value in bars at 20*l*. a ton, which is considerably under the present price, is 700,000*l*. the remaining 42,250 tons, cast into cannon, cylinders, and machinery, &c. at 14*l*. a ton, are worth 591,500*l*. The supply of foreign bar-iron is chiefly obtained from Russia and Sweden; and the quantity imported on an average of six years, ending with 1805, after deducting what was re-exported, has been 33,628 tons, value 865,182*l*. which with the sums before mentioned, amounts to 2,156,682*l*. This value is greatly increased by subsequent labour; but the proportion of the increase cannot be easily determined, the quantity of labour being so very different in different articles.

Some years ago the value of the iron-manufacture was estimated at 8,700,000*l*. which sum appears rather too high at present; but including tin and lead, the value of the whole will probably not be taken too high at 10,000,000*l*. and the number of persons employed at 200,000.

The copper and brass manufactures are now established in this country in all their branches. Till about the years 1720 or 1730, most of the copper and brass utensils for culinary and other purposes, used in this country, were imported from Hamburgh and Holland, being procured from the manufactories of Germany; even so late as the years 1745 and 1750, copper tea-kettles, saucepans, and pots of all sizes, were imported here in large quantities; but through the persevering industry, capitals, and enterprising spirit of our miners and manufacturers, these imports have become totally unnecessary, the articles being now all made here, and far better than any other country can produce. The discovery of new copper-mines in Cornwall, Derbyshire, and Wales, about the year 1773, contributed to the extension of the manufacture in this country; and it appears to be still increasing, notwithstanding the very great advance in the price of copper, which must certainly be attended with some disadvantage with respect to foreign markets. The value of wrought copper and brass exported during the year 1799 was 1,222,187*l*. and there is reason to believe, that the whole value of these manufactures at present is at least 3,600,000*l*. and the number of persons employed about 60,000.

The steel, plating, and hardware manufactures, including the toy trade, have been carried to a great extent of late years, and may amount in value to 4,000,000*l*. and the persons employed to at least 70,000.

It must be confessed, that many of these estimates are unavoidably defective from the want of public documents respecting many important branches of trade; they may, however, be sufficiently accurate to shew, in a general view, the relative extent of the principal manufactures of Great Britain, viz.

	Annual value.	Persons employed.
Woollen	£.16,400,000	440,340
Leather	10,500,000	241,818
Cotton	11,000,000	347,271
Silk	2,700,000	65,000
Linen and flax	2,000,000	95,000
Hemp	1,600,000	35,000
Paper	900,000	30,000
Glass	1,500,000	36,000
Potteries	2,000,000	45,000
Iron, tin, and lead	10,000,000	200,000
Copper and brass	3,600,000	60,000
Steel, plating, &c.	4,000,000	70,000
	£.67,200,000	1,665,429

There are many other manufactures, such as those of hats, horn, straw, &c. which, though of themselves of less importance than most of those above enumerated, are together of very considerable amount, and employ a great number of hands. There are likewise some, which, though not generally included among the manufactures, are certainly such in a great degree, and might, with much propriety, be classed with them.

It may be proper to observe, that those who have rated the number of persons employed in the different branches very considerably higher than is here stated, have generally included a variety of collateral employments, as mariners, carriers, miners, &c. whereas the numbers here given are meant to include only the persons directly employed in the various transactions and operations necessary for bringing the raw materials into their finished consumable state.

Trade-winds. See Wind.

TRADESCANTIA, a genus of the hexandria monogynia class of plants, the flower of which consists of three orbiculated, plane, and very patent petals; and its fruit is an oval trilocular capsule, containing a few angulated seeds. 19 species.

TRAGACANTH. See Astragalus.

Tragacanth, *gum*, or, as some call it, gum-adragant, or gum dragon, is the produce of the above and some other shrubs. The gum is brought to us in long and slender pieces, of a flatted figure more or less, and these not straight, or rarely so; but commonly twisted and contorted various ways, so as to resemble worms. We sometimes meet with it like the other vegetable exsudations, in roundish drops, but these are much more rare. It is moderately heavy, of a firm consistence, and properly speaking, very tough rather than hard; and is extremely difficult to powder, unless first carefully dried, and the mortar and pestle kept dry. Its natural colour is a pale whitish, and in the cleanest pieces it is something transparent. It is often, however, met with tinged brownish, and of other colours, and more opake. It has no smell, and very little taste, but what it has is disagreeable. Taken into the mouth, it does not grow clammy, and stick to the teeth, as the gum arabic does, but melts into a kind of very soft mucilage. It dissolves in water but slowly, and communicates its mucilaginous quality to a great quantity of that fluid. It is by no means soluble in oily or spirituous liquors, nor is it inflammable. It is brought to us from the island of Crete, and from several parts of Asia. It is to be chosen in long twisted pieces, of a whitish colour, very clear, and free from all other colours; the brown, and particularly the black, are wholly to be rejected.

Tragacanth has the same virtues with gum arabic, but in a greater degree. It greatly inspissates and obtunds the acrimony of the humours, and is therefore found of service in inveterate coughs, and other disorders of the breast, arising from an acrid phlegm, and in stranguries, heat of urine, and all other complaints of that kind. It is usually given in the compound powder, called the species diatragacanthi frigidæ, rarely alone. It is also, by some, esteemed a very great external remedy for wounds, and in this sense made an ingredient in some sympathetic powders, with vitriol and other things. It is by some recommended alone, in form of a powder or strong mucilage, for cracks and chaps in the nipples of women: but it is found, by experience, to be a very troublesome application in those cases, and to do more harm than good, as it dries by the heat of the part, and draws the lips of the wound farther asunder than before. See GUMS.

TRAGEDY. See POETRY.

TRAGIA, a genus of the monoecia triandria class of plants, without any flower-petals; its fruit is a very large tricoccous capsule of a roundish figure, containing single and roundish seeds. There are 8 species.

TRAGOPOGON, *goat's-beard*, a genus of plants of the class syngenesia, and the order polygamia æqualis; and in the natural system ranging under the 49th order, compositæ. The receptacle is naked, the calyx simple, and the pappus plumose. There are 14 species; of which two are British, the pratensis and porifolius. 1. The pratensis, or yellow goats'-beard, has its calyxes equal with the florets, and its leaves entire, long, narrow, sessile, and grassy. In fair weather this plant opens at sun-rising, and shuts between nine and ten in the morning. The roots are conical and esculent, and are sometimes boiled and served up at table like asparagus. It grows on meadows. 2. The porifolius, or purple goat's-beard, has the calyx longer than the radius of the floret; the flowers are large, purple, single, and terminal; and the leaves long, pointed, and bluish. The root is long, thick, and esculent. It grows in meadows, and is cultivated in gardens under the name of salsafy.

TRAJECTORY, a term often used, generally for the path of any body moving either in a void, or in a medium that resists its motion; or even for any curve passing through a given number of points. Thus Newton, Princip. lib. 1. prob. 22, purposes to describe a trajectory that shall pass through five given points.

TRAJECTORY *of a comet*, is its path or orbit, or the line it describes in its motion. This path, Hevelius, in his Cometographia, will have to be very nearly a right line; but Dr. Halley concludes it to be, as it really is, a very eccentric ellipsis; though its place may often be well computed on the supposition of its being a parabola. Newton, in prop. 41 of his 3d book, shews how to determine the trajectory of a comet from three observations; and in his last prop. how to correct a trajectory graphically described.

TRAMMELS, in mechanics, an instrument used by artificers for drawing ovals upon boards, &c. One part of it consists of a cross with two grooves at right angles; the other is a beam carrying two pins which slide in those grooves, and also the describing pencil. All the engines for turning ovals are constructed on the same principles with the trammels: the only difference is, that in the trammels the board is at rest, and the pencil moves upon it; in the turning engine, the tool, which supplies the place of the pencil, is at rest, and the board moves against it. See a demonstration of the chief properties of these instruments by Mr. Ludlam, in the Philos. Trans. vol. 70, p. 378, &c.

TRAMMEL-NET, is a long net, wherewith to take fowl by night in champain countries, much like the net used for the low bell, both in shape, bigness, and mashes. To use it, they spread it on the ground, so that the nether or further end, fitted with small plummets, may lie loose thereon; then the other part being borne up by men placed at the fore ends, it is thus trailed along the ground. At each side are carried great blazing lights, by which the birds are raised, and as they rise under the net they are taken.

TRANSCENDENTAL, or TRANSCENDANT, something elevated or raised above other things, which passes and transcends the nature of other inferior things.

Transcendental quantities, among geometricians, are indeterminate ones, or such as cannot be fixed, or expressed by any constant equation; such are all transcendental curves which cannot be defined by any algebraic equation, or which when expressed by an equation, one of the terms thereof is a variable quantity. Now whereas algebraists use to assume some general letters or numbers, for the quantity sought in these transcendental problems, Mr. Leibnitz assumes general or indefinite equations for the lines sought; *e.gr.* putting x and y for the absciss and ordinate, the equation he uses for a line sought is $a+bx+cy+exy+fxx+gyy$, &c.$=0$, by the help of which indefinite equation, he seeks the tangent: and by comparing the result with the given property of tangents, he finds the value of the assumed letters, a, b, c, d, &c. and thus defines the equation of the line sought.

If the comparison above-mentioned does not proceed, he pronounces the line sought not to be an algebraical, but a transcendental one. This supposed, he goes on to find the species of transcendency; for some transcendentals depend on the general division or section of a ratio, or upon the logarithms; others, upon the arcs of a circle; and others, on more indefinite and compound enquiries. He therefore, besides the symbols x and y, assumes a third, as v, which denotes the transcendental quantity; and of these three forms, a general equation for the line sought, from which he finds the tangent, according to the differential method, which succeeds even in transcendental quantities. The result he compares with the given properties of the tangent, and so discovers, not only the value of a, b, c, d, &c. but also the particular nature of the transcendental quantity. And though it may sometimes happen, that the several transcendentals are so to be made use of, and those of different natures too, one from one another; also though there are transcendents of transcendentals, and a progression of these in infinitum; yet we may be satisfied with the most easy and useful one; and for the most part, may have recourse to some peculiar artifices for shortening the calculus, and reducing the problem to as simple terms as may be.

This method being applied to the business of quadratures, or to the invention of quadratics, in which the property of the tangent is always given, it is manifest, not only how it may be discovered, whether the indefinite quadrature may be algebraically impossible; but also, how, when this impossibility is discovered, a transcendental quadratrix may be found, which is a thing not before shewn. So that it seems that geometry, by this method, is carried infinitely beyond the bounds to which Vieta and Des Cartes brought it; since, by this means, a certain and general analysis is established, which extends to all problems of no certain degree, and consequently not comprehended within algebraical equations.

Again, in order to manage transcendental problems, wherever the business of tangents or quadratures occurs, by a calculus, there is hardly any that can be imagined shorter, more advantageous, or more universal, than the differential calculus, or analysis of indivisibles and infinites.

By this method, we may explain the nature of transcendental lines, by an equation; *e. gr.* Let a be the arch of a circle, and x the versed sine; then will $a = \frac{sdx}{\sqrt{2x - xx}}$; and, if the ordinate of the cycloid is y, then will $y = \sqrt{2x - xx} + \frac{sdx}{\sqrt{2x - xx}}$; which equation perfectly expresses the relation between the ordinate y and the absciss x, and from it all the properties of the cycloid may be demonstrated.

Thus is the analytical calculus extended to those lines, which have hitherto been excluded; for no other reason, but that they were thought incapable of it.

TRANSFORMATION *of Equations*, in algebra, is the changing equations into others of a different form, but of equal value. This operation is often necessary, to prepare equations for a more easy solution, some of the principal cases of which are as follow: 1. The signs of the roots of an equation are changed, viz. the positive roots into negative, and the negative roots into positive ones, by only changing the signs of the 2d, 4th, and all the other even terms of the equation. Thus the roots of the equation

$$x^4 - x^3 - 19x^2 + 49x - 30 = 0, \text{ are}$$
$$+1, +2, +3, -5;$$

whereas the roots of the same equation having only the signs of the 2d and 4th terms changed, viz. of $x^4 + x^3 - 19x^2 - 49x - 30 = 0$, are $-1, -2, -3, +5$.

2. To transform an equation into another that shall have its roots greater or less than the roots of the proposed equation by some given difference, proceed as follows: Let the proposed equation be the cubic $x^3 - ax^2 + bx - c = 0$; and let it be required to transform it into another, whose roots shall be less than the roots of this equation by some given difference d; if the root y of the new equation must be the less, take it $y = x - d$, and hence $x = y + d$; then, instead of x and its powers, substitute $y + d$ and its powers, and there will arise this new equation

$$\text{(A)} \quad \left.\begin{array}{l} y^3 + 3dy^2 + 3d^2y + d^3 \\ \quad\; - ay^2 - 2ady - ad^2 \\ \qquad\qquad\; + by + bd \\ \qquad\qquad\qquad\; - c \end{array}\right\} = 0;$$

whose roots are less than the roots of the former equation by the difference d. If the roots of the new equation had been required to be greater than those of the old one, we must then have substituted $y = x + d$, or $x = y - d$, &c.

3. To take away the 2d or any other particular term out of an equation; or to transform an

equation, so that the new equation may want its 2d, or 3d, or 4th, &c. term of the given equation $x^3 - ax^2 + bx - c = 0$, which is transformed into the equation (A) in the last article. Now to make any term of this equation (A) vanish, is only to make the co-efficient of that term $= 0$; which will form an equation that will give the value of the assumed quantity d, so as to produce the desired effect, viz. to make that term vanish. So, to take away the 2d term, make $3d - a = 0$, which makes the assumed quantity $d = \frac{1}{3}a$. To take away the 3d term, we must put the sum of the co-efficients of that term $= 0$, that is, $3d^2 - 2ad + b = 0$, or $3d^2 - 2ad = -b$; then, by resolving this quadratic equation, there is found the assumed quantity $d = \frac{1}{3}a \pm \frac{1}{3}\sqrt{a^2 - 3b}$, by the substitution of which for d, the 3d term will be taken away out of the equation.

From whence it appears that, to take away the 2d term of an equation, we must resolve a simple equation; for the 3d term, a quadratic equation; for the 4th term, a cubic equation, and so on.

4. To multiply or divide the roots of an equation by any quantity; or to transform a given equation to another, that shall have its roots equal to any multiple or submultiple of those of the proposed equation. This is done by substituting, for x and its powers, $\frac{y}{m}$, or py, and their powers, viz. $\frac{y}{m}$ for x, to multiply the roots by m; and py for x, to divide the roots by p.

Thus, to multiply the roots by m, substituting $\frac{y}{m}$ for x in the proposed equation,

$x^n - ax^{n-1} + bx^{n-2}$ &c $= 0$, and it becomes

$$\frac{y^n}{m^n} - \frac{ay^{n-1}}{m^{n-1}} + \frac{by^{n-2}}{m^{n-2}} \text{ \&c} = 0;$$

or multiply all by m^n, then is

$$y^n - amy^{n-1} + bm^2y^{n-2} - cmcy^{n-3} \text{ \&c} = 0,$$

an equation that has its roots equal to m times the roots of the proposed equation.

In like manner, substituting py for x, in the proposed equation, &c. it becomes

$$y^n - \frac{ay^{n-1}}{p} + \frac{by^{n-2}}{p^2} - \frac{cy^{n-3}}{p^3} \text{ \&c} = 0,$$

an equation that has its roots equal to those of the proposed equation divided by p.

From whence it appears, that to multiply the roots of an equation by any quantity m, we must multiply its terms, beginning at the 2d term, respectively by the terms of the geometrical series, m, m^2, m^3, m^4, &c. And to divide the roots of an equation by any quantity p, that we must divide its terms, beginning at the 2d, by the corresponding terms of this series p, p^2, p^3, p^4, &c.

5. And sometimes, by these transformations, equations are cleared of fractions, or even of surds. Thus the equation

$$x^3 - ax^2\sqrt{p} + bx - c\sqrt{p} = 0,$$

by putting $y = x\sqrt{p}$, or multiplying the terms, from the 2d, by the geometricals $\sqrt{p}$, p, $p\sqrt{p}$, is transformed to

$$y^3 - apy^2 + bpy - cp^2 = 0.$$

6. An equation, as $x^3 - ax^2 + bx - c = 0$, may be transformed into another, whose roots shall be the reciprocals of the roots of the given equation, by substituting $\frac{1}{y}$ for x; by which it becomes $\frac{1}{y^3} - \frac{a}{y^2} + \frac{b}{y} - c = 0$; or, multiplying all by y^3, the same becomes

$$cy^3 - by^3 + ay - 1 = 0.$$

TRANSIT, in astronomy, signifies the passage of any planet, just by or over a fixed star, or the sun; and of the moon in particular, covering or moving over any planet.

TRANSIT INSTRUMENT. See OBSERVATORY.

TRANSITION, in music, the softening a disjunct interval by the introduction of intermediate sounds. In harmony, transition is the changing the genus, or mode, in a sensible but regular manner. Thus, when in the diatonic genus the bass moves so as to require in the parts the introduction of a minor semitone, it is a chromatic transition; and if we change the tone by favour of a diminished seventh, it is an enharmonic transition.

TRANSMISSION. See OPTICS.

TRANSMUTATION, in geometry, denotes the reduction or change of one figure or body into another of the same area or solidity, but of a different form; as a triangle into a square, a pyramid into a parellelopiped, &c. In the higher geometry, transmutation is used for the converting a figure into another of the same kind and order, whose respective parts rise to the same dimensions in an equation, admit of the same tangents, &c. If a rectilinear figure is to be transmuted into another, it is sufficient that the intersections of the lines which compose it are transferred, and the lines drawn through the same in the new figure. If the figure to be transmuted is curvilinear, the points, tangents, and other right lines by means whereof the curve line is to be defined, must be transferred.

TRANSOM, among builders, denotes the piece that is framed across a double-light window.

TRANSOM, among mathematicians, signifies the vane of a cross-staff, or a wooden number fixed across, with a square whereon it slides, &c.

TRANSOM, in a ship, a piece of timber which lies athwart the stern, between the two fashion-pieces, directly under the gun-room port.

TRANSPORTATION, the act of conveying or carrying a thing from one place to another.

Transportation is a kind of punishment, or more properly an alleviation or commutation of punishment, for criminals convicted of felony; who for the first offence, unless it is an extraordinary one, are generally transported to the plantations (at present to New South Wales), there to bear hard labour for a term of years; within which if they return, they are executed without further trial than identifying their persons.

TRANSPORTATION *of plants*. In sending plants from one country to another, great cautions are necessary. The plants sent from a hotter country to a colder, should be always put on board in the spring of the year, that the heat of the season may be advancing as they approach the colder climates; and, on the contrary, those which are sent from a colder country to a hotter, should be sent in the beginning of winter. The best way of packing up plants for a voyage, if they are such as will not bear keeping out of the earth, is to have boxes with handles, filling them with earth, and planting the roots as close together as may be; the plants should be set in these boxes three weeks before they are to be put on board; and in good weather they should be set upon the deck, and in bad removed or covered with a tarpaulin. If they are going from a hotter country to a colder one, they must have very little moisture; if, on the contrary, they are going from a colder to a warmer, they may be allowed water more largely, and being shaded from the heat of the sun, they will come safe.

A great many plants, however, will live out of the earth a considerable while; as the sedums, euphorbiums, mesembryanthemums, and other succulent ones. These need no other care than the packing them up with moss in a close box; and there should be a little hay put between them, to prevent them from wounding or bruising one another, and holes bored in the boxes to keep them from heating and putrefying. In this manner they will come safe from a voyage of two or three, or even four or five months. Several trees also will come safe in the same manner; taking them up at a season when they have done growing, and packing them up with moss. Of this sort are oranges, olives, capers, jasmines, and pomegranate-trees. These, and many others, are annually brought over to us from Italy; and, though they are three or four months in the passage, seldom miscarry. The best way of sending over seeds, is in their natural husks, in a bag, or packed up in a gourd-shell, keeping them dry, and out of the way of vermin.

TRANSPOSITION, in algebra, the bringing any term of an equation over to the other side.

TRANSUBSTANTIATION, in theology, the conversion or change of the substance of the bread and wine in the eucharist, into the body and blood of Jesus Christ, which the Romish church hold is wrought by the consecration of the priest. This is a main point in the Romish religion, and is rejected by the protestants, the former maintaining the transubstantiation to be real, the latter only figurative; interpreting the text hoc est corpus meum, "this *signifies* my "body:" but the council of Trent stood up strenuously for the literal sense of the verb *est*, and say expressly, that in transubstantiation the body and blood of our Lord Jesus Christ are truly, really, and substantially, under the species of bread and wine. The controversies about this point are almost innumerable.

TRANSVERSE MUSCLES, in anatomy, are certain muscles arising from the transverse processes of the vertebræ of the loins. See ANATOMY.

TRAPA, a genus of the tetrandria monogynia class of plants, the corolla whereof consists of four petals, vertically ovated, and larger than the cup: the fruit is a hard osseous capsule, of an oblong oval figure, containing only one cell, and armed with four sharp thick spines, placed oppositely in the middle of the sides, and pointed; these before were the leaves of the calyx: the seed is a covered single nucleus, of an oval figure. There are two species, aquatics.

TRAPEZIUM, in geometry, a plane figure contained under four unequal right lines. 1. Any three sides of a trapezium taken together, are greater than the third. 2. The two diagonals of any trapezium, divide it into four proportional triangles. 3. If two sides of a trapezium are parallel, the rectangle under the aggregate of the parallel sides and one-half their distance, is equal to that trapezium. 4. If a parallelogram circumscribes a trapezium, so that one of the sides of the parallelogram is parallel to a diagonal of the trapezium, that parallelogram will be the double of the trapezium. 5. If any trapezium has two of its opposite angles, each a right angle, and a diagonal is drawn joining these angles; and if from the other two angles are drawn two perpendiculars to that diagonal; the distances from the feet of these perpendiculars to those right angles, respectively taken, will be equal. 6. If the sides of a trapezium are each bisected, and the points of bisection are joined by four right lines, these lines will form a parallelogram, which will be one-half of the trapezium. 7. If the diagonals of a trapezium are bisected, and a right line joins these points, the aggregate of the squares of the sides is equal to the aggregate of the squares of the diagonals, together with four times of the square of the right line joining the point of bissection. 8. In any trapezium, the aggregate of the diagonals is less than the aggregate of four right lines drawn from any point (except the intersection of the diagonals) within the figure.

TRAPS. See Rocks, *primitive.*

TRAVERSE, or Transverse, in general, denotes something that goes athwart another; that is, crosses and cuts it obliquely.

Hence, to traverse a piece of ordnance, among gunners, signifies to turn or point it which way one pleases, upon the platform.

In fortification, traverse denotes a trench with a little parapet, or bank of earth, thrown perpendicularly across the moat, or other work, to prevent the enemy's cannon from raking it. These traverses may be from twelve to eighteen feet, in order to be cannon-proof; and their height about six or seven feet, or more if the place is exposed to any eminence. And to preserve a communication, a passage of about five or six feet wide must be left at one end of the traverse. If any part of a work, thus shut in by one or more traverses, is likely to be defended by the musketry, it will be proper to add to the traverses one or more footbanks within the defence, for the troops to mount on when they want to fire over the traverse.

Traverse. See Navigation.

Traverse, in law, signifies sometimes to deny, sometimes to overthrow or undo a thing, or to put one to prove some matter; much used in answers to bills in chancery: or it is that which the defendant pleads or says in bar to avoid the plaintiff's bill, either by confessing and avoiding, or by denying and traversing the material parts thereof.

Traverse an Indictment, is to take issue upon the chief matter, and to contradict or deny some point of it. A traverse must be always made to the substantial part of the title. Where an act may indifferently be intended to be at one day or another, there the day is not traversable. In an action of trespass generally, the day is not material; though if a matter is done upon a particular day, there it is material and traversable. 2 Roll's Rep. 37.

TRAVESTY, or Travesti, a French term, derived from the verb travestir, to disguise one's self, or to appear in masquerade: and hence, travesty is applied to the disfiguring of an author, or the translating him into a style and manner different from his own, by which means it becomes difficult to know him.

TREACLE. See Sugar, &c.

TREASON, in law, is divided into high treason and petty treason. High treason, as comprized under the famous high treason act, as it is called, or the statute 25th Edw. III., is divided into seven heads.

1. When a man compasses or imagines the death of the king, queen, or the heir apparent, he is guilty of high treason. But as this compassing or imagining is an act of the mind, it cannot be proved unless demonstrated by some overt (or open) act. To conspire to imprison the king, and to assemble company for the purpose, to procure arms and ammunition with the intent to kill him, or even taking any measures to put such designs into execution, as consulting of the best means of putting him to death, are overt or open acts.

2. To violate the queen-consort, the king's eldest daughter, or the wife of the heir apparent, is high treason; and if both parties consent, they are alike guilty. This is to guard the blood royal from pollution, so that to violate a queen or princess dowager is not treason.

3. If a man levies war against the king in his realm, he is guilty of high treason. This may be done under pretence of redressing grievances, as well as to dethrone the king. An insurrection with the avowed design of destroying all inclosures, all brothels, &c. is likewise treason; though a tumult to destroy any particular inclosure or brothel would only amount to a riot: but in the first instance, the universality of the design renders it high treason. A mere conspiracy to level war is not treason, unless the design is particularly pointed against the king, when it falls under the first head, viz. compassing or imagining his death.

4. To be an adherent to the king's enemies in his realm, or aiding them in his realm, or elsewhere, is treason; but this must be demonstrated by some overt act, as the giving them intelligence, sending provisions, surrendering up a fortress by combination with the enemy, and not by cowardice, in which case it is an offence against the laws of war, but not treason. Giving assistance to foreign pirates or robbers who invade our coasts without any open hostilities between their nation and our own, or any commission from any state at war with Great Britain; also aiding our own fellow-subjects in rebellion at home; are both treasons; but to relieve a rebel fled out of the kingdom is not. And if a person through force or fear is obliged to join the rebels, provided he leaves them at the first safe opportunity, he is not guilty.

5. Counterfeiting the great or privy seal is likewise high treason.

6. Counterfeiting the king's money; or bringing false and counterfeit money into the realm, and knowing it to be false, uttering it, is the sixth species of treason. Counterfeiting it is of itself treason, without making payment with it; and if the minters alter the legal standard of gold and silver, it is treason. As to importing foreign counterfeit money, it is held that uttering it without importing it is not within the statute.

7. The seventh and last species of treason under this statute is, if a man slays the chancellor, treasurer, or the king's justices of either of the benches, justices in eyre, or justices of assize, and all other justices assigned to hear and determine, being in their places during their offices. This extends only to killing them, and not to wounding and assaulting them. The barons of the exchequer are not specified as within the act, but by the stat. 5 Eliz. c. 18, and 1 W. and M. c. 21, the lord keeper or commissioners of the great seal are within it.

There are other treasons, not comprized under this act, which may be divided into three heads: 1. Such as relate to papists. 2. Such as relate to falsifying the coin or other royal signatures. 3. Such as relate to securing the protestant succession in the house of Hanover.

For the first see Papists. For the second see Coinage.

8. By the stat. 1 Anne, s. 2, c. 17, if any person shall endeavour to deprive or hinder any person being the next in succession to the crown, according to the limitations of the act of settlement, from succeeding to the crown, and attempt the same by any overt act, such offence shall be high treason. And by stat. 6 Anne, c. 7. if any person by writing or printing maintains and affirms that any person has any right or title to the crown of this realm, otherwise than according to the act of settlement; or that the kings of this realm, with the authority of parliament, are not able to make laws and statutes to bind the crown and the descent thereof; such person shall be guilty of high treason.

The punishment for this crime is very severe; that the criminal shall be dragged on the ground to the place of execution, though a sledge is now allowed through humanity, and be hanged and cut down alive, his entrails taken out and burned before his face, his head cut off, and his body quartered. The punishment for coining is, however, more mild.

Treason, *misprision of.* There is likewise a misprision of treason, which is the concealing the knowledge of treason without assenting to it, 1 and 2 Ph. and Mary, c. 10. The stat. 13 Eliz. c. 2, enacts, that those who forge foreign coins not current in Great Britain, their aiders, abettors, and procurers, shall be all guilty of misprision of treason. The punishment for this crime, which is a degree lower than high treason, is loss of the profits of lands for life, forfeiture of goods, and perpetual imprisonment.

Treason, *petit* (which is an aggravated degree of murder), according to the stat. 25th Edw. III. c. 2, may happen three ways; by a servant killing his master, a wife her husband, or an ecclesiastical person his superior to whom he owes faith and obedience: a servant who kills his master, whom he has left upon a grudge conceived while in his service; for the intention was formed while the relation subsisted: so if a wife is separated a mensa & thoro, the vinculum matrimonii is not dissolved; and if she kills her husband after the divorce, she is guilty. And a clergyman owes canonical obedience to the bishop who ordained him, to him in whose diocese he is beneficed, and also to the metropolitan of such suffragan; and therefore to kill any of these is petit treason. The punishment is, for a man, to be drawn and hanged; for a woman, it was to be drawn and burnt; but this barbarous act is now repealed, and the punishment made simil r to that of the men. They, their aidors and abettors, are deprived the benefit of clergy.

TREASURE TROVE, is where any money or coin, gold, silver, plate, or bullion, is hidden in the earth, or other private place, the owner being unknown; in which case, the treasure belongs to the king, or some other who claims by the king's grant, or by prescription. Brac. Lib. 3. But if he that hid it is known, or afterwards found out, the owner, and not the king, is entitled to it. 1 Black. 295. If it is found in the sea, or upon the earth, it does not belong to the king, but to the finder, if no owner appears. Black. 295.

TREASURER, an officer to whom the treasure of a prince, or corporation, is committed to be kept, and duly disposed of.

The lord high treasurer of Great Britain, or first commissioner of the treasury when in commission, has under his charge and government all the king's revenue, which is kept in the exchequer. He holds his place during the king's pleasure, being instituted by the delivery of a white staff to him: he has the check of all the officers employed in collecting the customs and other royal revenues; and in his gift and disposition are all the offices of the customs in the several ports of the kingdom; escheators in every county are nominated by him; he also makes leases of the lands belonging to the crown. This office is now always executed by a commission, who are entitled, "the commissioners for executing the office of lord high treasurer," and the first commissioner is commonly prime minister.

There is, besides the lord-treasurer, a treasurer of the king's houshold; who is of the privy council, and, with the comptroller and steward of the marshalsea, has great power.

To these may be added the treasurer of the navy; as also the treasurer of the king's chamber, and of the wardrobe; and most corporations throughout the kingdom have treasurers, whose office is to receive their rents, and disburse their common expences.

The treasurer of the county is an officer that keeps the county-stock, in which office there are two in every county; who are chosen by the major part of the justices of the peace at Easter-sessions. They ought to have certain estates in lands, or to be worth 150*l.* in personal estate; and are to continue in their office only for a year, at the end whereof, or within ten days after the expiration of the year, they must account to their successors, under certain penalties. The county-stock which this officer has the keeping of, is raised by rating every parish annually; and the same is from time to time disposed of to charitable uses, towards the relief of maimed soldiers and mariners, prisoners in the county gaols, paying the salaries of governors of houses of correction, and relieving poor alms-houses, &c.

TREE. See Forest Trees, Planting, Plants, Timber, &c.

TREFOIL. See Trifolium.

TREMELLA, a genus of plants of the class of cryptogamia, and natural order of algæ. It is a gelatinous membranous substance; the parts of the fructification scarcely visible. There are 11 species, of which five are indigenous; the nostoc, lichenoides, verrucosa, hemispherica, and purpurea. 1. The nostoc, or jelly rain tremella, is found in pastures and by the sides of gravel-walks in gardens after rains; not uncommon in spring, summer, and autumn. It is a membranaceous, pellucid, and gelatinous substance, without any visible root; of a yellowish dull green-colour; assuming various forms, either round, angular, plaited or folded together irregularly, like the intestines, or a pocket-handkerchief, an inch or two, or more, in diameter: soft to the touch when moist; but thin, membranaceous, and brittle, when dry; and of a black fuscous colour. The antient alchemists called this vegetable the flowers of heaven, and imagined that from it they should procure the universal menstruum: but all their researches ended in discovering that by distillation it yielded some phlegm, volatile salt, and empyreumatic oil. It has been extolled in wounds, ulcers, &c. but no regard is ever paid to it by judicious practitioners. Dr. Darwin says, he has been well informed that this tremella is a mucilage voided by herons after they have eaten frogs. 2. The lichenoides, or transparent tremella, is erect, plane, margin curled, lacinulated, and brown. It grows on heaths and in woods, &c. 3. Verrucosa, or warty tremella, is tubercular, solid, wrinkled, roundish, and resembling a bladder; it is of a blackish yellow. It grows on stones in rivulets. 4. Hemispherica, or sea tramella, is scattered among confervæ, fuci, &c. 5. Purpurea, or purple tremella, is globular, sessile, solitary, and smooth. It grows on ditch-banks about London.

TREMOLITE. This mineral is found chiefly near St. Gothard, in Switzerland; and takes its name from mount Tremola, where it was first observed by Saussure. It occurs massive and in crystals. The primitive form of its crystals is a rhomboidal prism, whose sides are inclined to each other at angles of 126° 52′ 12″ and 53° 7′ 48″. It usually occurs in four-sided prisms, terminated by dihedral summits; and not unfrequently the two acute edges, or all the four, are truncated. Texture radiated. Fragments splintery. Specific gravity from 2.9 to 3.2. Fibres easily separated, so that it appears soft, yet it scratches glass. Phosphoresces very readily when struck or rubbed in the dark. Before the blowpipe, melts into a white scoria. Werner divides this species into three subspecies.

A specimen of tremolite analysed by Klaproth, contained

65.0	silica
38.0	lime
0.5	magnesia
0.5	oxide of iron
6.0	water and carbonic acid.
100.0	

A specimen of this mineral from the castle-hill of Edinburgh, analysed by Dr. Kennedy, yielded

51.5	silica
32.0	lime
0.5	alumina
0.5	oxide of iron
8.5	soda
5.0	carbonic acid
98.0,	with some traces of magnesia and muriatic acid.

Bournon has shewn that the property which the tremolite has of phosphorescing when rubbed, is owing to the presence of carbonat of lime.

TREMOR. See Medicine.

TRENCHES, in a siege, are ditches made by the besiegers, that they may approach more securely to the place attacked; on which account they are also called lines of approach. The tail of the trench is the place where it was begun, and its head is the place where it ends.

Trenches are also made to guard an encampment.

The trenches are usually opened or begun in the night-time, sometimes within musket-shot, and sometimes within half or whole cannon-shot of the place; generally about 800 fathoms. They are carried on in winding lines, nearly parallel to the works, so as not to be in view of the enemy, nor exposed to the enemy's shot.

The workmen employed in the trenches are always supported by a number of troops to defend them against the sallies of the besieged. The pioneers, and other workmen sometimes work on their knees, and are usually covered with mantlets or saucissons; and the troops who support them lie flat on their faces, in order to avoid the enemy's shot. On the angles or sides of the trench, there are lodgments, or epaulements, in form of traverses, the better to hinder the sallies of the garrison, and to favour the advancement of the trenches, and to sustain the workmen.

The platforms for the batteries are made behind the trenches; the first at a good distance, to be used only against the sallies of the garriosn. As the aproaches advance, the batteries are brought nearer, to ruin the defences of the place, and dismount the artillery of the besieged. The breach-batteries are made when the trenches are advanced near the covert-way.

If there are two attacks, it will be necessary to have lines of communication, or boyaus, between the two, with places of arms at convenient distances. The trenches are 6 or 7 feet high with the parapet, which is 5 feet thick, with banquettes for the soldiers to mount upon.

The approaches at a siege are generally carried on upon the capitals of the works attacked; because the capitals produced are, of all other situations in the front of a work, the least exposed to the fire of either the cannon or musketry; and are the least in the line of fire between the besieged and besiegers' batteries. But if, from particular circumstances, these or other advantages do not attend the approaches upon the capitals, they are by no means to be preferred to other positions.

The trenches of communication, or zigzags, are 3 feet deep, 10 feet wide at bottom, and 13 feet at top, having a berm of one foot, beyond which the earth is thrown to form a parapet.

The parallels or places of arms of the trenches are 3 feet deep, 12 feet wide at bottom, and 17 or 18 feet wide at top, having a banquette of about 3 feet wide, with a slope of nearly as much.

The first night of opening the trenches, the greatest exertions are made to take advantage of the enemy's ignorance as to the side of attack; and they are generally carried on as far in advance as the first parallel, and even sometimes to the completion of that work. The workmen set out on this duty, each with a fascine of 6 feet, a pick-ax, and a shovel; and the fascines being laid so as to lap one foot over each other, leave 5 feet of trench for each man to dig.

The usual method of directing the trenches or zig-zags, is by observing during the day some near object in a line with the salient parts of the work, and which may serve as a direction in the night: or if the night is not very dark, the angles of the works may be seen above the horizon; but as both these methods are subject to uncertainty, the following is proposed to answer every case: having laid down the plan of attack, the exact positions of the flanked angles of the works of the front attacked, and particularly of those most extended to the right and left; mark on the plan the point of commencement for the first portions of zig-zag, the point where it crosses the capital, and the point to which it extends on the other side of the capital: this last point will be the commencement of the second branch: then mark off the point where this branch crosses the capital, and its extent on the other side; and this will give the commencement of the third branch; and so on for the others. Thus provided with a plan ready marked off, it will be very easy, even in the darkest night, to lay down the points where the zig-zags are to cross the capital, and the points to which they are to be produced beyond them. The first parallel is generally run about 600 yards from the place, and of such extent as to embrace the prolongation of the faces of all the works which fire upon the trenches; and each end has a return of about 30 or 40 yards.

The second parallel is constructed upon the same principles, and of the same extent, as the first, at the distance of about 300 yards from the salient angles of the covert-way. This parallel is usually formed of gabions; each workman carrying a gabion, a fascine, a shovel, and a pick ax. After this the trenches are usually carried on by sap.

The half-parallels are about 140 or 150 yards from the covert-way, and extend sufficiently on each side to embrace the prolongation of the branches of a covert-way.

The third parallel must not be nearer than the foot of the glacis, or it will mask the ricochet batteries. It is generally made rather wider than the other parallels.

Cavaliers of the trenches must not be nearer than 28 yards from the covert-way, or they will be liable to be annoyed by hand-grenades.

Trench, *returns of a*, are the elbows and turnings, which form the lines of approach, and are made, as near as can be, parallel to the place, to prevent their being enfiladed.

Trenches, *to mount the*, is to mount guard in the trenches, which is generally done in the night.

Trenches, *to relieve the*, is to relieve the guard of the trenches.

Trenches, *to scour the*, is to make a vigorous sally upon the guard of the trenches, force them to give way and quit their ground, drive away the workmen, break down the parapet, fill up the trench, and nail their cannon.

Trenches, *counter*, are trenches made against the besiegers; which consequently have their parapet turned against the enemy's approaches, and are enfiladed from several parts of the place, on purpose to render them useless to the enemy, if they should chance to become masters of them; but they should not be enfiladed or commanded by any height in the enemy's possession.

Trenches, *to open the*, is to break ground for the purpose of carrying on approaches towards a besieged place.

TREPANNING. See Surgery.

TREPIDATION. See Medicine.

TRESPASS, is any trangression of the law, under treason, felony, or misprision of either. Staundf. Pl. Cor. 38.

Trespass signifies going beyond what is lawful; hence it follows that every injurious act is, in the large sense of this word, a trespass. But as many injurious acts are distinguished by particular names, as treason, murder, rape, and other names, the legal sense of the word trespass is confined to such injurious acts as have not acquired a particular name. Some trespasses are not accompanied with any force; a trespass of this sort is called a trespass upon the case: and the proper remedy for the party injured, is by an action upon the case. Other trespasses are accompanied with force, either actual or implied. If a trespass which was accompanied with either actual or implied force, has been injurious to the public, the proper remedy in every such case, is by an indictment, or by information. And if a trespass that was acccompanied with an actual force, has been injurious only to one or more private persons, the offender is in every such case liable to an indictment, or to an information; for although the injury has in such case been only done to one or more private persons, as every trespass accompanied with actual force is a breach of the peace, it is to be considered and punished as an offence against the public. 5 Bac. Abr. 150.

A man is answerable for not only his own trespass, but that of his cattle also. 3 Black. 211.

And the law gives the party injured, a double remedy in this case; by permitting him to distrain the cattle thus doing damage, till the owner shall make him satisfaction, or else by leaving him to the common remedy by action. And in either of these cases of trespass committed on another's land, either by a man himself or his cattle, the action that lies, is the action of trespass with force and arms; for the law always couples the idea of force with that of intrusion upon the property of another. 3 Black. 210.

In some cases, trespass is justifiable; or rather entry on another's land or house shall not in these cases be accounted trespass: as if a man came there to demand or pay money there payable, or to execute in a legal manner the process of the law. 3 Black 219.

To prevent trifling and vexatious actions of trespass, it is enacted by 43 Eliz. c. 6. 22 and 23 Car. II. c. 9. and 8 & 9 W. c. II. that where a jury who try an action of trespass, give less damages than 40*s*. the plaintiff shall be allowed no more costs than damages; unless the judge shall certify on the back of the record, that the freehold or title of the land came chiefly in question. But if it shall appear that the trespass was wilful and malicious, the plaintiff shall have his full costs. And every trespass is wilful, where the defendant has been forewarned, and malicious where the intent of the defendant appears to be to harass or injure the plaintiff. 3 Black. 370.

TRESPASSER, denotes a person that commits a trespass against another; in respect of whom it is held, that though the law permits a person to enter a tavern, and a landlord to distrain on lands, &c. yet if he abuses this liberty by committing any trespass, he will be judged a trespasser ab initio.

TRET, in commerce, an allowance made for the waste, or the dirt, that may be mixed with any commodity, which is always four pounds in every hundred and four pounds weight. See Tare.

TREWIA, a genus of the polyandria monogynia class of plants, having no corolla besides the cup; the fruit is a turbinated, triquetrous, coronated, trilocular, trivalvar capsule: the seed is single, convex on one side, and angular on the other. There is one species, a tree of the East Indies.

TRIAL, in law, the examination of a cause, civil or criminal, according to the laws of the land, before a proper judge: or, it is the manner and order observed in the hearing and determining of causes. There are divers kinds of trials; as those of matters of fact, which must be tried by a jury; matters of law which are only triable by the courts; and matters of record, which are to be tried by the records themselves. The most general rule has been, that the jurymen on a trial shall be chosen out of that town or precinct, &c. in which the matter of fact is alleged, or the nearest thereto, for the better cognizance of the matter; and not to leave things to be tried in foreign counties, where the jury are strangers to the whole matter. Where any trial is for murder, it must be in the county wherein the fact was committed; but if the assault is in one county, and the person assaulted happens to die in another county, the indictment may be found by a jury of the county where the party died: and by special commission, when a person is indicted in one county he may be tried in another. In all criminal cases the custom is to ask the prisoner how he will be tried, which was formerly a very significant question, though it is not so now; because antiently there were trials by combat, by ordeal, and by jury; and when the prisoner answered, By God and his country, it appeared he made choice to be tried by a jury; which is the only way now used for the trial of criminals.

The method of proceeding in a criminal case is this: First the bill of indictment against the offender is prepared, and the prosecutor and his witnesses attend on the grand jury, and there give in their evidence; which being done, the grand inquest either find the bill of indictment, or bring it in ignoramus; and if the bill is found, the prisoner is brought to the bar of the court, and the clerk of the arraigns calling him by his name, desires him to hold up his hand, saying, "Thou art indicted by the name of — —, for such a felony, &c. (setting forth the crime laid in the indictment). How sayest thou; art thou guilty of this felony whereof thou art indicted, or not guilty?" To which the prisoner answering, "Not guilty," the clerk says, "Culprit, how wilt thou be tried?" whereupon the defendant answers, "By God and my country;" which plea of the prisoner the clerk records, and then the panel of the petty-jury is called over.

After the jury are sworn, and the indictment is read over to them, and they are charged, the evidences on both sides, for and against the prisoner, are called, sworn, and examined in open court; after which the jury bring in their verdict; and if they find the prisoner guilty, their verdict is recorded, and the prisoner is taken from the bar: but if they bring him in not guilty, the prisoner is discharged. On the prisoner being brought in guilty, proclamation is made for all persons to keep silence, upon which the prisoner is again brought to the bar, and the verdict repeated: after which sentence is passed on him, and an order or warrant is made for his execution.

The methods of trial, in our civil courts, are as follows: viz. The declaration is first drawn for the plaintiff, and when the appearance of the defendant is entered, it has been usual to deliver it with an imparlance to the defendant's attorney; and the term following, rule is to be given with the secondary for the defendant to plead by such a day, or else the plaintiff is to have judgment: and the defendant having pleaded, a copy of the issue is made by the plaintiff, and delivered to the defendant's attorney, at the same time giving him notice of the trial; in order to which the venire facias must be taken out and returned by the sheriff: and likewise the habeas corpora, or distringas, to bring in the jury; on which the record is made up, and the parties proceed to trial by their counsel and witnesses; and the jury give in their verdict, &c. But in case the defendant neglects to plead, and suffers it to go by default, on entering such a judgment, a writ of inquiry of damages is awarded returnable next term, notice of the execution whereof the defendant's attorney is to have; and which being executed, and the damages inserted in a schedule annexed to the writ, a rule is given, and costs are taxed by the prothonotary, &c.

TRIANDRIA, in the Linnæan system of botany, a class of plants, the third in order; comprehending all such plants as have hermaphrodite flowers, with three stamina, or male parts, in each; whence the name. See BOTANY.

TRIANGLE, in geometry, a figure bounded or contained by three lines or sides, and which consequently has three angles, from whence the figure takes its name.

Triangles are either plane, or spherical, or curvilinear. Plane when the three sides of the triangle are right lines; but spherical when some or all of them are arcs of great circles on the sphere.

Plane triangles take several denominations, both from the relation of their angles, and of their sides, as below. See GEOMETRY.

The chief properties of plane triangles are as follow, viz. In any plane triangle,

1. The greatest side is opposite to the greatest angle, and the least side to the least angle, &c. Also, if two sides are equal, their opposite angles are equal; and if the triangle is equilateral, or has all its sides equal, it will also be equiangular, or have all its angles equal to one another. 2. Any side of a triangle is less than the sum, but greater than the difference, of the other two sides. 3. The sum of all the three angles, taken together, is equal to two right angles. 4. If one side of a triangle is produced out, the external angle, made by it and the adjacent side, is equal to the sum of the two opposite internal angles. 5. A line drawn parallel to one side of a triangle, cuts the other two sides proportionally, the corresponding segments being proportional, each to each, and to the whole sides; and the triangle cut off is similar to the whole triangle.

If a perpendicular is let fall from any angle of a triangle, as a vertical angle, upon the opposite side as a base; then, 6. The rectangle of the sum and difference of the sides, is equal to twice the rectangle of the base and the distance of the perpendicular from the middle of the base. Or, which is the same thing in other words, 7. The difference of the squares of the sides, is equal to the difference of the squares of the segments of the base. Or, as the base is to the sum of the sides, so is the difference of the sides to the difference of the segments of the base. 8. The rectangle of the legs or sides is equal to the rectangle of the perpendicular and the diameter of the circumscribing circle.

If a line is drawn bisecting any angle, to the base or opposite side; then, 9. The segments of the base, made by the line bisecting the opposite angle, are proportional to the sides adjacent to them. 10. The square of the line bisecting the angle, is equal to the difference between the rectangle of the sides and the rectangle of the segments of the base.

If a line is drawn from any angle to the middle of the opposite side, or bisecting the base, then, 11. The sum of the squares of the sides, is equal to twice the sum of the squares of half the base and the line bisecting the base. 12. The angle made by the perpendicular from any angle and the line drawn from the same angle to the middle of the base, is equal to half the difference of the angles at the base. 13. If through any point within a triangle three lines are drawn parallel to the three sides of the triangle, the continual products or solids made by the alternate segments of these lines will be equal. 14. If three lines are drawn from the three angles through any point within a triangle, to the opposite sides; the solid products of the alternate segments of the sides are equal, viz. 15. Three lines drawn from the three angles of a triangle to bisect the opposite sides, or to the middle of the opposite sides, do all intersect one another in the same point, and that point is the centre of gravity of the triangle; and the distance of that point from any angle is equal to double the distance from the opposite side, or one segment of any of these lines is double the other segment: moreover the sum of the squares of the three bisecting lines is $\frac{3}{4}$ of the sum of the squares of the three sides of the triangle. 16. Three perpendiculars bisecting the three sides of a triangle, all intersect in one point, and that point is the centre of the circumscribing circle. 17. Three lines bisecting the three angles of a triangle, all intersect in one point, and that point is the centre of the inscribed circle. 18. Three perpendiculars drawn from the three angles of a triangle upon the opposite sides, all intersect in one point. 19. Any triangle may have a circle circumscribed about it, or touching all its angles, and a circle inscribed within it, or touching all its sides. 20. The square of the side of an equilateral triangle is equal to three times the square of the radius of its circumscribing circle. 21. If the three angles of one triangle are equal to the three angles of another triangle, each to each, then those two triangles are similar, and their like sides are proportional to one another, and the areas of the two triangles are to each other as the squares of their like sides. 22. If two triangles have any three parts of the one (except the three angles) equal to three corresponding parts of the other, each to each, those two triangles are not only similar, but also identical, or having all their six corresponding parts equal, and their areas equal. 23. Triangles standing upon the same base, and between the same parallels, are equal; and triangles upon equal bases, and having equal altitudes, are equal. 24. Triangles on equal bases, are to one another as their altitudes, and triangles of equal altitudes are to one another as their bases; also equal triangles have their bases and altitudes reciprocally proportional. 25. Any triangle is equal to half its circumscribing parallelogram; or half the parallelogram on the same or an equal base, and of the same or equal altitude. 26. Therefore the area of any triangle is found by multiplying the base by the altitude, and taking half the product. 27. The area is also found thus: Multiply any two sides together, and multiply the product by the sine of their included angle, to radius 1 and divided by 2. 28. The area is also otherwise found thus, when the three sides are given: Add the three sides together, and take half their sum; then from this half sum subtract each side severally, and multiply the three remainders and the half sum continually together; then the square root of the last product will be the area of the triangle. 29. In a right-angled triangle, if a perpendicular is let fall from the right angle upon the hypothenuse, it will divide it into two other triangles similar to one another, and to the whole triangle. 30. In a right-angled triangle, the square of the hypothenuse is equal to the sum of the squares of the two sides; and, in general, any figure described upon the hypothenuse is equal to the sum of two similar figures described upon the two sides. 31. In an isosceles triangle, if a line is drawn from the vertex to any point in the base, the square of that line, together with the rectangle of the segments of the base, is equal to the square of the side. 32. If one angle of a triangle is equal to 120°, the square of the base will be equal to the squares of both the sides, together with the rectangle of those sides; and if those sides are equal to each other, then the square of the base will be equal to three times the square of one side, or equal to twelve times the square of the perpendicular from the angle upon the base. 33. In the same triangle, viz. having one angle equal to 120°, the difference of the cubes of the sides about that angle, is equal to a solid contained by the difference of the sides and the square of the base; and the sum of the cubes of the sides is equal to a solid contained by the sum of the sides and the difference between the square of the base and twice the rectangle of the sides.

TRIANGULAR COMPASSES, are such as have three legs, or feet, whereby to take off any triangle at once; much used in the construction of maps, globes, &c.

TRIANGULAR NUMBERS, are a kind of polygonal numbers. being the sums of arithmetical progressions, which have 1 for the common difference of their terms.

Thus, from these arithmeticals 1 2 3 4 5 6, are formed the triang. numb. 1 3 6 10 15 21, or the third column of the arithmetical triangle abovementioned.

The sum of any number n of the terms of the triangular numbers, 1, 3, 6, 10, &c, is =

$$\frac{n^3}{6} + \frac{n^2}{2} + \frac{n}{3}, \text{ or } \frac{n}{1} \times \frac{n+1}{2} \times \frac{n+2}{3}$$

which is also equal to the number of shot in a triangular pile of balls, the number of rows, or the number in each side of the base, being n.

The sum of the reciprocals of the triangular series, infinitely continued, is equal to 2; viz.,

$$1 + \tfrac{1}{3} + \tfrac{1}{6} + \tfrac{1}{10} + \tfrac{1}{15} \text{ \&c} = 2.$$

For the rationale and management of these numbers, see Simpson's Algebra, sect. 15.

TRIANGULAR CANON, the tables of artificial sines, tangents, secants, &c.

TRIANGULAR QUADRANT, is a sector furnished with a loose piece, whereby to make it an equilateral triangle.

The calendar is graduated thereon, with the sun's place, declination, and other useful lines; and by the help of a string and a plummet, and the divisions graduated on the loose piece, it may be made to serve for a quadrant.

TRIANTHEMA, a genus of the class and order decandria digynia. The calyx is mucronate below the tip; no corolla; stamina 5 or 10; germ. retuse; capsule cut round. There are seven species.

TRIBULUS, *caltrops*, a genus of the decandria-monogynia class of plants, the corolla of which consists of five oblong, obtuse, and patent petals: its fruit is of a roundish figure and aculeated, being composed of five capsules, gibbous on one side, and armed with three or four points on the other, angulated and convergent; and containing numerous seeds, turbinated and oblong. There are four species.

TRICEPS. See ANATOMY.

TRICERA, a genus of the class and order monoecia tetrandria. There is no corolla; the male is four-leaved; filaments four, ovate; female calyx five-leaved; styles conical; capsules three, horned, three-celled. There is one species, a shrub of Jamaica.

TRICHECHUS, *walrus*, a genus of quadrupeds of the order bruta. The generic character is, fore-teeth (in the full-grown animal) none either above or below; tusks solitary, in the upper jaw; grinders with wrinkled surfaces; lips doubled; hind feet at the extremity of the body, uniting into a fin. The genus trichechus is entirely marine, and contains but three species, besides varieties: of these the principal is the trichechus rosmarus, or, as it is sometimes called, the sea-horse, or walrus.

1. Trichechus rosmarus, arctic walrus. This animal inhabits the northern seas, and is principally found within the arctic circle. It grows to a very large size, having been sometimes seen of the length of eighteen feet, and of such a thickness as to measure twelve feet round the middle of the body. The walrus is of an inelegant form; having a small head, short neck, thick body, and short legs: the lips are very thick, and the upper lip is indented or cleft into two large rounded lobes: over the whole surface of this part are scattered numerous semitransparent bristles, of a yellowish tinge, and of such a thickness as almost to equal a straw in diameter: they are about three inches long, and are slightly pointed at their extremities; the eyes are small: instead of external ears there are only two small, round orifices; the skin on the whole animal is thick, and more or less wrinkled and is scattered over with short brownish hair: on each foot are five toes, all connected by webs, and on each toe is a small nail: the hind feet are considerably broader than the fore feet: the tail is extremely short. In the upper jaw are two large and long tusks, bending downwards: there are no cutting-teeth; but in each jaw, both above and below, are four roundish grinders with flat tops: the tusks are sometimes upwards of two feet in length, but are more generally of about one foot long: and it sometimes happens that the two tusks are not perfectly equal in length. The chief resorts of the walrus are the seas about the northern parts of America. They are found in the gulph of St. Laurence according to Mr. Pennant, between latitude 47 and 48. They are also found in Davis's Straits and within Hudson's Bay, lat. 62. They inhabit the coast of Greenland; and are found in great numbers about Spitsbergen, and on the floating ice in those parts. They occur likewise on the coasts of Nova Zembla, and on the headlands stretching towards the north pole.

They are gregarious animals, and are sometimes seen in vast multitudes on the masses of floating ice so frequent in the northern seas. They are said to produce their young early in the spring, and rarely bring more than one at a birth: their food consists of sea-plants, shell-fish, &c.

The walrus is a harmless animal, unless provoked or attacked, in which case it becomes furious, and is extremely vindictive. When surprised upon the ice, the female is said first to provide for the safety of the young, by flinging it into the sea, and immediately precipitating itself after it; carrying it to a secure distance, and then returning, with great rage, to revenge the injury. They will sometimes attempt to fasten their teeth on the boats, with an intent to sink them; or rise in numbers under them to overset them; at the same time shewing all the marks of rage, by roaring in a dreadful manner, and gnashing their teeth with great violence; if once thoroughly irritated, the whole herd will follow the boats till they lose sight of them. They are strongly attached to each other; and it is said that a wounded walrus has been known to sink to the bottom, rise suddenly up again, and bring with it multitudes of others, which have united in an attack upon the boat whence the insult came.

The teeth of the walrus are used as ivory; but on this subject authors seem to vary considerably; some representing them as superior to common ivory, and others greatly inferior, and more subject to turn yellow. The animals are now killed chiefly for the sake of the oil; and it is said that a very strong and elastic leather may be prepared from the skin. See Plate Nat. Hist. fig. 404.

2. Trichechus dugong, Indian walrus. This species is a native of the seas about the Cape of Good Hope and the Philippine islands. It does not, however, seem to be very clearly known to naturalists. The grinders differ from those of the walrus, being broader in proportion: of these there are four on each side in the upper jaw, and three in the lower. The head is said to be of a sharper or narrower form. This species, in the Philippine Islands, is said to be called by the name of dugung.

3. Trichechus borealis, manate or whale-tailed trichechus. This animal seems to approach so nearly to the cetaceous or whale tribe, as scarcely to deserve, according to Mr. Pennant, the name even of a biped; what are called the feet being little more than pectoral fins, which serve only for swimming, and are never used to assist the animal either in walking or landing; for it never goes ashore, nor ever attempts to climb the rocks like the walrus and the seal. It brings forth in the water, and, like the whale, suckles its young in that element. Like the whale, it is also destitute of voice; and has also a horizontal tail, which is broad, and of the form of a crescent, without even rudiments of hind feet.

So complete is the account given by Mr. Pennant of this animal, that we shall here deliver the most material parts of that author's description, rather than attempt a new one.

It inhabits the seas about Berings and the other Aleutian islands, which intervene between Kamtschatka and America, but never appears off Kamtschatka, unless blown ashore by a tempest. It is probably the same species which is found above Mindanao, but is certainly that which inhabits near Rodiguez, vulgarly called Diego Reys, an island to the east of Mauritius, or the Isle of France, near which it is likewise found. It is also probable that it extends to New Holland. They live perpetually in the water, and frequent the edges of the shores; and, in calm weather, swim in great droves near the mouths of rivers: in the time of flood they come so near the land that a person may stroke them with his hand: if hurt, they swim out to the sea, but presently return again. They live in families, one near another; each consists of a male, a female, a half-grown young one, and a very small one. The females oblige the young to swim before them, while the other old ones surround, and, in a manner, guard them on all sides. The affection between the male and female is very great; for if she is attacked, he will defend her to the utmost; and if she is killed, will follow her corpse to the very shore, and swim for some days near the place it has been landed at.

They are vastly voracious, and feed not only on the fuci that grow in the sea, but such as are flung on the edges of the shore. When they are filled, they fall asleep on their backs. During their meals they are so intent on their food, that any one may go among them, and choose which he likes best. Their back and sides are generally above water; and numbers of gulls, from time to time, perch on their backs, in order to pick the insects which they find upon them.

They continue in the Kamtschatkan and American seas the whole year; but in winter they are very lean, so that one may count their ribs. They are taken by harpoons fastened to a strong cord; and after they are struck, it requires the force of thirty men to draw them on shore. Sometimes, when they are transfixed, they will lay hold of the rocks with their paws, and stick so fast as to leave the skin behind before they can be forced off. When a manati is struck, its companions swim to its assistance: some will attempt to overturn the boat, by getting under it; others will press down the rope, in order to break it; and others will strike at the harpoon with their tails, with a view of getting it out, in which they often succeed. They have no voice; but make a noise, by hard breathing, like the snorting of a horse.

They are of an enormous size: some are twenty-eight feet long, and eight thousand pounds weight: but, if the Mindanao species is the same with this, it decreases in size as it advances southward, for the largest which Dampier saw there weighed only six hundred pounds. The head, in proportion to the bulk of the animal, is small, oblong, and almost square: the nostrils are filled with short bristles; the gape or rictus is small; the lips are double; near the junction of the two jaws the mouth is full of white tubular bristles, which serve the same purpose as the laminæ in whales, to prevent the food from running out with the water: the lips are also full of bristles, which serve instead of teeth to cut the strong roots of sea-plants, which, floating ashore, are a sign of the vicinity of these animals. In the mouth are no teeth; only two flat white bones, one in each jaw, one above, another below, with undulated surfaces, which serve instead of grinders.

The eyes are extremely small, not larger than those of a sheep: instead of ears are only two minute orifices, which will scarcely permit a quill to enter: the tongue is pointed and small: the neck thick, and its junction with the head scarcely distinguishable; and the last always hangs down.

The circumference of the body near the shoulders is twelve feet; about the belly twenty; near the tail only four feet eight inches: the head thirty-one inches: the neck near seven feet: and from these measurements may be collected the deformity of the animal. Near the shoulders are two feet, or rather fins, which are only two feet two inches long, and have neither fingers nor nails; beneath they are concave, and covered with hard bristles; the tail is thick, strong, and horizontal, ending in a stiff black fin, and like the substance of whalebone, being much split on the fore part and slightly forked; but both ends are of equal length like the whale.

The skin is very thick, hard, and black; full of inequalities, like the bark of oak; so hard as scarcely to be cut with an ax, and has no hair upon it: beneath the skin is a thick blubber, which is said to taste like oil of almonds. The flesh is coarser than beef, and will not soon putrefy: the young ones taste like veal: the skin is used for shoes, and for covering the sides of boats. The Russians call this animal morskaia korowa or sea-cow, and kapustnik or eater of herbs.

4. Trichechus australis, round-tailed manati. This species grows to the length of fourteen or fifteen feet, and is found in the rivers of Africa; particularly in the river Senegal: the lips are thick; the eyes as small as peas; and there are two very small orifices in the place of ears: in each jaw on each side are nine grinding teeth, in all thirty-six: the neck is short and thicker than the head: the greatest thickness of the body is about the should- from whence it gradually tapers to the tail, which is horizontal, broad, thickest in the middle, growing thinner to the edges, and quite round. The feet are placed at the shoulders; and beneath the skin are bones for five complete toes, and externally are three or four nails, flat and rounded: near the base of each leg, in the female is a small teat. The flesh of this animal is said to resemble veal: it is, however, chiefly killed by the negroes for the sake of the blubber or fat.

TRICHIURUS, a genus of fishes of the order apodes; the generic character is, head stretched forwards, with lateral gill-covers; teeth ensiform, semisagittate at the tips; gill-membrane seven-rayed; body ensiform, compressed, with subulate finless tail.

1. Trichiurus argenteus, silver trichiure. This fish is equally distinguished by the singularity of its shape, and brilliancy of its colour: the body is extremely compressed, of a great length, and gradually tapers as it approaches the extremity, till at length it terminates in a very fine point: the whole fish, except on the fins, is of the brightest silver-colour: the head is narrow; the mouth very wide, the lower jaw longer than the upper, and furnished with differently sized teeth, the longest of which are barbed at the tips by a sharp descending process or hook on one side: the tongue is smooth, longish, and triangular: in the throat are two rough bones: the eyes are vertical, approximated, and large: the lateral line is of a gold-colour, and, commencing behind the gill-covers, is continued to the tip of the tail: the dorsal fin, which is of moderate width, transparent, and of a yellowish tinge, commences almost immediately behind the head, and runs to within a very small distance of the extremity of the tail, at which part it degenerates into a mere membrane, being strongly radiated in other parts: the pectoral fins are rather small, and of an ovate shape: there is, properly speaking, no direct vent-fin, but a series of very small naked spines or rays, to the number of about 110, are continued from the vent, which is situated about the middle of the body, to near the tip of the tail. The general length of this fish is from two to three feet: it is said to be of a very voracious nature, swims with rapidity, and in the pursuit of its prey sometimes leaps into small vessels which happen to be sailing by. It is a native of the rivers and larger lakes of South America, and is considered as an eatable fish. It is also said to be found in some parts of India, and in China. See Plate Nat. Hist. fig. 407.

2. Trichiurus electricus, electrical trichiure. This species, which seems nearly equal in size to the preceding, differs not only in the conformation of the jaws, which are both of equal length, but in the form of its teeth, which are all very minute: the tail is not so extremely slender and sharp as in the former, and the colour of the whole animal is pale brown, variegated with spots of a deeper cast. It is a native of the Indian seas, and is said to possess a degree of electrical power. There are only these two species.

TRICHODA, a genus of vermes infusoria; the generic character is, a worm invisible, pellucid, hairy or horned. Ample accounts of this genus, which is very numerous, will be found in Adams's work on the Microscope. See Plate Nat. Hist. fig. 406. There are about sixty species.

TRICOCEPHALUS, a genus of vermes intestina. The generic character is, body round, elastic, and variously twisted; head or fore part much thicker, and furnished with a slender exsertile proboscis; tail or lower part long, capillary, and tapering to a fine point. There are six species: T. hominis, see Plate Nat. Hist. fig. 405, inhabits the intestines of sickly children, generally the cæcum, and in considerable numbers: about two inches long and resembling the ascarides in colour. The other species are named from animals on which they live, as the equi, apri, muris, vulpis, and lacertæ.

TRICHILIA, a genus of the class and order decandria monogynia. The calyx is mostly five-toothed; petals five; nectarium toothed; capsules three-celled, three-valved; seeds berried. There are 12 species, trees chiefly of the West Indies.

TRICHOCARPUS, a genus of the class and order polyandria digynia. The calyx is four or five parted; no corolla; styles two, bifid; capsules bristly, four-valved, many-seeded. These is one species, a tree of Guiana.

TRICHOMANES, a genus of plants of the class cryptogamia, and order filices. The parts of fructification are solitary; and terminated by a stile like a bristle, on every edge of the leaf. There are 27 species; of which two are natives of Britain, the pixidiferum and tunbrigense. 1. Pixidiferum, or cup-trichomanes, has subbipinnated leaves, the pinnæ being alternate, close-lobed and linear. It is found among stones in wet grounds in England. 2. Tunbrigense, or Tunbridge trichomanes, has pinnated leaves, the pinnæ being oblong, dichotomous, decurrent, and dentated. It is found in the fissures of moist rocks in Wales, and in many rocky places in Scotland.

TICOCCEÆ, the name of the 38th order in Linnæus's Fragments of a Natural Method, consisting of plants with a single three-cornered capsule, having 3 cells or internal divisions, each containing a single seed. See Botany.

TRICOSANTHES, a genus of plants of the class monœcia, and order syngenesia, and in the natural system ranging under the 34th order, cucurbitaceæ. There are seven species; only one of which is cultivated in the British gardens, the anguina or snake-gourd, which is a native of China, an annual, and of the cucumber tribe.

TRICOSTEMA, a genus of the didynamia gymnospermia class of plants, with a monopetalous ringent and falcated flower. The stamina are four extremely long filaments; and four roundish seeds are contained in the cup. There are three species.

TRIDAX, a genus of the syngenesia polygamia superflua class of plants, with a radiated flower, and the lesser hermaphrodite ones of the disc monopetalous, and funnel-fashioned. The seeds are winged with down, and contained in the cup. There is one species.

TRIENTALIS, *chickweed winter-green*, a genus of plants of the class heptandria, and order monogynia, and in the natural system ranging under the 20th order, rotaceæ. The calyx is heptaphyllous; the corolla is equal and plane, and is divided into seven segments; the berry is unilocular and dry. There is only one species, the europæa, which is indigenous, and the only genus of heptandria that is so. The stalk is single, five or six inches high, terminated with five, six, or seven oval pointed leaves; from the centre of which arise on long footstalks commonly two white starry flowers, each generally consisting of seven oval and equal petals, succeeded by a globular dry berry, covered with a thin white rind, having one cell, and containing several angular seeds.

TRIFOLIUM, *trefoil* or *clover*, a genus of plants of the class diadelphia, and order decandria, and in the natural system ranging under the 32d order, papilionaceæ. The flowers are generally in round heads; the pod is scarcely longer than the calyx, univalve, not opening, deciduous. The leaves are three together. There are 51 species; of which 17 are natives of Britain. We shall describe some of the most remarkable of these:

1. Officinale or melilot, has naked racemous pods, dispermous, wrinkly, and acute, with an erect stalk. It grows in corn-fields, and by the way-sides, but not common. The stalk is erect, firm, striated, branched, and two or three feet high; the leaves ternate, smooth, obtusely oval, and serrated; the flowers are small, yellow, pendulous, and grow in long close spikes at the tops of the branches; the pod is very short, turgid, transversely wrinkled, pendulous, and contains either one or two seeds. The plant has a very peculiar strong scent, and disagreeable, bitter, acrid taste, but such, however, as is not disagreeable to cattle. The flowers are sweet-scented. It has generally been esteemed emollient and digestive, and been used in fomentations and cataplasms, particularly in the plaster employed in dressing blisters; but is now laid aside, as its quality is found to be rather acrid and irritating than emollient or resolvent. It communicates a loathsome flavour to wheat and other grain, so as to render it unfit for making bread.

2. Trifolium repens, white creeping trefoil, or Dutch clover, has a creeping stalk, its flower gathered into an umbellar head, and its pods tetraspermous. It is very common in fields and pastures. It is well known to be excellent fodder for cattle; and the leaves are a good rustic hygrometer, as they are always relaxed and flaccid in dry weather, but erect in moist or rainy.

3. Trifolium pratense, purple or red clover, is distinguished by dense spikes, unequal corollas, by bearded stipulas, ascending stalks, and by the calyx having four equal teeth. The red clover is common in meadows and pastures, and is the species which is generally cultivated as food for cattle. It abounds in every part of Europe, in North America, and even in Siberia. It delights most in rich, moist, and sunny places, yet flourishes in dry, barren, and shady places. See HUSBANDRY.

4. Alpestre, long-leaved purple trefoil, or mountain-clover. The spikes are dense; the corollas somewhat equal; the stipulas are bristly and divergent; the leaflets lanceolated; the stalks stiff, straight, and very simple. It grows in dry, mountainous, woody places, in Hungary, Austria, and Bohemia, &c.; but is not said to be a native of Britain.

5. The medium has been confounded with the two species last mentioned; but it is to be distinguished from them by having loose spikes, corollas somewhat equal, stipulas subulate and connivent, and stalks flexuose and branched. It is found in dry elevated situations, especially among shrubs, or in woods where the soil is chalky or clay, in England, Scotland, Sweden, Denmark, &c.

TRIGLA, *gurnard*, a genus of fishes of the order of thoracici. The generic character is, head large, mailed, and marked by rough lines; gill-covers spiny; gill-membrane seven-rayed; finger-shaped processes, in most species, near the pectoral fins.

1. Trigla gurnardus, grey gurnard. Length from one to two feet, or more; colour above deep grey, with blackish and red spots, beneath silvery; scales small; lateral line very strongly marked, and consisting of a series of larger, rounded, whitish scales with a dusky central spot. Native of the European seas, and not uncommon about our own coasts, feeding on worms, insects, &c.

2. Trigla lyra, piper gurnard. Size nearly equal to the former species; lateral line formed of small scales; colour bright rose-red, silvery beneath; scales small; pectoral fins large, and slightly tinged with dull blue; tail of similar colour; the other fins yellowish, with red rays. Native of the European seas, and considered as an excellent fish for the table.

3. Trigla cuculus, cuckow gurnard. An elegant species. Length about a foot; shape more slender than in the preceding kinds; colour, on the upper parts, a beautiful red, more or less distinctly marked by whitish transverse bars, beneath silvery; scales extremely small; lateral line composed of pointed white scales edged with black; a similar row on each side the back; fins transparent; the first dorsal marked on the edge by a black spot, the second tinged near its edge with yellow. Native of the European seas, and esteemed as a food.

4. Trigla hirundo, sapphirine gurnard. Size equal to that of the grey gurnard; scales middle-sized; lateral line rough; pectoral fins very large, of a violaceous olive, sometimes, according to Mr. Pennant, richly edged and spotted with blue. Native of the European seas, occasionally springing out of the water to some distance by means of its large pectoral fins.

5. Trigla volans, flying gurnard. A highly singular and beautiful species. Length about twelve inches; colour crimson above, pale or whitish beneath; head blunt, and armed on each side with two very strong and large spines, pointing backwards; whole body covered with extremely strong carinated and sharp-pointed scales, so united as not to be distinctly separable; first dorsal fin pale violet, crossed with deeper lines, and at its origin two separate rays longer than the rest; second dorsal fin pale, with the rays barred with brown; pectoral fins extremely large, transparent, of an olive-green, richly varied with numerous bright-blue spots; pectoral processes six in number, and not separate, as in other species, but united into the appearance of a small fin on each side the thorax; tail pale-violet, with the rays crossed by dusky spots, and strengthened on each side the base by two obliquely transverse bony ribs or bars. Native of the Mediterranean, Atlantic, and Indian seas, where it swims in shoals, and is often seen flying out of the water to a considerable distance, in the manner of the genus exocœtus. There are in all 14 species.

TRIGLOCHIN, a genus of plants of the class hexandria, and order trigynia, and in the natural system ranging under the fifth order, tripetaloidæ. The calyx is triphyllous; the petals are three; there is no style; the capsule opens at the base. There are three species, of which the palustre and maritimum are British.

1. Palustre, or harrow-headed grass, has an oblong trilocular capsule. The stalk is simple, eight or ten inches high; the leaves long and narrow; the flowers are greenish, and grow at the end of a long spike. It is frequent in moist ground.

2. Maritimum, or sea-spiked grass, has ovate sexlocular capsules; the stalk is short; the spike long, and flowers purplish. It is frequent on the sea-coasts. Linnæus says that cattle eat these two species with avidity.

TRIGONELLA, *fenugreek*, a genus of plants of the class diadelphia, and order decandria, and in the natural system arranged under the 32d order, papilionaceæ. The vexillum and alæ are nearly equal and patent, resembling a tripetalous corolla. There are 12 species, of which the most remarkable is the fœnumgræcum, or fenugreek, a native of Montpelier, in France. Fenugreek is an annual plant, which rises with a hollow, branching, herbaceous stalk, a foot and a half long, with trifoliate leaves, placed alternately, whose lobes are oblong, oval, indented on their edges, and have broad furrowed footstalks. Fenugreek seeds have a strong disagreeable smell, and an unctuous farinaceous taste, accompanied with a slight bitterness. The principal use of these seeds is in cataplasms and fomentations, for softening, maturating, and discussing tumours; and in emollient and carminative clysters. They are an ingredient in the oleum e mucilaginibus of the shops, to which they communicate a considerable share of their smell, but this is not now in use.

TRIGONIA, a genus of the diadelphia decandria class and order of plants. The calyx is five-parted; petals five, unequal; nect. two scales at the base of the germ; filaments some barren; capsules leguminous, three-cornered, three-celled, three-valved. There are two species, of Guiana.

TRIGONOMETRY is that part of geometry which teaches how to measure the sides and angles of triangles. Trigonometry is either plane or spherical, of each of which we shall treat in order.

Plane Trigonometry is the science which treats of the analogies of plane triangles, and of the methods of determining their sides and angles. For this purpose, it is not only requisite that the peripheries of circles, but also that certain right lines in and about a circle, are supposed to be divided into some assigned number of equal parts. These lines are denominated sines, tangents, secants, &c. The sides of plane triangles may be estimated in feet, yards, chains, or by any other definite measures, or by abstract numbers: but the angles are measured by the arcs of a circle, contained between the two legs, having the angular point for its centre.

Every circle is supposed to be divided into 360 equal parts, called degrees; each degree into 60 equal parts, called minutes; each minute into 60 equal parts, called seconds. An angle is said to be of as many degrees, minutes, seconds, &c. as are contained in the arc, or part of the circumference, by which it is measured.

A right angle is measured by the fourth part of the circumference, or 90°; an obtuse angle is greater than 90°, and an acute angle is less than 90°. Degrees, minutes, &c. are marked at the top of the figures by which the are is denoted. Thus we say $34^{\circ}\ 28'\ 50''$, thirty-four degrees, twenty-eight minutes, and fifty seconds.

The difference of an arc from 90°, or a quadrant, is called its *complement*; and its difference from 180°, its *supplement*: thus in Plate Miscel. fig. 246, the arc AB is the complement of HB: but AB is the supplement of BD.

A *chord*, or subtense, is a right line drawn from one extremity of an arc to the other: thus BE is the chord or subtense of the arc BAE, or BDE.

The *sine*, or, as it is sometimes called, the *right sine*, of an arc, is a right line drawn from one extremity of the arc, perpendicular to the diameter passing through the other extremity: thus BF is the sine of the arc AB, or BD.

The *versed sine* of an arc is the part of the diameter, intercepted between the arc and its sine: AF is the versed sine of AB, and DF of the arc DB.

The *co-sine* of an arc is the part of the diameter intercepted between the center and the sine, and is equal to the sine of the complement of that arc. Thus CF is the co-sine of the arc AB, and is equal to BI, the sine of its complement HB.

The *tangent* of an arc, is a right line touching the circle in one extremity of that arc, continued from thence to meet a line drawn from the center through the other extremity; which line is called the *secant* of the same arc: thus AG is the tangent, and CG the secant of the arc AB.

The *co-tangent* and *co-secant* of an arc, are the tangent and secant of the complement of that arc: thus HK and CK are the co-tangent and co-secant of the arc AB.

The lines here described, belong equally to an angle as to the arc by which it is measured; and, except the chords and versed sines, they are all common to two arcs or angles which are the supplements of each other.

So that if the sine, tangent, &c. of any arc or angle above 90° are required, it is the same thing as to find the sine, tangent, &c. of its supplement, or what it wants of 180°.

They are also called the natural sines, tangents, &c. of the arcs or angles to which they belong; and the logarithms of the numbers by which they are represented, are the logarithmic sines, tangents, &c.

And as one or other of these lines make a part of every trigonometrical operation, they have been calculated to a given radius, for every degree, minute, &c. of the quadrant, and ranged in tables for use.

Whence, by the help of such a table, the sine, tangent, &c. of any arc or angle, may be found by inspection; and, vice versa, the arc, or angle, to which any sine, tangent, &c. belongs.

Upon this table also, and the doctrine of similar triangles, depends the solution of the several cases of plane trigonometry, which may be performed either by the natural or logarithmic sines, tangents, &c., as occasion requires.

But the logarithmic sines, tangents, &c., are those most commonly used; as the calculations, in this case, are all performed by adding and subtracting only, instead of multiplying and dividing, as is required by the natural sines, &c.

The sine, tangent, &c. of any arc or angle being of the same magnitude as the sine, tangent, &c. of its supplement, it is plain that a table of these lines made for every degree, minute, &c. of the quadrant, or 90°, will serve for the whole circle.

It is also to be observed that, in every such table, the natural sines, tangents, &c. are usually calculated to radius 1; but in order that the logarithmic sines, tangents, &c. may be all positive, they are calculated to radius 1.0000000000, or 1 with 10 cyphers, the logarithm of which is 10, so that the latter are the logarithms of the former, with 10 added to the index.

And, as the natural sines, tangents, &c. of any angles or arcs of different circles, are proportional to the radii of those circles, their values may be readily found, or made to correspond to any radius whatever.

In every plane triangle, three things must be given to find the rest; and of these three one at least must be a side, because the same angles are common to an infinite number of triangles.

It is also to be observed, that all the varieties that can possibly happen in the solution of plane triangles, are comprised under the three following cases: viz.

1. When two of the three given things are a side and its opposite angle.
2. When two sides and their included angle are given.
3. When the three sides are given.

Each of which cases may be resolved, either by geometrical construction, by arithmetical computation, or instrumentally.

In the first of these methods, the triangle is constructed, by laying down the sides from a scale of equal parts, and the angles from a scale of chords, or a protractor, and then measuring the unknown parts by the same scale or instrument from which the others were taken.

In the second method, having stated the proportion, according to the proper rule, multiply the second and third terms together, and divide the product by the first, and the quotient will be the fourth term required, for the natural numbers. Or, in working by logarithms, add the logarithms of the second and third terms together, and from the sum take the logarithm of the first, and the number answering to the remainder will be the fourth term sought.

In the third method, or instrumentally, as suppose by the logarithmic lines on one side of the common two-foot scales, extend the compasses from the first term to the second or third as they happen to be of the same kind; and that extent will reach from the other term to the fourth term required, taking both extents towards the same end of the seale.

The second of these methods, however, or that in which the operation is performed by logarithms, is the one generally employed; the other two being chiefly of use as checks on the calculations, or, in certain simple cases, where a near approximate value of the quantities to be determined is thought sufficient.

It may here also be further remarked, that when one or more logarithms are to be subtracted, in any operation, it will be better to write down their *complements*, or what each of them wants of 10.0000000 instead of the logarithms themselves, and then add them together, abating as many tens in the index of the sum as there were logarithms to be subtracted.

Thus, if the logarithm to be subtracted is 3.4932758, it will be the same thing as to add its complement 6.5067242; and if it is 9.07432600, its complement, or the number to be added, will be 0.92567400; which numbers are readily found by beginning at the left hand and subtracting each figure of the logarithm from 9, except the last significant figure on the right, which must be subtracted from 10.

If the index of the logarithm, whose complement is to be taken, is greater than 10, write down what the index wants of 19, and the rest of the figures as before; and, after the addition, subtract 20 from the index of the sum. And if the logarithm of a decimal is to be subtracted, add 10 to the index, and then take the complement of the resulting number, and the rest of the figures, as before.

Thus the complement of the logarithm 12.4907327 is 7.5092673; and the complement of the logarithm of 3.5972648 is 2.4027352.

PROPERTIES OF PLANE TRIANGLES, REQUIRED IN THE PRACTICAL PART OF THIS SCIENCE.

The sum of all the three angles of any plane triangle is equal to two right angles, or 180°.

The greater side is opposite to the greater angle; and the less side to the less angle.

The sum of any two sides is greater than the third; and the difference of any two sides is less than the third.

The triangle is equilateral, isosceles, or scalene, according as its three angles are all equal, or only two of them equal, or all three unequal.

The angles opposite to the two least sides are acute; and if there is an obtuse angle, it is opposite to the greatest side.

A perpendicular drawn from the opposite angle to the longest side will fall within the triangle; and the greater and less segment will be next the greater and less side.

In an isosceles triangle, a perpendicular drawn from the vertex will bisect both the base and the vertical angle.

In a right-angled triangle the hypothenuse is equal to the square root of the sum of the squares of the other two sides; and either of the sides is equal to the square root of the difference of the squares of the hypothenuse and the other side.

Note, also, that if the half difference of any two quantities is added to their half sum, it will give the greater of those quantities: and, if it is subtracted from the half sum, it will give the less.

CASE I. When two of the three given things are a side and its opposite angle, to find the rest.

RULE. The sides of any plane triangle are to each other as the sines of their opposite angles, and vice versa:—That is,

As any side is to the sine of its opposite angle, so is any other side to the sine of its opposite angle.

Or, As the sine of any angle is to its opposite side, so is the sine of any other angle to its opposite side.

Hence, to find an angle, begin the proportion with a side opposite to a given angle; and to find a side, begin with an angle opposite to a given side.

Note. When two sides and an angle opposite to one of them are given, to find the rest, the question is sometimes ambiguous, or admits of two different answers.

Thus, if the given angle is opposite to the least of the two given sides, the angle to be found, by the rule, may be either an acute angle or its supplement; but, if it is opposite to the greater side, the required angle will be acute.

Example I. In the plane triangle ABC, fig. 247.

Given { AC 236, BC 350 } yards, ∠ B 38° 40′. Required the other parts.

By Construction.

1. Lay down the line BC = 350, from some convenient scale of equal parts.

2. Make the ∠ B = 38° 40′ by a scale of chords, or other instrument.

3. With the centre C, and radius 236, taken from the same scale of equal parts, cross BA in A or *a*.

4. Join CA or C*a*, and the triangle ABC, or *a*BC, is the one required.

Then, the angles C and A, measured by the scale of chords, and the side BA, or B*a*, by the scale of equal parts, will be found to be as follows, viz.

∠ C $29\frac{1}{4}$°	∠ A $67\frac{3}{4}$°	AB 184
or $73\frac{1}{2}$	or $112\frac{1}{4}$°	or 362

By Calculation.

As side AC	- 236	2.3729120
		7.6270880
Is to sine ∠ B	- 38° 40′	9.7957330
So is side BC	- 350 -	2.5440680
To sine ∠ A	67° 54′ or 112° 6′	9.9668890
	38° 40′ 38° 40′	
Sum	106° 34′ or 150° 46′	
Subtract	180° 0′ 180° 0′	
Leaves	73° 26′ or 29° 14′ ∠ C	

Then,

: Sine ∠ B 38° 40′	-	9.7957330
		0.2042670
: Side AC 236	- -	2.3729120
:: Sine ∠ C 29° 14′	-	9.6887467
: Side AB 184.47	-	2.2659257

Or,

: Sine ∠ B 38° 40′	-	9.7957330
		0.2042670
: Side AC 236	- -	2.3729120
:: Sine ∠ C 73° 26′	-	9.9815870
: Side *a*B 362.04	-	2.5587660

As the results in this rule are determined by means of the sines which are always the same for an acute angle and its supplement, it is plain that, in certain cases, there may be two triangles with the same data; one acute-angled, and the other obtuse-angled: and, consequently, when there is no restriction or limitation in the question, either of them may be taken for the one required.

Thus, in the figure given above, where the least side AC is opposite to the given acute angle B, it appears, from the construction, that either ABC or *a*BC is the triangle sought. But, when the given angle is right or obtuse, it will be opposite to the greatest side, and in this case there can be no ambiguity: for then neither of the other angles can be obtuse, and the geometrical construction will accordingly form only one triangle.

Instrumentally.

In the first proportion, extend the compasses from 236 to 350, upon the line of numbers, and that extent will reach, upon the sines, from $38\frac{2}{3}$° to $67\frac{3}{4}$°, for the ∠ A.

In the second proportion, extend from $38\frac{2}{3}$° to $29\frac{1}{4}$°, or $73\frac{1}{2}$° upon the sines, and that extent will reach, upon the line of numbers, from 236 to 184, or 362, for the side AB, or *a*B.

Example II. In the plane triangle ABC,

Given { AB 131, BC 97, ∠ C 90° } Ans. { AC 88.045, ∠ A 47° 46′, ∠ B 42° 14′ }

Required the other parts.

Example III. In the plane triangle ABC,

Given { BC 305, ∠ B 51° 15′, ∠ C 37° 21; } Ans. { AC 237.93, AB 185.09, ∠ A 91° 24′ }

Required the other parts.

Example IV. In the plane triangle ABC,

Given { AB 195, AC 203, ∠ B 45° } Ans. { ∠ A 92° 13′, ∠ C 42° 47′, BC 286.87 }

Required the other parts.

Example V. In the plane triangle ABC,

Given { BC 345, AC 232, ∠ B 37° 20′ } Ans. { AB 174.07 or 374.56, ∠ C 27° 4′ or 78° 16′, ∠ A 115° 36′ or 64° 24′ }

Required the other parts.

Case II. When two sides and their included angle are given, to find the rest.

Rule. As the sum of any two sides of a plane triangle, is to their difference, so is the tangent of half the sum of their opposite angles, to the tangent of half their difference.

Then the half difference of these angles, added to their half sum, gives the greater angle, and subtracted from it gives the less.

And as all the angles are now known, the remaining side may be found by Case I.

Note. Instead of the tangent of half the sum of the two unknown angles, we may use the cotangent of half the given angle, or the tangent of half its supplement, which are all equal to each other.

Example. In any plane triangle ABC,

Given { AB 1075, BC 2394 } feet, ∠ B 34° 46′. Required the rest.

By Construction. 1. Draw BC = 2394, from a scale of equal parts.

2. Set off the ∠ B = 34° 46′, by a scale of chords, or other instrument.

3. Make AB = 1075, by the same scale of equal parts, as before.

4. Join A, C, and the triangle is constructed.

Then, the parts being measured, we shall have ∠ A = $123\frac{1}{6}$°, ∠ C = $22\frac{1}{12}$°, and side AC = 1630 feet.

By Calculation.

: AB + BC	3469	-	3.5402043
			6.4597957
: AB ∽ BC	1319	-	3.1202448
:: Tan. $\frac{A+C}{2}$	72° 37′	-	10.5043702
: Tan. $\frac{A \backsim C}{2}$	50° 32′	-	10.0844107
Sum	123° 9′ ∠A		
Diff.	22° 5′ ∠C.		

Then,

: Sine ∠ A	123° 9′ or 56° 51′		9.9228509
			0.0771491
: Side BC	- 2394	-	3.3791241
:: Sine ∠B	- 34° 46′	-	9.7560544
: Side AC	- 1630.5	-	3.2123276

Case III. When the three sides are given, to find the angles.

Rule. Make the longest side the base, and let fall a perpendicular upon it from the opposite angle.

Then, as the base, or sum of its segments, is to the sum of the other two sides, so is the difference of those sides, to the difference of the segments of the base.

And half this difference, being added to half the base, will give the greater segment; and, subtracted from it, will give the less.

Then, in each of the right-angled triangles, formed by the perpendicular, there will be known two sides and an angle opposite to one of them; from whence the other angles may be found, by Case I.

Example I. In any plane triangle ABC,

Given { AB 464, AC 348, BC 690 } yards. Required the angles.

By Construction. 1. Draw BC = 690, by a scale of equal parts.

2. With the centres B, C, and radii 464 and 348, taken from the same scale, describe arcs intersecting each other in A.

3. Join AB, AC, and the triangle is constructed.

Then, by measuring the angles with a protractor, or by the scale of chords, they will be found to be nearly as follows, viz. ∠A = $115\frac{1}{2}$°, ∠B = 27°, and ∠C = $37\frac{1}{8}$°.

By Calculation.

Having let fall the perpendicular AD, it will be

: BC or BD + DC	690	-	2.8388491
			7.1611509
: AB + AC	- 812	-	2.9095560
:: AB ∽ AC	- 116	-	2.0644580
: BD ∽ DC	- 136.51	-	2.1351649

Hence $\frac{690 + 136.51}{2} = 413.25 = $ BD.

And $\frac{690 - 136.51}{2} = 276.75 = $ CD.

Then, in the triangle ABD, right-angled at D,

: AB	- 464	-	2.6665180
: BD	- 413.25	-	2.6162129
:: Sine ∠D	- 90°	-	10.0000000
: Sine ∠BAD	62° 57′	-	9.9496949
	90° 0′		
	27° 3′ ∠ B.		

And, in the triangle ACD, right-angled at D,

: AC	- 348	-	2.5415792
: DC	- 276.75	-	2.4420876
:: Sine ∠ D	- 90° 0′	-	10.0000000
: Sine ∠ CAD	52° 40′	-	9.9005084
	90° 0′		
	37° 20′ ∠ C		
Also	62° 57′ ∠ BAD		
And	52° 40′ ∠ CAD		
Makes	115° 37′ ∠ BAC.		

Whence ∠ B = 27° 3′, ∠ C = 37° 25′, and ∠ BAC = 115° 37′.

These three problems include all the cases or varieties of plane triangles, as well right-angled as oblique, that can possibly happen; but there are some other theorems, for right-angled triangles, that are often more convenient in practice than the general ones, the most useful of which is the one that follows:

Case IV. In any right-angled triangle, As radius is to the tangent of either of the acute angles, so is the side adjacent to that angle, to the side opposite to it; and vice versâ.

Or, As radius is to the cotangent of either of the acute angles, so is the side opposite to that angle, to the side adjacent to it; and vice versâ.

It may also be observed, that the sine of either of the acute angles of a right-angled triangle, being equal to the cosine of the other, the latter may be used instead of the former, whenever it renders the operation more simple.

Example I. In any right-angled plane triangle ABC,

Given { BC 324; ∠ B 53° 7′ 48″ } Required the other parts.

By Construction. Make BC = 324, and ∠ B = 53° 7′; then raise the perpendicular CA, meeting BA in A; and the triangle is constructed: in which AB will be found to measure 540, and AC 432; and ∠ A, which is the complement of ∠ B, is 36° 53′.

By Calculation.

:	Rad. or sine	- 90° -		10.0000000
:	Tan. ∠ B	- 53° 7′ 48″		10.1249371
::	Side BC	- 324 -		2.5105450
:	Side AC	- 432 -		2.6354821

:	Sine ∠ A or cos. ∠ B	53° 7′ 48″		9.7781524
:	Side BC	- - 324 -		2.5105450
::	Rad. or sine ∠ C	- 90° -		10.0000000
:	Side AB	- - 540 -		2.7323926

And 90° — 53° 7′ 48″ = 36° 52′ 12″ ∠ A.

We shall now give in a tabular form, (1) The solution of the cases of right-angled plane triangles: and (2) The solution of the cases of oblique plane triangles.

The Solution of the Cases of right-angled plane Triangles, fig. 248.

Case	Given.	Sought.	Proportion.
1	The hypothenu. AC and theangles	The leg BC.	Asthe radius (or the sine of B) is to the hyp. AC; so is the sine of A, to its opposite side BC.
2	The hyp. AC and one leg AB.	The angles.	As, AC : rad. :: AB : sine of C; whose complement gives the angle A.
3	The hyp AC and one leg AB.	The other leg BC.	Let the angles be found by case 2; then, as rad. : AC :: sine of A : BC.
4	The angles and one leg AB.	The hypothenuse AC.	As, sine of C : AB :: rad. (sine of B) : AC.
5	The angles and one leg AB.	The other leg BC.	As, sine of C : AB :: sine of A : BC. Or, rad. : tang. of A :: AB : BC.
6	The two legs AB and BC.	The angles.	As, AB : BC :: rad. : tang. of A, whose complement gives the angle C.
7	The two legs AB and BC.	The hypothenuse AC.	Find the angles, by case 6, and from thence the hyp. AC, by case 4.

The Solution of the Cases of Oblique Plane Triangles, fig. 249.

Case	Given.	Sought.	Proportion.
1	The angles and one side AB.	Either of the other sides,suppose BC.	As, sine of C : AB :: sine of A : BC.
2	Twosides AB, BC, and the ang.Copposite to 1 of them.	Theother angles A and ABC.	As, AB : sine of C :: BC : sine of A; which, added to C, and the sum subtracted from 180°,gives the angle ABC.
3	Twosides AB, BC, and the ang.Copposite to 1 of them.	Theother side AC.	Find the angle ABC, by case 2; then, as sine of A : BC :: sine of ABC : AC.
4	Twosides AB, AC, and the included angle A.	Theother angles C, and ABC.	As, AB + AC : AB — AC :: tang.of the comp.of ½A : tang.of an ang.which added to the said comp. gives the greater ang. C; and subtracted leaves the lesser ABC.
5	Twosides AB, AC, and the included angle A.	Theother side BC.	Find the angles, by case 4, and then BC, by case 1.
6	All the sides.	An angle, suppose A.	Let fall a perpendicular BD, opposite the required angle, and suppose DG = AD; then AC : BC + BA :: BC — BA : CG, which subtracted from AC, and the remainder divided by 2, gives AD; whence A will be found, by case 2 of right angles.

Spherical Trigonometry. Spherical Trigonometry is the art whereby, from three given parts of a spherical triangle, we discover the rest: and, like plane trigonometry, is either right-angled or oblique-angled. But before we give the analogies for the solution of the several cases in either, it will be proper to premise the following theorems:

Theorem I. In all right-angled spherical triangles, the sign of the hypothenuse : radius :: sine of a leg : sine of its opposite angle. And the sine of a leg : radius :: tangent of the other leg : tangent of its opposite angle.

Demonstration. Let AEDAFG (fig. 250,) represent the eighth part of a sphere,where the quadrantal planes EDFG, EDBC, are both perpendicular to the quadrantal plane ADFB: and the quadrantal plane ADGC is perpendicular to the plane EDFG; and the spherical triangle ABC is right-angled at B, where CA is the hypothenuse, and BA, BC, are the legs.

To the arches GF, CB, draw the tangents HF, OB, and the sines GM, CI, on the radii DF, DB; also draw BL the sine of the arch AB, and CK the sine of AC: and then join IK and OL. Now HF, OB, GM, CI, are all perpendicular to the plane ADFB. And HD, GK, OL, lie all in the same plane ADGC. Also FD, IK, BL, lie all in the same plane ADGC. Therefore the right-angled triangles HFD, CIK, ODL, having the equal angles HDF, CKI, OLB, are similar. And CK : DG :: CI : GM; that is, as the sine of the hypothenuse : rad. :: sine of a leg : sine of its opposite angle. For GM is the sine of the arc GF, which measures the angle CAB. Also, LB : DF :: BO : FH: that is, as the sine of a leg : radius :: tangent of the other leg : tangent of its opposite angle. Q. E. D.

Hence it follows, that the sines of the angles of any oblique spherical triangle ACD (fig. 251,) are to one another, directly, as the sines of the opposite sides. Hence it also follows, that in right-angled spherical triangles, having the same perpendicular, the sines of the bases will be to each other, inversely, as the tangents of the angles at the bases.

Theorem II. In any right-angled spherical triangle ABC (fig. 252,) it will be, As radius is to the co-sine of one leg, so is the co-sine of the other leg to the co-sine of the hypothenuse.

Hence, if two right-angled spherical triangles ABC, CBD, (fig. 251,) have the same perpendicular BC, the co-sines of their hypothenuses will be to each other, directly, as the co-sines of their bases.

Theorem III. In any spherical triangle it will be, As radius is to the sine of either angle, so is the co-sine of the adjacent leg to the co-sine of the opposite angle.

Hence, in right-angled spherical triangles, having the same perpendicular, the co-sines of the angles at the base will be to each other, directly, as the sines of the vertical angles.

Theorem IV. In any right-angled spherical triangle it will be, As radius is to the co-sine of the hypothenuse, so is the tangent of either angle to the co-tangent of the other angle.

As the sum of the sines of two unequal arches is to their difference, so is the tangent of half the sum of those arches to the tangent of half their difference: and as the sum of the co-sines is to their difference, so is the co-tangent of half the sum of the arches to the tangent of half the difference of the same arches.

Theorem V. In any spherical triangle ABC (figs. 253 and 254), it will be, As the co-tangent of half the sum to half their difference, so is the co-tangent of half the base to the tangent of the distance (DE) of the perpendicular from the middle of the base.

Since the last proportion, by permutation, becomes co-tang. $\frac{AC + BC}{2}$: co-tang. AE :: tang. $\frac{AC - BC}{2}$: tang. DE, and as the tangents of any two arches are, inversely, as their co-tangents; it follows, therefore, that tang AE : tang. $\frac{AC + BC}{2}$ :: tang. $\frac{AC - BC}{2}$: tang. DE; or, that the tangent of half the base is to the tangent of half the sum of the sides, as the tangent of half the difference of the sides to the tangent of the distance of the perpendicular from the middle of the base.

Theorem VI. In any spherical triangle ABC (fig. 253), it will be, As the co-tangent of half the sum of the angles at the base is to the tangent of half their difference, so is the tangent of half the vertical angle to the tangent of the angle which the perpendicular CD makes with the line CF bisecting the vertical angle.

The following propositions and remarks, concerning spherical triangles (selected and communicated to Dr. Hutton by the reverend Nevil Maskelyne, D. D. astronomer-royal, F. R. S.), will also render the calculation of them perpicuous, and free from ambiguity.

1. A spherical triangle is equilateral, isoscelar, or scalene, according as it has its three angles all equal, or two of them equal, or all three unequal; and vice versa.

2. The greatest side is always opposite the

greatest angle, and the smallest side opposite the smallest angle.

3. Any two sides taken together are greater than the third.

4. If the three angles are all acute, or all right, or all obtuse; the three sides will be, accordingly, all less than 90°, or equal to 90°, or greater than 90°; and vice versa.

5. If from the three angles A, B, C, (fig. 253,) of a triangle ABC, as poles, there are described, upon the surface of the sphere, three arches of a great circle DE, DF, FE, forming by their intersections a new spherical triangle DEF; each side of the new triangle will be the supplement of the angle at its pole; and each angle of the same triangle will be the supplement of the side opposite to it in the triangle ABC.

6. In any triangle ABC, (fig. 255,) or A*b*C, right-angled in A, 1st, The angles at the hypothenuse are always of the same kind as their opposite sides; 2dly, The hypothenuse is less or greater than a quadrant, according as the sides including the right angle are of the same or different kinds; that is to say, according as these same sides are either both acute or both obtuse, or as one is acute and the other obtuse. And vice versa, 1st, The sides including the right angle are always of the same kind as their opposite angles: 2dly, The sides including the right angle will be of the same or different kinds, according as the hypothenuse is less or more than 90°; but one at least of them will be of 90°, if the hypothenuse is so.

The Solution of the Cases of right-angled Spherical Triangles (fig. 252.).

Case.	Given.	Sought.	Solution.
1	The hyp. AC and one angle A	The opposite leg BC	As radius : sine hyp. AC :: sine A : sine BC (by the former part of theor. 1.)
2	The hyp. AC and one angle A	The adjacent leg AB	As radius : co-sine of A :: tang. AC : tang. AB (by the latter part of theor. 1.)
3	The hyp. AC and one angle A	The other angle C	As radius : co-sine of AC :: tang. A : co-tang. C (by theorem 4.)
4	The hyp. AC and one leg AB	The other leg BC	As co-sine AB : radius :: co-sine AC : co-sine BC (by theorem 2.)
5	The hyp. AC and one leg AB	The opposite angle C	As sine AC : radius :: sine AB : sine C (by the former part of theorem 1.)
6	The hyp. AC and one leg AB	The adjacent angle A	As tang. AC : tang. AB :: radius : co-sine A (by theorem 1.)
7	One leg AB and the adjacent angle A	The other leg BC	As radius : sine AB :: tang. A : tang. BC (by theorem 4.)
8	One leg AB and the adjacent angle A	The opposite angle C	As radius : sine A :: co-sine of AB : co-sine of C (by theorem 3.)
9	One leg AB and the adjacent angle A	The hyp. AC	As co-sine of A : radius :: tang. AB : tang AC (by theorem 1.)
10	One leg BC and the opposite angle A	The other leg AB	As tang. A : tang. BC :: radius : sine AB (by theorem 4.)
11	One leg BC and the opposite angle A	The adjacent angle C	As co-sine BC : radius :: co-sine of A : sine C (by theorem 3.)
12	One leg BC and the opposite angle A	The hyp. AC	As sine A : sine BC :: radius : sine AC (by theorem 1.)
13	Both legs AB and BC	The hyp. AC	As radius : co-sine AB :: co-sine BC : co-sine AC (by theorem 2.)
14	Both legs AB and BC	An angle, suppose A	As sine AB : radius :: tang. BC : tang. A (by theorem 4.)
15	Both angles A and C	A leg, suppose AB	As sine A : co-sine C :: radius : co-sine AB (by theorem 3.)
16	Both angles A and C	The hyp. AC	As tang. A : co-tang. C :: radius : co-sine AC (by theorem 4.)

Note, The 10th, 11th, and 12th cases are ambiguous; since it cannot be determined by the data, whether ABC, and AC, are greater or less than 90° each.

In any spherical triangle, the area, or surface inclosed by its three sides upon the surface of the globe, will be found by this proportion:

As 8 right angles, or 720°,
Are to the whole surface of the sphere;
Or, as 2 right angles, or 180°,
To one great circle of the sphere;
So is the excess of the 3 angles above 2 right angles,
To the area of the spherical triangle.

Hence, if a denotes .7854,
$d =$ diam. of the globe, and
$s =$ sum of the 3 angles of the triangle;

then $ad \times \frac{s - 180}{180} =$ area of the spherical triangle.

Hence also, if r denotes the radius of the sphere, and c its circumference; then the area of the triangle will thus be variously expressed; viz., Area $= ad^2 \times \frac{s - 180}{180} = cd \times \frac{s - 180}{720} = cr \times \frac{s - 180}{360}$; or barely $= r \times \overline{s - 180°}$, in square degrees, when the radius r is estimated in degrees; for then the circumference c is $= 360°$.

Farther, because the radius r, of any circle, when estimated in degrees, is $= \frac{180}{3.14159 \text{ \&c.}} = 57.2957795$, the last rule $r \times \overline{s - 180}$, for expressing the area A of the spherical triangle, in square degrees, will be barely

$$A = 57.2957795\, s - 10313.24 =$$
$$= 57\tfrac{50}{169} s - 10313\tfrac{1}{4} \text{ very nearly.}$$

Hence may be found the sums of the three angles in any spherical triangle, having its area A known; for the last equation give the sum $s = \frac{A}{r} + 180 = \frac{A}{57.29 \text{ \&c.}} + 180 = \frac{169A}{9683} + 180$.

So that, for a triangle on the surface of the earth, whose three sides are known; if it is but small, as of a few miles extent, its area may be found from the known length of its sides, considering it as a plane triangle, which gives the value of the quantity A; and then the last rule above will give the value of s, the sum of the three angles; which will serve to prove whether those angles are nearly exact, that have been taken with a very nice instrument, as in large and extensive measurements on the surface of the earth.

Spherical Polygon, is a figure of more than three sides, formed on the surface of a globe by the intersecting arcs of great circles.

The area of any spherical polygon will be found by the following proportion, viz.

As 8 right angles, or 720°,
To the whole surface of the sphere;
Or, as 2 right angles, or 180°,
To a great circle of the sphere;
So is the excess of all the angles above the product of 180, and 2 less than the number of angles,
To the area of the spherical polygon.

That is, putting $n =$ the number of angles,
$s =$ sum of all the angles,
$d =$ diam. of the sphere,
$a = .78539$ &c.;

Then A $= ad^2 \times \frac{s - (n - 2)\, 180}{180} =$ the area of the spherical polygon.

Hence other rules might be found, similar to those for the area of the spherical triangle.

Hence also, the sum s of all the angles of any spherical polygon, is always less than $180n$, but greater than $180\,(n - 2)$; that is, less than n times 2 right angles, but greater than $n - 2$ times 2 right angles.

This will be deemed sufficient on the subject as an introduction to trigonometry, and we can with great satisfaction refer our readers for farther information to Bonnycastle's "Treatise on Plane and Spherical Trigonometry, with their most useful Practical Applications," which is unquestionably the best book on the subject in the English language.

TRIGUERA, a genus of the pentandria monogynia class and order of plants. The corolla is bell-shaped; nect. short; berry four-celled, two seeds in each cell. There are two species, of no note.

TRIHILATÆ, from tres, "three," and hilum, "an external mark on the seed;" the name of the 23d class in Linnæus's Fragments of a Natural Method; consisting of plants

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with three seeds, which are marked with an external cicatrix or scar, where they are fastened within the fruit. See BOTANY.

TRILIX, a genus of the class and order polyandria monogynia. The calyx is three-leaved; corolla three-petalled; berry five-celled, many seeded. There is one species, a shrub of Carthagena.

TRILLION, in arithmetic, a billion of billions.

TRILLIUM, a genus of the hexandria trigynia class and order of plants. The calyx is three-leaved; corolla three-petalled; berry three-celled. There are three species, hardy perennials.

TRIM *of a ship*, her best posture, proportion of ballast, and hanging of her masts, &c. for sailing. To find the trim of a ship, is to find the best way of making her sail swiftly, or how she will sail best. This is done by easing of her masts and shrouds; some ships sailing much better when they are slack, than when they are taut or fast; but this depends much upon experience and judgment, and the several trials and observations which the commander and other officers may make aboard.

TRINGA, *sandpiper*, a genus of birds belonging to the order of grallæ. The bill is somewhat tapering, and of the length of the head; the nostrils are small; the toes are four in number and divided, the hind toe being frequently raised from the ground. According to Dr. Latham, there are 45 species, of which 18 are British. We shall describe some of the most remarkable.

1. Vanellus, lapwing, or tewit, is distinguished by having the bill, crown of the head, crest, and throat, of a black colour; there is also a black line under each eye; the back is of a purplish green; the wings and tail are black and white, and the legs red; the weight is eight ounces, and the length 13 inches. It lays four eggs, making a slight nest with a few bents. The eggs have an olive cast, and are spotted with black. The young, as soon as hatched, run like chickens. The parents show remarkable solicitude for them, flying with great anxiety and clamour near them, striking at either men or dogs that approach, and often fluttering along the ground like a wounded bird, to a considerable distance from their nest, to delude their pursuers; and to aid the deceit, they become more clamorous when most remote from it. The eggs are held in great esteem for their delicacy, and are sold by the London poulterers for 4 or 5 shillings the dozen. In winter, lapwings join in vast flocks; but at that season are very wild: their flesh is very good, their food being insects and worms. During October and November, they are taken in the fens in nets, in the same manner that ruffs are; but are not preserved for fattening, being killed as soon as caught.

2. Pugnax. The male of this species is called ruff, and the female reeve. The name ruff is given to the males because they are furnished with very long feathers, standing out in a remarkable manner, not unlike the ruff worn by our ancestors. The ruff is of as many different colours as there are males; but in general it is barred with black; the weight is six or seven ounces; the length one foot. The female, or reeve, has no ruff; the common colour is brown; the feathers are edged with a very pale colour; the breast and belly white. Its weight is about four ounces. See Plate Nat. Hist.

These birds appear in the fens in the earliest spring, and disappear about Michaelmas. The reeve lays four eggs in a tuft of grass, the first week in May, and sit about a month. The eggs are white, marked with large rusty spots. Fowlers avoid in general the taking of the females; not only because they are smaller than the males, but that they may be left to breed.

Soon after their arrival, the males begin to hill; that is, to collect on some dry bank near a splash of water, in expectation of the females who resort to them. Each male keeps possession of a small piece of ground, which it runs round till the grass is worn quite away, and nothing but a naked circle is left. When a female lights, the ruffs immediately fall to fighting. It is a vulgar error, that ruffs must be fed in the dark, lest they should destroy each other by fighting on admission of light. The truth is, every bird takes its stand in the room as it would in the open fen. If another invades its circle, an attack is made, and a battle ensues. They make use of the same action in fighting as a cock, place their bills to the ground and spread their ruffs. Mr. Pennant says he has set a whole roomful a fighting, by making them move their stations; and, after quitting the place, by peeping through a crevice, seen them resume their circles, and grow pacific.

When a fowler discovers one of those hills, he places his net over night, which is of the same kind as those that are called clap or day nets; only it is generally single, and is about 14 yards long and four broad. The fowler resorts to his stand at day-break, at the distance of one, two, three, or four hundred yards from the nets, according to the time of the season; for the later it is, the shyer the birds grow. He then makes his first pull, taking such birds as he finds within reach; after that he places his stuffed birds or stales, to entice those that are continually traversing the fen. When the stales are set, seldom more than two or three are taken at a time. A fowler will take forty or fifty dozen in a season. These birds are found in Lincolnshire, the isle of Ely, and in the East Riding of York. They visit a place called Martin-Mere, in Lancashire, the latter end of March or beginning of April; but do not continue there above three weeks; where they are taken in nets, and fattened for the table with bread and milk, hempseed, and sometimes boiled wheat; but if expedition is required, sugar is added, which will make them in a fortnight's time a lump of fat: they then sell for two shillings or half a crown a-piece. They are dressed like the woodcock, with their intestines: and when killed at the critical time, say the epicures, are the most delicious of all morsels.

3. Canutus, or knot, has the forehead, chin, and lower part of the neck, brown, inclining to ash-colour; the back and scapulars deep brown, edged with ash-colour; the coverts of the wings white, the edges of the lower order deeply so, forming a white bar; the breast, sides, and belly, white, the two first streaked with brown; the coverts of the tail marked with white and dusky spots alternately; the tail ash-coloured, the outmost feather on each side white; the legs of a blueish grey; and the toes, as a special mark, divided to the very bottom; the weight four ounces and a half. These birds, when fattened, are preferred by some to the ruffs themselves. They are taken in great numbers on the coasts of Lincolnshire, in nets such as are employed in taking ruffs; with two or three dozen of stales of wood painted like the birds, placed within: 14 dozens have been taken at once. Their season is from the beginning of August to that of November. They disappear with the first frosts. Camden says, they derive their name from king Canute, Knute, or Knout, as he is sometimes called; probably because they were a favourite dish with that monarch. We know that he kept the feast of the purification of the Virgin Mary with great pomp and magnificence at Ely; and this being one of the fen birds, it is not unlikely that he met with it there.

4. The hypoleucos, or common sandpiper, except in pairing time, is a solitary bird. It is never found near the sea, but frequents rivers, lakes, and other fresh waters. Its head is brown, streaked with downward black lines; the neck, an obscure ash-colour; the back and coverts of the wings, brown, mixed with a glossy green, elegantly marked with transverse dusky lines; the breast and belly are of a pure white; the quill-feathers and the middle feathers of the tail are brown; the legs of a dull pale green.

5. The alpina, or dunling sandpiper, is at once distinguished from the others by the singularity of its colours. The back, head, and upper part of the neck, are ferruginous, marked with large black spots; the lower part of the neck white, marked with short dusky streaks; the coverts of the wings ash-colour; the belly white, marked with large black spots, or with a black crescent pointing towards the thighs; the tail is ash-coloured; legs black; toes divided to their origin. In size it is superior to that of a lark. These birds are found on our sea-coasts; but may be reckoned among the more rare kinds. They lay four eggs of a dirty white colour, blotched with brown round the thicker end, and marked with a few small spots of the same colour on the smaller end. They are common on the Yorkshire coasts, and esteemed a great delicacy.

6. The cinclus, purre, or stint, is in length seven and a half inches; the head and hind part of the neck are ash-coloured, marked with dusky lines; a white stroke divides the bill and eyes; the back is of a brownish ash-colour; the breast and belly white; the coverts of the wings and tail a dark brown, edged with light ash-colour or white; the upper part of the quill-feathers dusky, the lower white; the legs of a dusky green; the toes divided to their origin. The bill an inch and a half long, slender and black; irides dusky. These birds come in large flocks on our sea-coasts in winter.

TRINITARIANS, those who are orthodox and believe in the trinity: those who do not believe therein, being called anti-trinitarians.

TRINITY-HOUSE, a kind of college at Deptford, belonging to a company or corporation of seamen, who, by the king's charter, have power to take cognizance of those persons who destroy sea-marks, and to get reparation of such damages; and to take care of other things belonging to navigation. At present, many gentry and some nobility are members of that community.

The master, wardens, and assistants of the trinity-house, may set up beacons, and marks for the sea, in such places near the coasts or forelands, as to them shall seem meet. By a statute of queen Elizabeth, no steeple, trees, or other things standing as sea-marks, shall be taken away or cut down, upon pain that every person guilty of such offence, shall forfeit 100*l.* and if the person offending is not possessed of the value, he shall be deemed convict of outlawry.

TRINITY, *fraternity of*, a religious society instituted at Rome by St. Philip Neri, in 1548. These religious were appointed to take care of the pilgrims who came to visit the tombs of St. Peter and St. Paul. The society originally consisted of only 15 religious, who assembled on the first Sunday of every month, in the church of St. Saviour del Campo, to hear the exhortations of the founder; after whose death pope Paul IV. gave the fraternity the church of St. Benedict, near which they have since built a large hospital, for the reception of pilgrims. The fraternity is one of the most considerable in Rome, and most of the nobility of both sexes have been members of it.

TRINOMIAL, or TRINOMIAL ROOT, in mathematics, is a root consisting of three parts connected together by the signs + or —, as $x+y+z$, or $a+b-c$. See BINOMIAL and ROOT.

TRIO, in music, a part of a concert wherein three persons sing; or more properly, a musical composition consisting of three parts. Trios are the finest kinds of composition, and these are what please most in concerts.

TRIOPTERIS, a genus of the decandria trigynia class of plants, the corolla whereof consists of six oval, erectopatulous, equal and permanent petals, surrounded by three others, smaller than themselves, but equal to one another; there is no pericarpium; the seeds are three, erect, and carinulated at the back, each of them has externally at its base an ala, and at its apex two; these alæ are what in the flowering state of the plant appear to be petals, but they are not truly such. There are two species, shrubs of the West Indies.

TRIOSTEUM, a genus of the pentandria monogynia class and order of plants. The calyx is the length of the corolla; corolla one-petalled, almost equal; berry three-celled, unequal; seeds solitary. There are three species, herbs of North America. The roots are said to be emetic.

TRIPLARIS, a genus of the dioecia dodecandria class and order. The calyx is very large, three or six-parted; corolla three-petalled; nect. three-sided. There are two species, trees of South America.

TRIPLE, or TRIPLE TIME, in music, a time consisting of three measures in a bar; the two first of which are beaten with the hand or foot down, and the third marked by its elevation. There were formerly in use no less than six different triple measures: first, that of three breves in a bar, denoted by the figure 3; secondly, that of three semibreves in a bar, the sign of which was $\frac{3}{1}$; thirdly, that of three minims in a bar, marked by $\frac{3}{2}$; fourthly, that of three crotchets in a bar, implied by $\frac{3}{4}$; fifthly, that of three quavers in a bar, signified by $\frac{3}{8}$; and, sixthly, that of three semiquavers in a bar, expressed by $\frac{3}{16}$. But at present we only employ three different triples; that of three minims, that of three crotchets, and that of three quavers. The reader being informed that the semibreve (which is now the longest note in common use, and therefore made the common standard of reckoning), is equal in duration to two minims, or to four crotchets, or eight quavers, will readily comprehend the propriety of announcing these different measures by the above figures; and will perceive that, to indicate a time of three minims in a bar (*i. e.* three halves, or second parts, of a semibreve), no method more concise or simple could be adopted, than that of placing at the beginning of the movement the figures $\frac{3}{2}$; for a time of three crotchets (*i. e.* three-fourth parts of a semibreve), the figures $\frac{3}{4}$; and for a time of three quavers (*i. e.* three-eights of a semibreve), the figures $\frac{3}{8}$.

The old musicians considered the triple, or three-timed measure, as superior to the binary, or two-timed, and for that reason called it the perfect time.

TRIPLE PROGRESSION, an expression in old music, implying a series of perfect fifths. A progression of sounds thus explained by theorists: let any sound be represented by unity, or the number 1; and as the third part of a string has been found to produce the twelfth, or octave of the fifth above the whole string, a series of fifths may be represented by a triple geometric progression of numbers, continually multiplied by 3; as 1, 3, 9, 27, 81, 243, 729; and these terms may be equally supposed to represent twelfths, or fifths, either ascending or descending: for whether we divide by 3, or multiply by 3, the terms will either way be in the proportion of a twelfth, or octave to the fifth.

TRIPLICATE RATIO, the ratio which cubes bear to one another.

This ratio is to be distinguished from triple ratio, and may be thus conceived. In the geometrical proportions 2, 4, 8, 16, 32, as the ratio of the first term (2) is to the third (8) duplicate of the first to the second, or of the second to the third, so the ratio of the first to the fourth is said to be triplicate of the ratio of the first to the second, or of that of the second to the third, or of that of the third to the fourth, as being compounded of three equal ratios. See RATIO.

TRIPOLI, a mineral found sometimes in an earthy form, but more generally indurated. Its texture is earthy. Specific gravity 2 to 2.5. It absorbs water, feels harsh and dry. Scarcely adheres to the tongue; takes no polish from the nail; does not stain the fingers. Colour generally pale yellowish grey; also different kinds of yellow, brown, and white. According to Klaproth, a species of this mineral contained

66.5	silica
7.0	alumina
2.5	oxide of iron
1.5	magnesia
1.25	lime
19.0	air
97.75.	

TRIPSACUM, a genus of the monœcia triandria class and order of plants. The male calyx is a glume, four-flowered; corolla, glume membranaceous; female calyx, glume perforated sinuses; corolla, glume two-valved; styles two; seed one. There are two species, grasses of the West Indies.

TRISECTION, or TRISSECTION, the dividing a thing into three. The term is chiefly used in geometry, for the division of an angle into three equal parts. The trisection of an angle geometrically, is one of those great problems whose solution has been so much sought by mathematicians for these two thousand years, being in this respect on a footing with the quadrature of the circle, and the duplicature of the cube angle.

The cubic equation by which the problem of trisection is resolved, is as follows: Let c denote the chord of a given arc, or angle, and x the cord of the 3d part of the same, to the radius 1; then is $x^3 - 3x = -c$,
by the resolution of which cubic equation is found the value of x, or the chord of the 3d part of the given arc or angle, whose chord is c; and the resolution of this equation, by Cardan's rule, gives the chord

$$x = \sqrt[3]{\frac{-c+\sqrt{c^2-4}}{2}} + \frac{1}{\sqrt[3]{\frac{-c+\sqrt{c^2-4}}{2}}}$$

$$\text{or } x = \sqrt[3]{\frac{-c+\sqrt{c^2-4}}{2}} + \sqrt[3]{\frac{-c-\sqrt{c^2-4}}{2}}$$

TRISETOUS, in entomology, three-bristled, applied chiefly to the tail of insects, as in the ephemera.

TRISPAST, in mechanics, a machine with three pullies, or an assemblage of three pullies for raising of great weights.

TRITICUM, *wheat*, a genus of plants of the class triandria, and order digynia, and in the natural system ranging under the fourth order, gramina. The calyx is bivalve, solitary, and generally containing three florets; the corolla is bivalve, one valve being bluntish, the other acute. There are 19 species, the æstivum, summer or spring wheat; hybernum, winter, Lammas, or common wheat; compositum, turginum, or cone wheat; polonicum, or Polish wheat; spelta, or spelt wheat; monococcum, or one-grained wheat; prostratum, or trailing wheat-grass; pumilum, or dwarf wheat-grass: junceum, or rush wheat-grass; repens, or couch-grass; tenellum, or tender wheat-grass; maritimum, or sea wheat-grass; unilaterale, or spiked sea-wheat; unioloides, or linear-spiked wheat-grass; distichum, loliaceum, caninum, hispanicum. Of what country the first six species are natives, cannot now be determined: the prostratum is a native of Siberia; the junceum, repens, unilaterale, and maritimum, are natives of Britain; the tenellum is a native of Spain, and the unioloides is a native of Italy. It may also be observed, that the first nine are annuals, the rest are perennials.

Linnæus comprehends the different kinds of wheat cultivated at present under six species; but cultivation has produced a great many varieties from these.

1. Triticum æstivum, or spring-wheat, has four flowers in a calyx, three of which mostly bear grain. The calyces stand pretty distant from each other, on both sides a flat smooth receptacle. The leaves of the calyx are keel-shaped, smooth, and they terminate with a short arista. The glumes of the flowers are smooth and bellying, and the outer leaf of three of the glumes in every calyx is terminated by a long arista, but the three inner ones are beardless. The grain is rather longer and thinner than the common wheat. It is supposed to be a native of some part of Tartary. The farmers call it spring-wheat, because it will come to the sickle with the common wheat, though it should be sown in February or March. The varieties of it are: triticum æstivum spica et grana rubente. Spring wheat, with a red spike and grain. Triticum æstivum rubrum, spica alba. Red spring wheat, with a white spike. Triticum æstivum, spica et grana alba. Spring wheat, with a white spike and grain.

2. Triticum hybernum, winter or common wheat, has also four flowers in a calyx, three of which are mostly productive. The calyces stand on each side a smooth flat receptacle, as in the former species, but they are not quite so far asunder. The leaves of the calyx are bellying, and so smooth that they appear as if polished, but they have no arista. The glumes of the flowers too are smooth, and the outer ones, near the top of the spike, are often tipped with short aristæ. The grain is rather plumper than the former, and is the sort most generally sown in England; whence the name of common wheat. Its varieties are: triticum hybernum, spica et grana rubente. Common wheat, with a red spike and grain. Triticum hybernum rubrum, spica alba. Common red wheat, with a white spike. Triticum hybernum, spica et grana alba. Common wheat, with a white spike and grain.

3. Triticum turgidum, thick-spiked or cone-wheat. It is easily distinguished from either of the former: for though it has four flowers in a calyx, after the manner of them, yet the whole calyx and the edges of the glumes are covered with soft hairs. The calyces too stand thicker on the receptacle, and make the spike appear more turgid. Some of the outer glumes near the top of the spike are terminated by short aristæ, like those of the common wheat. The grain is shorter, plumper, and more convex on the back than either of the former species. Its varieties are numerous, and have various appellations in different counties, owing to the great affinity of several of them. Those most easily to be distinguished are: triticum turgidum conicum album. White cone wheat. Triticum turgidum conicum rubrum. Red cone wheat. Triticum turgidum aristiferum. Bearded cone wheat. Triticum turgidum spica multiplici. Cone wheat, with many ears. The third variety is what the farmers call clog wheat, square wheat, and rivets. The grain of this is remarkably convex on one side, and when ripe the awns generally break in pieces and fall off. This sort is very productive, but it yields an inferior flour to that of the former two species.

4. Triticum Polonicum, or Polish wheat, has some resemblance to the turgidum, but both grain and spike are longer. The calyx contains only two flowers, and the glumes are furnished with very long aristæ; the teeth of the midrib are bearded. As this sort is seldom sown in England, there is no telling what varieties it produces.

5. Triticum spelta, spelt or German wheat. At first view this has a great resemblance to barley, but it has no involucrum. The calyx is truncated; that is, it appears as if the ends were snipped off, and it contains four flowers, two of which are hermaphrodite, and the glumes bearded, but the intermediate ones are neuter. There are two rows of grain as in barley, but they are shaped like wheat. It is much cultivated in France, Germany, and Italy.

6. Triticum monococcum, St. Peter's corn, or one-grained wheat, has three flowers in each calyx alternately bearded, and the middle one neuter. The spike is shining, and has two rows of grain in the manner of barley. Where it grows naturally is not known, but it is cultivated in Germany; and in conjunction with spelt wheat is there made into bread, which is coarse, and not so nourishing as that made of common wheat. Malt made of any of our wheats is often put into beer, and a small quantity of it will give a large brewing a fine brown transparent tincture.

Of the perennial kinds, or wheat grasses, the repens, or couch grass is unfortunately too well known to the gardener and husbandman; the others are of little note.

The respectable president of the Royal Society, whose attention is constantly directed to those branches of knowledge which are most practically useful, has published some remarks on the blight in corn in the year 1805; and we feel ourselves discharging a duty in making them as generally known as our circulation extends.

He begins by observing that the blight in corn is occasioned by the growth of a minute parasitic fungus or mushroom on the leaves, stems, and glumes of the living plant. Felice Fontana published, in the year 1767, an elaborate account of this mischievous weed, with microscopic figures, which give a tolerable idea of its form; more modern botanists have given figures both of corn and of grass affected by it, but have not used high magnifying powers in their researches.

He adds, "agriculturists do not appear to have paid, on this head, sufficient attention to the discoveries of their fellow-labourers in the field of nature; for though scarcely any English writer of note on the subject of rural economy, has failed to state his opinion of the origin of this evil, no one of them has yet attributed it to the real cause, unless Mr. Kirby's excellent papers on some diseases of corn, published in the Taansactions of the Linnæan Society, are considered as agricultural essays.

It is necessary to premise, that the striped appearance of the surface of a straw which may be seen with a common magnifying glass, is caused by alternate longitudinal partitions of the bark, the one imperforate, and the other furnished with one or two rows of pores or mouths, shut in dry, open in wet weather, and well calculated to imbibe fluid whenever the straw is damp.

By these pores, which exist also on the leaves and glumes, it is presumed that the seeds of the fungus gain admission, and at the bottom of the hollows to which they lead, (see Plate II. fig. 1, 2), they germinate and push their minute roots, no doubt (though these have not yet been traced) into the cellular texture beyond the bark, where they draw their nourishment, by intercepting the sap that was intended by nature for the nutriment of the grain; the corn of course becomes shrivelled in proportion as the fungi are more or less numerous on the plant; and as the kernel only is abstracted from the grain, while the cortical part remains undiminished, the propo tion of flour or bran in blighted corn, is always reduced in the same degree as the corn is made light. Some corn of this year's crop will not yield a stone of flour from a sack of wheat; and it is not impossible that in some cases the corn has been so completely robbed of its flour by the fungus, that if the proprietor should choose to incur the expence of threshing and grinding it, bran would be the produce, with scarcely an atom of flour for each grain.

Every species of corn, properly so called, is subject to the blight; but it is observable that spring corn is less damaged by it than winter, and rye less than wheat, probably because it is ripe and cut down before the fungus has had time to increase in any large degree. Tull says that "white cone, or bearded wheat, which hath its straw like a rush full of pith, is less subject to blight than Lammas wheat, which ripens a week later."

The spring wheat of Lincolnshire was not in the least shrivelled this year, though the straw was in some degree affected: the millers allowed that it was the best sample brought to market. Barley was in some places considerably spotted, but as the whole of the stem of that grain is naturally enveloped in the hose or basis of the leaf, the fungus can in no case gain admittance to the straw; it is, however, to be observed that barley rises from the flail lighter this year than was expected from the appearance of the crop when gathered in.

It seems probable that the leaf is first infected in the spring or early in the summer, before the corn shoots up into straw, and that the fungus is then of an orange colour; after the straw has become yellow, the fungus assumes a deep chocolate brown: each individual is so small that every pore on a straw will produce from 20 to 40 fungi, as may be seen in the plates, and every one of these will no doubt produce at least 100 seeds; if then one of these seeds tillows out into the number of plants that appear at the bottom of a pore in Plate II. fig. 1, 2, how incalculably large must the increase be! A few diseased plants scattered over a field must very speedily infect a whole neighbourhood, for the seeds of fungi are not much heavier than air, as every one who has trod upon a ripe puff-ball must have observed by seeing the dust, among which is its seed, rise up and float on before him.

How long it is before this fungus arrives at puberty, and scatters its seeds in the wind, can only be guessed at by the analogy of others; probably the period of a generation is short, possibly not more than a week in a hot season: if so, how frequently in the latter end of the summer must the air be loaded with this animated dust, ready, whenever a gentle breeze, accompanied with humidity, shall give the signal to intrude itself into the pores of thousands of acres of corn. Providence, however, careful of the creatures it has created, has benevolently provided against the too extensive multiplication of any species of being; was it otherwise, the minute plants and animals, enemies against which man has the fewest means of defence, would increase to an inordinate extent: this, however, can in no case happen, unless many predisposing causes afford their combined assistance. But for this wise and beneficent provision, the plague of slugs, the plague of mice, the plagues of grubs, wire-worms, chafers, and many other creatures whose power of multiplying is countless as the sands of the sea, would, long before this time, have driven mankind, and all the larger animals, from the face of the earth.

Though all old persons who have concerned themselves in agriculture, remember the blight in corn many years, yet some have supposed that of late years it has materially increased; this, however, does not seem to be the case. Tull, in his Horsehoeing Husbandry, page 74, tells us, that the year 1725 "was a year of blight, the like of which was never before heard of, and which he hopes may never happen again;" yet the average price of wheat in the year 1726, when the harvest of 1725 was at market, was only 36*s*. 4*d*. and the average of the five years of which it makes the first, 37*s*. 7*d*.--1797 was also a year of great blight; the price of wheat in 1798 was 49*s*. 1*d*. and the average of the five years, from 1795 to 1799, 63*s*. 5*d*.

The climate of the British isles is not the only one that is liable to the blight in corn. It happens occasionally in every part of Europe, and probably in all countries where corn is grown. Italy is very subject to it, and the last harvest of Sicily has been materially hurt by it. Specimens received from the colony of New South Wales, shew that considerable mischief was done to the wheat crop there in the year 1803, by a parasitic plant, very similar to the English one.

It has been long admitted by farmers, though scarcely credited by botanists, that wheat in the neighbourhood of a barberry bush seldom escapes the blight. The village of Rollesby in Norfolk, where barberries abound, and wheat seldom succeeds, is called by the opprobrious appellation of mildew Rollesby. Some observing men have of late attributed this very perplexing effect to the farina of the flowers of the barberry, which is in truth yellow, and resembles in some degree the appearance of the rust, or what is presumed to be the blight in its early state.

It is, however, notorious to all botanical observers, that the leaves of the barberry are very subject to the attack of a yellow parasitic fungus, larger, but otherwise much resembling the rust in corn.

Is it not more than possible that the parasitic fungus of the barberry and that of wheat, are one and the same species, and that the seed is transferred from the barberry to the corn? Misletoe, the parasitic plant with which we are the best acquainted, delights most to grow on the apple and hawthorn, but it flourishes occasionally on trees widely differing in their nature from both of these. In the Home Park, at Windsor, misletoe may be seen in abundance on the lime trees planted there in avenues. If this conjecture is founded, another year will not pass without its being confirmed by the observations of inquisitive and sagacious farmers.

It would be presumptuous to offer any remedy for a malady, the progress of which is so little understood; conjectures, however, founded on the origin here assigned to it, may be hazarded without offence.

It is believed to begin early in the spring, and first to appear on the leaves of wheat in the form of rust, or orange-coloured powder; at this season, the fungus will, in all probability, require as many weeks for its progress from infancy to puberty, as it does days during the heats of autumn; but a very few plants of wheat, thus infected, are quite sufficient if the fungus is permitted to ripen its seed, to spread the malady over a field, or indeed over a whole parish.

The chocolate-coloured blight is little observed till the corn is approaching very nearly to ripeness; it appears then in the field in spots, which increase very rapidly in size, and are in calm weather somewhat circular, as if the disease took its origin from a central position.

May it not happen, then, that the fungus is brought into the field in a few stalks of infected straw, uncorrupted, among the mass of dung laid in the ground at the time of sowing? It must be confessed, however, that the clover lays, on which no dung from the yard was used, were as much infected last autumn as the manured crops. The immense multiplication of the disease in the last season, seems, however, to account for this; as the air was no doubt frequently charged with seed for miles together, and deposited it indiscriminately on all sorts of crops.

It cannot, however, be an expensive precaution to search diligently in the spring for young plants of wheat infected with the disease, and carefully to extirpate them, as well as all grasses, for several are subject to this or a similar malady, which have the appearance of orange-coloured or of black stripes on their leaves, or on their straw; and if experience shall prove that uncorrupted straw can carry the disease with it into the field, it will cost the farmer but little precaution to prevent any mixture of fresh straw from being carried out with his rotten dung to the wheat field.

In a year like the present, that offers so fair an opportunity, it will be useful to observe attentively whether cattle in the straw-yard thrive better or worse on blighted than on healthy straw. That blighted straw, retaining on it the fungi that have robbed the corn of its flour, has in it more nutritious matter than clean straw which has yielded a crop of plump grain, cannot be doubted; the question is, whether this nutriment in the form of fungi does, or can be made to agree as well with the stomachs of the animals that consume it, as it would do in that of straw and corn.

It cannot be improper in this place to remark, that although the seeds of wheat are rendered, by the exhausting power of the fungus, so lean and shrivelled, that scarcely any flower fit for the manufacture of bread can be obtained by grinding them, these very seeds will, except, perhaps, in the very worst cases, answer the purpose of seed-corn as well as the fairest and plumpest sample that can be obtained, and, in some respects, better; for as a bushel of much blighted corn will contain one-third, at least, more grains in number than a bushel of plump corn, three bushels of such corn will go as far in sowing land, as four bushels of large grain.

The use of the flour of corn in furthering the process of vegetation, is to nourish the minute plant from the time of its developement till its roots are able to attract food from the manured earth; for this purpose, one-tenth of the contents of a grain of good wheat is more than sufficient. The quantity of flour in wheat has been increased by culture and management, calculated to improve its qualities for the benefit of mankind, in the same proportion as the pulp of apples and pears has been increased, by the same means, above what is found on the wildings and crabs in the hedges.

It is customary to set aside or to purchase for seed-corn, the boldest and plumpest samples that can be obtained; that is, those that contain the most flour; but this is an unnecessary waste of human subsistence; the smallest grains, such as are sifted out before the wheat is carried to market, and either consumed in the farmer's family, or given to his poultry, will be found by experience to answer the purpose of propagating the sort whence they sprung, as effectually as the largest.

Every ear of wheat is composed of a number of cups placed alternately on each side of the straw; the lower ones contain, according to circumstances, three or four grains, nearly equal in size, but towards the top of the ear, where the quantity of nutriment is diminished by the supply of those cups that are nearer the root, the third or fourth grain in a cup is frequently defrauded of its proportion, and becomes shrivelled and small. These small grains, which are rejected by the miller, because they do not contain flour enough for his purpose, have, nevertheless, an ample abundance for all purposes of vegetation, and as fully partake of the sap, (or blood, as we should call it in animals,) of the kind which produced them, as the fairest and fullest grain that can be obtained from the bottoms of the lower cups by the wasteful process of beating the sheaves.

TRITOMA, a genus of insects of the coleoptera order. The generic character is, antennæ clavate, the club perfoliate; lip emarginate; anterior feelers hatchet-shaped; shells as long as the body. There are ten species,

TRITON, a genus of vermes mollusca. The generic character is, body long; mouth with an involute spiral proboscis; tentacula, or arms, twelve, viz. six on each side, divided nearly to the base, the end ones cheliferous. There is only a single species, viz. the littoreous, which is found in Italy, in various cavities of submarine rocks, and may be seen in many species of the lepas, particularly in the anatafera.

TRITURATION. See Pharmacy.

TRIUMFETTA, a genus of the dodecandria monogynia class of plants, the corolla of which consists of five linear, erect, obtuse petals, hollowed, and bent backwards; the point is prominent below the apex; the fruit is a globose capsule, every where surrounded with hooked prickles, and contains four cells; the seeds are two, convex on one side and angular on the other; but only one of the two seeds of each cell usually ripens. There are 11 species, chiefly shrubs of the West Indies.

TRIXIS, a genus of the syngenesia polygamia class and order of plants. The corollæ of the ray are trifid, seeds hairy at the top, without any down; recept. chaffy. There are three species, herbs of the West Indies.

TROCHAIC VERSE, in the Latin poetry, a kind of verse, so called because the trochees chiefly prevail, as the iambus does in the iambic. It generally consists of seven feet and a syllable; the odd feet, for the most part, consist of trochees, though a tribrachys is sometimes admitted, except in the seventh foot; these two feet are likewise used in the other places, as is also the spondæus, dactylus, and anapæstus. The following is an example:

1 2 3 4 5
Solus | aut rex | aut po | eta | non quot |
6 7 ½
annis | nasci | tur.

TROCHANTER. See ANATOMY.

TROCHE. See PHARMACY.

TROCHEE, in the Greek and Latin poetry, a foot consisting of two syllables, the first long and the second short, as in the words mūsă and sērvăt.

TROCHILUS, *humming-bird*, a genus of birds belonging to the order of picæ. The rostrum is subulate, filiform, and longer than the head, the apex being tubular; the upper mandible sheaths the lower. The tongue is filiform and tubulous, the two threads coalescing; the feet are slender and fit for walking; the tail has ten feathers. There are 65 species, none of which are natives of Britain. They are all remarkable for the beauty of their colours, and most of them for the smallness of their size, though some are eight or nine inches in length. They are divided into two families, viz. those with crooked bills, and those with straight bills. See Plate Nat. Hist. fig. 408. Of these we shall describe the four following species:

1. The exilis, or little humming-bird, has a crooked beak, is an inch and a half in length; frequently weighing less than 50 grains. The bill is black, and half an inch in length; the body greenish-brown, with a red shining, inimitable gloss; the head is crested with a small tuft, green at bottom, but of a sparkling gold colour at top; quills and tail fine black. It is a native of Guiana; and the velocity of it in flying is so great, that the eye can scarcely keep pace with its motion.

2. The moschitus, or ruby-necked humming-bird, according to Marcgrave, is the most beautiful of the whole genus. Its length is three inches four lines; the bill straight, eight lines long, and blackish; the top of the head and hind part of the neck are as bright as a ruby, and of the same colour: the upper parts of the body are brown, with a faint mixture of green and gold; the throat and fore-part of the neck are the colour of the most brilliant topaz; the belly, sides, and thighs, are brown; but on the lower part of the belly, on each side, is a spot of white; the tail is rufous purple, inclining to violet at the ends; the two middle feathers are shortest; the legs and claws blackish. The female has only a dash of golden or topaz on the breast and fore-part of the neck; the rest of the under parts are greyish-white. This species is found in Brasil, Curassoa, Guiana, and Surinam. See Plate Nat. Hist. fig. 409.

3. The minimus, or least humming-bird, is exceeded, both in weight and dimensions, by several species of bees. The total length is one inch and a quarter; and when killed, weighs no more, according to Sir Hans Sloane, than 20 grains. The bill is straight and black, three lines and a half in length; the upper parts of the head and body are of a greenish gilded brown, in some lights appearing reddish; the under parts are greyish-white; the wings are violet-brown; the tail of a bluish-black, with a gloss of polished metal; but the outer feather, except one on each side, is grey from the middle to the tip, and the outer one wholly grey; legs and claws brown. The female is less than the male; the whole upper side of a dirty brown, with a slight gloss of green; the under parts of a dirty-white. These birds are found in various parts of South America and the adjacent islands.

4. Superciliosus, white shaft, or supercilious humming-bird, has a bill twenty lines long; the feathers of the tail next the two long shafts are also the longest, and the lateral ones continually decrease to the two outermost, which are the shortest, and this gives the tail a pyramidal shape; its quills have a goldgloss on a grey and blackish ground, with a whitish edge at the point, and the two shafts are white through the whole projecting portions; all the upper side of the back and head gold-colour; the wing violet-brown; and the under side of the body white-grey.

These birds subsist on the nectar or sweet juice of flowers: they frequent those most which have a long tube, particularly the impatiens noli me tangere, the monarda with crimson flowers, and those of the convolvulus tribe. They never settle on the flower during the action of extracting the juice, but flutter continually like bees, moving their wings very quick, and making a humming noise; whence their name. They are not very shy, suffering people to come within a foot or two of the place where they are, but when approached nearer, fly off like an arrow out of a bow. They often meet and fight for the right to a flower, and this all on the wing. In this state they often come into rooms where the windows stand open, fight a little, and go out again. When they come to a flower which is juiceless, or on the point of withering, they pluck it off as if in anger, by which means the ground is often quite covered with them. When they fly against each other, they have, besides the humming, a sort of chirping noise, like a sparrow or chicken. They do not feed on insects or fruit; nor can they be kept long in cages, though they have been preserved alive for several weeks together, by feeding them with water in which sugar had been dissolved.

This bird most frequently builds in the middle of a branch of a tree, and the nest is so small that it cannot be seen by a person who stands on the ground; any one therefore desirous of seeing it must get up to the branch, that he may view it from above: it is for this reason that the nests are not more frequently found. The nest is of course very small, and quite round; the outside, for the most part composed of green moss, common on old pales and trees; the inside of soft down, mostly collected from the leaves of the great mullein, or the silk grass; but sometimes they vary the texture, making use of flax, hemp, hairs, and other soft materials: they lay two eggs of the size of a pea, which are white, and not bigger at one end than the other.

The above account of the manners will in general suit all the birds of this genus; for as their tongues are made for suction, it is by this method alone that they can gain nourishment: no wonder, therefore, they can scarcely be kept alive by human art. Captain Davies, however, kept these birds alive for four months by the following method: He made an exact imitation of some of the tubular flowers with paper, fastened round a tobacco-pipe, and painted them of a proper colour; these were placed in the order of nature, in the cage wherein these little creatures were confined; the bottoms of the tubes were filled with a mixture of brown sugar and water as often as emptied; and he had the pleasure of seeing them perform every action, for they soon grew familar, and took the nourishment in the same manner as when ranging at large, though close under his eye.

TROCHOID. See CYCLOID.

TROCHUS, a genus of vermes testacea: the generic character is, animal a limax; shell univalve, spiral, more or less conic; aperture somewhat angular or rounded; the upper side transverse and contracted; pillar placed obliquely. See Plate Nat. Hist. fig. 410. There are about 120 species.

TROGON, or *curucui*, a genus of birds of the order picæ. The generic character is, bill shorter than the head, sharp-edged, hooked, the mandibles serrate, at the edge; feet formed for climbing. There are nine species. They all inhabit warm countries, are solitary, and live in damp unfrequented woods, building on the lower branches: their flight is short, and they feed on insects: body long; nostrils covered with bristles; feet short, woolly; tail very long, consisting of 12 feathers.

TROLLIUS, *globe-flower*, in botany, a genus of plants of the class polyandria, and order polygynia, and in the natural system ranging under the 26th order, multisiliquæ. The calyx is wanting; there are about 14 petals; the capsules are very numerous, ovate, and many seeded. There are two species, the asiaticus and europæus; the latter of which is a British plant. The europæus, or European globe-flower, has its corollets connivent, and from nine to sixteen nectaria, of the length of the stamina, linear, plane, incurvated, and perforated at the inside of the base. The leaves are divided first into five segments down to the base: the segments are again divided, each about halfway, into two or three lobes, which are sharply indented on the edges. The stalk is a foot high, and scarcely branched; the flower is yellow, globose, and spacious. It grows at the foot of mountains, and by the sides of rivulets. The country people in Sweden strew their floors and pavements on holidays with the flowers, which have a pleasant smell, and are ornamental in gardens. The asiaticus is little different, except that the corolla inclines to orange.

TRONAGE, the mayor and commonalty of the city of London, are ordained keepers of the beams and weights for weighing merchants' commodities, with power to assign clerks, porters, &c. of the great beam and balance, which weighing of goods and wares, is called tronage.

TROPÆOLUM, the *Indian cress*, or *nasturtium*, a genus of the octandria-monogynia class of plants, the flower of which consists of five roundish petals inserted into the divisions of the cup; the two upper petals are sessile; the three others have very long and barbated ungues: the fruit consists of three convex capsules, fulcated, and striated on one side, and angular on the other; the seeds are three, gibbous on one side, and angulated on the other, but upon the whole somewhat roundish, and striated deeply. There are five species.

TROPE. See RHETORIC.

TROPHIS, a genus of the dioecia tetrandria class and order of plants. There is no calyx and no female corolla; the male corolla is four-petalled; the style is two-parted; berry one-seeded. There is one species, the ramoom tree of Jamaica.

TROPHY, *tropæum*, among the antients, a pile or heap of arms of a vanquished enemy, raised by the conqueror in the most eminent part of the field of battle. The trophies were usually dedicated to some of the gods, especially Jupiter. The name of the deity to whom they were inscribed, was generally mentioned, as was that also of the conqueror. The spoils were at first hung upon the trunk of a tree; but instead of trees, succeeding ages erected pillars of stone, or brass, to continue the memory of their victories. To demolish a trophy was looked upon as a kind of sacrilege, because they were all consecrated to some deity. The representation of a trophy is often to be met with on medals of the Roman emperors, struck on occasion of victories; wherein, besides arms and spoils, are frequently seen one or two captives by the sides of the trophy.

TROPICS. See ASTRONOMY, and GEOGRAPHY.

TROVER is the remedy prescribed by the law, where any person is in possession of the property of another, which he unlawfully detains. Previous to commencing of this action, a demand of the property so detained, must be made in writing by some person properly authorized by the owner of the property; and upon refusal to restore it, the law presumes an unlawful conversion, and the party is entitled to this action, and will recover damages to the value of the property detained. As trover implies trespass, the smallest damages will carry costs. A similar action may be brought for the unlawful detention of any property, on which the specific article so detained may be recovered; but as articles detained must be precisely stated in the declaration, and is attended with some difficulty, this action is very seldom brought.

TROUT. See SALMO.

TROY-WEIGHT, one of the most antient of the different kinds used in Britain. The ounce of this weight was brought from Grand Cairo in Egypt, about the time of the crusades, into Europe, and first adopted in Troyes, a city of Champagne, whence the name. The pound English troy contains 12 ounces, or 5760 grains. It was formerly used for every purpose; and is still retained for weighing gold, silver, and jewels; in some degree for compounding medicines; for experiments in natural philosophy; and for comparing different weights with each other.

TROY-WEIGHT, *Scots*, was established by James VI. in the year 1618, who enacted, that only one weight should be used in Scotland, viz. the French troy stone of 16 pounds, and 16 ounces in the pound. The pound contains 7600 grains, and is equal to 17 oz. 6 dr. avoirdupois. The cwt. or 112 lb. avoirdupois, contains only 103 lb. $2\frac{1}{4}$ oz. of this weight, though generally reckoned equal to 104 lb. This weight is nearly, if not exactly, the same as that of Paris and Amsterdam; and is generally known by the name of Dutch weight. Though prohibited by the articles of union, it is still used in weighing iron, hemp, flax, most Dutch and Baltic goods, meal, butchers-meat, unwrought pewter and lead, and some other articles. See WEIGHTS.

TRUCE, in war, denotes a suspension of arms, or a cessation of hostilities between two armies, in order to settle articles of peace, bury the dead, or the like.

TRUFFLES, in natural history, a kind of subterraneous puff-ball, being a species of fungi, which grows under the surface of the earth. See LYCOPERDON.

TRUMPET, the loudest of all portable wind instruments, and consisting of a folded tube generally made of brass, and sometimes of silver.

The antients had various instruments of the trumpet kind, as the tuba, cornua, &c. Moses, as the scripture informs us, made two of silver to be used by the priests; and Solomon, Josephus tells us, made two hundred lik those of Moses, and for the same purpose.

The modern trumpet consists of a mouth-piece, near an inch across. The pieces which conduct the wind are called the branches; the parts in which it is bent the potences; and the canal between the second bend and the extremity the pavilion; the rings where the branches take asunder, or are soldered together, the knots, which are five in number, and serve to cover the joints.

One particular in this powerful and noble instrument is, that, like the horn, it only commands certain notes within its compass.

The trumpet produces, as natural and easy sounds, G above the bass-cliff note, or fiddle G, C on the first ledger line below in the treble, E on the first line of the stave, G on the second line, C on the third space, and all the succeeding notes up to C in alt, including the sharp of F, the fourth of the key.

Solo performers can also produce B flat (the third above the treble-cliff note) and by the aid of a newly invented slide many other notes which the common trumpet cannot sound are now produced.

A method has lately been discovered for varnishing the inside of trumpets, so as not to injure the fineness of the sound, and yet to prevent the deleterious effects occasioned by drawing in the oxide of copper into the lungs.

TRUMPET *marine*, a kind of monochord, consisting of three tables, which form its triangular body. It has a very narrow neck, with one thick string, mounted on a bridge, which is firm on one side, and tremulous on the other. It is struck with a bow by the right hand, while the thumb of the left is pressed on the string. The peculiarity of its sound, which resembles that of the trumpet, is produced by the tremulation of the bridges. This insrument, like that of the tones of which it imitates, is confined to certain notes, and some of these are imperfect.

TRUMPET, *harmonical*, an instrument that imitates the sound of a trumpet, which it resembles in every thing, excepting that it is longer, and consists of more branches; it is generally called sackbut.

TRUMPET, *speaking*, is a tube from six to fifteen feet long, made of tin, perfectly straight, and with a very large aperture; the mouth-piece being large enough to receive both lips.

The speaking-trumpet, or stentorophonic tube, as some call it, is used for magnifying sound, particularly that of speech, and thus causing it to be heard at a great distance. How it does this will be easy to understand from the structure of it, thus illustrated: Let ACB be the tube, BD the axis, and B the mouth-piece for conveying the voice to the tube. Plate Miscel. fig. 244.

It is then evident, when a person speaks at B in the trumpet, the whole force of his voice is spent upon the air contained in the tube, which will be agitated through the whole length of the tube; and by various reflections from the side of the tube; to the axis, the air along the middle part of the tube will be greatly condensed, and its momentum proportionably increased, so that when it comes to agitate the air at the orifice of the tube AC, its force will be as much greater than what it would have been without the tube, as the surface of a sphere, whose radius is equal to the length of the tube, is greater than the surface of the segment of such a sphere, whose base is the orifice of the tube. See SOUND.

For a person speaking at B, without the tube, will have the force of his voice spent in exciting concentric superficies of air all around the point B; and when those superficies or pulses of air are diffused as far as D every way, it is plain the force of the voice will be diffused through the whole superficies of a sphere whose radius is BD; but in the trumpet it will be so confined, that at its exit it will be only diffused through so much of that spherical surface of air, as corresponds to the orifice of the tube. But since the force is given, its intensity will be always inversely, as the number of particles it has to move; and therefore in the tube it will be to that without, as the superficies of such a sphere to the area of the large end of the tube nearly.

To make this matter yet plainer by calculation, let $BD=5$ feet, then will the diameter of the sphere $DE=10$ feet, the square of which is 100, which, multiplied by 0,7854, gives 78,54 square feet for the area of a great circle AHEFC. And, therefore, four times that area, viz. $4\times78{,}54=314{,}16$ square feet in the superficies of the aerial sphere. If now the diameter AC, of the end of a trumpet, is one foot, its area will be 0,7854; but 7854 : 314.16 : : 1 : 400, therefore the air at the distance of BD, will be agitated by means of the trumpet, with a force 400 times greater than by the bare voice alone. Again, it is farther evident how instruments of this form necessarily assist the hearing; for the weak and languid pulses of the air being received by the large end of the tube, and greatly multiplied and condensed by the tremulous motion of the parts of the tube, and air agitated by them, are conveyed to the ear by the small end, and strike it with an impetus as much greater than they would have done without it, as the area of the small end at B is less than the area of the larger end AC. From what has been said, it is evident the effect of the tube in magnifying sound, either for speaking or hearing, depends chiefly upon the length of the tube. But yet some advantage may be derived from the particular shape. Some very eminent philosophers have proposed the figure which is made by the revolution of a parabola about its axis, as the best of any, where the mouth-piece of the parabola, and, consequently, the sonorous rays will be reflected parallel to the axis of the tube. But this parallel reflection seems no way essential to the magnifying of sound; on the contrary, it appears rather to hinder such an effect, by preventing the infinite number of reflections and reciprocations of sound; in which, according to sir Isaac Newton, its augmentation principally consists. For all reciprocal motion, in every return, is augmented by its generating cause, which is here the tremulous motions of the parts of the tube. In every repercussion, therefore, from the sides of the tube, the agitations and pulses of confined air must necessarily be increased; and consequently this augmentation of the impetus of the pulses must be proportional to the number of such repercussions; and therefore, to the length of the tube, and to such a figure as is most productive of them. Whence it appears that the parabolic trumpet is of all the most unfit for this purpose, instead of being the best.

But there is one thing more which contributes to the augmenting of these agitations of air in the tube, and that is the proportion which the several portions of air bear to each other, when divided by transverse sections, at very small, but equal distances, from one end of the tube to the other. Thus, let those several divisions be made at the points *a, b, c, d, e*, &c. which let the right lines *ak, bl, cm, dn*, &c. be taken in geometrical proportion. Then will the portions of air contained between B and *a*, *a* and *b*, *b* and *cc*, *cc* and *d*, &c. be very nearly in the same proportion, as being in the same ratio with their bases, when the points of division are indefinitely near together.

But when any quantity of motion is communicated to a series of elastic bodies, it will receive the greatest augmentation when those bodies are in geometrical proportion. Therefore, since the force of the voice is impressed upon, and gradually propagated through, a series of elastic portions of air in a geometrical ratio to each other, it shall receive the greatest augmentation possible.

Now, since by construction it is $Ba = ab = bc = cd$, &c. and also $ak : bl :: bl : cm :: cm : dn$, and so on; therefore, the points *k, l, m, n, o, p, k, r, s*, as will, in this case, form that curve line which is called the logarithmic curve; consequently a trumpet, formed by the revolution of this curve about its axis, will augment the sound in a greater degree than any other figured tube whatever.

TRUMPET, *listening* or *hearing*, is an instrument invented by Joseph Landini, to assist the hearing of persons dull of that faculty, or to assist us to hear persons who speak at a great distance.

Instruments of this kind are formed of tubes, with a wide mouth, and terminating in a small canal, which is applied to the ear. The form of these instruments evidently shews how they conduce to assist the hearing, for the greater quantity of the weak and languid pulses of the air being received and collected by the large end of the tube, are reflected to the small end, where they are collected and condensed; thence entering the ear in this condensed state, they strike the tympanum with a greater force than they could naturally have done from the ear alone.

Hence it appears that a speaking-trumpet may be applied to the purpose of a hearing-trumpet, by turning the wide end towards the sound, and the narrow end to the ear.

TRUMPET-FLOWER. See BIGNONIA.

TRUMPET-SHELL, the English name of the buccinum of authors. See BUCCINUM.

TRUNCATED, in general, is an appellation given to such things as have, or seem to have, their points cut off: thus we say, a truncated cone, pyramid, leaf, &c.

In entomology it means when the elytra (or upper wings) are shorter than the abdomen, and terminated by a transverse line.

TRUNNIONS, or TRUNIONS *of a piece of ordnance*, are those knobs or bunches of the gun's metal, which bear her up on the cheeks of the carriage: and hence the trunnion-ring is the ring about a cannon, next before the trunnions.

TRUSS OF FLOWERS, is used by florists to signify many flowers growing together on the head of a stalk, as in the cowslip, auricula, &c.

TRUSS is also used for a sort of bandage or ligature made of steel, or the like matter, wherewith to keep up the parts, in those who have hernias or ruptures. See SURGERY.

TRUSSES, in a ship, are ropes made fast to the parrels of a yard, either to bind the yard to the mast when the ship rolls, or to hale down the yards in a storm, &c.

TRUST, is a right to receive profits of land, and to dispose of the land in equity. And one holding the possession and disposing of it at his will and pleasure, are signs of trust. Chan. Rep. 52.

A trust is but a new name given to an use, and invented to evade the statute of uses. 21 Vin. 493.

What is a declaration of trust, and when a trust shall be raised. By stat. 29 C. II. c. 3. all declaration or creation of trust shall be manifested by some writing signed by the party, or by his last will in writing, or else shall be void. And by sect. 9 of the same act, assignments of trust shall be in writing, signed by the party assigning the same, or by his last will, or else shall be of no effect.

What shall be deemed a trust by implication. By 29 Car. II. all declarations of trusts were to be made in writing; but in the said act there is a saving with regard to trusts resulting by implication of law, which are left on the footing whereon they stood before the act; now a bare declaration by parole before the act, would prevent any resulting trust. 2 Vern. 294.

If a man purchases lands in another's name, and pays the money, it will be a trust for him that paid the money, though no deed is made.

TRUSTEE, one who has an estate, or money, put or trusted in his hands, for the use of another. Where two or more persons are appointed trustees, if one of them only receives all or the greatest part of the profits of the lands, &c. and is in arrear, and unable to satisfy the person to whom he is seised in trust, the other, in that case, shall not be answerable for more than comes to his hands.

TUBE, in general, pipe, conduit, or canal; a cylinder, hollow withinside, either of lead, iron, wood, glass, or other matter, for the air, or some other fluid, to have a free passage or conveyance through.

Small silver or leaden tubes are frequently used by surgeons to draw off blood, matter, or water, from the different parts of the body. They are made of various sizes and shapes.

TUBE, in astronomy, is sometimes used for a telescope, or, more properly, for that part into which the lenses are fitted, and by which they are directed and used. See OPTICS.

TUBIPORA, a genus of zoophyta The generic character is, animal a nereis; coral consisting of erect, hollow, cylindrical, parallel aggregate tubes. There are ten species: the musica inhabits the American and Indian seas, is fixed to rocks and other corals; bright scarlet, consisting of an assortment of upright parallel tubes, rising over each other by stages, like cells of an honeycomb, divided by transverse partitions. The Indians use it in cases of strangury, and wounds inflicted by venomous animals.

TUBULARIA, a genus of zoophyta: stem tubular, simple or branched, fixed by the base: animal proceeding from the end of the tube, and having its head crested with tentacula. There are 26 species; the magnifica inhabits the West Indies, adhering to rocks, and is the most splendid genus of them all: it has the power of withdrawing its tentacula within the tube, and the tube within the rock on which it resides.

TUFAS, beds of lime deposited on vegetables, which by their destruction give great lightness and porousness to the mass.

TUG, in military affairs, *Fr.* A Turkish term for tail; a sort of standard, called so by the Turks. It consists of a horse's tail, which is fixed to a long pole or half-pike, by means of a gold button. The origin of this standard is curious. It is said, that the Christians having given battle to the Turks, the latter were broken, and in the midst of their confusion lost their grand standard. The Turkish general, being extremely agitated at the untoward circumstances which happened, most especially by the loss of the great standard, cut off a horse's tail with his sabre, fixed it to a half-pike, and holding it in his hand, rode furiously towards the fugitives, and exclaimed, 'Here is the great standard; let those who love me, follow into action.' This produced the desired effect. The Turks rallied with redoubled courage, rushed into the thickest of the enemy, and not only gained the victory, but recovered their standard. Other writers assert, that six thousand Turks having been taken prisoners during a general engagement, contrived to escape from their guard or escort, and afterwards fought so gallantly, that they regained another battle; that in order to recognize one another, they cut off a horse's tail, which they carried as a standard; that when they joined the Ottoman army, they still made use of the tug or tail; that the Turks, in consequence of the victory which was obtained under this new standard, looked upon it as a happy omen; and that since that period they have always fought under it as their banner, and the signal of success.

Whatever may have been the origin, it is certain, that when the grand signor takes the field in person, seven of these tails are always carried before him; and when he is in camp, they are placed in front of his tent.

The grand visier is entitled to three of these tails.

The three principal bashaws of the empire, viz. those of Bagdad, Grand Cairo, and Breda, have the grand signor's permission to use this mark of distinction, throughout the whole extent of their jurisdiction.

Those bashaws that are not visiers have the privilege of having two tails.

The beys, who are subordinate to the bashaws, have only one.

TULBAGIA, a genus of plants of the class and order hexandria monogynia. The corolla is funnel-form; nect. three-leaved; capsule superior. There are two species, bulbs of the Cape.

TULIP. See Tulipa.

TULIPA, *tulip*, a genus of plants of the class hexandria, and order monogynia, and in the natural system ranging under the 10th order, coronariæ. The corolla is hexapetalous and campanulated, and there is no style. The species of this genus are five; the sylvestris, or Italian yellow tulip, a native of the south of Europe; the gesneriana, or common tulip, a native of the Levant; the breyniana, or cape tulip, a native of the Cape of Good Hope, the biflora, and the suavolens.

1. The sylvestris, or wild European tulip, has an oblong bulbous root, sending up long narrow spear-shaped leaves; and a slender stalk, supporting at top a small yellow flower, nodding on one side, having acute petals.

2. The gesneriana, Gesner's Turky tulip of Cappadocia, or common garden tulip, has a large, oblong, tunicated, solid, bulbous root, covered with a brown skin, sending up long, oval, spear-shaped leaves; an upright round stalk, from half a foot to a yard high, and its top crowned with a large bell-shaped erect hexapetalous flower, of almost all colours and variegations in the different varieties.

This tulip, and its vast train of varieties, is generally cultivated for the ornament of our gardens, and much admired by all for its great variety and beautiful appearance; it grows freely in the open ground in any common soil of a garden, and proves a very great decoration to the beds and borders of the pleasure-ground for six weeks or two months in spring, by different plantings of early and late sorts; planting the principal part in autumn, and the rest towards Christmas, and in January or February. The autumn plantings will come earliest into bloom, and flower the strongest; and the others will succeed them in flowering. In summer, when the flowering is past, and the leaves and stalks assume a state of decay, the bulbs of the choicest varieties are generally taken up, the offsets separated, and the whole cleaned from filth; then put up to dry till October or November, and planted again for the future year's bloom.

Of this species, which is the florist's delight, the varieties may be divided into two principal classes, viz. 1. Early or dwarf spring tulips (præcoces). 2. Late flowering tall tulips (serotine). 1. Early tulips. The early tulips are, among florists, distinguished by the appellation of præcoces, (early) because they flower early in the spring, a month or more before the others; are much shorter stalked, and the flowers smaller, but in great reputation for their early bloom and their gay lively colours, both of self-colours, and broken into flaked variegations, such as reds, crimson, scarlet, carnations, violets, purples, yellow, &c. with flowers of each, edged and flaked with red, yellow, and white, in many diversities. 2. Late flowering common tulips. This class is denominated late flowering, and by the florists called serotines, because they blow later in the spring, a month or more, than the præcoces, *i. e.* not coming into flower before the end of April, May, and June. They are all of tall growth, supporting large flowers, and furnish an almost endless variety in the vast diversity of colours; after, they break from whole blowers into variegations and stripes, exceeding all others of the tulip kind in beauty and elegance of flower.

All the varieties are succeeded by plenty of ripe seed in July and August, contained in an oblong capsule of three cells, having the seeds placed on each other in double rows. By the seeds many new varieties may be raised, which however will not attain a flowering state till they are seven or eight years old; and after that will require two or three years, or more, to break into variegations, when the approved varieties may be marked, and increased by offsets of the root.

The colours in greatest estimation in variegated tulips are the blacks, golden yellows, purple-violets, rose, and vermilion, each of which being variegated various ways; and such as are striped with three different colours distinct and unmixed, with strong regular streaks, but with little or no tinge of the breeder, may be called the most perfect tulips. It is rare to meet with a tulip possessing all these properties.

As to the manner of obtaining this wonderful variety of colours in tulips, it is often accomplished by nature alone, but is sometimes assisted and forwarded by some simple operations of art; such as that, in the first place, when the seedling bulbs of the whole blower or breeder are arrived to full size, and have flowered once, to transplant them into beds of any poor dry barren soil, in order that, by a defect of nutriment in the earth, the natural luxuriance of the plant may be checked, and cause a weakness in their general growth, whereby they generally, in this weakened or infirm state, gradually change and break out into variegations, some the first year, others not till the second or third; and according as they are thus broken they should be planted in beds of good earth.

Another method to assist nature in effecting the breaking the breeding tulips into diversified colours, is to make as great a change as possible in the soil; if they were this year in a light poor soil, plant them the next in a rich garden mould, and another year in a compost of different earths and dungs; or transplant them from one part of the garden to another, or into different gardens, &c. or from one country to another; all of which contributes to assist nature in producing this desirable diversity of colours and variegations.

The double tulip is also a variety of the common tulip, and is very beautiful, though not in such estimation among the florists as the common single variegated sorts, not possessing such a profusion of variegations in the colours and regularity of stripes; they however exhibit an elegantly ornamental appearance.

Tulip roots are sold in full collection, consisting of numerous varieties, at most of the nurseries and seedsmen, who both propagate them themselves by offsets and seed, and import vast quantities annually from Holland, the Dutch being famous for raising the grandest collections of the finest tulips, and other bulbous flowers, in the greatest perfection.

TUMOUR, or Tumor, in medicine and surgery, a preternatural rising or hard swelling on any part of the body.

TUN, or Ton, originally signifies a large vessel or cask of an oblong form, biggest in the middle, and diminishing towards its two ends, girt about with hoops, and used for stowing several kinds of merchandize, for convenience of carriage; as brandy, oil, sugar, skins, hats, &c. This word is also used for certain vessels of extraordinary bigness, serving to keep wine for several years.

Tun is also a certain measure for liquids; as wine, oil, &c. See Measure.

Tun is also a certain weight, whereby the burden of ships, &c. are estimated. See Ton and Weight.

TUNE, or Tone, in music, that property of sounds whereby they come under the relation of acute and grave to one another. See Tone, and Sound.

Sonorous bodies we find differ in tune: 1. According to the different kinds of matter; thus a wedge of silver sounds much more acute than a wedge of gold of the same shape and dimensions, in which case the tones are proportional to the specific gravity. 2. According to the different quantities of the same matter in bodies of the same figure, a solid sphere of brass, one foot diameter, sounds acuter than one of two feet diameter; in which case the tunes are proportional to the quantity of matter. Here then are different tunes connected with different specific gravities and quantities of matter, as their immediate cause. In effect, the measures of tune are only sought in the relations of the motions that are the cause of sound, which are no way so discernable as in vibrations of chords.

In the general we find that in two chords, all things being equal, except tension, or thickness, or length, the tunes are different; there must, therefore, be a difference in the vibrations owing to these different tensions, &c. which difference can only be in the velocity of the courses and recourses of the chords, through the spaces wherein they move to and again. Now, upon examining the proportion of the velocity, and the things just mentioned, wherein it depends, it is found, to a demonstration, that all the vibrations of the same chord are performed in equal times. Hence, as the tone of a sound depends on the nature of these vibrations, whose difference we can conceive no otherwise than as having different velocities; and as the small vibrations of the same chord are performed in equal times, and it is found true, in fact, that the sound of any body arising from any individual stroke, though it grows gradually weaker, yet continues the same tone from first to last; it follows, that the tone is necessarily connected with a certain quantity of time, in making every single vibration; or that a certain number of vibrations, accomplished in a given time, constitutes a certain determinate tune; for the more frequent those vibrations are, the more acute the tone; and, the slower and fewer they are, the more grave the sound, though performed in the same space of time; so that any given note of a tune is made by one certain measure of velocity of vibrations, that is, such certain courses and recourses of a chord or string, in such a certain space of time, constitute a determinate tune.

TUNGSTEN, a mineral found in Sweden, of an opaque white colour and great weight, whence its name tungsten, or ponderous stone. This ore was analysed by Scheele, who found that it was composed of lime and a peculiar earthy-like substance, which from its properties he called tungstic acid. The basis of the acid was found to contain a metal which was named tungsten, and which was obtained from the acid mixed with charcoal.

Tungsten, called by some of the German chemists scheelium, is of a greyish-white colour, or rather like that of iron, and has a good deal of brilliancy.

It is one of the hardest of the metals; for Vauquelin and Hecht could scarcely make any impression upon it with a file. It seems also to be brittle. Its specific gravity is 17.6. It is therefore the heaviest of the metals after gold and platinum.

It requires for fusion a temperature at least equal to 170° Wedgewood. It seems to have the property of crystallizing on cooling, like all the other metals.

It is not attracted by the magnet.

When heated in an open vessel, it gradually absorbs oxygen, and it is converted into an oxide. Tungsten seems capable of combining with two different proportions of oxygen, and of forming two different oxides; the black and the yellow.

The protoxide or black oxide may be obtained by heating the yellow oxide for some hours in a covered crucible. The peroxide or yellow oxide, known also by the name of tungstic acid, is found native in wolfram, and may be obtained from it by boiling three parts of muriatic acid on one of wolfram. The acid is to be decanted off in about half an hour, and allowed to settle. A yellow powder gradually precipitates. This powder is to be dissolved in ammonia, the solution is to be evaporated to dryness, and the dry mass kept for some time in a red heat. It is then yellow oxide in a state of purity. This oxide has no taste. It is insoluble in water, but remains long suspended in that liquid, forming a kind of yellow milk, which has no action on vegetable colours. When heated in a platinum spoon it becomes dark green; but before the blowpipe on charcoal it acquires a black colour. It is composed of 80 parts of tungsten and 20 of oxygen. Its specific gravity is 6.12.

1. The sulphuret of tungsten is of a bluish black colour, hard, and capable of crystallizing. Phosphorus is capable of combining with tungsten; but none of the properties of the phosphuret have been ascertained.

The simple incombustibles do not seem capable of uniting with tungsten.

The Elhuyarts alone attempted to combine tungsten with other metals. They mixed 100 grains of the metals to be alloyed with 50 grains of the yellow oxide of tungsten and a quantity of charcoal, and heated the mixture in a crucible. The result of their experiments is as follows:

With gold and platinum the tungsten did not combine. With silver it formed a button of a whitish-brown colour, something spongy, which with a few strokes of a hammer extended itself easily, but on continuing them it split in pieces. This button weighed 142 grains.

With copper it gave a button of a copperish red, which approached to a dark brown, was spongy, and pretty ductile, and weighed 133 grains. With crude or cast iron, of a white quality, it gave a perfect button, the fracture of which was compact and of a whitish brown colour: it was hard, harsh, and weighed 137 grains; and with lead it formed a button of a dull dark brown, with very little lustre, spongy, very ductile, and splitting into leaves when hammered: it weighed 127 grains.

The button formed with tin was of a lighter brown than the last, very spongy, somewhat ductile, and weighed 138 grains.

That with antimony was of a dark-brown colour, shining, something spongy, harsh, and broke in pieces easily: it weighed 108 grains.

That of bismuth presented a fracture, which, when seen in one light, was of a dark-brown colour, with the lustre of a metal, and in another appeared like earth, without any lustre; but in both cases an infinity of little holes could be distinguished over the whole mass. This button was pretty hard, harsh, and weighed 68 grains.

With manganese it gave a button of a dark-bluish-brown colour and earthy aspect; and on examining the internal part of it with a lens, it resembled impure dross of iron; it weighed 107 grains.

TUNGSTIC ACID. The substance called tungstic acid by Scheele and Bergman was discovered by Scheele in 1781. This philosopher obtained it from the tungstat of lime, by treating it with nitric acid and ammonia alternately. The acid dissolves the lime, and the ammonia combines with the tungstic acid. The ammoniacal solution, when saturated with nitric or muriatic acid, deposits a white powder, which is the tungstic acid of Scheele.

This powder has an acid taste, it reddens vegetable blues, and is soluble in 20 parts of boiling water. The De Luyarts have demonstrated, that this pretended acid is a compound of yellow oxide of tungsten, the alkali employed to dissolve it, and the acid used to precipitate it. Thus, when prepared according to the above-described process, it is a compound of yellow oxide, ammonia, and nitric acid. Their conclusions have been more lately confirmed by the experiments of Vauquelin and Hecht. This substance must therefore be erased from the class of acids, and placed among the salts.

The real acid of tungsten is a yellow powder; the method of procuring which, and its properties, have been already described under the denomination of yellow oxide of tungsten. It ought rather, as Vauquelin and Hecht have properly remarked, to be classed among the oxides than the acids; for it is insoluble in water, tasteless, and has no effect on vegetable blues. It agrees with the acids indeed in the property of combining with alkalies and earths, and perhaps also with some metallic oxides, and forming with them salts which have been denominated tungstats; but several other metallic oxides, those of lead, silver, and gold, for instance, possess the same property. These oxides, therefore, may be called acids with as much propriety as the yellow oxide of tungsten.

The affinities of this oxide, as far as they have been ascertained, are as follows:

Lime;	Soda,
Barytes,	Ammonia,
Strontian,	Glucina,
Magnesia,	Alumina,
Potass,	Zirconia.

The manner in which it was produced is evident: tungstic acid is composed of oxygen and tungsten; the oxygen combined with the carbon, and left the metal in a state of purity.

TUNICA, a kind of waistcoat or under-garment, in use amongst the Romans. They wore it within doors by itself, and abroad under the gown. The common people could not afford the toga, and so went in their tunics, whence Horace calls them populus tunicatus. The several sorts of the tunic were the palmata, the angusticlavia, and the laticlavia. The first was worn by generals in a triumph, and perhaps always under the toga picta; it had its name either from the great breadth of the clavi, or buttons, equal to the palm of the hand; or else from the figures of palms embroidered on it. It was by these three different sorts of tunics, that the three different orders of the Roman people were distinguished in habit.

TUNNAGE. See TONNAGE.

TUNNY. See SCOMBER.

TURBITH, or TURPETH-ROOT. See CONVOLVULUS.

TURBO, the WREATH, in zoology, a genus of insects belonging to the order of vermes testacea. The animal is of the snail kind; the shell consists of one spiral solid valve, and the aperture is orbicular. There are 166 species; of which the most remarkable are, 1. The littoreus, or periwinkle. This is abundant on most rocks far above low-water mark. The Swedish peasants believe that when these shells creep high up the rocks, they indicate a storm from the south. They are eaten by the poor people in most parts of this kingdom. Young lobsters are said to take up their lodging in the empty shells of these animals, which has given occasion to a notion that periwinkles are changed into lobsters. But we apprehend the mistake to have originated from the circumstance of the cancer diogenes, or soldier-crab, which is a kind of small lobster or shrimp, naturally naked, which takes shelter in the cast shells of harbinated shell-fish. 2. The clathrus, or barbed wreath, has a taper shell of eight spires, distinguished by elevated divisions, running from the aperture to the apex. There is a variety pellucid, with very thin edges. It is analogous to that curious and expensive shell, the wentle-trap. See Plate Nat. Hist. fig. 411.

TURBOT. See PLEURONECTES.

TURDUS, the thrush, a genus of birds belonging to the order of passeres. The bill is straight, bending towards the point, and slightly notched near the end of the upper mandible. The nostrils are oval, half covered with a membrane; the corners of the mouth are furnished with a few slender hairs, and the tongue is slightly jagged at the end. There are 136 species, of which seven are British, the viscivorus, pilaris, iliacus, musicus, roseus, merula, and torquatus.

1. The viscivorus, or missel, is the largest of the genus. Its length is eleven inches; its breadth sixteen and a half. The bill is shorter and thicker than that of other thrushes; dusky, except the base of the lower mandible, which is yellow. The irides are hazel. Head, back, and lesser coverts of the wings, are of a deep olive-brown. The lower part of the back is tinged with yellow. The lowest order of lesser coverts, and the great coverts, are brown, the first tipped with white, the last both tipped and edged with the same colour. The inner coverts of the wings white. The tail is brown; the three outermost feathers tipped with white. The cheeks and throat are mottled with brown and white; the breast and belly are whitish yellow, marked with large spots of black; the legs are yellow. These birds build their nests in bushes, or on the side of some tree, and lay four or five eggs: their note of anger or fear is very harsh, between a chatter and shriek. Its song, however, is very fine; which it begins sitting on the summit of a high tree, very early in the spring, often with the new year, in blowing showery weather, which makes the inhabitants of Hampshire call it the storm-cock. It feeds on insects, holly and misseltoe berries, which are the food of all the thrush kind: in severe snowy weather, when there is a failure of their usual diet, they are observed to scratch out of the banks of hedges the root of arum, or the cuckoo-pint; this is remarkably warm and pungent, and a provision suitable to the season.

2. The pilaris, or fieldfare, is in length ten inches, in breath seventeen. The head is ash-coloured inclining to olive, and spotted with black; the back and greater coverts of the wings of a fine deep chesnut; the tail is black; the lower parts of the two middlemost feathers, and the interior upper sides of the outmost feathers, excepted; the first being ash-coloured, the latter white. The legs are black; the talons very strong. This bird passes the summer in the northern parts of Europe; also in Lower Austria. It breeds in the largest trees: feeds on berries of all kinds, and is very fond of those of the juniper. Fieldfares visit our islands in great flocks about Michaelmas, and leave us the latter end of February or the beginning of March.

These birds and the redwings were the turdi of the Romans, which they fattened with crumbs of figs and bread mixed together. Varro informs us that they were birds of passage, coming in autumn, and departing in the spring. They must have been taken in great numbers; for, according to Varro (lib. 3. c. 5.), they were kept by thousands together in their fattening aviaries. They do not arrive in France till the beginning of December.

3. The musicus, or throstle, is in length nine inches, in breadth thirteen and a half. In colour, it so nearly resembles the missel-thrush, that no other remark need to be added, but that it is less, and that the inner coverts of the wings are yellow. The throstle is the finest of our singing birds, not only for the sweetness and variety of its notes, but for the long continuance of its harmony; for it obliges us with its song for near three parts of the year. Like the missel-bird, it delivers its music from the top of some high tree; but to form its nest descends to some low bush or thicket: the nest is made of earth, moss, and straw, and the inside is curiously plaistered with clay, or rather clay and cow-dung mixed. It lays five or six eggs, of a pale bluish green, marked with dusky spots.

4. The iliacus, or redwing, has a very near resemblance to the throstle; but is less: their colours are much the same; only the sides under the wings and the inner coverts in this are of a reddish orange, in the throstle yellow; above each eye is a line of yellowish white, beginning at the bill and passing towards the hind part of the head. These birds appear in Great Britain a few days before the fieldfare; they come in flocks, and from the same countries as the latter. With us they have only a disagreeable piping note; but in Sweden, during the spring, they sing very finely, perching on the top of some tree among the forests of maples. They build their nests in hedges, and lay six blueish-green eggs spotted with black.

5. The merula, or blackbird; when the male has attained its full age, it is of a fine deep black, and the bill of a bright yellow; the edges of the eyelids yellow. When young, the bill is dusky, and the plumage of a rusty black, so that they are not to be distinguished from the females; but at the age of one year they attain their proper colour. This bird is of a very retired and solitary nature, and frequents hedges and thickets, in which it builds earlier than any other bird; the nest is formed of moss, dead grass, fibres, &c. lined and plaistered with clay, and that again covered with hay or small straw. It lays four or five eggs of a dusky green colour, marked with irregular spots. The note of the male is extremely fine, but too loud for any place except the woods; it begins to sing early in the spring, continues its music part of the summer, desists in the moulting season, but resumes it for some time in September and the winter months.

6. The torquatus, or ring-ouzel, is superior in size to the blackbird; the length is eleven inches, breadth seventeen. The bill in some is wholly black, in others the upper half is yellow; on each side the mouth are a few bristles; the head and whole upper part of the body are dusky, edged with pale brown; the quill-feathers and the tail are black. The coverts of the wings, the upper part of the breast, and the belly, are dusky, slightly edged with ash-colour. The middle of the breast is adorned with a white crescent, the horns of which point to the hind part of the neck. In some birds this is of a pure white, in others of a dirty hue. In the females and in young birds this mark is wanting, which gave occasion to some naturalists to form two species of them. The ring-ouzel inhabits the Highland hills, the north of England, and the mountains of Wales. They are also found to breed in Dartmoor, in Devonshire, and in banks on the sides of streams. The places of their retreat are not known. In Scotland and Wales they breed in the hills, but descend to the lower parts to feed on the berries of the mountain-ash. They migrate in France at the latter season; and appear in small flocks about Monthard in Burgundy, in the beginning of October, but seldom stay above two or three weeks.

To these we shall add the description of the orpheus, or mocking thrush, which is a native of America. It is about the size of a thrush, of a white and grey colour, and a reddish bill. It is possessed not only of its own natural notes, which are musical and solemn, but it can assume the tone of every other animal in the wood, from the wolf to the raven. It seems even to sport itself in leading them astray. It will at one time allure the lesser birds with the call of their males, and then terrify them when they come near with the screams of the eagle. There is no bird in the forest but it can mimick; and there is none that it has not at times deceived by its call. But, unlike such as we usually see famed for mimicking with us, and who have no particular merit of their own, the mock-bird is ever sure to please when it is most itself. At those times it usually frequents the houses of the American planters; and sitting all night on the chimney-top, pours forth the sweetest and the most various notes of any bird whatever. It would seem, if accounts are true, that the deficiency of most other song-birds in that country is made up by this bird alone. They often build their nests in the fruit-trees about houses, feed upon berries and other fruits, and are easily rendered domestic. See Plate Nat. Hist. fig. 412.

TURIONES, among herbalists, denotes the first young tender shoots, which plants annually put forth.

TURKEY. See MELEAGRIS.

TURMERIC. See CURCUMA.

TURNAMENT, or TOURNAMENT, a martial sport, or exercise, which the antient cavaliers used to perform to shew their bravery and address.

TURNERA, a genus of the pentandria trigynia class of plants, the flower of which consists of five petals obversely cordated, and sharp-pointed; the fruit is an oval, unilocular capsule, containing a great many oblong and obtuse seeds. There are nine species.

TURNING, the art of forming hard bodies, as wood, ivory, or iron, into a round or oval shape, by means of a machine called a lathe. This art was well known to the antients, and seems to have been carried by them to a very great degree of perfection; at least, if we believe the testimony of Pliny and several other authors, who tell us, that those precious vases enriched with figures in half-relief, which still adorn our cabinets, were turned on the lathe. See LATHE.

The art of turning is of considerable importance, as it contributes essentially to the perfection of many other arts. The architect uses it for many ornaments, both within and without highly finished houses. The mathematician, the astronomer, and the natural philosopher, have recourse to it, not only to embellish their instruments, but also to give them the necessary dimension and precision. In short, it is an art absolutely necessary to the goldsmith, the watchmaker, the joiner, and the smith.

Turning is performed by the lathe, of which there are various kinds, and several instruments, as gouges, chisels, drills, formers, and screw-tales, used for cutting what is to be turned into its proper form as the lathe turns round. See Plate Miscel. fig. 131; and Plate Lamp, &c. fig. 6, &c.

The lathe should be fixed in a place very well lighted; it should be immoveable, and neither too high nor too low. The puppets should neither be so low as to oblige the workman to stoop in order to see his work properly, nor so high that the little chips, which he is continually driving off, should come into his eyes.

The piece to be turned should be rounded, (if it is wood) before it is put on the lathe, either with a small hatchet made for the purpose, or with a plane, or with a file, fixing it in a vice, and shaving it down till it is every where almost of an equal thickness, and leaving it a little larger than it is intended to be when finished off. Before putting it on the lathe, it is also necessary to find the centre of its two end surfaces, and that they should be exactly opposite to each other, that when the points of the puppets are applied to them, and the piece is turned round, no side may belly out more than another. To find these two centres, lay the piece of wood to be turned upon a plank; open a pair of compasses to almost half the thickness of the piece, fix one of the legs in the plank, and let the point of the other touch one of the ends of the piece, brought into the same plane with the plank on which the compasses are fixed, and very near the fixed leg. Describe four arches on that end at equal distances from each other, at the circumference of the end, but intersecting one another within; the point of intersection is the centre of the end. In the same manner must the centre of the other end be found. After finding the two centres, make a small hole at each of them, into which insert the points of the puppets, and fix the piece so firmly as not to be shaken out, and yet loose enough to turn round without difficulty.

The piece being thus fixed, it is necessary in the next place to adjust the cord, by making it pass twice round the piece, and in such a manner, that the two ends of the cord, both that which is fixed to the spang and to the footboard, come off on the side on which the turner stands, that the piece may move against the edge of the cutting-tool and be turned. If the lathe is moved by a wheel, the manner of adjusting the cord needs no direction.

If the workman does not chuse to be at the trouble to find the two centres of the piece in the manner described above, let him lay, as nearly as he can, the centre of one end upon the point of the left hand puppet, and then let him push forward the right hand puppet, striking it with a mallet till its point is as near as can be in the centre of the other end of the piece; and then fixing the right hand puppet by a gentle blow of the mallet on the key, let him turn round the piece to see by the eye if the centres have been properly found. If any part of it bellies out, let him strike that part gently with the mallet till it goes properly; then let him strike one of the puppets pretty smartly to drive the points into the piece, and afterwards fix the puppet by striking the key. If the workman cannot judge by the eye whether the piece is turning properly round its centres or not, he should apply gently the point of an instrument called a triangular graver, leaning it on the rest, and it will mark by a line the place where the piece is out of its centre; and by striking upon this line with a mallet, the piece can easily be placed properly. The rest, of which we have just spoken, ought to be placed upon the two arms of the lathe, and fixed with screws as near the piece as the workman pleases.

The piece being fixed between the two points of the puppets, the cord adjusted, and the rest fixed as near the work as possible without touching it; the workman is now to take a gouge of a proper size in his left hand, and hold it by the handle a little inclined, keeping the back of the hand lowermost. With his right hand, the back of which is to be turned upwards, he is to grasp it near the end on this side of the rest; then leaning the gouge on the rest, he is to present the edge of it a little higher than the horizontal diameter of the piece, so as to form a kind of tangent to its circumference; then putting the right foot on the footboard, and turning round the wheel, and holding the gouge firmly on the rest, the piece will be cut neatly. In the same manner are the chisels, formers, and other instruments to be used, taking care that the wood shall be cut equally, and that the instrument shall not be pushed improperly, sometimes stronger than at others; and taking care also, that the instrument used does not follow the work, but that it is kept firmly in the hand without yielding.

The young turner ought to endeavour to acquire the management of the gouge and the chisel, which are the instruments by far the most frequently used, and the most necessary in this art; by them, almost entirely, are the soft woods turned; as for hard woods and other things, as box, ebony, horn, ivory, and the metals, they are hardly ever turned except by shaving off. In that case gravers are to be used with square, round, or triangular mouths. They should be held horizontally while applied to the wood, and not obliquely as directed for the gouge and the chisel.

After the work is completely turned, it is next to be polished, and this cannot be done with the instruments hitherto mentioned. Soft woods, as pear-tree, hazel, and maple, ought to be polished with shark-skin or Dutch rushes. There are different species of sharks: some of which have a greyish, others a reddish skin. Shark-skin is always the better to be a good deal used; at first it is too rough for polishing. The Dutch rush is the equisetum hyemale of Linnæus, which grows in moist places among mountains. It is remarkable for having flinty particles in the substance of its leaves, which render it so useful in polishing. It has a naked, simple, and round stem, about the thickness of a writing-pen. The oldest plants are the best. Before using them they should be moistened a little, otherwise they break in pieces almost immediately, and render it exceedingly difficult to polish with them. They are particularly proper for smoothing hard woods, as box, lignum-vitæ, ebony, &c. After having cleaned up the piece well, it should be rubbed gently either with wax or olive-oil, then wiped clean and rubbed with its own raspings or with a cloth a little worn. Ivory, horn, silver, and brass, are polished with pumice-stone finely pounded and put upon leather or a linen cloth a little moistened: with this the piece is rubbed as it turns round in the lathe; and to prevent any dirt from adhering to any part of it, every now and then it is rubbed gently with a small brush dipt in water. To polish very finely, the workmen make use of tripoli, and afterwards of putty or calx of tin. Iron and steel are polished with very fine powder of emery; this is mixed with oil, and put between two pieces of very tender wood, and then the iron is rubbed with it. Tin and silver are polished with a burnisher, and that kind of red stone called in France sanguine dure. They may be polished also with putty, putting it dry on shammy-skin or with the palm of the hand.

To succeed in turning iron, it is necessary to have a lathe exceedingly strong in all its parts, and exceedingly well fixed. The puppets should be short, and the rest well fixed very near the work; the back of the rest should be two or three lines lower than the iron to be turned.

The lathe and other instruments being prepared, it is necessary to determine the length and thickness of the iron to be turned according to the design which is to be executed, and to make a model of it in wood a little thicker than it ought to be; then one exactly like this is to be forged of the best iron that can be procured; that is, it must not be new, but well prepared and well beaten with hammers; it must have no flaws, nor cracks, nor pimples. New iron, which has not been well beaten, often contains round drops of cast iron, called by the workmen grains, which blunt the edges of the gouges, chisels, and other instruments used for cutting; break them, or make them slide. The iron being forged according to the model, it should be annealed, that is, heated red hot, and allowed to cool slowly on the coals till the fire goes out of itself. Some people, to soften the iron, cover it over with clay and allow it to cool. The iron cylinder being thus made, it is next to be put upon the lathe, finding the centres as formerly directed, and boring a small hole in them that the iron may not escape from the points.

The points should be oiled from time to time to prevent their being excessively heated and spoiled while the iron is turning. A crotchet is then to be applied to the iron to be turned a little above its centre, pretty gently, and by this means the inequalities of the cylinder will be taken off. Other instruments are then to be applied to mould the iron according to the model; and whenever any of them grow hot, they are to be plunged into a bason of water lying beside the workman. If the iron, after being properly turned, is to be bored like a gun-barrel, one of the puppets is to be removed, and another substituted in its place, having a square hole through it, into which the collar of the iron is to be fixed firmly, so as not to shake; then borers are to be applied, like those which locksmiths use to bore keys; and beginning with a small one, and afterwards taking larger ones, the hole is to be made as wide and deep as necessary; great care must be taken to hold the borers firm to the rest, otherwise there is danger of not boring the hole straight. The borer must be withdrawn from time to time to oil it and to clean the hole. Since it is difficult to make a hole quite round with borers alone, it is necessary to have also an instrument a good deal smaller than the hole, one of the sides of which is sharp, very well tempered, and a little hollow in the middle. This instrument being fixed in a pretty long handle, is to be applied with steadiness to the inner surface of the hole, and it will entirely remove every inequality that may have been there before its application.

For turning ovals, a lathe of somewhat a different construction is used. The axis or spindle, having on it the pulley over which the band-cord passes for turning the lathe, is fixed between the two puppets so as to turn round easily; one end of it passes through one of the puppets, and to it is firmly fixed a circular plate of brass, so that it turns round along with the spindle. Upon this plate two brazen segments of circles are fastened, the circumferences of which correspond to the circumference of the plate; their chords are parallel, and equally distant from the centre of the plate, so that they leave a distance between them. They have a groove in each of them; in these grooves another plate is placed, which exactly fills up the space between the two grooves, but is shorter than the diameter of the larger circular plate on which it is laid. This plate is made to slide in the grooves. To its centre is annexed a short spindle, on which the piece of wood to be turned is fixed. When the lathe is set a going, the circular plate moves round, and carries the piece along with it; the plate of brass on which the piece is fixed, being fixed loosely in the grooves already described, slides down a little every time that the grooves become perpendicular to the floor (and there are particular contrivances to prevent it from sliding down too far); and by these two motions combined (the circular one of the large plate, and the straight one of the small), the circumference of the piece of wood to be turned necessarily describes an oval; and gouges or other tools being applied in the usual manner, supported on the rest, it is cut into an oval accordingly. The small plate may be made to slide either more or less in the grooves; and by this contrivance the transverse diameter of the oval, or rather ellipse, may be made longer or shorter at pleasure. Another, and still simpler method if possible, of turning ovals, is this: Take two ovals of metal, exactly of the size of the oval which you intend to make; fix them firmly on the spindle of the lathe, so as to turn round with it; fix between them the wood to be turned, and then it is easy, by the help of chisels and other tools, to cut it, as the lathe goes, into exactly the figure of the external ovals. Or an oval may be formed by placing the wood, or whatever is to receive that shape, obliquely on the lathe. There are several other ingenious methods of turning, but our bounds do not permit us to enter upon them. We shall therefore conclude this article with a number of receipts, which every turner ought to know.

1. The method of moulding boxes both of shell and horn. In the first place, form a proper mould, which must consist of two pieces, viz. of a circle about half an inch thick, which should slope a little in order to draw out the moulded shell the more easily; and a ring fitted to the outside of the circle, so that both together make the shape of a box. These two pieces being adjusted, it is necessary to round the shell to be moulded of such a size, that when moulded, it will be a little higher than the ring of the mould, that there may be no deficiency. The mould is then to be put into a press on a plate of iron, exactly under the screw of the press; put then the shell upon the circle of the mould, so that its centre also is exactly opposite to the screw of the press: then take a piece of wood formed into a truncated cone, and not so thick as the diameter of the circle of the mould, nor so deep as the ring; then put a plate of iron above the cone, and screw down the press gently and cautiously till the whole is well fixed; then plunge the whole into a cauldron of boiling water placed above a fire. In eight or ten minutes the shell or horn will begin to soften; screw the press a little firmer that the wooden cone may sink into the softened shell: repeat this from time to time till the cone is quite sunk in the mould; then take out the press and plunge it into cold water. When it is cold, take the box now formed out of the mould, and put into the inside of it a new mould of tin exactly of the form you wish the inside of the box to be; do the same with the outside, put it again into the press, and plunge it into boiling water; screw the press gradually till the box is fashioned as you desire.

2. Method of preparing green wood so that it will not split in the turning. Having cut your wood into pieces of a proper size, put it into a vessel full of a ley made with wood ashes. Boil it there about an hour; then, taking the cauldron off the fire, allow the ley to cool; then take out the wood and dry it in the shade.

3. Method of giving an ebony-black to hard and fine woods. After forming the wood into the destined figure, rub it with aqua fortis a little diluted. Small threads of wood will rise in the drying, which you will rub off with pumice-stone. Repeat this process again, and then rub the wood with the following composition: Put into a glazed earthen vessel a pint of strong vinegar, two ounces of fine iron-filings, and half a pound of pounded galls, and allow them to infuse for three or four hours on hot cinders. At the end of this time augment the fire, and pour into the vessel four ounces of copperas (sulphat of iron), and a chopin of water having half an ounce of borax and as much indigo dissolved in it; and make the whole boil till a froth rises. Rub several layers of this upon your wood; and, when it is dry, polish it with leather on which you have put a little tripoli.

4. Method of giving to plum-tree the colour of Brazil wood. Slack lime with urine, and bedaub the wood over with it while it is hot; allow it to dry; then take off the coat of lime, and rub it with chamois-skin well oiled. Or, steep your wood in water having a quantity of alum dissolved in it, five or six hours, kept lukewarm during a night: and when it is dry, rub it, as before directed, with chamois-skin well oiled.

5. Method of giving a fine black colour to wood. Steep your wood for two or three days in lukewarm water in which a little alum has been dissolved; then put a handful of logwood, cut small, into a pint of water, and boil it down to less than half a pint. If you then add a little indigo, the colour will be more beautiful. Spread a layer of this liquor quite hot on your wood with a pencil, which will give it a violet-colour. When it is dry, spread on another layer; dry it again, and give it a third; then boil verdegris at discretion in its own vinegar, and spread a layer of it on your wood; when it is dry, rub it with a brush, and then with oiled chamois-skin. This gives a fine black, and imitates perfectly the colour of ebony.

6. Method of cleaning and whitening bones before using them. Having taken off with a saw the useless ends of the bones, make a strong ley of ashes and quick-lime, and into a pailful of this ley put four ounces of alum, and boil the bones in it for an hour; then take the vessel containing the ley off the fire, and let it cool; then take out the bones and dry them in the shade.

7. Method of soldering shells. Clean the two sides of the shells which you wish to join together; then, having joined them, wrap them up in linen folded double and well moistened; then heat two plates of iron pretty hot, that they may keep their heat for some time; and putting your shells rolled up between them under a press, which you must screw very tight, leave them there till the whole is cold, and they will be soldered. If you do not succeed the first time, repeat the process.

8. Method of moulding shells. Put six pints of water into a kettle; add to it an ounce of olive or other oil; make the water boil; then put in your shell, and it will grow soft. Take it out, and put it into a mould under a press, and it will take the figure you want. This must be done quickly; for if the shell cools ever so little, the process will fail. It will not require much pressure.

9. Method of tinging bones and ivory red. Boil shavings of scarlet cloth in water. When it begins to boil, throw in a quarter of a pound of ashes made from the dregs of wine, which will extract the colour: then throw in a little rock alum to clear it, and pass the water through a linen cloth. Steep your ivory or bone in aqua fortis, and put it into the water. If you wish to leave white spots, cover the places destined for them with wax.

10. To tinge ivory black. Steep the ivory during five or six days in water of galls, with ashes made with dried dregs of wine and arsenic; then give it two or three layers of the same black with which plum-tree is blackened in order to imitate ebony. Or dissolve silver in aqua fortis, and put into it a little rose water. Rub the ivory with this, and allow it to dry in the sun.

11. Method of hardening wood to make pulleys. After finishing the pulley, boil it seven or eight minutes in olive-oil, and it will become as hard as copper.

12. To make Chinese varnish. Take of

gum-lac in grains four ounces; put it into a strong bottle with a pound of good spirit of wine, and add about the bulk of a hazel-nut of camphor. Allow them to mix in summer in the sun, or in winter on hot embers for twenty-four hours, shaking the bottle from time to time. Pass the whole through a fine cloth, and throw away what remains upon it. Then let it settle for twenty-four hours, and you will find a clear part in the upper part of the bottle, which you must separate gently and put into another vial, and the remains will serve for the first layers.

TURNPIKE, a gate set up across a road, watched by an officer for the purpose, in order to stop travellers, waggons, coaches, &c. to take toll of them towards repairing or keeping the roads in repair.

Justices of the peace, and other commissioners, are authorised to appoint surveyors of the roads, and collectors of toll. In case any persons shall drive horses or other cattle through grounds adjoining to the highways, thereby to avoid the toll, they are liable to forfeit 10*s*. Likewise if any one assaults a collector of the tolls, or by force passes through a turnpike-gate without paying, he forfeits 5*l*. leviable by justices of peace; and maliciously pulling down a turnpike is deemed felony, &c. It is also enacted, that 20*s*. shall be paid for every hundred that a carriage with its loading weighs above 6000 pounds weight, and that engines may be set up at turnpikes for weighing such carriages.

TURPENTINE. See Pinus, and Resins.

TURRÆ, a genus of plants of the class and order decandria monogynia. The calyx is one-leafed, bell-shaped, five-toothed, very small, permanent. There are five species, shrubs of the East Indies.

TURRITIS, *tower-mustard*, a genus of the tetradynamia siliquosa class of plants, with a tetrapetalous cruciform flower: its fruit is an extremely long pod, containing numerous seeds. There are eight species.

TUSCAN ORDER. See Architecture.

TUSSILAGO, *colt's-foot*, a genus of plants of the class syngenesia, and order polygamia superflua; and in the natural system ranging under the 49th order, compositæ. The receptacle is naked; the pappus simple; the scales of the calyx equal, of the same height as the disk, and somewhat membranaceous. There are fourteen species, three of which are indigenous to Britain, the farfara, hybrida, and petasites. The farfara, or common colt's-foot, grows plentifully on the banks of rivulets, or in moist and clayey soils. The leaves were formerly smoked in the manner of tobacco, and a syrup or decoction of them and the flowers stands recommended in coughs and other disorders of the breast and lungs. It seems now to be almost entirely rejected. The downy substance under the leaves, boiled in a lixivium with a little saltpetre, makes excellent tinder. The petasites, or common butter-bur, is frequent in wet meadows, and by the sides of rivers. Its leaves are the largest of any plant in Great Britain, and in heavy rains afford a seasonable shelter to poultry and other small animals. The root dug up in the spring is resinous and aromatic.

TUTOR, in the civil law, is one chosen to look to the person and estate of children left by their fathers and mothers in their minority. A person nominated tutor either by testament, or by the relations of the minor, is to decline that office if he has five children alive, if he has any other considerable tutorage, if he is under twenty-five years of age, if he is a priest, or a regent in an university, or if he has any law-suit with the minors, &c. The marriage of a pupil, without the consent of his tutor, is invalid. Tutors may do any thing for their pupils, but nothing against them; and the same laws which put them under a necessity of preserving the interest of the minors, put them under an incapacity of hurting them.

Tutor, is also used in our universities for a member of some college or hall, who takes on him the instruction of some young students in the arts or faculties.

TUTORAGE, *tutela*, in the civil law, a term equivalent to guardianship in the common law, signifying an office imposed on any one to take care of the effects of one or more minors. See Guardian, and Tutor.

By the Roman law, there are three kinds of tutorage; testamentary, which is appointed by the father's testament; legal, which is given by the law to the nearest relation; and dative which is appointed by the magistrate. But in all customary provinces, all tutorages are dative and elective; and though the father has by testament nominated the next relation to his pupil, yet is not that nomination of any force, unless the choice is confirmed by that of the magistrate, &c. By the Roman law, tutorage expires at fourteen years of age.

TUTTY. See Zinc.

TWA-NIGHTS GESTE, among our ancestors, was a guest that staid at an inn a second night, for whom the host was not answerable for any injury done by him, as he was in case of a third night-awn hynde.

TWELF-HINDI, among the English Saxons, was where every person was valued at a certain price; and if any injury was done either to a person or his goods, a pecuniary mulct was imposed, and paid in satisfaction of that injury, according to the worth and quality of that person to whom it was done, in which case such as were worth 1200 shillings were called twelf-hindi; and if an injury was done to such persons, satisfaction was to be made accordingly.

TWI-HINDI, among our Saxon ancestors, were persons valued at 200*s*. These men were of the lowest degree, and if such were killed, the mulct was 30*s*. See Twelfhindi.

TWILIGHT. See Astronomy.

TYCHONIC SYSTEM or Hypothesis, an order or arrangement of the heavenly bodies, of an intermediate nature betwen the Copernican and Ptolemaic, or participating alike of them both.

This system had its name and original from Tycho Brahe, a nobleman of Denmark who lived in the latter part of the 17th century. This philosopher, though he approved of the Copernican system, yet could not reconcile himself to the motion of the earth; and being on the other hand convinced the Ptolemaic scheme could not be true, he contrived one different from either. In this the earth has no motion allowed it, but the annual and diurnal phenomena are solved by the motion of the sun about the earth, as in the Ptolemaic scheme; and those of Mercury and Venus are solved by this contrivance, though not in the same manner, nor so simply and naturally, as in the Copernican system. The Tychonic system then supposed the earth in the centre of the world, that is, of the firmament of stars, and also of the orbits of the sun and moon; but at the same time it made the sun the centre of the planetary motions, viz. of the orbits of Mercury, Venus, Mars, Jupiter and Saturn. Thus the sun with all its planets, was made to revolve about the earth once a year, to solve the phenomena arising from the annual motion, and every twenty-four hours, to account for those of the diurnal motion. But this hypothesis is so monstrously absurd, and contrary to the great simplicity of nature, and, in some respects, even contradictory to appearances, that it obtained but little credit, and soon gave way to the Copernican system.

After this scheme had been proposed for some time, it received a correction by allowing the earth a motion about its axis to account for the diurnal phenomena of the heavens; and so this came to be called the semi-tychonic system. But this was still void of the truth, and encumbered with such hypotheses as the true mathematician and the genuine philosopher could never relish.

TYLE. See Tile.

TYMPANUM, or Tympan, in mechanics, a kind of wheel placed round an axis or cylindrical beam, on the top of which are two levers or fixed staves, for the more easy turning the axis, in order to raise a weight required. The tympanum is much the same with the peritrochium, but that the cylinder of the axis of the peritrochium is much shorter, and less than the cylinder of the tympanum.

Tympanum *of a machine*, is also used for a hollow wheel, wherein one or more people, or other animals, walk to turn it; such as that of some cranes, calenders, &c.

TYPE, a copy, image, or resemblance of some model. This word is much used among divines, to signify a symbol, sign, or figure of something to come.

Type, among letter-founders and printers, the same with letter.

Types *for printing*. In the business of cutting, casting, &c. letters for printing, the letter-cutter must be provided with a vice, hand-vice, hammers, and files of all sorts for watchmakers' use; as also gravers and sculpters of all sorts, and an oil-stone, &c. suitable and sizeable to the several letters, to be cut: a flat gage made of box to hold a rod of steel, or the body of a mould, &c. exactly perpendicular to the flat of the using file: a sliding-gage, whose use is to measure and set off distances between the shoulder and the tooth, and to mark it off from the end, or from the edge of the work; a face-gage, which is a square notch cut with a file into the edge of a thin plate of steel, iron, or brass, of the thickness of a piece of common tin, whose use is to proportion the face of each sort of letter, viz. long letters, ascending letters, and short letters. So there must be three gages, and the gage for the long letters is the length of the whole body supposed to be divided into 42 equal parts. The gage for the ascending letters, Roman and

Italic is $\frac{5}{7}$, or 30 parts of 42, and 33 parts for the English face. The gage for the short letters is $\frac{3}{7}$, or 18 parts of 42 of the whole body for the Roman and Italic, and 22 parts for the English face.

The Italic and other standing gages are to measure the scope of the Italic stems, by applying the top and bottom of the gage to the top and bottom lines of the letters, and the other side of the gage to the stem; for when the letter complies with these three sides of that gage, it has its true shape.

The next care of the letter-cutter is to prepare good steel punches, well tempered, and quite free from all veins of iron; on the face of which he draws or marks the exact shape of the letter with pen and ink if the letter is large, or with a smooth blunted point of a needle if it is small; and then with sizeable and proper-shaped and pointed gravers and sculpters, digs or sculps out the steel between the strokes or marks so made on the face of the punch, and leaves the marks standing on the face. Having well shaped the inside strokes of his letter, he deepens the hollows with the same tools; for, if a letter is not deep in proportion to its width, it will, when used at press, print black, and be good for nothing. This work is generally regulated by the depth of the counter punch. Then he works the outside with proper files till it is fit for the matrice.

But before we proceed to the sinking and justifying of the matrices, we must provide a mould to justify them by, of which there are draughts in Plate Miscel. figs. 1*, 2*. Every mould is composed of an upper and an under part. The under part is delineated in fig. 1*. The upper part is marked fig. 2*. and is in all respects made like the under part excepting the stool behind, and the bow or spring also behind; and excepting a small roundish wire between the body and carriage, near the break, where the under part has a small rounding groove made in the body. This wire, or rather half-wire, in the upper part, makes the nick in the shank of the letter, when part of it is received into the groove in the under part. These two parts are so exactly fitted and gaged into one another (viz. the male gage marked *c* in fig. 2* into the female marked *g* in fig. 1*) that when the upper part of the mould is properly placed on, and in the under part of the mould, both together make the entire mould, and may be slid backwards for use so far, till the edge of either of the bodies on the middle of either carriage comes just to the edge of the female gages cut in each carriage: and they may be slid forward so far, till the bodies on either carriage touch each other: and the sliding of these two parts of the mould backwards makes the shank of the letter thicker, because the bodies on each part stand wider asunder; and the sliding them forwards makes the shank of the letter thinner, because the bodies on each part of the mould stand closer together. The parts of the mould are as follow: viz. a, The carriage. b, The body. c, The male gage. d e, The mouth piece. f, The register. g, The female gage. h h, The hag *a a a a*, The bottom plate. *b b b*, The wood on which the bottom plate lies. *c c c*, The mouth. *dd*, The throat. *e d d*, The pallet. *f*, The nick. *g g*, The stool. *h h*, The spring or bow.

Then the mould must be justified: and first the founder justifies the body, by casting about 20 proofs or samples of letters; which are set up in a composing stick, with all their nicks towards the right hand; and then, by comparing these with the pattern letters, set up in the same manner, he finds the exact measure of the body to be cast. He also tries if the two sides of the body are parallel, or that the body is no bigger at the head than at the foot, by taking half the number of his proofs and turning them with their heads to the feet of the other half; and if then the heads and the feet are found exactly even upon each other, and neither to drive out nor get in, the two sides may be pronounced parallel. He farther tries whether the two sides of the thickness of the letter are parallel, by first setting his proofs in the composing stick with their nicks upwards and then turning one half with their heads to the feet of the other half; and if the heads and feet lie exactly upon each other, and neither drive out nor get in, the two sides of the thickness are parallel.

The mould thus justified, the next business is to prepare the matrices. A matrice is a piece of brass or copper, of about an inch and a half long, and of a thickness in proportion to the size of the letter it is to contain. In this metal is sunk the face of the letter intended to be cast, by striking the letter-punch about the depth of an n. After this, the sides and face of the matrice must be justified and cleared with files, of all bunchings made by sinking the punch.

Every thing thus prepared, it is brought to the furnace; which is built of brick upright with four square sides, and a stone on the top, in which stone is a wide round hole for the pan to stand in. A foundry of any consequence has several of these furnaces in it.

As to the metal of which the types are to be cast, this, in extensive foundries, is always prepared in large quantities; but cast into small bars of about 20 pounds weight, to be delivered out to the workmen as occasion requires. In the letter-foundries, which have been long carried on with the greatest reputation we are informed, that a stock of metal is made up at two different times of the year, sufficient to serve the casters at the furnace for six months each time. For this purpose, a large furnace is built under a shade, furnished with a wheel vent, in order the more equally to heat the sides of a strong pot of cast iron, which holds, when full, 15 hundred-weight of the metal. The fire being kindled below, the bars of lead are let softly down into the pot, and their fusion promoted by throwing in some pitch and tallow, which soon inflame. An outer chimney which is built so as to project about a foot over the farthest lip of the pot, catches hold of the flame by a strong draught, and makes it act very powerfully in melting lead: whilst it serves at the same time to convey away all the fumes, &c. from the workmen to whom this laborious part of the business is committed. When the lead is thoroughly melted, a due proportion of the regulus of antimony and other ingredients is put in, and some more tallow is inflamed to make the whole incorporate sooner. The workmen now having mixed the contents of the pot very thoroughly by stirring long with a large iron ladle, next proceed to draw the metal off into the small troughs of cast iron, which are ranged to the number of fourscore upon a level platform faced with stone, built towards the right hand. In the course of a day, 15 hundred weight of metal can be easily prepared in his manner; and the operation is continued for as many days as are necessary to prepare a stock of metal of all the various degrees of hardness. After this, the whole is disposed into presses according to its quality, to be delivered out occasionally to the workmen.

The founder must now be provided with a ladle, which differs nothing from other iron ladles but in its size; and he is provided always with ladles of several sizes, which he uses according to the size of the letters he is to cast. Before the caster begins to cast, he must kindle his fire in the furnace to melt the metal in the pan. He therefore takes the pan out of the hole in the stone, and there lays in coals and kindles them; and, when they are well kindled, he sets the pan in again, and puts metal into it to melt; if it is a small-bodied letter he casts, or a thin letter of great bodies, his metal must be very hot; nay sometimes red-hot, to make the letter come. Then having chosen a ladle that will hold about so much as the letter and break is, he lays it at the toking-hole, where the flame bursts out, to heat. Then he ties a thin leather, cut with its narrow end against the face to the leather-groove of the matrice, by whipping a brown thread twice about the leather-groove, and fastening the thread with a knot. Then he puts both halves of the mould together, and puts the matrice into the matrice-cheek; and places the foot of the matrice on the stool of the mould, and the broad end of the leather upon the wood of the upper half of the mould, but not tight up, lest it might hinder the foot of the matrice from sinking close down upon the stool in a train of work. Then laying a little rosin on the upper wood of the mould, and having his casting-ladle hot, he with the boiling side of it melts the rosin: and, while it is yet melted, presses the broad end of the leather hard down on the wood, and so fastens it to the wood: all this is the preparation.

Now he comes to casting; in the performance of which, placing the under half of the mould in his left hand, with the hook or hag forward, he clutches the ends of its wood between the lower part of the ball of his thumb and his three hind fingers; then he lays the upper half of the mould upon the under half, so that the male gages may fall into the female gages, and at the same time the foot of the matrice places itself upon the stool; and, clasping his left-hand thumb strong over the upper half of the mould, he nimbly catches hold of the bow or spring with his right-hand fingers at the top of it, and his thumb under it, and places the point of it against the middle of the notch in the backside of the matrice, pressing it as well forwards towards the mould as downwards by the shoulder of the notch close upon the stool, while at the same time with his hinder fingers, he draws the under half of the mould towards he ball of his thumb, and thrusts by the ball of his thumb the upper part towards his fingers that both the registers of the mould may press against both sides of the matrice, and his thumb and fingers press both halves of the mould close together.

He then takes the handle of his ladle in his right hand, and with the ball of it gives a stroke, two or three, outwards upon the surface of the melted metal, to scum or clear it from the film or dust that may swim upon it; then takes up the ladle full of metal, and having his mould in his left hand, he a little twists the left side of his body from the furnace, and brings the geat of his ladle (full of metal) to the mouth of the mould, and twists the upper part of his right hand towards him to turn the metal into it, while at the same moment of time he jilts the mould in his left hand forwards, to receive the metal with a strong shake (as it is called), not only into the body of the mould, but while the metal is yet hot running, swift and strongly, into the very face of the matrice, to receive its perfect form there, as well as in the shank.

He then takes the upper half of the mould off the under half, by placing his right-hand thumb on the end of the wood next his left-hand thumb and his two middle-fingers at the other end of the wood: and finding the letter and break lie in the under half of the mould (as most commonly by reason of its weight it does), he throws or tosses the letter, break and all, upon a sheet of waste paper laid for that purpose on the bench, just a little beyond his left hand, and is then ready to cast another letter as before: and also, the whole number that is to be cast with that matrice. A workman will ordinarily cast about three thousand of these letters in a day.

When the casters at the furnace have got a sufficient number of types upon the tables, a set of boys come and nimbly break away the jets from them: the jets are thrown into the pots, and the types are carried away in parcels to other boys, who pass them swiftly under their fingers, defended by leather, upon smooth flat stones, in order to polish their broad-sides. This is a very dexterous operation, and is a remarkable instance of what may be effected by the power of habit and long practice; for these boys, in turning up the other side of the type, do it so quickly by a mere touch of the fingers of the left hand, as not to require the least perceptible intermission in the motion of the right hand upon the stone. The types, thus finely smoothened and flattened on the broad-sides, are next carried to another set of boys, who sit at a square table, two on each side, and there are ranged up on long rulers or sticks, fitted with a small projection, to hinder them from sliding off backwards. When the sticks are so filled, they are placed, two and two, upon a set of wooden pins fixed into the wall, near the dresser, sometimes to the amount of a hundred, in order to undergo the finishing operations. This workman, who is always the most expert and skilful in all the different branches carried on at the foundry, begins by taking one of these sticks, and, with a peculiar address, slides the whole column of types off upon the dressing-stick: this is made of well-seasoned mahogany, and furnished with two end-pieces of steel, a little lower than the body of the types, one of which is moveable, so as to approach the other by means of a long screw-pin, inserted in the end of the stick. The types are put into this stick with their faces next to the back or projection; and after they are adjusted to one another so as to stand even, they are then bound up, by screwing home the moveable end-piece. It is here where the great and requisite accuracy of the moulds comes to be perceived; for in this case the whole column, so bound up, lies flat and true upon the stick, the two extreme types being quite parallel, and the whole has the appearance of one solid continuous plate of metal. The least inaccuracy in the exact parallelism of the individual type, when multiplied so many times, would render it impossible to bind them up in this manner, by disposing them to rise or spring from the stick by the smallest pressure from the screw. Now, when lying so conveniently with the narrow edges uppermost, which cannot possibly be smoothed in the manner before mentioned by the stones, the workman does this more effectually by scraping the surface of the column with a thick-edged but sharp razor, which at every stroke brings on a very fine smooth skin, like polished silver; and thus he proceeds till in about half a minute he comes to the farther end of the stick. The other edges of the types are next turned upwards, and polished in the same manner. It is whilst the types thus lie in the dressing-stick, that the operation of bearding or barbing is performed, which is effected by running a plane, faced with steel, along the shoulder of the body next to the face; which takes more or less off the corner, as occasion may require. Whilst in the dressing-stick they are also grooved, which is a very material operation. In order to understand this, it must be remembered, that when the types are first broken off from the jets, some superfluous metal always remains, which would make them bear very unequally against the paper whilst under the printing-press, and effectually mar the impression. That all these inequalities may, therefore, be taken away, and that the bearings of every type may be regulated by the shoulders imparted to them all alike from the mould, the workman or dresser proceeds in the following manner: The types being screwed up in the stick as before mentioned with the jet end outermost, and projecting beyond the wood about one-eighth of an inch, the stick is put into an open press, so as to present the jet-end uppermost, and then every thing is made fast by driving a long wedge, which bears upon a slip of wood, which lies close to the types the whole length: then a plough or plane is applied, which is so constructed as to embrace the projecting part of the types betwixt its long sides, which are are made of polished iron. When the plane is thus applied, the steel cutter bearing upon that part between the shoulders of the types where the inequalities lie, the dresser dexterously glides it along, and by this means strips off every irregular part that comes in the way, and so makes an uniform groove the whole length, and leaves the two shoulders standing; by which means every type becomes precisely like to another, as to the height against paper. The types being now finished, the stick is taken out of the press, and the whole column replaced upon the other stick; and after the whole are so dressed, he proceeds to pick out the bad letters previous to putting them up into pages and papers. In doing this he takes the stick into his left hand, and turning the faces near to the light, he examines them carefully; and whenever an imperfect or damaged letter occurs, he nimbly plucks it out with a sharp bodkin, which he holds in the right hand for that purpose. Those letters which, from their form, project over the body of the type, and which cannot on this account be rubbed on the stones, are scraped on the broad-sides with a knife or file, and some of the metal next the face pared away with a pen-knife, in order to allow the type to come close to any other. This operation is called kerning.

The excellence of printing-types consists not only in the due performance of all the operations above described, but also in the hardness of the metal, form, and fine proportion of the character, and in the exact bearing and ranging of the letters in relation to one another. See Printing.

TYPHA, cat's-tail, a genus of plants of the classs monoecia, and order triandria; and in the natural system ranging under the 3d. order, calamariæ. The amentum of the male flower is cylindrical; the calyx is scarcely distinguishable; there is no corolla. The female has a cylindrical amentum below the male; the calyx is composed of villous hair; there is no corolla, and only one seed fixed on a capillary papus. There are two species, both natives of Britain; the latifolia and angustifolia. 1. Latifolia, great cat's-tail, or reed mace, is frequent in ponds and lakes. The stalk is six fet high; the leaves a yard long, hardly an inch wide, convex on one side: the amentum, or cylindrical club, which terminates the stalk, is about six inches long, of a dark-brown or fuscous colour. Cattle will sometimes eat the leaves, but Schreber thinks them noxious: the roots have sometimes been eaten in sallads, and the down of the amentum used to stuff cushions and mattresses. Linnæus informs us, that the leaves are used by the coopers in Sweden to bind the hoops of their casks. 2. Angustifolia, narrow-leaved cat's-tail, is found in pools and ditches. The leaves are semi-cylindrical, and the male and female spikes are remote and slender.

TYPOGRAPHY. See Printing.

U.

U, or V, the twentieth letter of our alphabet. In numerals V stands for five; and with a dash added at top, thus V̄, it signifies five thousand. In abbreviations, amongst the Romans, V. A. stood for Veterani assignati; V. B. viro bono; V. B. A. viri boni arbitratu; V. B. F. vir bonæ fidei; V. C. vir consularis; V. C. C. F. vale, conjux charissime, feliciter: V. D. D. voto dedicatur; V. G. verbi gratia; Vir. Ve. virgo vestalis; VL. videlicit; V. N. quinto nonarum.

VACATION, in law, is the whole time betwixt the end of one term and the beginning of another.

This word is also applied to the time from the death of a bishop, or other spiritual person, till the bishopric, or dignity, is supplied with another.

VACCINATION. Inoculation with the vaccine virus, for the purpose of securing against the infection of the small pox.

This subject cannot fail to "come home to the business and bosom" of every one; for where is the individual of such slender connection or limited sympathies, as to be indifferent to a question which "involves the lives annually of 40,000 in Britain alone," and of the same proportion throughout the civilized world?

It would be superfluous, then, to apologize for making the vaccine controversy a subject of separate and prominent disquisition.

We shall first lay before our readers a general history of the circumstances which led to the introduction of the new, as a substitute for the old, inoculation; we shall then enumerate the advantages which vaccination lays claim to, canvas the objections which have been made to the admission of such claims, and conclude by describing the general characteristics of perfect, and marks denoting spurious, cow-pock infection.

It is scarcely necessary to acquaint any reader by whom the first public proposal was made respecting the cow-pox inoculation. Dr. Jenner, while employed in the practice of surgery in a district of Gloucestershire, was surprized to find that many individuals whom he was called upon to inoculate, resisted every attempt to infect them with the small-pox virus. Upon enquiring into the occasion of this extraordinary immunity, he learnt that those in whom it existed had previously undergone a disease contracted by milking cows affected with a peculiar eruption on their teats. "It appeared (says Dr. Jenner) that this disease had been known among the dairy-maids from time immemorial, and that a vague opinion prevailed that it was a preventive of the small pox. This opinion I found was comparatively new among them; for all the old farmers declared they had no such idea in their early days: a circumstance which seemed easily accounted for, from my knowing that the common people were very rarely inoculated for the small pox, till that practice was rendered general by the improved method introduced by the Suttons; so that the working people in the dairies were seldom put to the test of the preventive power of the cow-pox." In prosecuting his enquiries, Dr. Jenner found it to be an unanimous opinion among medical practitioners in the neighbourhood, that the disease thus contracted from the cow was by no means to be relied on as a security against variolous infection; an opinion which he was at first concerned to find apparently well founded by the occurrence of the latter, in some individuals, who had been, as was imagined, subjected to the former.

This discouraging circumstance, although it damped the ardour of Dr. Jenner, did not occasion the abandonment of his investigation; and he was shortly gratified in ascertaining that the cow was subject to several varieties of eruption on her teats, all capable of producing ulcerations on the hands of the milkers, but not of insuring against the infection of small pox. This discovery removed the great obstacle to his interesting research, and our experimentalist was the first to distinguish and divide the genuine from the spurious cow-pox.

His expectations of success were a second time impaired, by finding that even among those who had been infected with the genuine virus, some were afterwards obnoxious to the small-pox contagion; and this difference of subsequent susceptibility was even witnessed in different individuals who had received the infection from the same animal.

It required no common share of perseverance still to abide by the object of pursuit after this seemingly almost insurmountable impediment to success. Dr. Jenner, however, was engaged in an undertaking of too much magnitude and moment to abandon it, unless from absolute necessity, and he still persisted.

It occurred to him that the specific properties of the cow-pock matter might vary with its progressive changes after secretion; and putting this likewise to the test of experiment, the result coincided with his conjecture, affording an explanation of this second anomaly equally clear and satisfactory with the former. He found, by repeated trials, that the genuine or preventive disease was only capable of being engendered by the matter from the ulcer in its earliest stages; that when from continuance it had undergone certain decompositions, it was no more capable of producing the true cow-pox than those eruptions of which we have already spoken. With these restrictions, Dr. Jenner found that the immunity from the variolous occasioned by the vaccine infection was for life; at least individuals without any effect were subjected to the former after the lapse of 15, 27, and even 50 years from the latter infection.

During this very curious and important investigation, Dr. Jenner was struck with the idea that the preventive he had discovered of small-pox contagion might be propagated from one individual to another in the manner of variolous inoculation; and for this supposition it does not seem improper to notice that he had, in one sense, the authority of analogy beyond that which could be claimed by the first ingrafters of variola; for the natural vaccine distemper is itself produced by a species of inoculation, which it is well known is by no means the case with the natural small pox.

We have stated this circumstance not from a desire to prejudge the question of the comparative merits of the variolous and vaccine inoculations. It is the duty of every one, it is ours especially and officially, to state arguments and facts as we find them, whether inimical to, or in favour of, either one or the other practice.

In pursuance of the plan we have above laid down, we now proceed to give as concentrated a view as possible of the superior advantages contended for by the advocates of inoculation for the cow-pox.

These we shall principally extract from a popular work on vaccinia, by Dr. Thornton, one of the most ardent and effective supporters and propagators of the new discovery.

1. It is maintained that the constitutional affection which cow-pox produces, is incomparably milder than that from variolous inoculation. The proportion of deaths from inoculated small pox is stated by Dr. Willan to be 1 in 250. "The zealous antivaccinists have denied it to be greater, under judicious treatment, than 1 in 1000." In the present, as in other instances, we leave the reader to select his own authority. We have only to add, that we believe the mortality at all of the vaccine distemper, in an immediate or direct manner, has not been contended for. This first proposition, then, in favour of the vaccine disease, is scarcely contested.

2. The cow-pox never disfigures the countenance. Of this, likewise, there is no dispute, as it refers to the distemper merely, independantly of the supposed consequences of it, which we are shortly to canvas.

3. The cow-pox may be introduced into the system without any apprehension of consequences, under circumstances which render even the inoculated small pox, in some measure, dangerous, such as the periods of teething, of pregnancy, and of advanced age. This proposition we believe to be likewise too well founded, and generally admitted to need substantiating by examples.

4. The cow-pox inoculation does not, like that of the small pox, disseminate the disease

it is not infectious. This is a most material circumstance in favour of the new inoculation. It is an undisputed fact that the mortality of small pox has increased since the adoption of the artificial mode of communicating it. Though many individuals have profited by inoculation, it has destroyed more lives, upon the whole, than it has preserved; and has aggravated the sufferings of those who have refused to employ it, in a greater degree than it has relieved those who have availed themselves of its protection.

5. The cow-pock does not leave any bad humours after it.

6. "Its security, as a prophylactic against the small pox, is equal to the small pox itself, either natural or inoculated." Thornton.

Under these six heads we believe that we have included all the benefits which are stated to have resulted from the Jennerian practice by its several advocates; and we apprehend it is only in the two last particulars that any material difference of sentiment now prevails. Even those who are still adverse to vaccine, as a substitute for small pox, inoculation, will allow that the dispute respecting the propriety or impropriety of the new practice, principally, if not entirely, hinges upon the validity or invalidity of the two last of the above propositions; for if we are to forego the advantages of Jenner's discovery, from an apprehension of an unjustifiable interference with the decrees of Providence, we should not only be compelled likewise to abandon variolous inoculation, but we ought no longer to think of arresting the progress of fever, of mitigating the violence of pain, or of extracting a carious tooth.

It is then the two last propositions which demand a separate and particular investigation.

First, Does the cow-pock engender other diseases? or, in the phraseology before used, does it leave any humours after it?

It is necessary to observe, that those gentlemen who have protested against vaccinia as introductory of other diseases, have described these affections to be principally cutaneous. Now those who aver that this is an absolute misrepresentation; and that so far from being followed by the alleged consequences, the number of scrophulous and cutaneous disorders which have followed upon the small pox, naturally and artificially introduced, are in a greater proportion than those which have happened posterior to vaccine inoculation; are much more numerous than the advocates for the contrary side of the question. On this ground, then, the inference from every principle of reasoning would be drawn by an impartial judgment in favour of vaccination. It will not, we hope, by the antivaccinist, be considered as irregular or unfair, to appeal on this head to a particular authority, viz. Dr. Willan, who, if he has no title to be considered as "the oracle of the metropolis in all cutaneous diseases," has unquestionably a right to speak on this head "as one having authority." This gentleman asserts that no new disorders have been introduced since the discovery of vaccination, and that the cutaneous affections which had been previously prevalent have in no measure increased in virulence. But Dr. Willan, it will perhaps be urged, may be a prejudiced, and therefore an incorrect, judge. Aware of the possibility of such objection to his statement, this physician has not given the detail of his own private practice merely in order to authorize his assertion, but has inserted in his treatise Dr. Bateman's extract from the register of patients at the public dispensary in London.

In the year 1797, before the publication of Dr. Jenner's enquiry, the total number of diseases was 1730; the number of chronic cutaneous eruptions was 85. In 1798, total number of diseases 1664; chronic cutaneous eruptions 82. In 1804 the proportions are 1915—89. In 1805, 1974—94. Nearly the same proportion, our author adds, may be deduced on comparing Dr. Murray's, Dr. Reid's, Dr. Walker's, and my own reports on diseases in London for the last ten years; and these, it may be added, were made without any reference to the vaccine controversy. Ought, then, the individual cases brought forward by the gentlemen opposed to vaccination to outweigh, or even balance, the contrary evidence above adduced? Here again we leave the reader to make his own inference.

If it should be urged that we have not brought forward the cases opposed to vaccinia, it is answered, neither have we adduced the more numerous instances which make against the variolous inoculation. In fact, the uncertainty of medical evidence forbids any satisfactory conclusion but that which is deduced from comparison on a large and general scale.

It would be, however, doing injustice to the cause of vaccination, to omit the following statements from Mr. Trye, surgeon to the Gloucester infirmary: 1st. "A more healthy description of human beings does not exist, nor one more free from chronic cutaneous impurities, than that which suffers most from cow-pox, by reason of their being employed in dairies.

2d. "The Gloucester infirmary, one of the largest provincial hospitals, is situated in a county in which accidental cow-pox has been prevalent from time immemorial: many hundreds among the labouring people have had the cow-pox since the establishment of that institution, and that more severely than is generally the case in artificial vaccination; and yet not a single patient in half a century has applied to the infirmary for relief of any disease, local or constitutional, which he or she imputed or pretended to trace to the cow-pox. And let it be repeated and remembered, that the artificial in no respect differs from the accidental cow-pox, except in being generally less virulent."

But the most momentous question still remains to be discussed. Does the cow-pock afford a permanent security against variolous infection?

Towards the decision of this point it will be found of essential consequence to revert to the two obstacles which we have already stated, as having presented themselves to Dr. Jenner in the commencement of his investigation.

While the reader retains this in mind, he will readily, we think, perceive the self-refutation contained in the following remarks of Dr. Rowley: "No other questions are admissible in vaccination than, Have the parties been inoculated for the cow-pox? Yes. Have they had the small pox afterwards? Yes. As to how, when, where, whether the cow-pox took, was genuine or spurious, or any arguments, however specious, as pretexts for doubts or failures, they are evasive or irrelative to the question. They may confound fools, but not heighten the credit of vaccination."

On this declaration it has been forcibly remarked, that "it would be little less absurd to tell a jury in a trial for murder, that the only question was, whether a pistol had been fired or not; and that it was of no consequence to inquire whether it was loaded with ball, or whether the sufferer had died of a pistol-shot."

After what we have already stated respecting those eruptions which had been indiscriminately thought the same as the true vaccine disease, and of the changes which the cow-pox matter is itself susceptible of, we think our readers will unite in opinion with us, that the questions respecting the genuine or spurious cow-pox, "the how, the when, and the where' the parties were inoculated, are most material points to ascertain, as preliminary steps to decision respecting alleged failures.

By the further statement which will be given in the sequel, it will be perceived that there are several circumstances necessary to the perfection and absolutely preventive power of vaccine inoculation, which it is by no means unfair to suppose were overlooked by, or unknown to, the inoculators at the early periods of the practice. "During the years 1799 and 1800, vaccine inoculation was performed by ten or twelve thousand persons who had never seen the vaccine pustule." (Dr. Willan.) Now, under these circumstances, we cannot help agreeing with this author that it is rather matter of surprise that the number of unsuccessful cases has proved so comparatively small.

Here it is material to observe, that the majority of those examples which have been brought forward as examples of variolous, after vaccine disease, have been attended with so much irregularity, that they cannot be considered as genuine cases of small pox. This, we think, has been rendered evident by the very able and dispassionate examination of Dr. Willan on the progress and termination of the most formidable of such cases as have occurred in and about the metropolis.

But let it be granted to the opposer of vaccination, that several instances have been presented of perfect and regular small pox subsequent to the vaccine disease, equally genuine and regular, "yet still the Jennerian practice must maintain its ground triumphantly, if it can be shewn to be *as effectual* a preventive of small pox as the old inoculation. Now we think it has been demonstrated beyond the possibility of contradiction, that the number of authenticated cases of small pox after the old inoculation, and even after a former attack of the natural disease, are more numerous in proportion than those that are alleged with any probability of such an occurrence after complete vaccination." The writer of the article from which we have extracted the above observations, goes on to say: "On the whole, we think there are not fewer than twenty distinct cases of small pox, occurring a second time in the same subject, each of them authenticated far more completely than any one that has been cited by the adversaries of vaccination. We are persuaded, indeed, that we shall be supported by every impartial person who makes himself master of the whole evidence, in saying, that there are not so many as ten cases of small pox, after perfect vaccination, proved in such a way as to be entitled to any sort of attention. Now the medical council, consisting of almost all the great practitioners in London, have reported that 'nearly as many persons have been already vaccinated in this kingdom, as were ever inoculated for the small pox since the first introduction of that practice; so that if the two cases were exactly upon a footing, the risk of failure seems to be at least twice as great in the small-pox inoculation as in that for the cow-pox.' And yet who is there in the present day who thinks for a moment of alleging possible insecurity as an argument against variolous inoculation? It may be instructive to state that this argument was however used against the old at the time of its introduction, and urged much in the same spirit as it now is against the new. Dr. Willan and others, in their respective treatises, have cited many examples of the mode in which the variolous controversy was carried on, a single one of which our limits will only permit us to extract.

"I fear they may be accounted physicians of no value and forgers of lies, who so confidently tell us what it is impossible for them to know, namely, that they who undergo their experiment (the inoculation for small pox) are for ever thereby secured from any future danger of infection." Page 18, Rev. Mr. Massey's sermon against the dangerous and sinful practice of inoculation.

Against the suggestion of Mr. Goldson, that, although the natural cow-pox may secure from variolous infection, the inoculated disease may be more precarious and uncertain, we think it of consequence to notice in the first place, that were the variolous and vaccine inoculation to be judged and compared a priori upon the ground of analogy alone, the latter would have the fairest pretensions to public confidence. The natural and the inoculated cow-pox, we have already said, are ingrafted upon the system in nearly a similar manner; in the instance of variolous infection, this is not the case. Further, the vaccine matter, whether taken directly from the cow, or from the arm of an inoculated person, produces an affection which is not so generally dissimilar as the ingrafted and naturally received small pox; what authority then have we for inferring that the virus undergoes that specific change in the human body, which the theory of Mr. Goldson supposes? If then permanence of security is allowed to the natural (and the admission of this, from a man of such ability and candour as Mr. Goldson, is exceedingly material), we cannot but suppose it repugnant to every principle of analogy, to deny it to the inoculated cow-pox.

It is necessary to remark, that the cases which have been collected and recorded, do by no means serve to strengthen the suspicion of immunity for a given time; for the utmost irregularity has been shewn, with respect to the period of variolous subsequent to vaccine infection. "The cases," says Dr. Willan, "which I have adduced of variolous eruption, took place without any certain order, from five months to seven years after vaccination. If it is said that the preventive power of the cow-pox ceases in some persons at the end of a month or two, while in others it lasts sixty or seventy years, according to the varieties of constitution, the assertion is too vague to admit of an answer."

The inoculated small pox, when first introduced, was limited like the vaccine; first to two, afterwards to three, and then to four years; but experience has fully established the falsity of these assumptions, and the most determined sceptic no longer talks of temporary immunity from variolous inoculation.

To urge the argument further against the doctrine of partial and limited security, would be, we think, superfluous; unsupported by analogy, and unsustained by fact, it falls mole suâ.

We now proceed to extract from Dr. Willan's treatise the characteristics of perfect, and marks of spurious, vaccination.

"Vaccination," says our author, "is accounted perfect, when recent lymph has been carefully inserted beneath the cuticle, in a person free from any contagious disorder; and has produced a semitransparent pearl-coloured vesicle, which, after the ninth day, is surrounded by a red areola, and afterwards terminates in a hard dark-coloured scab. The form and structure of this vesicle are peculiar; its base is circular, or somewhat oval, with a diameter of about four lines on the tenth day. Till the end of the eighth day, its upper surface is uneven, being considerably more elevated at the margin than about the centre, and sometimes indented by one or two concentric furrows; but on the ninth or tenth day, the surface becomes plane, and in a very few instances, the central part is highest. The margin is turgid, firm, shining, and rounded so as often to extend a little beyond the line of the base.

"The vesicle consists internally of numerous little cells, filled with clear lymph, and communicating with each other. The areola, which is formed round the vesicle, is of an intense red colour. Its diameter differs in different persons, from a quarter of an inch to two inches, and it is usually attended with a considerable tumour and hardness of the adjoining cellular membrane. On the eleventh and twelfth day, as the areola declines, the surface of the vesicle becomes brown in the centre, and less clear at the margins. The cuticle then begins to separate, and the fluid in the cells gradually concretes into a hard rounded scab of a reddish-brown colour. The scab becomes at length black, contracted, and dry, but it is not detached until after the twentieth day from the inoculation. It leaves a permanent circular cicatrix, about five lines in diameter, and a little depressed, the surface being marked with very minute pits or indentations, denoting the number of cells, of which the vesicle has been composed."

Such are the general characteristics of perfect vaccination. "Imperfect vaccination is not characterised by any uniform sign or criterion, but exhibits in different cases very different appearances, as pustules, ulcerations, or vesicles of an irregular form. The vaccine pustule is conoidal; it increases rapidly from the second to the fifth or sixth day, when it is raised on a hard inflamed base, with diffuse redness extending beyond it on the skin. It is usually broken before the end of the sixth day, and is soon after succeeded by an irregular yellowish-brown scab. The redness disappears in a day or two, and the tumour gradually subsides.

"Vaccination is imperfect or insufficient, 1. When the fluid employed has lost some of its original properties. 2. When the persons inoculated were soon afterwards affected with any contagious fever. 3. When they are affected at the time of inoculation, with some chronic cutaneous disorders.

"1. The qualities of the vaccine fluid are altered, soon after the appearance of an inflamed areola round the vesicle; and the fluid, although taken out of a vesicle in the best possible state, may be injured by heat, exposure to air, rust, moisture, and other causes.

"When scales are formed over variolous pustules, and vaccine vesicles, the matter they afford is often acrid and putrescent; and if inoculated, it perhaps neither communicates the vaccine pock nor the small pox, but produces a fatal disease, with symptoms similar to those which arise from slight wounds received in dissecting putrid bodies. Should the pustules remain entire till the twentieth day of eruption, matter taken from them, even at that period, will sometimes communicate the disease in its usual form, though perhaps with considerable virulence. We are, however, now assured on good authority, that matter improperly kept, or the thick matter from collapsed and scabbing variolous pustules, and used for the purpose of inoculation, does not always produce the small pox, nor prevent the future occurrence of that disease, although the persons inoculated may have had inflammation and suppuration of the arm, and pains in the axilla, with fever and eruptions on the ninth or tenth day. In like manner, if the vaccine fluid employed is taken at a late period, as from the twelfth to the eighteenth day, it does not always produce the genuine cellular vesicle, but is in some cases wholly inefficient, while in others it suddenly excites a pustule or ulceration, in others an irregular vesicle, and in others erysipelas. Failures may have been occasioned by repeatedly puncturing or draining the vesicle, on two or three successive days.

"2. Eruptive fevers, and other febrile diseases, interfere with the progress of the vaccine vesicle. The measles, scarlatina, varicella, typhus, and influenza, appearing soon after vaccination, either render it ineffective, or suspend the action of the virus.

"3. The cutaneous diseases which sometimes impede the formation of the genuine vaccine vesicle, are herpes (including the shingles, and vesicular ring-worm), the dry and the humid tetter, and the lichen; but especially the porrigo (or tinea), comprising the varieties denominated crusta-lactea, area, achores, and favi, all of which are contagious. To these should perhaps be added the itch and prurigo."

"The right inference," our author in another part of his treatise observes, "from the mistakes or failures, and from the nicety of vaccine inoculation, is, that those only should be inoculators, who have had a sufficient education, and who have particularly attended to the subject of vaccination." Dr. Willan then goes on to enforce the propriety of a strict examination, and in dubious cases a reinoculation, of those persons especially who were inoculated between the 1st of January, 1799, and the 1st of January, 1802.

We are under the necessity of stating, that in the present article we have appealed principally to the authority of Dr. Willan, not merely on account of the intrinsic and universally acknowledged value of such authority; but because this gentleman, being neither an inoculator nor a partisan, cannot fail to be acquitted even by those who are least disposed to liberality of sentiment, of being in any measure influenced by the motives charged upon vaccinators in the following sentences, which, the reader will be surprised to find, are the composition of a learned, sagacious, and most respectable physician:

"The cow-pox inoculators who have been principals, reproach one another as not having the genuine matter, or skilful management, of vaccination; each says his brother-labourers in the same vineyard are wrong. If the small pox happens after Peter's operation, James, Paul, and John, are not at all surprised; if from James, Paul, or John, disasters happen, Peter says it is what he expected. Each pretends to some superior mystery over his brother-vaccinator. Each leader seems to say,—Come to my shop; this is the only true booth in the fair: that the new one—this is the only true one." (Dr. Moseley.)

It would be unjust to conclude without admitting the only shadow of justification, which such language can claim; namely, the equal and perhaps prior interference of medical writers, on the opposite side of the question. We cannot forget the mode in which Mr. Goldson's first candid and dispassionate inquiry into the merits of vaccination, was replied to by some of the vaccinators. Surely party rancour ought at least to be excluded from this subject of universal interest.

VACCINIUM, the WHORTLE-BERRY, or BILBERRY, a genus of plants of the class octandria, and order monogynia; and arranged in the natural system under the 18th order, bicornes. The calyx is superior; the corolla monopetalous: the filaments inserted into the receptacle; the berry quadrilocular and polyspermous. There are 27 species, the most remarkable of which are: 1. The myrtilus, black-whorts, whortle-berries, or bilberries, growing in woods and on heaths abundantly. The flowers frequently vary, with five segments at the rim, and with ten stamina. The berries when ripe are of a bluish-black colour, but a singular variety, with white berries, was discovered by the duke of Athol, growing in the woods about mid-way between his two seats of Dunkeld and Blair. The berries have an astringent quality. In Arran and the Western Isles they are given in diarrhœas and dysenteries with good effect. The Highlanders frequently eat them in milk, which is a cooling agreeable food; and sometimes they make them into tarts and jellies, which last they mix with whisky, to give it a relish to strangers. They dye a violet-colour; but it requires to be fixed with alum. The grouse feed upon them in the autumn. 2. The uliginosum, or great bilberry-bush, is found in low moist grounds, and almost at the summits of the Highland mountains. The leaves are full of veins, smooth and glaucous, especially on the under side; the berries are eatable, but not so much esteemed as the preceding; as they are apt, if eaten in any quantity, to give the head-ache. 3. The vitis idæa, or red whortle-berries, frequent in dry places, in heaths, woods, and on mountains. The berries have an acid cooling quality, useful to quench the thirst in fevers. The Swedes are very fond of them made into the form of a rob or jelly, which they eat with their meat as an agreeable acid, proper to correct the animal alkali. 4. The oxycoccus, cranberries, moss-berries, or moor-berries, frequent on peat-bogs. The stalks are long, slender, woody, weak, and trailing; the leaves are stiff, acutely oval, glaucous underneath, their edges turned back, and growing alternate; two or three flowers grow singly on long red footstalks out of the extremity of the branches; the flowers are red, divided deeply into four acute segments, which are reflexed quite backwards; the filaments are downy; the antheræ ferruginous, and longer than the filaments; the berries red, and about the size of the hawthorn-berries. At Long-town, on the borders of Cumberland, they are made so considerable an article of commerce, that at the season when they are ripe, not less than 20*l.* or 30*l.*'s worth are sold by the poor people each market-day for five or six weeks together, which are afterwards dispersed over different parts of the kingdom for making the well-known cranberry-tarts.

VAGINA. See ANATOMY.

VAGINALIS, a genus of birds of the order grallæ: the generic character is, bill strong, thick, conic-convex, compressed; the upper mandible covered above with a moveable horny sheath; nostrils small, placed before the sheath; tongue above round, beneath flattened, pointed at the tip; face naked, papillous; wings with an obtuse excrescence under the flexure; legs strong, four-toed, naked a little above the knees; toes rough beneath, claws grooved. There is but a single species, which inhabits New Zealand and the South Sea islands, from 15 to 18 inches long, and feeding on shell-fish.

VAGRANTS are divided into three classes: 1st. Idle and disorderly persons. These, as described by the vagrant-act, consist of those who threaten to run away and leave their wives and children to the parish. All persons returning to a parish whence they have been legally removed, without bringing a certificate from the parish to which they belong. All who, not having wherewith to maintain themselves, refuse to work. All who beg alms from door to door, or in the streets and highways. Likewise those who, not using proper means to get employment, or possessing ability to work, refuse to do it; or spend money in alehouses, or in any improper manner; and by not employing a proper proportion of their earnings towards the maintenance of their families, suffer them to become chargeable to the parish. The punishment for these offences is a commitment to the house of correction, and hard labour, for any definite time not exceeding a month; the time must be set forth in the warrant of commitment, which must al o shew the authority of the person committing. The commitment must be in execution, that is to say, for punishment; and being so, the justice must make a record of the conviction, and transmit the same to the sessions. Any person may apprehend and carry such persons before a magistrate; and if they resist or escape, they shall be punished as rogues and vagabonds: the reward for such apprehension is 5*s.*, to be paid by the overseer of the parish.

2. Rogues and vagabonds. No infant under the age of seven years can be called a rogue and vagabond, but shall be removed to its place of settlement, like other paupers.

The following is a list of those who are deemed rogues and vagabonds: All persons gathering alms under pretended losses; persons going about as collectors for prisons or hospitals; fencers; bearwards; common players not legally authorised; minstrels; jugglers; real or pretended gypsies; fortune-tellers; any persons using any subtle craft to impose upon any of his majesty's subjects, or playing at unlawful games, or any who have run away and left their wives and children a charge to the parish; all petty chapmen and pedlars not authorised by law; all persons not giving a good account of themselves; all beggars pretending to be soldiers or seamen, or pretending to go to work in harvest; or illegal dealers in lottery tickets and shares. And all other persons wandering abroad and begging, shall be deemed rogues and vagabonds; the reward for apprehending such persons is 10*s.*, to be paid by the high constable, on an order from the justice. There is a penalty of 10*s.* on a constable who refuses or neglects to apprehend them.

3. Incorrigible rogues, are all end-gatherers, offending against the stat. 13 Geo.; which is collecting, buying, receiving, or carrying, any ends of yarn, wefts, thrums, short yarn, or other refuse of cloth or woollen goods. All persons apprehended as rogues and vagabonds, and escaping, or refusing to go before a justice, or refusing to be conducted by the pass, or giving a false account of themselves on examination, after warning. All rogues or vagabonds escaping from the house of correction before the expiration of the time of their commitment; and all who have been punished as rogues and vagabonds, and repeat the offence.

There is by 17 Geo. II. c. 25, a privy search appointed; and the justices or two of them four times a year at least meet, and command the constables of every ward or parish, properly assisted, to make a general search in one night, and cause all vagrants that shall be found on such search to be brought before a justice; and two justices, in case such person is charged as a vagrant, or on suspicion of felony, may examine him; and if he cannot shew some lawful way of getting his livelihood, or procure bail for his reappearance, may commit him for a certain time not exceeding six days; and if, after advertising his person, and any thing about him suspected to be stolen, no accusation is brought, he shall be discharged or dealt with according to law. All rogues and vagabonds are examined upon oath as to their parish, and the written examination signed by them and the justice, and transmitted to the sessions.

The punishment is public whipping, or confinement to the house of correction till the next sessions, or any less time; and if at the sessions the court adjudge such person a rogue and vagabond, or an incorrigible rogue, they may order such rogue or vagabond to the house of correction and hard labour for six months, or such incorrigible rogue for not less than six months or more than two years, and during his confinement to be whipped as they shall think fit. And if such rogue or vagabond is a male above 12 years old, the court may, after his confinement, send him to be employed in his majesty's service: and if such incorrigible rogue shall make his escape, or offend a second time, he shall be transported for seven years. After such whipping or confinement, the justice may, by a pass under his hand (of which a duplicate shall be filed at the next sessions), cause him to be conveyed to the place of his last legal residence, and if that cannot be found, to the place of his birth; and if they are under fourteen years of age, and have parents living, then to the place of their abode; and the parish to which the vagrant shall be conveyed, shall employ him in some workhouse till he gets some employment; and if he refuses to work, he shall be sent to the house of correction and hard labour.

The general tenor of the laws respecting vagrants, is extremely severe, and very justly so; and it is the duty of every justice of the peace to keep his district free from this class, as they are great burthens to the parish, and very difficult to be removed. For the best account of the vagrant-act, vide Burn's Justice, vol. 4, article Vagrant.

VAHLIA, a genus of plants of the class and order pentandria digynia. The calyx is five-leaved; corolla five-petalled; capsule inferior, one-celled, many-seeded. There is one species, a herb of the Cape.

VALANTIA, a genus of plants in the order monœcia, of the class polygamia, and in the natural system arranged under the 41st order, the asperifoliæ. There is scarcely any calyx; the corolla is monopetalous, flat, four-parted; the stamina four, with small antheræ; the hermaphrodite flowers have a pistillum with a large germen, a bifid style the length of the calyx, and one seed; the pistilla of the male flowers are hardly discernible. There are 9 species, only one of which is a native of Britain, the cruciata; the stalks of which are square, the whole plant hairy, the leaves oval and verticillate, four in a whorl; the flowers are yellow, and grow on short peduncles out of the alæ of the leaves. The roots, like those of the galium, to which it is nearly related, will dye red. It is astringent, and was once used as a vulnerary.

VALENTINIANS, in church history, a sect of christian heretics, who sprung up in the second century, and were so called from their leader Valentinus. The valentinians were only a branch of the gnostics, who realized or personified the Platonic ideas concerning the Deity, whom they called Pleroma, or plenitude. Their system was this: the first principle is Bythos, *i.e.* depth, which remained many ages unknown, having with it Ennoe, or thought, and Sige, or silence; from these sprung the Nous, or intelligence, which is the only son, equal to, and alone capable of comprehending, the Bythos; the sister of Nous they called Aletheia, or truth; and these constituted the first quaternity of æons, which were the source and original of all the rest; for Nous and Aletheia produced the world and life, and from these two proceeded man and the church. But besides these eight principal æons, there were twenty-two more, the last of which, called Sophia, being desirous to arrive at the knowledge of Bythos, gave herself a great deal of uneasiness, which created in her anger and fear, of which was born matter. But the Horos, or bounder, stopped her, preserved her in the Pleroma, and restored her to perfection. Sophia then produced the Christ and the Holy Spirit, which brought the æons to their last perfection, and made every one of them contribute their utmost to form the Saviour. Her Enthymese, or thought, dwelling near the Pleroma, perfected by the Christ, produced every thing that is in the world, by its divers passions. The Christ sent into it the Saviour, accompanied with angels, who delivered it from its passions, without annihilating it; and thence was formed corporeal matter.

VALERIANA, a genus of plants, of the class triandria and order monogynia, and in the natural system arranged under the 48th order, aggregatæ. There is hardly any calyx; the corolla is monopetalous, gibbous at the base, situated above the germen; there is only one seed. There are 31 species, only four of which are natives of Britain, the officinalis, the olitoria, the rubra, and the dioica; of these only the officinalis is useful. The root of this plant is perennial; the stalk is upright, smooth, channelled, round, branched, and rises from two to four feet in height; the leaves on the stem are placed in pairs upon short broad sheaths; they are composed of several lance-shaped, partially dentated, veined, smooth pinnæ, with an odd one at the end, which is the largest; the floral leaves are spear-shaped and pointed; the flowers are small, of a white or purplish colour, and terminate the stem and branches in large bunches. It flowers in June, and commonly grows about hedges and woods.

It is supposed to be the φυ of Dioscorides and Galen, by whom it is mentioned as an aromatic and diuretic: it was first brought into estimation in convulsive affections by Fabius Columna, who relates that he cured himself of an epilepsy by the root of this plant; we are told, however, that Columna suffered a relapse of the disorder; and no further accounts of the efficacy of valerian in epilepsy followed till those published by Dominicus Panarolus fifty years afterwards, in which three cases of its success are given.

The advantages said to be derived from this root in epilepsy, caused it to be tried in several other complaints termed nervous, particularly those produced by increased mobility and irritability of the nervous system, in which it has been found highly serviceable. Bergius states its virtues to be antispasmodic, diaphoretic, emmenagogue, diuretic, anthelmintic. The root in substance is most effectual, and is usually given in powder from a scruple to a drachm; its unpleasant flavour may be concealed by a small addition of mace. A tincture of valerian in proof spirit and in volatile spirit is ordered in the London Pharmacopœia. Cats are very fond of the smell of this root, and seem to be intoxicated by it.

VALLISNERIA, in botany, a genus of the diœcia diandria class of plants, with a monopetalous tripartite flower; its fruit is a long, cylindraceous, and unilocular capsule, containing numerous oval seeds. There are two species.

VALVE, in hydraulics, pneumatics, &c. is a kind of lid or cover to a tube, vessel, or orifice, contrived to open one way; but which, the more forcibly it is pressed the other way, the closer it shuts the aperture, like the clapper of a bellows: so that it either admits the entrance of a fluid into the tube, or vessel, and prevents its return; or permits it to escape, and prevents its re-entrance.

Valves are of great use in the air-pump, and other wind-machines; in which they are usually made of pieces of bladder. In hydraulic engines, as the emboli or suckers of pumps, they are mostly of strong leather, of a round figure, and fitted to shut the apertures of the barrels or pipes. Sometimes they are made of two round pieces of leather enclosed between two others of brass; having divers perforations, which are covered with another piece of brass, moveable upwards and downwards, on a kind of axis, which goes through the middle of them all. Sometimes they are made of brass, covered over with leather, and furnished with a fine spring, which gives way upon a force applied against it; but upon the ceasing of that, returns the valve over the aperture. See Pump, and Hydrostatics.

Valve, in anatomy, a thin membrane applied on several cavities and vessels of the body, to afford a passage to certain humours going one way, and prevent their reflux towards the place whence they came.

VAN, Vant, or Vaunt, a term derived from the French avant, or avaunt, signifying before, or foremost of any thing; thus we say, the van-guard of an army, &c.

Van, in sea-language, denotes the foremost division of any naval armament, or the part that usually leads the way to battle, or advances first in the order of sailing.

VANDELLIA, a genus of plants of the class didynamia and order angiospermia. The calyx is quadrifid; the corolla ringent; the two exterior filaments proceed from the disc of the lip of the corolla; the antheræ are connected; the capsule is unilocular and polyspermous. There are only two species known, the diffusa and pratensis.

VANE, in a ship, &c. a thin slip of some kind of matter, placed on high in the open air, turning easily round on an axis or spindle, and veered about by the wind, to shew its direction or course.

Vanes, in mathematical or philosophical instruments, are sights made to slide and move upon cross-staves, fore-staves, quadrants, &c.

VANGNESIA, a genus of plants of the class and order pentandria monogynia. The calyx is five-toothed; corolla, tube globular, with a hairy throat; stigma bilamellate; berry inferior, four or five-seeded. There is one species, a tree of China.

VANILLA. See Epidendrum.

VAPOUR. See Evaporation, and Fluidity.

VARIABLE, in geometry and analytics, is a term applied by mathematicians to such quantities as are considered in a variable or changeable state, either increasing or decreasing. Thus the abscisses and ordinates of an ellipsis, or other curve line, are variable quantities; because they vary or change their magnitude together, the one at the same time with the other. But some quantities may be variable by themselves alone, or while those connected with them are constant; as the abscisses of a parallelogram, whose ordinates may be considered as all equal, and therefore constant. Also the diameter of a circle, and the parameter of a conic section, are constant, while their abscisses are variable.

Variable quantities are usually denoted by the last letters of the alphabet, z, y, x, &c.; while the constant ones are denoted by the leading letters, a, b, c, &c.

Some authors, instead of variable and constant quantities, use the terms fluent and stable quantities.

The indefinitely small quantity by which a variable quantity is continually increased or decreased in very small portions of time, is called the differential, or increment or decrement. And the rate of its increase or decrease at any point, is called its fluxion; while the variable quantity itself is called the fluent. And the calculation of these, is the subject of the new methodus differentialis, or doctrine of fluxions.

VARIANCE, in law, signifies any alteration of a thing formerly laid in a plea; or where the declaration in a cause differs from the writ, or from the deed upon which it is grounded. 2 Lit. Abr. 629.

If there is a variance between the declaration and the writ, it is error, and the writ shall abate. And if there appears to be a material variance between the matter pleaded, and the manner of pleading it, this is not a good plea; for the manner and matter of pleading ought to agree in substance, or there will be no certainty in it. Cro. Jac. 479.

VARIATION, in geography and navigation, is the deviation of the magnetical needle, in the mariner's compass, from the true north point, towards either the east or west; or it is an arch of the horizon, intercepted between the meridian of the place of observation and the magnetic meridian. See MAGNETISM.

VARIATION, in astronomy. The variation of the moon, called by Bulliald the reflection of her light, is the third inequality observed in the moon's motion; by which, when out of the quadratures, her true place differs from her place twice equated. See ASTRONOMY.

Newton makes the moon's variation to arise partly from the form of her orbit, which is an ellipsis; and partly from the inequality of the spaces which the moon describes in equal times, by a radius drawn to the earth.

To find the greatest variation. Observe the moon's longitude in the octants; and to the time of observation compute the moon's place twice equated; then the difference between the computed and observed place, is the greatest variation.

Tycho makes the greatest variation 40′ 30″; and Kepler makes it 51′ 49″. But Newton makes the greatest variation, at a mean distance between the sun and the earth, to be 35′ 10″; at the other distances, the greatest variation is in a ratio compounded of the duplicate ratio of the times of the moon's synodical revolution directly, and the triplicate ratio of the distance of the sun from the earth inversely. And therefore in the sun's apogee, the greatest variation is 33′ 14″, and in his perigee 37′ 11″; provided that the eccentricity of the sun is to the transverse semidiameter of the orbis magnus, as 16 $\frac{15}{16}$ to 1000. Or, taking the mean motions of the moon from the sun, as they are stated in Dr. Halley's tables, then the greatest variation at the mean distance of the earth from the sun will be 35′ 7″, in the apogee of the sun 33′ 27″, and in his perigee 36′ 51″.

VARIATION *of curvature*, in geometry, is used for that inequality or change which takes place in the curvature of all curves except the circle, by which their curvature is more or less in different parts of them. And this variation constitutes the quality of the curvature of any line.

Sir Isaac Newton makes the index of the inequality, or variation of curvature, to be the ratio of the fluxion of the radius of curvature to the fluxion of the curve itself: and Maclaurin, to avoid the perplexity that different notions, connected with the same terms, occasions to learners, has adopted the same definition; but he suggests, that this ratio gives rather the variation of the ray of curvature, and that it might have been proper to have measured the variation of curvature rather by the ratio of the fluxion of the curvature itself to the fluxion of the curve; so that, the curvature being inversely as the radius of curvature, and consequently its fluxion as the fluxion of the radius itself directly, and the square of the radius inversely, its variation would have been directly as the measure of it according to Newton's definition, and inversely as the square of the radius of curvature.

According to this notion, it would have been measured by the angle of contact contained by the curve and circle of curvature, in the same manner as the curvature itself is measured by the angle of contact contained by the curve and tangent. The reason of this remark may appear from this example: The variation of curvature, according to Newton's explication, is uniform in the logarithmic spiral, the fluxion of the radius of curvature in this figure being always in the same ratio to the fluxion of the curve; and yet, while the spiral is produced, though its curvature decreases, it never vanishes; which must appear a strange paradox to those who do not attend to the import of sir Isaac Newton's definition.

The variation of curvature at any point of a conic section, is always as the tangent of the angle contained by the diameter that passes through the point of contact, and the perpendicular to the curve at the same point; or to the angle formed by the diameter of the section, and of the circle of curvature. Hence the variation of curvature vanishes at the extremities of either axis, and is greatest when the acute angle, contained by the diameter passing through the point of contact and the tangent, is least.

When the conic section is a parabola, the variation is as the tangent of the angle, contained by the right line drawn from the point of contact to the focus, and the perpendicular to the curve. See CURVATURE.

From sir Isaac Newton's definition may be derived practical rules for the variation of curvature, as follows:

1. Find the radius of curvature, or rather its fluxion: then divide this fluxion by the fluxion of the curve, and the quotient will give the variation of curvature; exterminating the fluxions when necessary, by the equation of the curve, or perhaps by expressing their ratio by help of the tangent, or ordinate, or subnormal, &c.

2. Since $\frac{\dot{z}^3}{-\dot{x}\ddot{y}}$, or $\frac{\dot{z}^3}{-\ddot{y}}$ (putting $\dot{x}=1$) denotes the radius of curvature of any curve z, whose absciss is x, and ordinate y, if the fluxion of this is divided by $\dot{z}$, and $\dot{z}$ and $\ddot{z}$ are exterminated, the general value of the variation will come out $\frac{-3\dot{y}\ddot{y}^2+\dddot{y}(1+\dot{y}^2)}{\ddot{y}^2}$; then, substituting the values of $\dot{y}$, $\ddot{y}$, $\dddot{y}$ (found from the equation of the curve) into this quantity, it will give the variation sought.

Ex. Let the curve be the parabola, whose equation is $ax=y^2$. Here then $2y\dot{y}=a\dot{x}=a$, and $\dot{y}=\frac{a}{2y}$; hence $\ddot{y}=\frac{-a\dot{y}}{2yy}=\frac{-aa}{4y^3}$, and $\dddot{y}=\frac{-3aa\dot{y}}{2y^4}=\frac{3a^3}{8y^5}$. Therefore

$$\frac{-3\dot{y}\ddot{y}^2+\dddot{y}(1+\dot{y}^2)}{\ddot{y}^2}=-3\dot{y}+\dddot{y}\times\frac{1+\dot{y}^2}{\ddot{y}^2}$$

$$=\frac{-3a}{2y}+\frac{3a^3}{8y^5}\times\left(1+\frac{aa}{4yy}\right)\times\frac{16y^6}{a^4}=\frac{6y}{a},$$

the variation sought.

VARIOLÆ, the small-pox, in medicine. See MEDICINE, and VACCINATION.

VARNISH, a thick, viscid, shining liquor, used by painters, gilders, and various other artificers, to give a gloss and lustre to their works; as also to defend them from the weather, dust, &c. See RESINS.

A coat of varnish ought to possess the following properties: 1. It must exclude the action of the air; because wood and metals are varnished to defend them from decay and rust. 2. It must resist water; for otherwise the effect of the varnish could not be permanent. 3. It ought not to alter such colours as are intended to be preserved by this means. It is necessary, therefore, that a varnish should be easily extended or spread over the surface, without leaving pores or cavities, that it should not crack or scale, and that it should resist water.

Resins are the only bodies that possess these properties, consequently they must form the basis of every varnish. For this purpose, they must be dissolved, as minutely divided as possible, and combined in such a manner, that the imperfections of those that might be disposed to scale, may be corrected by others.

Resins may be dissolved by three agents: 1. by fixed, or fat oil; 2. by volatile, or essential oil; 3. by spirit of wine. Accordingly we have three kinds of varnish; fat or oily varnish, essential oil varnish, and spirit varnish.

These agents are of such a nature as either to dry up and become hard, or to evaporate and fly off, leaving the resin fixed behind.

Varnishes should be carefully kept from dust, and in very clean vessels; they should be laid as thin and even as possible with a large flat brush, taking care to lay the strokes all one way. A warm room is best for varnishing in, as cold chills the varnish, and prevents it from lying even.

Varnishes are polished with pumice-stone and tripoli. The pumice-stone must be reduced to a very fine powder, and put upon a piece of serge moistened with water; with this the varnished substance is to be rubbed equally and lightly. The tripoli must also be reduced to a fine powder, and put upon a clean woollen cloth moistened with olive-oil, with which the polishing is to be performed. The varnish is then to be wiped with soft linen, and, when quite dry, cleaned with starch, or Spanish white, and rubbed with the palm of the hand, or with a linen cloth.

Fat oil varnish. Fixed, or fat oil, will not evaporate; nor will it become dry of itself. To make it dry, it must be boiled with metallic calces or oxides. Litharge is generally used for this purpose. Oil so prepared is called drying-oil. To accelerate the drying of oil varnish, oil of turpentine is added.

Gum-copal, and amber, are the substances principally employed in oil varnishes; the copal being whitest, is used for varnishing light; the amber for dark colours.

It is best to dissolve them before mixing them with the oil; because, by this means, they are in less danger of being scorched, and at the same time the varnish is more beautiful. They should be melted in an iron pot over the fire; they are in a proper state for receiving the oil when they give no resistance to the iron spatula, and when they run off from it drop by drop.

To make oil varnish, pour four, six, or eight ounces of drying-oil among sixteen ounces of melted copal, or amber, by little and little, constantly stirring the ingredients at the same time with the spatula. When the oil is well mixed with the copal or amber, take it off the fire; and when it is pretty cool, pour in sixteen ounces of the essence of Venice turpentine. After the varnish is made, it should be passed through a linen cloth.

Oil varnishes become thick by keeping; but when they are to be used, it is only necessary to pour in a little Venice-turpentine, and to put them a little on the fire. Less turpentine is necessary in summer than in winter; too much oil hinders the varnish from drying; but when too little is used, it cracks, and does not spread properly.

Black varnishes for coaches and iron-work. This varnish is composed of asphaltum, resin, and amber, melted separately, and afterwards mixed; the oil is then added, and afterwards the turpentine, as directed above. The usual proportions are, twelve ounces of amber, two of resin, two of asphaltum, six of oil, and twelve of turpentine.

A varnish for rendering silk water and air-tight. To render the linseed-oil drying, boil it with two ounces of sugar of lead, and three ounces of litharge, for every pint of oil, till the oil has dissolved them; then put a pound of birdlime, and half a pint of the drying-oil, into a pot of iron or copper, holding about a gallon; and let it boil gently over a slow charcoal fire, till the birdlime ceases to crackle; then pour upon it two pints and a half of drying-oil, and boil it for about an hour longer, stirring it often with an iron or wooden spatula. As the varnish, in boiling, swells much, the pot should be removed from the fire, and replaced when the varnish subsides. While it is boiling, it should be occasionally examined, in order to determine whether it has boiled enough. For this purpose, take some of it upon the blade of a large knife, and after rubbing the blade of another knife upon it, separate the knives; and when, on their separation, the varnish begins to form threads between the two knives, it has boiled enough, and should be removed from the fire. When it is almost cold, add about an equal quantity of spirit of turpentine; mix both well together, and let the mass rest till the next day; then, having warmed it a little, strain and bottle it. If it is too thick, add spirit of turpentine. This varnish should be laid upon the stuff when perfectly dry, in a lukewarm state; a thin coat of it upon one side, and, about twelve hours after, two other coats should be laid on, one on each side; and in 24 hours the silk may be used.

Mr. Blanchard's varnish for air-balloons. Dissolve elastic gum (caoutchouc, or Indian rubber), cut small, in five times its weight of spirit of turpentine, by keeping them some days together; then boil one ounce of this solution in eight ounces of drying linseed-oil for a few minutes, and strain it. Use it warm.

Essential oil varnish. The essential varnishes consist of a solution of resin in oil of turpentine, or other essential oil. This varnish being applied, the turpentine evaporates, leaving the resin behind. They are commonly used for pictures.

Spirit varnishes. When resins are dissolved in alcohol, commonly called spirit of wine, the varnish dries very speedily, but is subject to crack. This fault is corrected by adding a small quantity of oil of turpentine, which renders it brighter, and less brittle when dry.

To dissolve gum-copal in spirit of wine. Dissolve half an ounce of camphor in a pint of alcohol, or spirit of wine; put it into a circulating glass, and add four ounces of copal in small pieces; set it in a sand-heat so regulated, that the bubbles may be counted as they rise from the bottom; and continue the same heat till the solution is completed.

Camphor acts more powerfully upon copal than any other substance. If copal is finely powdered, and a small quantity of dry camphor rubbed with it in the mortar, the whole becomes in a few minutes a tough coherent mass. The process above described will dissolve more copal than the menstruum will retain when cold. The most economical method will therefore be, to set the vessel which contains the solution by for a few days; and when it is perfectly settled, pour off the clear varnish, and leave the residuum for a future operation.

This is a very bright solution of copal; it is an excellent varnish for pictures, and may perhaps be found to be an improvement in fine japan works; as the stoves used in drying those articles may drive off the camphor entirely, and leave the copal pure and colourless upon the work.

A varnish for wainscot, cane-chairs, &c. Dissolve in a quart of spirit of wine, eight ounces of gum-sandarach, two ounces of seed-lac, and four ounces of resin; then add six ounces of Venice turpentine. If the varnish is to produce a red colour, more of the lac and less of sandarach should be used, and a little dragon's-blood should be added. This varnish is very strong.

A varnish for toilet-boxes, cases, fans, &c. Dissolve two ounces of gum-mastich, and eight ounces of gum-sandarach, in a quart of alcohol: then add four ounces of Venice-turpentine.

A varnish for violins, and other musical instruments. Put four ounces of gum-sandarach, two ounces of lac, two ounces of gum-mastich, an ounce of gum-elemi, into a quart of alcohol, and hang them over a slow fire till they are dissolved; then add two ounces of turpentine.

Varnish for employing vermilion for painting equipages. Dissolve in a quart of alcohol six ounces of sandarach, three ounces of gum-lac, and four ounces of resin; afterwards add six ounces of the cheapest kind of turpentine; mix it with a proper quantity of vermilion when it is to be used.

Seed-lac varnish. Take spirit of wine, one quart; put it in a wide-mouthed bottle; add to it eight ounces of seed-lac, that is large-grained, bright, and clear, free from dirt and sticks; let it stand two days, or longer, in a warm place, often shaking it. Strain it through a flannel into another bottle, and it is fit for use.

Shell-lac varnish. Take one quart of spirit of wine, eight ounces of the thinnest and most transparent shell-lac, which, if melted in the flame of a candle, will draw out in the longest and finest hair; mix and shake these together, and let them stand in a warm place for two days, and it is ready for use. This varnish is softer than that which is made from seed-lac, and therefore is not so useful; but may be mixed with it for varnishing wood, &c.

White varnish for clock-faces, &c. Take of spirit of wine (highly rectified) one pint, which divide into four parts; then mix one part with half an ounce of gum-mastich, in a phial; one part of spirit, and half an ounce of gum-sandarach, in another phial; one part of spirit, and half an ounce of the whitest parts of gum-benjamin. Then mix and temper them to your mind. It would not be amiss to add a little bit of white resin, or clear Venice-turpentine, in the mastich-bottle; it will assist in giving a gloss. If your varnish proves too strong and thick, add spirit of wine only; if too hard, some dissolved mastich; if too soft, some sandarach or benjamin. No other rule can be given, unless the quality of the gums and the spirit could be ascertained. When you have brought it to a proper temper, warm the silvered plate before the fire, and with a flat camel's-hair pencil, stroke it all over until no white streaks appear.

Varnish, among medallists, signifies the colours antique medals have acquired in the earth.

The beauty which nature alone is able to give to medals, and art has never yet attained to counterfeit, enhances the value of them; that is, the colours, with which certain soils, in which they have a long time lain, tinge the metals; some of which are blue, almost as beautiful as the turquoise; others with an inimitable vermilion colour; others with a certain shining polished brown, vastly finer than Brasil figures.

The most usual varnish is a beautiful green, which hangs to the finest strokes without effacing them, more accurately than the finest enamel does on metals. No metal but brass is susceptible of this; for the green rust that gathers on silver always spoils it, and it must be got off with vinegar or lemon-juice.

Falsifiers of medals have a false or modern varnish, which they use on their counterfeits, to give them the appearance, or air, of being antique. But this may be discovered by its softness, it being softer than the natural varnish, which is as hard as the metal itself. Some deposit their spurious metals in the earth for a considerable time, by which means they contract a sort of varnish, which may impose upon the less knowing; others use sal ammoniac, muriat of ammonia, and others burnt paper.

VARRONIA, a genus of plants of the class and order pentandria monogynia. The corolla is five-cleft; drupe with a four-celled nut. There are nine species, shrubs of the West Indies.

VASSAL, in old law-books, denotes a tenant that held in fee of his lord, to whom he vowed fidelity and service.

VATERIA, a genus of the polyandria monogynia class of plants, the flower of which consists of five oval and patent petals; and its fruit is a turbinated, coriaceous, and unilocular capsule, containing a single oval seed. There is one species.

VATICA, a genus of the dodecandria monogynia class and order of plants. The calyx is five-cleft; petals five; anthers 15, sessile, four-celled. There is one species, a tree of China.

VAULT, in architecture, an arched roof, so contrived that the stones which form it sustain each other. Vaults are, on many occasions, to be preferred to soffits or ceilings, as they give a greater height and elevation, and are besides more firm and durable.

Salmasius observes, that the antients had only three kinds of vaults. The first was the fornix, made cradle-wise; the second a testudo, *i.e.* tortoise-wise, which the French call cul de four, or oven-wise; and the third concha, or trumpet-wise. But the moderns have subdivided these three sorts into many more, to which they have given different names, according to their figures and uses; some of them are circular, and others elliptical.

Again, the sweeps of some are larger, others less, portions of a sphere. All such as are above hemispheres are called high, or surmounted vaults; and all that are less than hemispheres, are called low, or surbased vaults, or testudines.

In some vaults the height is greater than the diameter; in others it is less; others again are quite flat, and only made with haunses; others like ovens, or in the form of a cul de four, &c. and others growing wider as they lengthen, like a trumpet.

Vaults, *master*, are those that cover the principal parts of buildings, in contradistinction to the upper or subordinate vaults, which only cover some little part, as a passage or gate, &c.

Vault, *double*, is one that is built over another, to make the outer decoration range with the inner; or, to make the beauty and decoration of the inside consistent with that of the outside, leaves a space between the concavity of the one and the convexity of the other; instances of which we have in the dome of St. Peter's at Rome, St. Paul's at London, and in that of the Invalids at Paris.

Vaults with compartments, are such whose sweep, or inner face, is enriched with pannels of sculpture, separated by platbands. These compartments, which are of different figures according to the vaults, and usually gilt on a white ground, are made with stone or brick walls, as in the church of St. Peter at Rome, or with plaister on timber vaults.

Vaults, *theory of.* A semicircular arch or vault, standing on two piedroits, or imposts, and all the stones that compose them, being cut, and placed in such manner as that their joints or beds, being prolonged, do all meet in the centre of the vault; it is evident that all the stones must be in the form of wedges, *i. e.* must be wider and bigger at top; by means of which they sustain each other, and mutually oppose the effort of their weight, which determines them to fall. The stone in the middle of the vaults, which stands perpendicular to the horizon, and is called the key of the vault, is sustained on each side by two contiguous stones, just as by two inclined planes; and, consequently, the effort it makes to fall is not equal to its weight. But still that effort is the greater, as the inclined planes are less inclined; so that if they were infinitely little inclined, *i.e.* if they were perpendicular to the horizon as well as the key, it will tend to fall with its whole weight, and would actually fall but for the mortar. The second stone, which is on the right or left of the key-stone, is sustained by a third, which, by virtue of the figure of the vault, is necessarily more inclined to the second than the second is to the first; and consequently the second, in the effort it makes to fall, employs a less part of its weight than the first. For the same reason, the stones from the key-stone employ still a less and less part of their weight to the last; which, resting on a horizontal plane, employs no part of its weight, or, which is the same thing, makes no effort at all, as being entirely supported by the impost. Now, in vaults, a great point to be aimed at is, that all the voussoirs, or key-stones, make an equal effort towards falling. To effect this, it is visible, that as each (reckoning from the key to the impost) employs still a less and less part of its whole weight; the first, for instance, only employing one-half; the second, one third; the third, one-fourth, &c. there is no other way of making those different parts equal, but by a proportionable augmentation of the whole; *i. e.* the second stone must be heavier than the first, the third than the second, &c. to the last; which should be infinitely heavier.

M. De la Hire demonstrates what that proportion is, in which the weight of the stones of a semicircular arch must be increased to be in equilibrio, or to tend with equal forces to fall, which is the firmest disposition a vault can have. The architects before him had no certain rule to conduct themselves by, but did all at random. Reckoning the degrees of the quadrant of a circle, from the key-stone to the impost, the extremity of each stone will take up so much the greater arch as it is farther from the key.

M. De la Hire's rule is, to augment the weight of each stone above that of the key-stone, as much as the tangent of the arch of the stone exceeds the tangent of the arch of half the key. Now the tangent of the last stone of necessity becomes infinite, and of consequence its weight should be so too; but, as infinity has no place in practice, the rule amounts to this, that the last stones should be loaded as much as possible, that they may the better resist the effort which the vault makes to separate them; which is called the shoot or drift of the vault. Mr. Parent has since determined the curve, or figure, which the extrados, or outside of a vault, whose intrados, or inside, is spherical, must have, that all the stones may be in equilibrio.

Vault, *key of*, is a stone or brick in the middle of the vault, in form of a truncated cone, serving to bind or fasten all the rest.

UBIQUITARIANS, in church-history, a sect of heretics who sprung up in Germany about the year 1590, and maintained that the body of Jesus Christ is ubique, every where, or in every place, at the same time. However, they were not quite agreed among themselves; some holding, that the body of Jesus Christ, even during his mortal life, was every where; and others dating the ubiquity of his body from the time of his ascension only.

VECTOR, in astronomy, a line supposed to be drawn from any planet moving round a centre, or the focus of an ellipsis, to that centre or focus.

VEER, a sea-term variously used. Thus veering out a rope, denotes the letting it go by hand, or letting it run of itself. It is not used for letting out any running rope except the sheet.

Veer is also used in reference to the wind; for, when it changes often, they say it veers about.

VEGETATION. See Plants, *physiology of*

VEIN. See Anatomy.

Vein, among miners, is that space which is bounded with woughs, and contains ore, spar, canck, clay, chirt, croil, brownhen, pitcher-chirt, cur, which the philosophers call the mother of metals, and sometimes soil of all colours. When it bears ore, it is called a quick vein; when no ore, a dead vein.

VELEZIA, a genus of the pentandria digynia class and order of plants. The calyx is filiform, five-toothed; corolla five-petalled, small; capsules one-celled; seeds numerous. There is one species.

VELLA, a genus of the tetradynamia siliculosa class of plants, with a tetrapetalous cruciform flower; the stamina are six filaments, about the length of the cup; and the fruit is a globose, cristated, bilocular pod, containing a few roundish seeds. There are two species.

VELVET, a rich kind of stuff, all silk, covered on the outside with a close, short, fine, soft shag, the other side being a very strong close tissue. The nap or shag, called also the velveting, of this stuff, is formed of part of the threads of the warp, which the workman puts on a long narrow-channeled ruler or needle, which he afterwards cuts, by drawing a sharp steel tool along the channel of the needle to the ends of the warp.

There are velvets of various kinds, as Plain, that is, uniform and smooth, without either figures or stripes.

Figured velvet, that is, adorned and worked with divers figures, though the ground is the same with the figures; that is, the whole surface velveted.

Ramaged or branched velvet, representing long stalks, branches, &c. on a satin ground, which is sometimes of the same colour with the velvet, but more usually of a different one. Sometimes, instead of satin, they make the ground of gold and silver; whence the denominations of velvets with gold ground, &c.

Shorn velvet, is that wherein the threads, that make the velveting, have been ranged in the channeled ruler, but not cut there. Striped velvet, is that wherein there are stripes of different colours running along the warp; whether these stripes are partly velvet and partly satin, or all velveted. Cut velvet, is that whereon the ground is a kind of taffety, or gros de tours, and the figures velvet.

Velvets are likewise distinguished, with regard to their different degrees of strength and goodness, into velvets of four threads, three threads, two threads, and a thread and a half. The first are those where there are eight threads of shag, or velveting, to each tooth of the reed; and the second have only six, and the rest four.

In general, all velvets, both worked and cut, shorn and flowered, are to have their warp and shag of organsin, spun and twisted, or thrown in the mill; and their woof of silk well boiled, &c.

VENEERING, Vaneering, or Fineering, a kind of marquetry, or inlaying, whereby several thin slices or leaves of fine woods, of different kinds, are applied and fastened on a ground of some common wood.

There are two kinds of inlaying; the one which is the most common and more ordinary, goes no farther than the making of compartments of different woods; the other requires much more art, in representing flowers, birds, and similar figures.

The first kind is properly called veneering; the latter is more properly called marquetry.

The wood used in veneering is first sawed out into slices or leaves about a line in thickness; *i. e.* the twelfth part of an inch. In order to saw them, the blocks or planks are placed upright, in a kind of sawing-press.

These slices are afterwards cut into narrow slips, and fashioned divers ways, according to the design proposed; then the joints having been exactly and nicely adjusted, and the pieces brought down to their proper thickness with several planes for the purpose, they are glued down on a ground or block, with good strong English glue.

The pieces being thus jointed and glued, the work, if small, is put in a press; if large, it is laid on a bench covered with a board, and pressed down with poles or pieces of wood, one end of which reaches to the ceiling of the room, and the other bears on the board.

When the glue is thoroughly dry, it is taken out of the press, and finished; first with little planes, then with scrapers, some of which resemble rasps, which take off the dents, &c. left by the planes.

After it has been sufficiently scraped, they polish it with the skin of a dog-fish, wax, and a brush, or polisher of shave-grass; which is the last operation.

VENIRE FACIAS, in law, a writ judicial awarded to the sheriff to cause a jury of the neighbourhood to appear, when a cause is brought to issue, to try the same; and if the jury come not at the day of this writ, then there shall go a habeas corpora, and after a distress, till they appear. 2 Haw. 298.

Venire facias, is also the common process upon any presentment, being in nature of a summons for the party to appear; and this is a proper process to be first awarded on an indictment for any crime under the degree of treason, or felony, or maihem, except in such cases wherein other process is directed by statute. And if by the return to such venire, it appears that the party has lands in the county, whereby he may be distrained, then a distress infinite shall be issued from time to time till he appears; but if the sheriff returns that he has no lands in his bailiwick, then upon his non-appearance, a writ of capias shall issue to take his body. 4 Black. 313.

VENTILAGO, a genus of the class and order of plants pentandria monogynia. The calyx is tubular; corolla, scales protecting the stamen, which are inserted in the calyx. There is one species, a shrub of the East Indies.

VENTILATOR, a machine by which the noxious air of any close place, as an hospital, gaol, ship, chamber, &c. may be changed for fresh air.

The noxious qualities of bad air have been long known; and Dr. Hales and others have taken great pains to point out the mischiefs arising from foul air, and to prevent or remedy them. That philosopher proposed an easy and effectual one, by the use of his ventilators; the account of which was read before the Royal Society in May 1741. In mines, ventilators may guard against the suffocations, and other terrible accidents, arising from damps. The air of gaols has often proved infectious; and we had a fatal proof of this, by the accident that happened some years since at the Old Bailey sessions. After that, ventilators were used in the prisons, which were worked by a small windmill, as that placed on the top of Newgate; and the prison became more healthy.

Dr. Hales farther suggests, that ventilators might be of use in making salt; for which purpose there should be a stream of water to work them; or they might be worked by a windmill, and the brine should be in long narrow canals, covered with boards of canvas, about a foot above the surface of the brine, to confine the stream of air, so as to make it act upon the surface of the brine, and carry off the water in vapours. Thus it might be reduced to a dry salt, with a saving of fuel, in winter and summer, or in rainy weather, or any state of the air whatever. Ventilators, he apprehends, might also serve for drying linen hung in low, long, narrow galleries, especially in damp or rainy weather, and also in drying woollen cloths after they are fulled or dyed; and in this case, the ventilators might be worked by the fulling watermill. Ventilators might also be an useful appendage to malt and hop-kilns; and the same author is farther of opinion, that a ventilation of warm dry air from the adjoining stove, with a cautious hand, might be of service to trees and plants in green-houses; where it is well known that air full of rancid vapours which perspire from the plants, is very unkindly to them, as well as the vapours from human bodies are to men; for fresh air is as necessary to the healthy state of vegetables, as of animals. Ventilators are also of excellent use for drying corn, hops, and malt. Gunpowder may be thoroughly dried, by blowing air up through it by means of ventilators; which is of great advantage to the strength of it. These ventilators, even the smaller ones, will also serve to purify most easily, and effectually, the bad air of a ship's well, before a person is sent down into it, by blowing air through a trunk reaching near the bottom of it. And in a similar manner may stinking water, and ill-tasted milk, &c. be sweetened, viz. by passing a current of air through them, from bottom to top, which will carry the offensive particles along with it.

The method of drawing off air from ships by means of fire-pipes, which some have preferred to ventilators, was published by sir Robert Moray, in the Philos. Trans. for 1665. These are metal pipes, about $2\frac{1}{2}$ inches diameter, one of which reaches from the fire-place to the well of the ship, and thre others branches go to other parts of the ship; the stove-hole and ash-hole being closed up, the fire is supplied with air through these pipes.

In the latter part of the year 1741, Mr. Triewald, military architect to the king of Sweden, informed the secretary to the Royal Society, that he had in the preceding spring invented a machine for the use of ships of war, to draw out the foul air from under their decks, which exhausted 36172 cubic feet of air in an hour, or at the rate of 21732 tuns in 24 hours. In 1742 he sent one of these to France, which was approved of by the Academy of Sciences at Paris, and the navy of France was ordered to be furnished with the like ventilators.

There are various ways of ventilation, or changing the air of rooms. Mr. Tidd contrived to admit fresh air into a room, by taking out the middle upper sash pane of glass, and fixing in its place a frame box, with a round hole in its middle, about six or seven inches diameter; in which hole are fixed, behind each other, a set of sails of very thin broad copper-plates, which spread over and cover the circular hole, so as to make the air which enters the room, and turning round these sails, to spread round in thin sheets sideways; and so not to incommode persons by blowing directly upon them, as it would do, if it was not hindered by the sails.

This method however is very unseemly and disagreeable in good rooms; and therefore, instead of it, the late ingenious Mr. John Whitehurst substituted another; which was, to open a small square or rectangular hole in the party-wall of the room, in the upper part near the ceiling, at a corner or part distant from the fire; and before it he placed a thin piece of metal or pasteboard, &c. attached to the wall in its lower part just below the hole, but declining from it upwards, so as to give the air, that enters by the hole, a direction upwards against the ceiling, along which it sweeps and disperses itself through the room, without blowing in a current against any person. This method is very useful to cure smoky chimneys, by thus admitting conveniently fresh air. A picture placed before the hole prevents the sight of it from disfiguring the room. This, and many other methods of ventilating, he meant to have published, and was occupied upon, when death put an end to his useful labours. These since have been published, viz. in 1794, 4to. by Dr. Willan.

VENTRILOQUISM, an art by which certain persons can so modify their voice, as to make it appear to the audience to proceed from any distance, and in any direction. Some faint traces of this art are to be found in the writings of the antients; and it is the opinion of M. De la Chapelle, who in the year 1772 published an ingenious work on the subject, that the responses of many of the oracles were delivered by persons thus qualified, to serve the purposes of delusion. As the antient ventriloquists, when exercising their art, seemed generally to speak from their own bellies, the name by which they were designed was abundantly significant: but it is with no great propriety that modern performers are called ventriloquists, and their art ventriloquism, since they appear more frequently to speak from the pockets of their neighbours, or from the roof or distant corners of the room, than from their own mouths or their own bellies.

From Brodeau, a learned critic of the sixteenth century, we have the following account of the feats of a capital ventriloquist and cheat, who was valet-de-chambre to Francis the First. The fellow, whose name was Louis Brabant, had fallen desperately in love with a young, handsome, and rich heiress; but was rejected by the parents as an unsuitable match for their daughter, on account of the lowness of his circumstances. The young lady's father dying, he made a visit to the widow, who was totally ignorant of his singular talent. Suddenly, on his first appearance in open day, in her own house, and in the presence of several persons who were with her, she heard herself accosted, in a voice perfectly resembling that of her dead husband, and which seemed to proceed from above, exclaiming, "Give my daughter in marriage to Louis Brabant; he is a man of great fortune, and of an excellent character. I now endure the inexpressible torments of purgatory, for having refused her to him. If you obey this admonition, I shall soon be delivered from this place of torment. You will at the same time provide a worthy husband for your daughter, and procure everlasting repose to the soul of your poor husband."

The widow could not for a moment resist this dread summons, which had not the most distant appearance of proceeding from Louis Brabant; whose countenance exhibited no visible change, and whose lips were close and motionless, during the delivery of it. Accordingly, she consented immediately to receive him for her son-in-law. Louis's finances, however, were in a very low situation; and the formalities attending the marriage-contract rendered it necessary for him to exhibit some show of riches, and not to give the ghost the lie direct. He accordingly went to work upon a fresh subject, one Cornu, an old and rich banker at Lyons; who had accumulated immense wealth by usury and extortion, and was known to be haunted by remorse of conscience on account of the manner in which he had acquired it.

Having contracted an intimate acquaintance with this man, he, one day while they were sitting together in the usurer's little back parlour, artfully turned the conversation on religious subjects, on demons and spectres, the pains of purgatory, and the torments of hell. During an interval of silence between them, a voice was heard, which to the astonished banker seemed to be that of his deceased father, complaining, as in the former case, of his dreadful situation in purgatory, and calling upon him to deliver him instantly thence, by putting into the hands of Louis Brabant, then with him, a large sum for the redemption of christians then in slavery with the Turks; threatening him at the same time with eternal damnation if he did not take this method to expiate likewise his own sins. The reader will naturally suppose that Louis Brabant affected a due degree of astonishment on the occasion; and further promoted the deception, by acknowledging his having devoted himself to the prosecution of the charitable design imputed to him by the ghost. An old usurer is naturally suspicious. Accordingly the wary banker made a second appointment with the ghost's delegate for the next day; and, to render any design of imposing upon him utterly abortive, took him into the open fields, where not a house, or a tree, or even a bush, or a pit, was in sight, capable of screening any supposed confederate. This extraordinary caution excited the ventriloquist to exert all the powers of his art. Wherever the banker conducted him, at every step his ears were saluted on all sides with the complaints and groans not only of his father, but of all his deceased relations, imploring him for the love of God, and in the name of every saint in the calendar, to have mercy on his own soul and theirs, by effectually seconding with his purse the intentions of his worthy companion. Cornu could no longer resist the voice of heaven, and accordingly carried his guest home with him, and paid him down 10,000 crowns: with which the honest ventriloquist returned to Paris, and married his mistress. The catastrophe was fatal. The secret was afterwards blown, and reached the usurer's ears; who was so much affected by the loss of his money, and the mortifying railleries of his neighbours, that he took to his bed and died.

This trick of Louis Brabant is even exceeded by an innocent piece of waggery played off not forty years ago by another French ventriloquist on a whole community. We have the story from M. De la Chapelle, who informs us, that M. St. Gill, the ventriloquist, and his intimate friend, returning home from a place whither his business had carried him, sought for shelter from an approaching thunder-storm in a neighbouring convent. Finding the whole community in mourning, he enquired the cause, and was told that one of their body had died lately, who was the ornament and delight of the whole society. To pass away the time, he walked into the church, attended by some of the religious, who showed him the tomb of their deceased brother, and spoke feelingly of the scanty honours they had bestowed on his memory. Suddenly a voice was heard, apparently proceeding from the roof of the quire, lamenting the situation of the defunct in purgatory, and reproaching the brotherhood with their lukewarmness and want of zeal on his own account. The friars, as soon as their astonishment gave them power to speak, consulted together, and agreed to acquaint the rest of the community with this singular event, so interesting to the whole society. M. St. Gill, who wished to carry on the joke still farther, dissuaded them from taking this step; telling them that they would be treated by their absent brethren as a set of fools and visionaries. He recommended to them, however, the immediately calling of the whole community into the church, where the ghost of their departed brother might probably reiterate his complaints. Accordingly all the friars, novices, lay-brothers, and even the domestics of the convent, were immediately summoned and collected together. In a short time the voice from the roof renewed its lamentation and reproaches, and the whole convent fell on their faces, and vowed a solemn reparation. As a first step, they chanted a De profundis in a full choir: during the intervals of which the ghost occasionally expressed the comfort he received from their pious exercises and ejaculations on his behalf. When all was over, the prior entered into a serious conversation with M. St. Gill; and on the strength of what had just passed, sagaciously inveighed against the absurd incredulity of modern sceptics and pretended philosophers, on the article of ghosts or apparitions. M. St. Gill thought it now high time to disabuse the good fathers. This purpose, however, he found it extremely difficult to effect, till he had prevailed upon them to return with him into the church, and there be witnesses of the manner in which he had conducted this ludicrous deception.

A ventriloquist, who performed feats somewhat similar to these, made his appearance in Edinburgh, and many of the other towns of Great Britain, a few years ago. He imitated successfully the voice of a squeaking child, and made it appear to proceed from whatever place he chose; from the pockets of the company; from a wooden doll, with which he held many spirited conversations; from beneath a hat or a wine-glass, and out of any person's foot or hand. When the voice seemed to come from beneath a glass or hat, it was dull and on a low key, as sounds confined always are; and what evinced his dexterity was, that when the glass was raised from the table during the time of his speaking, the words or syllables uttered afterwards were on a higher key, in consequence, one would have thought, of the air being readmitted to the speaker. This part of the experiment failed, however, when the management of the glass was at a distance committed to any of the company; but as the room was not well illuminated, we are inclined to attribute this failure to the ventriloquist not being able to perceive at what precise instant of time the glass was removed from the table.

The same artist imitated the tones of a scolding old woman, disturbed at unseasonable hours by a person demanding admission into her house. We have heard that, when in Edinburgh, the same practitioner astonished a number of persons in the Fishmarket, by making a fish appear to speak, and give the lie to its vender, who affirmed that it was fresh, and caught in the morning.

The editor of this dictionary heard some years ago, in Portugal, a ventriloquist who was at least equal to any of those above-mentioned. Indeed, he could scarcely have believed the fact from any authority, had he not been himself an ear-witness. The man held conversations with the figure of a child, which he carried under his cloak, with persons apparently out of the room, in the street, and even on the roof of the house. The voices were all varied according to the character of the person with whom he affected to converse, and it was impossible not to believe that they proceeded from the quarter where he pretended they were stationed.

We have never, we confess, found a satisfactory explanation of this phenomenon. The most plausible is that which refers it to a certain delicacy of ear in the performer. Such an ear, it is observed, perceives every difference which change of place produces in the same sound; and if a person possessed of such an ear has sufficient command over his organs of speech, to produce by them a sound in all respects similar to another proceeding from any distant object, to the audience the sound which he utters must appear to proceed from that object. If this is the true theory of ventriloquism, it does not seem to be possible for the most expert ventriloquist to speak in his usual tones of conversation, and at the same time make the voice appear to come from a distance; for these tones must be supposed familiar to his audience, and to be in their minds associated with the ideas of his figure, place, and distance. There can, however, be no doubt, that if, by a peculiar modification of the organs of speech, a sound of any kind can be produced, which in faintness, tone, body, and in short every other sensible quality, perfectly resembles a sound delivered from the roof of an opposite house, the ear will naturally, without examination, refer it to that situation and distance; the sound which the person hears being only a sign, which he has from his infancy been constantly accustomed, by experience, to associate with the idea of a person speaking from a house-top. If, however, this theory is true, how comes it that ventriloquism is not more frequently and successfully practised? The man whom the editor saw in Portugal, was apparently an ignorant and illiterate person, and either could not, or would not, give any account of the principles of his art.

VENUE, in law, the neighbourhood whence juries are to be summoned for trial of causes. In local actions, as of trespass and ejectment, the venue is to be from the neighbourhood of the place, where the lands in question lie; and in all real actions, the venue must be laid in the county where the thing is for which the action is brought. But in transitory actions, for injuries that may have happened any where, as debt, detinue, slander, or the like, the plaintiff may declare in what county he pleases; and then the trial must be in that county in which the declaration is laid. Though if the defendant will make affidavit, that the cause of action, if any, arose not in that, but in another county, the court will direct a change of the venue, and oblige the plaintiff to declare in the proper county; and the court will sometimes move the venue, from the proper jurisdiction (especially of the narrow and limited kind), upon a suggestion duly supported, that a fair and impartial trial cannot be had therein. 3 Black. 294.

With respect to criminal cases, it is ordained by stat. 21 Jac. I. c. 4, that all informations on penal statutes, shall be laid in the counties where the offences were committed.

VENUS, in astronomy, one of the inferior planets, revolving round the sun in an orbit between that of Mercury and the Earth. See Astronomy.

Venus, in zoology, a genus of insects belonging to the order of vermes testacea. This animal is a tethys; the shell is bivalve; the hinge with three teeth near each other, one placed longitudinally and bent inwards. There are a great many species, of which the most remarkable is the mercenaria, or commercial, with a strong, thick, weighty shell, covered with a brown epidermis; pure white within; slightly striated transversely: circumference above 11 inches. These are called in North America clams; they differ from other species only in having a purple tinge within. Wampum, or Indian money, is made of them.

Venus's *fly-trap*. See Dionæa Muscipula.

VEPRECULÆ, diminutive from vepres, "a briar or bramble;" the name of the 31st order in Linnæus's Fragments of a Natural Method. See Botany.

VERATRUM, a genus of plants of the class polygamia, and order monœcia; and in the natural system arranged under the 10th order, coronariæ. There is no calyx; the corolla has six petals; there are six stamina; the hermaphrodite flowers have three pistils and three capsules. There are four species, none of which are natives of Britain. The most important is the album, or hellebore, the root of which is perennial, about an inch thick, externally brown, internally white, and beset with many strong fibres; the stalk is thick, strong, round, upright, hairy, and usually rises four feet in height; the leaves are numerous, very large, oval, entire, ribbed, plaited, without footstalks, of a yellowish green colour, and surround the stem at its base: the flowers are of a greenish colour, and appear from June to August in very long, and branched, terminal spikes.

It appears from various instances, that every part of the plant is extremely acrid and poisonous, as its leaves and even seeds prove deleterious to different animals. Greding employed it in a great number of cases of the maniacal and melancholic kind; the majority of these, as might be expected, derived no permanent benefit; several, however, were relieved, and five completely cured by this medicine. It was the bark of the root, collected in the spring, which he gave in powder, beginning with one grain: this dose was gradually increased according to its effects. With some patients one or two grains excited nausea and vomiting, but generally eight grains were required to produce this effect, though in a few instances a scrupl and even more was given.

Veratrum has likewise been found useful in epilepsy, and other convulsive complaints; but the diseases in which its efficacy seems least equivocal, are those of the skin; as scabies and different prurient eruptions, herpes, morbus pediculosus, lepra, scrophula, &c. and in many of these it has been successfully employed both internally and externally. As a powerful stimulant and irritating medicine, its use has been resorted to only in desperate cases, and then it is first to be tried in very small doses in a diluted state, and to be gradually increased according to the effects.

VERB, in grammar, a word serving to express what we affirm of any subject, or attribute to it.

VERBASCUM, a genus or plants of the class pentandria, and order monogynia; and in the natural system arranged under the 28th order, luridæ. The corolla is rotated, and rather unequal; the capsule is monolocular and bivalved. There are 19 species, five of which are natives of Britain:

1. The thapsus, or great mullein, which has a stem single, simple, erect, covered with leaves, about six feet high; leaves large, broad, white, woolly on both sides, sessile, decurrent; flowers terminal, in a long spike, sessile, yellow. Catarrhal coughs and diarrhœas are the complaints for which it has been internally prescribed. Dr. Hume tried it in both, but it was only in the latter disease that this plant succeeded. He relates four cases in which a decoction of verbascum was given; and from which he concludes, that it "is useful in diminishing or stopping diarrhœas of an old standing, and often in easing the pains of the intestines. These acquire a great degree of irritability; and the ordinary irritating causes, aliment, bile, distension from air, keep up a quicker peristaltic motion. This is obviated by the emollient and perhaps gentle astringent qualities of this plant."

2. The nigrum, or black mullein, having a stem beset with hairs that are beautifully branched; the blossoms yellow with purple tips. It is a beautiful plant, and the flowers are grateful to bees. Swine eat it; sheep are not fond of it; cows, horses, and goats, refuse it. The other British species are the lychnitis, blattana, and virgatum.

VERBENA, a genus of plants of the class of diandria, and order of monogynia; and in the natural system arranged under the 40th order, personatæ. The corolla is funnel-shaped; calyx one of the teeth truncate; seeds two or four, naked or very thinly arilled; stem two or four. There are 23 species, only one of which is a native of Britain; the officinalis, or common vervain, which grows on the road-sides near towns and villages. The leaves have many jagged clefts, the blossoms are pale blue. It manifests a slight degree of astringency, and was formerly much in use as a deobstruent, but is now disregarded. Mr. Millar says, that it is never found above a quarter of a mile from a house; whence the common people in England call it simpler's joy, because, wherever it is found, it is a certain sign of a house being near. Sheep eat it; cows, horses, and goats, refuse it.

VERBESINA, a genus of the syngenesia

polygamia superflua class of plants, with a radiated flower, made up of hermaphrodite tubulose ones on the disc, and a few lingulated ones on the verge; the seeds are angulated, and contained in the cup. There are eleven species.

VERDEGREASE, or VERDEGRIS. See COPPER.

Verdegris is an acetat of copper, useful in the arts as a pigment. The principles on which it is formed are these:

Acetic acid attacks copper very slowly in open vessels, converts it into an oxide, and dissolves it; but in close vessels no action takes place. This acid readily combines with the oxide of copper, and forms with it an acetat. This salt was known to the antients, and various ways of preparing it are described by Pliny. It is usually obtained by exposing plates of copper to the action of vinegar, till they are converted to a bluish-green powder, and then dissolving this powder in acetic acid, and crystallizing it.

Acetat of copper crystallizes in four-sided truncated pyramids. It has a beautiful bluish-green colour. Its specific gravity is 1.779. Its taste is disagreeably metallic, and, like all the compounds into which copper enters, it is poisonous. It is very soluble in water; alcohol likewise dissolves it. When exposed to the air, it effloresces. By distillation it gives out acetic acid. Proust first remarked that acetous acid and acetic acid form the same salt with copper; and hence concluded that there is no difference between the two acids. When sulphureted hydrogen gas is made to pass through a solution of this salt in water, the copper is deoxidized, and precipitates in the state of a blue sulphuret, and there remains behind an acid which possesses the properties of the acetic.

According to Proust, the acetat of copper is composed of

61	acid and water
39	oxide
100.	

When the verdegris of commerce is put into water, 0.56 parts of it are dissolved, and there remain 0.44 parts in the state of a fine green powder, which remains long suspended in the solution. Mr. Proust has ascertained that this powder is a subacetat of copper. It is decomposed by sulphuric acid, by potass, and by distillation. According to the analysis of Proust, it is composed of

37	acid and water
63	oxide
100.	

Thus it appears from the experiments of this philosopher, that the verdegris of commerce is composed of two different acetats of copper; the one soluble in water, the other insoluble. It is much used as a paint; and crystallized acetat of copper is a frequent ingredient in dying compounds. Verdegris is formed in great quantities at Montpelier. A particular account of the processes followed in that place has been published by Mr. Chaptal.

VERDEROR, a judicial officer of the king's forest, chosen by the king's writ in the full county-court of the same shire, within the forest where he dwells; he is sworn to maintain and keep the assizes of the forest, and to view, receive and enrol the attachments and presentments, of all manner of trespasses of vert and venison in the forest.

VERDICT, the answer of a jury, made upon any cause, civil or criminal, committed by the court to their examination, and this is twofold, general or special.

A general verdict is that which is given or brought into the court in like general terms to the general issue; as in an action of disseisin, the defendant pleads no wrong, no disseisin; then the issue is general, whether the fact is wrong or not; which being committed to the jury, they upon consideration of the evidence come in and say, either for the plaintiff, that it is a wrong and disseisin; or for the defendant, that it is no wrong, no disseisin.

A special verdict, is when they say at large, that such a thing and such a thing they find to be done by the defendant or tenant, so declaring the course of the fact, as in their opinion it is proved; and as to the law upon the fact, they pray the judgment of the court; and this special verdict, if it contains any ample declaration of the cause from the beginning to the end, is also called a verdict at large. Co. Lit. 128.

A special verdict is usually found where there is any difficulty or doubt respecting the laws; when the jury state the facts as proved, and pray the advice of the court thereon. A less expensive, and more speedy mode however, is to find a verdict generally for the plaintiff, subject, nevertheless, to the opinion of the judge, or the court above, on a special case drawn up and settled by counsel on both sides.

VERGE signifies the compass of the king's court, which bounds the jurisdiction of the lord steward of the household, and which is thought to have been 12 miles round.

The term verge is also used for a stick or rod, whereby one is admitted tenant to a copyhold estate, by holding it in his hand, and swearing fealty to the lord of the manor.

VERGERS, certain officers of the courts of kings'-bench and common-pleas, whose business it is to carry white wands before the judges.

There are also vergers of cathedrals, who carry a rod tipped with silver before the bishop, dean, &c.

VERJUICE, a liquor obtained from grapes or apples, unfit for wine or cyder; or from sweet ones, whilst yet acid and unripe. Its chief use is in sauces, ragouts, &c. though it is also an ingredient in some medicinal compositions, and is used by the wax-chandlers to purify their wax.

VERMES, the sixth class of animals in the Linnæan system, comprehending five orders. See NATURAL HISTORY, and ZOOLOGY.

VERNIER SCALE, a scale excellently adapted for the graduation of mathematical instruments, thus called from its inventor Peter Vernier, a person of distinction in the Franche Compté. Vernier's method is derived from the following principle: If two equal right lines, or circular arcs, A, B, are so divided, that the number of equal divisions in B is one less than the number of equal divisions of A, then will the excess of one division of B above one division of A, be compounded of the ratios of one of A to A, and of one of B to B.

For, let A contain 11 parts, then one of A to A is as 1 to 11, or $\frac{1}{11}$. Let B contain 10 parts, then one of B to B is as 1 to 10, or $\frac{1}{10}$. Now $\frac{1}{10} - \frac{1}{11} = \frac{11-10}{10 \times 11} = \frac{1}{10 \times 11} = \frac{1}{10} \times \frac{1}{11}$.

Or if B contains n parts, and A contains $n+1$ parts; then $\frac{1}{n}$ is one part of B, and $\frac{1}{n+1}$ is one part of A. And $\frac{1}{n} - \frac{1}{n+1} = \frac{n+1-n}{n \times \overline{n+1}} = \frac{1}{n} \times \frac{1}{n+1}$.

The most commodious divisions, and their aliquot parts, into which the degrees on the circular limb of an instrument may be supposed to be divided, depend on the radius of that instrument.

Let R be the radius of a circle in inches; and a degree to be divided into n parts, each being $\frac{1}{p}$th part of an inch.

Now the circumference of a circle, in parts of its diameter 2 R inches, is $3{,}1415926 \times 2$ R inches.

Then $360^\circ : 3{,}1415926 \times 2\ \text{R} :: 1^\circ : \frac{3{,}1415926}{360} \times 2$ R inches.

Or, $0{,}01745329 \times$ R is the length of one degree in inches.

Or, $0{,}01745329 \times \text{R} \times p$ is the length of 1°, in pth parts of an inch.

But as every degree contains n times such parts, therefore $n = 0{,}01745329 \times \text{R} \times p$.

The most commodious perceptible division is $\frac{1}{8}$ or $\frac{1}{10}$ of an inch.

Example. Suppose an instrument of 30 inches radius, into how many convenient parts may each degree be divided? how many of these parts are to go to the breadth of the vernier, and to what parts of a degree may an observation be made by that instrument?

Now, $0{,}01745 \times \text{R} = 0{,}5236$ inches, the length of each degree: and if p is supposed about $\frac{1}{8}$ of an inch for one division; then $0{,}5236 \times p = 4{,}188$ shows the number of such parts in a degree. But as this number must be an integer, let it be 4, each being 15′: and let the breadth of the vernier contain 31 of those parts, or $7\frac{3}{4}^\circ$, and be divided into 30 parts.

Here $n = \frac{1}{4}$; $m = \frac{1}{30}$; then $\frac{1}{4} \times \frac{1}{30} = \frac{1}{120}$ of a degree, or 30′, which is the least part of a degree that instrument can show.

If $n = \frac{1}{5}$, and $m = \frac{1}{36}$; then $\frac{1}{5} \times \frac{1}{36} = \frac{60}{5 \times 36}$ of a minute, or 20″.

The following table, taken as examples in the instruments commonly made from 3 inches to 8 feet radius, shows the divisions of the limb to nearest tenths of inches, so as to be an aliquot of 60's and what parts of a degree may be estimated by the vernier, it being divided into such equal parts, and containing such degrees as their columns show.

Rad inches.	Parts in a deg.	Parts in vernier.	Breadth of vernier.	Parts observed.
3	1	15	$15\frac{1}{4}$	4′ 0″
6	1	20	$20\frac{1}{4}$	3 0
9	2	20	$10\frac{1}{4}$	1 30
12	2	24	$12\frac{3}{4}$	1 15
15	3	20	$6\frac{3}{4}$	1 0
18	3	30	$10\frac{1}{4}$	0 40
21	4	30	$7\frac{1}{4}$	0 30
24	4	36	$9\frac{3}{4}$	0 25
30	5	30	$7\frac{1}{2}$	0 20
36	6	30	$5\frac{1}{4}$	0 20
42	8	30	$3\frac{7}{8}$	0 15
48	9	40	$4\frac{5}{9}$	0 10
60	10	36	$3\frac{7}{10}$	0 10
72	12	30	$2\frac{7}{12}$	0 10
84	15	40	$2\frac{2}{3}$	0 6
96	15	60	4	0 4

By altering the number of divisions, either in the degrees or in the vernier, or in both, an angle can be observed to a different degree of accuracy. Thus, to a radius of 30 inches, if a degree is divided into 12 parts; each being five minutes, and the breadth of the vernier is 21 such parts, or $1\frac{3}{4}°$, and divided into 20 parts, then $\frac{1}{12} \times \frac{1}{20} = \frac{1°}{240} = 15''$: or taking the breadth of the vernier $2\frac{7}{2}°$, and divided into 30 parts; then $\frac{1}{12} \times \frac{1}{30} = \frac{1°}{360}$, or $10''$: or $\frac{1}{12} \times \frac{1}{50} = \frac{1°}{600} = 60''$, where the breadth of the vernier is $4\frac{1}{4}°$.

VERONICA, a genus of plants of the class diandria, and order monogynia; and in the natural system arranged under the 40th order, personatæ. The corolla is four-cleft, wheel-shaped, with the lowest segment narrower; capsules superior, two-celled. There are 57 species; 15 are natives of Britain, only two of which have been applied to any use: 1. The officinalis, common male speedwell, or fluelin, growing on heaths and barren grounds. An infusion is recommended by Hoffman as a substitute for tea; but it is more astringent and less grateful. The herb was formerly esteemed in medicine for various disorders, but is now almost totally disused. Cows, sheep, goats, and horses, eat it; swine refuse it. 2. The beccabunga, or common brook-lime. This plant was formerly considered as of much use in several diseases, and was applied externally to wounds and ulcers: but if it has any peculiar efficacy, it is to be derived from its antiscorbutic virtue.

VERSE. See POETRY.

VERSED *sine of an arch*, a segment of the diameter of a circle, lying between the foot of a right sine, and the lower extremity of the arch.

VERT. See HERALDRY.

VERTEBRÆ. See ANATOMY.

VERTEX. See ANATOMY.

VERTICAL circle, in astronomy, a great circle of the sphere passing through the zenith and nadir, and cutting the horizon at right angles: it is otherwise called azimuth.

VERTICAL PLANE, in perspective, is a plane perpendicular to the geometrical plane, passing through the eye, and cutting the perspective plane at right angles.

VERTIGO. See MEDICINE.

VERVAIN. See VERBENA.

VESICA, in anatomy, a bladder; a membranous or skinny part, in which any humour is contained.

VESICATORY, an external medicine, serving to raise a blister; whence also it is itself, though improperly, called a blister.

VESPA, *wasp*, a genus of insects of the order hymenoptera. The generic character is, mouth with jaws, without proboscis; upper wings pleated; sting concealed; eyes lunated; body smooth.

The genus vespa is of great extent, 140 species; and is remarkable, like that of apis or bee, for the singular dexterity with which it constructs its habitation, which in many species is of considerable size. The common wasp, or vespa vulgaris, is known to every one. The nest of this species is a highly curious structure, and is prepared beneath the surface of some dry bank, or other convenient situation. Its shape is that of an upright oval, often measuring ten or twelve inches at least in diameter: it consists of several horizontal stages or stories of hexagonal cells, the interstices of each story being connected at intervals by upright pillars; and the exterior surface of the nest consists of a great many layers or pieces, disposed over each other in such a manner as best to secure the interior cavity from the effects of cold and moisture; the whole nest, comprizing both walls and cells, is composed of a substance very much resembling the coarser kinds of whitish-brown paper, and consists of the fibres of various dry vegetable substances, agglutinated by a tenacious fluid discharged from the mouths of the insects during their operations. The female wasps deposit their eggs in the cells, one in each cell appropriated for that purpose; from these are hatched the larvæ or maggots, which bear a near resemblance to those of bees: they are fed by the labouring wasps with a coarse kind of honey, and when arrived at their full size, close up their respective cells with a fine tissue of silken filaments, and, after a certain period, emerge in their complete or perfect form. The male insect, like the male bee, is destitute of a sting. The society or swarm of the common wasp, consists of a vast number of neutral or labouring insects, a much smaller number of males, and still fewer females. They do not, like bees, prepare and lay up a store of honey for winter use; but the few which survive the season of their birth, remain torpid during the colder months. Wasps in general are both carnivorous and frugivorous.

The hornet, vespa crabo of Linnæus, is a species of a far more formidable nature than the common wasp, and is of considerably larger size: its colour is a tawny yellow with ferruginous and black bars and variegations. The nest of this species is generally built in the cavity of some decayed tree, or immediately beneath its roots; and not unfrequently in timber-yards and other similar situations. It is of smaller size than that of the wasp, and of a somewhat globular form, with an opening beneath; the exterior shell consisting of more or few layers of the same strong paper-like substance with that prepared by the wasp: the cells are also of a similar nature, but much fewer in number, and less elegantly composed. The hornet, like the wasp, is extremely voracious, and preys on almost any kind of fresh animal substances which it can obtain, as well as honey, fruit, &c. &c. Its sting is greatly to be dreaded, and is often productive of very serious consequences.

A highly elegant wasp's nest is sometimes seen during the summer season, attached or hanging by its base to some straw or other projecting substance, from the upper part of unfrequented buildings or outhouses. It does not much exceed the size of an egg, but is of a more globular form, and consists of several concentric bells, with considerable intervals between each, the interior alone being entire, and furnished with a small round orifice: the rest reaching only about two-thirds from the base of the nest. In the centre of the complete or entire bell, is situated the congeries of cells, built round a small central pillar attached to the base: the cells are not very numerous, and their orifices look downwards. See Plate Nat. Hist. fig. 417.

VESPERTILIO, *bat*, a genus of mammalia, of the order primates. The generic character is, teeth erect, sharp-pointed, approximated; hands palmated, with a membrane surrounding the body, and giving the animal the power of flight.

The curious formation of these animals cannot be contemplated without admiration: the bones of the extremities being continued into long and thin processes, connected by a most delicately formed membrane or skin, capable, from its thinness, of being contracted at pleasure into innumerable wrinkles, so as to lie in a small space when the animal is at rest, and to be stretched to a very wide extent for occasional flight.

Should a speculative philosopher, not aware of the anatomical impossibility of success, attempt, by means of light machinery, to exercise the power of flight, he could not hit on a more plausible idea than that of copying the structure described. Accordingly, a celebrated author has most justly and judiciously represented a sage theorist busied in imitating, for this purpose, "the folding continuity of the wing of a bat."

The 26 species of this extraordinary genus may be divided into the tailed and the tailless bats.

1. Vespertilio murinus, the common bat, is about two inches and a half, if measured from the nose to the tip of the tail; and the extent of the wings, when fully expanded, is about nine inches. It is of a mouse-colour, tinged with reddish; the wings and ears black: these latter are small and rounded.

2. Vespertilio auritus, long-eared bat. This species, in its general appearance, is nearly similar to the former, though rather smaller; and the fur has less of the reddish tinge; but what immediately distinguishes it as a species, is the very great size of the ears, which are more than an inch long, and of a very considerable width; they are slightly rounded at the tips, and are furnished internally, as in most others of this genus, with a kind of secondary auricle or internal flap, so placed as to serve by way of a valve or guard to the auditory passage. Linnæus, even in the twelfth edition of the Systema Naturæ, seems to entertain a doubt whether this species is really distinct from the former, or merely a sexual difference.

This and the former are the two most common species in this country; and are those which we so often see fluttering about in the evenings of summer and autumn, frequently uttering a sharp stridulous note or scream during their flight, and pursuing the various kinds of insects on which they feed, particularly moths. They are sometimes taken by throwing up the heads of burdock whitened with flour; which the bats either mistaking for some insect, or casually dashing against, are caught by the hooked prickles and brought to the ground.

The bat is capable, like the mouse, of being tamed to a certain degree; and we are assured by Mr. White, in his Natural History of Selborne, that he was much amused in the summer of the year 1766 with the sight of a tame bat. "It would take flies out of a person's hand. If you gave it any thing to eat, it brought its wings round before the mouth, hovering, and hiding its head, in the manner of birds of prey when they feed. The adroitness it shewed in shearing off the wings of the flies, which were always rejected, was worthy of observation, and pleased me much. Insects seemed to be most acceptable, though it did not refuse raw flesh when offered; so that the notion that bats go down chimneys and gnaw men's bacon, seems no improbable story. While I amused myself with this wonderful quadruped, I saw it several times confute the vulgar opinion, that bats, when down on a flat surface, cannot get on the wing again, by rising with great ease from the floor. It ran, I observed, with more dispatch than I was aware of, but in a most ridiculous and grotesque manner."

Bats are commonly supposed to produce two young at a birth which they suckle for a considerable time. When recently born they adhere most tenaciously to the breast of the parent, so as not to be removed without difficulty.

Bats lodge in great numbers in the cavities of old buildings, under the projections of walls, in the hollows of trees, in rocky places, &c. &c. During winter they lie torpid in these recesses, till the warmth of the vernal atmosphere invites them abroad to make their evening excursions. When taken torpid and brought into a warm situation, they awake from their slumber, and again expand their wings. During this state of torpidity, the circulation of the blood is not to be perceived in the smaller vessels; but when thus awakened by warmth, it again becomes visible by the microscope. This was first observed by Leewenhoeck, who could perceive no appearance of circulation in such as were taken in their torpid state; but on bringing them to the fire, the circulation soon became very brisk.

Bats are said to drink on the wing, like swallows, by sipping the surface, as they play over pools and streams. They love to frequent waters, not only for the sake of drinking, but on account of the insects which are found over them in the greatest plenty.

The general appearance of the bat, together with its nocturnal flight, must be confessed to excite the idea of something hideous and dismal; and for this reason the antients consecrated it to Proserpine, and supposed it to be one of the inhabitants of her dreary regions; and it cannot fail to occur to the recollection of every one, that painters, in their representations of fiends and demons, usually exhibit them with the leathern wings of the bat. It is also equally evident, that the fabulous harpies of the antients must have originated from a similar source; the larger bats of India and Africa, by a little poetical exaggeration of their manners, answering extremely well to the general description of those monsters.

3. Vespertilio noctula, the noctule bat, is considerably larger than the former; its extended wings measuring from 14 to 15 inches: the length from the nose to the tip of the tail about four inches and a half. The nose is slightly bilobated; the ears small and rounded; the body is fleshy and plump; the shoulders very thick and muscular; the fur very soft and glossy, and of a bright chesnut-colour. This is an inhabitant of Britain and of France, but seems not to have been particularized as a distinct species, till described by M. Daubenton in Buffon's Natural History. It is said to be common in some parts of Russia, sheltering in caverns. It flies high in the air in search of food, and does not skim near the surface like the smaller bats. It has been occasionally found in great quantities under the eaves of old buildings, and has generally a strong and unpleasant smell.

5. Vespertilio ferrum equinum, horse-shoe bat, with a horse-shoe-shaped membrane at the tip of the nose; ears large, broad at the base, and sharp-pointed, inclining backward; no smaller or internal ear; colour of the upper part of the body deep-cinereous; of the lower, whitish. There is said to be a greater and smaller variety; perhaps the male and female. The greater is above three inches and a half long from the nose to the tip of the tail; the extent of wings above 14. This species is found in France, and, very rarely, in England. It is also said to be found about the Caspian Sea.

5. Vespertilio auripendulus, slouch-eared bat, with large pendulous ears, pointed at the ends; nose obtuse; tail long, included in a membrane, and terminated with a hook; colour above deep-chesnut, lighter on the belly, and cinereous on the sides; length three inches and four lines; extent of wing 15 inches. Native of Guiana.

6. Vespertilio leporinus, Peruvian bat. Linnæus, as Mr. Pennant well observes, carried away by the love of system, placed this species, in the twelfth edition of the Systema Naturæ, under a distinct genus, by the name of noctilio; stationing it at a great distance from the rest of the bats, in the order glires, next to the squirrels. This he did merely on account of its having only two cutting-teeth in each jaw. But succeeding observations have conspired to prove that the number and disposition of the teeth differ greatly in the different species of the bats; so that if a too rigid regard was paid to this particular, several distinct genera might be instituted instead of one; but the general characters of the bats are so striking as to render this perfectly unnecessary.

The Peruvian bat has a head something like a pug-dog; the ears large and straight, sharp at the ends, and pointing forwards; two canine teeth, and two small cutting teeth between, in each jaw; tail enclosed in the membrane which joins to each hind leg, and is also supported by two long cartilaginous ligaments involved in the membrane; colour of the fur iron-grey; body equal in size to a middling rat; extent of wing two feet five inches. Mr. Pennant observes, that Mr. Schreber's figure of this species is erroneously coloured, being represented of a straw-colour. It is a native of Peru. An extraordinary conformation, according to Seba, takes place in the legs of this bat; the tibia and fibula being placed separately from each other, and each invested by its own distinct and hairy skin. These, however, seem to be nothing more than the two cartilaginous ligaments mentioned by Mr. Pennant.

The remaining species (except the last) are distinguished by having no tails.

7. Vespertilio nasutus, great serotine bat, with a very long, straight, and strong nose, sloping down at the end; ears long, erect, dilated towards the bottom, rounded at the end; colour of the upper parts a reddish chesnut; sides of a clear yellow; remainder of a dirty white; length five inches and eight lines; extent of wings two feet.

This species is described in the supplemental volume of the count de Buffon's Natural History. It is a native of Guiana, where it is said to assemble in meadows, and other open places, in vast numbers; flying in company with goatsuckers, and both together in such numbers as to darken the air.

8. Vespertilio spectrum, spectre bat. This is a large species, and is a native of South America, where it is chiefly seen on palm-trees. The extent of wings is about two feet two inches, or more; and from the nose to the rump seven inches and a half. It has a long nose; large teeth; long, broad, and upright ears; and at the end of the nose is an upright, long, conical membrane, bending at the end. Hair on the body cinereous, and pretty long; wings full of ramified fibres; the membrane extends from hind leg to hind leg. There is no tail; but three tendons run from the rump to the edge of the membrane.

Mr. Buffon supposes this to be the vampire; but if the accounts of that animal's extraordinary faculty may be depended upon, we are still uncertain as to the species; Piso and others, who give the relation, omitting the particular description of the animal; and, indeed, it is most probable that the faculty which gave rise to the name is by no means confined to a single species, but may be practised by several of the larger bats in warm climates. See Plate Nat. Hist. fig. 416.

9. Vespertilio vampyrus, vampire bat. Of this tremendous animal there are some varieties in point of size and colour; or perhaps they may really be distinct races or species, though nearly allied. The largest, or the great Ternate bat, is, in general, about a foot long, with an extent of wings about four feet; but sometimes it is found far larger, and it has been said that specimens have been seen of six feet in extent. The general colour of the body is a deep reddish brown; brighter on the upper part of the neck and shoulders, as well as on the under parts of the body. The nose is sharp and black; the teeth large and sharp: there are four cutting-teeth both above and below, and the canine teeth are large and strong; the tongue is pointed, and terminated by sharp prickles; the ears are naked, blackish, and large, and are of a pointed form. The wings are black, or of the colour of those of the common bat. The membrane is divided behind, quite to the rump, there being no tail; the single claw on

the wings is large and strong, and those on the feet extremely so, as well as much curved.

This is the bat to which Linnæus applied the title of vampire, on the supposition of its being the species of which so many extraordinary accounts have been given relative to its power of sucking the blood both of men and cattle. This it is supposed to perform by inserting its aculeated tongue into the vein of a sleeping person, in so peculiar a manner as not to excite pain, fanning at the same time the air with its wings, by which means the sleep is rendered still more profound. This is what appears at first so extraordinary as to justify a degree of scepticism as to the fact: it is, however, so solemnly related, and seemingly so well authenticated, as to enforce belief. Mr. Condamine assures us, that the large bats have, in certain parts of America, destroyed, by this means, all the great cattle introduced there by the missionaries. It is affirmed by Bontius, as well as Nieuhoff, that the bats of Java attack those who lie with their feet uncovered, whenever they can gain access; and Gumilla, who mentions a greater and lesser kind, found on the banks of the Oronoque, declares them to be equally greedy after human blood. Persons thus attacked have, in consequence, been near passing from a sound sleep into eternity. It is, therefore, very unsafe to sleep with open windows, or in the open air, in those regions.

P. Martyr, who wrote soon after the conquest of South America, says, that in the isthmus of Darien, there are bats which suck the blood of men and cattle, when asleep, to such a degree as to awaken, and even kill them.

An instance is also related in colonel Stedman's Travels in Surinam, as having happened to himself, which puts the matter beyond a doubt.

Lastly, though it seems to have escaped the attention of modern naturalists, the self-same faculty has been, time out of mind, attributed to the common European bats, which are said to bite sleeping persons, and to suck the blood with the greatest avidity. This is mentioned by Aldrovandus, who seems to relate it as a generally-received opinion; observing, at the same time, that their attacks are infinitely inferior to the dangerous ones of the large exotic bats in India and America.

It remains to explain the reason of the term vampire, by which the above large species has been distinguished.

A vampire is an imaginary monster, supposed to suck the blood of sleeping persons. It also alludes to one of the most absurd superstitions that ever entered into the human mind. About the year 1732, an idea arose among the vulgar in some parts of Poland and Hungary, that certain bodies when interred, became possessed of the power of absorbing blood from those who were so unfortunate as to pass over or stand near their graves; it was, therefore, supposed necessary to dis-inter such bodies and wound them with a sword, by which means this pernicious power was supposed to be put a stop to, and the blood they had unjustly gained was evacuated. Astonishing as this folly may appear, it is yet more astonishing that a great many treatises were written on the subject, and that some considerable time elapsed before the superstition was completely destroyed.

VESTALS, *vestales*, among the antient Romans, were priestesses of the goddess Vesta, and had the perpetual fire committed to their charge. They were at first only four in number, but afterwards increased to six; and it does not appear that their number ever exceeded six, among whom one was superior to the rest, and called vestalis maxima.

The vestals were chosen from six to ten years of age, and obliged to strict continency for 30 years; the first ten of which were employed in learning the ceremonies of religion, the next ten in the performance of them, and the ten last in teaching them to the younger vestals. The habit of the vestals consisted of an head-dress, called infula, which sat close to their heads, and whence hung certain laces called vittæ, a kind of surplice made of white linen, and over it a purple mantle with a long train to it.

VESTIBULE, in architecture, a kind of entrance into a large building; being an open place before the hall, or at the bottom of the staircase. Vestibules intended for magnificence, are usually between the court and the garden.

VESTRY, a place adjoining to a church, where the vestments of the minister are kept; also a meeting at such place where the minister, churchwarden,, and principal men of most parishes, at this day make a parish vestry. On the Sunday before a vestry is to meet, public notice ought to be given, either in the church, or after divine service is ended, or else at the church-door as the parishioners come out, both of the calling of the said meeting, and also of the time and place of the assembling of it; and it is reasonable then also to declare for what business the said meeting is to be held, that none may be surprized, but that all may have full time before, to consider of what is to be proposed at the said meeting. Wats. c. 39.

VESUVIAN, a mineral found in lava, especially at Vesuvius, and formerly confounded with hyacinth. Its colour is brown or greenish. It is found in masses, but usually crystallized in rectangular eight-sided prisms. The primitive form of its crystals is the cube. The specific gravity is from 3.39 to 3.4. It scratches glass; the fracture is imperfectly conchoidal. It causes double refraction. Before the blowpipe it melts into yellowish glass. It is composed of

26.5	silica
40.2	magnesia
16.2	oxide of iron
16.0	lime
98.9	

VETCH. See VICIA.

VIBRATION, in mechanics, a regular reciprocal motion of a body, as a pendulum, &c. which, being freely suspended, swings or oscillates, first this way, then that.

VIBRIO, a genus of vermes infusoria. The generic character is, worm invisible to the naked eye, very simple, round, elongated. There are 20 species enumerated, and found chiefly in vegetable infusions.

VIBURNUM, a genus of plants of the class pentandria, order trigynia, and in the natural system arranged under the 43d order, dumosæ. The calyx is quinquepartite and above; the corolla divided into five lachinæ; the fruit a monospermous berry. There are 23 species, two of which are natives of Britain.

1. The lantana, common viburnum, wayfaring, or pliant mealy tree, having very pliant shoots covered with a lightish-brown bark; large heart-shaped, veined, serrated leaves, white and hoary underneath, and the branches terminated by umbels of white flowers, succeeded by bunches of red berries, &c.

2. The opulus, or Guelder rose, consisting of two varieties, one with flat flowers, the other globular. The former grows 18 or 20 feet high, branching opposite, of an irregular growth, and covered with a whitish bark: and large lobated or three-lobed leaves on glandulous footstalks. The latter has large globular umbels of white flowers at the ends of the branches in great abundance. This tree when in bloom exhibits a singularly fine appearance; the flowers, though small, are collected numerously into large globular umbels, round like a ball; hence it is sometimes called snowball-tree.

3. The tinus, common laurustinus, or evergreen viburnum. There are a great many varieties. All the different species of viburnum, both deciduous and evergreen kinds, being of the tree kind, are woody and durable in root, stem, and branches. They may all be propagated by layers; and are of such hardy temperature as to grow freely in the open ground all the year, in shrubberies, and other hardy plantations.

VICAR, one who supplies the place of another. The priest of every parish is called rector, unless the prædial tithes are appropriated, and then he is styled vicar; and when rectories are appropriated, vicars are to supply the rector's place. For the maintenance of the vicar, there was then set apart a certain portion of the tithes, commonly about a third part of the whole, which are now what are called the vicarial tithes, the rest being reserved to the use of the rectors, which for the like reason are denominated the rectorial tithes.

VICARAGE. For the most part vicarages were endowed upon appropriations; but sometimes vicarages have been endowed without any appropriation of the parsonage; and there are several churches where the tithes are wholly impropriated, and no vicarage endowed; and there the impropriators are bound to maintain curates to perform divine service, &c. The parsons, patron, and ordinary, may create a vicarage, and endow it; and in time of vacancy of the church, the patron and ordinary may do it; but the ordinary alone cannot create a vicarage, without the patron's assent.

VICE, in smithery, and other arts employed in metals, is a machine, or instrument, serving to hold fast any thing they are at work upon, whether it is to be filed, bent, rivetted, &c. To file square it is absolutely necessary that the vice should be placed perpendicular, with its chaps parallel to the work-bench.

VICE, *hand*, is a small kind of vice serving to hold the lesser works in, that require often turning about.

Of these there are two kinds: the broad-chapped hand-vice, which is that commonly used; and the square-nosed hand-vice, seldom used but for filing small round work. See SMITHERY.

VICE is also a machine used by the glaziers to turn or draw lead into flat rods, with grooves on each side to receive the edges of the glass. See GLAZIER'S VICE.

VICIA, a genus of plants of the class diadelphia, and order decandria; and in the natural system arranged under the 32d order, papilionaceæ. The stigma is bearded transversely on the lower side. There are 25 species, seven of which are natives of Britain. The most important are:

1. The sativa, common vetch, or tare. The stalks are round, weak, branched, about two feet long. Pinnæ five or seven pair, a little hairy, notched at the end; stipulæ dentated; flowers light and dark purple, on short pedicles, generally two together; pods erect; seeds black. It is known to be an excellent fodder for horses.

2. The cracca, tufted vetch. It has a stem branched, three or four feet long. Leaves pinnated; pinnæ generally 10 or 12 pairs, lance-shaped, downy; stipulæ entire; flowers purple, numerous, pendulous, in imbricated spikes. It is also reckoned an excellent fodder for cattle.

3. The faba, or common garden-bean. It is a native of Egypt. It is too well known to require description.

VICINAGE. *Common of vicinage* is, where the inhabitants of two townships, which lie contiguous, have usually intercommoned with one another, the beasts of the one straying mutually into the other's fields without any molestation from either. This, indeed, is only a permissive right, intended to excuse what in strictness is a trespass in both, and to prevent a multiplicity of suits; and, therefore, either township may inclose and bar out the other, though they have intercommoned time out of mind. Neither has any person of one town a right to put his beasts originally into the other's common; but if they escape and stray there of themselves, the law winks at the trespass. 2 Black. 34. See COMMON.

VIEW, in law, is generally where a real action is brought in any of the courts of record at Westminster, and it shall appear to the court to be proper and necessary that the jurors should have a view, they may order special writs of distringas, or habeas corpora, to issue, commanding the sheriff to have six of the first twelve of the jurors therein named, or of some greater number of them, at the place in question, &c. But as the having a view was not a matter of course, though such a practice had prevailed, and had been abused to the purposes of delay, the court thought it their duty to take care that their ordering a view should not obstruct justice, and prevent the cause from being tried; and they resolved not to order one any more, without a full examination into the propriety and necessity of it. For they were all clearly of opinion that the act of parliament meant that a view should not be granted, unless the court were satisfied that it was proper and necessary; and they thought it better that a cause should be tried upon a view had by any six, or by fewer than six, or even without any view, than be delayed for any greater length of time. Burr. 256.

VILLAIN, or VILLEIN, a man of servile or base degree.

Of these bondmen or villeins, there were two sorts in England: one termed a villain in gross, who was immediately bound to the person of his lord, and his heirs; the other, villein regardant to a manor, being bound to his lord as a member belonging and annexed to a manor whereof the lord was owner.

Both villains regardant, and villains in gross, were transferable by deed from one owner to another. They could not leave their lord without his permission; but if they ran away or were purloined from him, might be claimed and recovered by action like beasts, or other chattels. They held indeed small portions of land to sustain themselves and families; but it was at the mere will of the lord, who might dispossess them whenever he pleased. A villain could acquire no property either in lands or goods; but if he purchased either, the lord might enter upon him, and seize them to his own use. 1 Black. 93.

VILLARIA, a genus of plants of the class and order dioecia pentandria. The calyx has five petals; the perianth. is a three-celled berry. It seems to be little known.

VINCA, in botany, a genus of plants of the class pentandria, and order monogynia; and in the natural system arranged under the 30th order, contortæ. The corolla is twisted; there are two erect follicles; the seeds are naked. There are five species, only two of which are natives of Britain: 1. The major, great periwinkle. 2. The minor, small periwinkle.

VINCULUM, in mathematics, a character in form of a line, or stroke, drawn over a factor, divisor, or dividend, when compounded of several letters or quantities, to connect them, and shew they are to be multiplied, or divided, &c. together by the other term. Thus $d \times \overline{a + b - c}$ shews that d is to be multiplied into $a + b - c$.

VINDEMIATRIX, or VINDEMIATOR, a fixed star of the third magnitude in the constellation Virgo, whose latitude is 16° 12′ 34″ north, and longitude 5° 37′ 40″ of Libra, according to Mr. Flamsteed's catalogue.

VINE. See VITIS.

VINEGAR. See ACID, CHEMISTRY, ACETIC, and ACETOUS ACID.

Vinegar was known many ages before the discovery of any other acid, those only excepted which exist ready-formed in vegetables. It is mentioned by Moses; and indeed seems to have been in common use among the Israelites, and other Eastern nations, at a very early period. It is prepared from wine, from beer, ale, and other similar liquids. These are apt, as every one knows, to turn sour, unless they are kept very well corked. Now sour wine or beer is precisely the same with vinegar.

Boerhaave describes the following method of making vinegar, which is said to be still practised in different places:

Take two large oaken vats or hogsheads, and in each of these place a wooden grate or hurdle at the distance of a foot from the bottom. Set the vessel upright, and on the grate place a moderately close layer of green twigs or fresh cuttings of the vine. Then fill up the vessel with the footstalks of grapes, commonly called the rape, to the top of the vessel, which must be left quite open.

Having thus prepared the two vessels, pour into them the wine to be converted into vinegar, so as to fill one of them quite up, and the other but half-full. Leave them thus for 24 hours, and then fill up the half-filled vessel with liquor from that which is quite full. Four-and-twenty hours afterwards repeat the same operation; and thus go on, keeping the vessels alternately full and half-full during every 24 hours till the vinegar is made. On the second or third day there will arise, in the half-filled vessel, a fermentative motion, accompanied with a sensible heat, which will gradually increase from day to day. On the contrary, the fermenting motion is almost imperceptible in the full vessel; and as the two vessels are alternately full and half-full, the fermentation is by that means, in some measure, interrupted, and is only renewed every other day in each vessel.

When this motion appears to have entirely ceased, even in the half-filled vessel, it is a sign that the fermentation is finished; and therefore the vinegar is then to be put into casks close-stopped, and kept in a cool place.

All that is necessary to convert wine or beer into vinegar, is the contact of the external air, a temperature of 80°, and the presence of some substance to act as a ferment.

Vinegar is a liquid of a reddish or yellowish colour, a pleasant sour taste, and an agreeable odour. Its specific gravity varies from 1.0135 to 1.0251, and it differs also in its other properties according to the liquid from which it has been procured. It is very subject to decomposition; but Scheele discovered that if it is made to boil for a few moments, it may be kept afterwards for a long time without alteration. Besides acetic acid and water, vinegar contains several other ingredients, such as mucilage, tartar, a colouring matter, and often also two or more vegetable acids. When distilled at a temperature not exceeding that of boiling water, till about two thirds of it have passed over, all these impurities are left behind, and the product is pure acid diluted with water.

The acid thus obtained is a liquid as transparent and colourless as water, of a strong acid taste, and an agreeable colour, somewhat different from that of vinegar. In this state it is usually called acetous acid, or distilled vinegar. See ACETOUS ACID.

It may be preserved without alteration in close vessels. When exposed to a moderate heat, it evaporates completely, and without undergoing any change in its properties. When exposed to the action of cold, part of it congeals. The frozen portion, which consists almost entirely of water, may be easily separated; and by this method the acid may be obtained in a high degree of concentration. The more concentrated the acid is, the greater is the cold necessary to produce congelation. Mr. Lowitz has ascertained that the acid itself, how much soever it may be concentrated, crystallizes or congeals at the temperature of —22°.

When acetat of copper, reduced to powder, is put into a retort and distilled, there comes over a liquid at first nearly colourless, and almost insipid, and afterwards a highly concentrated acid. The distillation is to be continued till the bottom of the retort is red-hot. What remains in it then is only a powder of the colour of copper. The acid product, which should be received in a vessel by itself, is tinged green by a little copper which passes along with it; but when distilled over again in a gentle heat, it is obtained perfectly colourless and transparent. The acid thus obtained is exceedingly pungent and concentrated. It was formerly distinguished by the names of radical vinegar, and vinegar of Venice.

This acid is transparent and colourless like water. It has a peculiar aromatic smell when in the state of acetous acid; but concentrated acetic acid, when procured in the usual way, has an empyreumatic odour, mixed with the natural smell of vinegar, owing to a small portion of oil formed during the process.

A much easier method of obtaining acetic acid than that commonly used has been lately pointed out by Mr. Badoilier, apothecary at Chartres. All that is necessary is to distil a mixture of equal parts of acetat of lead and sulphat of copper in a glass retort. The acid comes perfectly pure on the application of a moderate heat.

The specific gravity of distilled vinegar varies from 1.007 to 1.0095; but radical vinegar is much more concentrated. In that state it is extremely pungent and acrid; and when it is applied to the skin, it reddens and corrodes it in a very short time. It is exceedingly volatile; and when heated in the open air, takes fire so readily, that one would be tempted to suspect the presence of ether in it. It unites with water in any proportion; and when concentrated, the mixture evolves a good deal of heat. See ACID, CHEMISTRY, &c.

VINEYARD, a plantation of vines. See VITIS.

The best situation of a vineyard is on the declivity of an hill, lying to the south. For the planting of a vineyard, observe the following method: In the month of July, while the outermost coat of the earth is very dry and combustible, plough up the sward; denshire, or burn-beat it, according to art, and in January following, spread the ashes. The ground being thus prepared, cut your trenches across the hill from east to west, because the vines being thus in ranks, the rising and setting of the sun will by that means pass through the intervals, which it would not do if they were set in any other position, neither would the sun dart its rays upon the plants during the whole course of the day.

Afterwards strain a line, and dig a trench about a foot deep; place your sets in it, about three feet distance one from another; trim off the superfluous roots, leaving no more than three or four eyes or buds upon that which is above ground; and plant them near half a foot deep, sloping, after the manner the quick is commonly set, so that they may point up the hill. That done, take long dung or straw, and lay it on the trenches in a convenient thickness to cover the earth, and preserve the roots from the dry piercing winds, which would otherwise much annoy them, and from the excessive scorching heats in summer; keep them well hoed, and free from weeds, and water them as occasion serves; the best time to plant is in January.

The first pruning of the new-set vine ought not to be till January, and then you should cut off all the shoots as near as you can, sparing but one of the most thriving, on which you are to leave only two or three buds, and so let all rest till May, the second year after planting. Take care then from time to time to destroy the weeds, and clear the roots of all suckers, which do but rob and draw out the virtue of your sets. The same method is to be followed the third year; then dig your whole vineyard, and lay it very level, taking care in this operation not to cut or wound any of the main roots with your spade. As for the younger roots, it is not so material, as they will grow the thicker; and this year you may enjoy some of the fruits of your vineyard, which, if answerable to your expectation, will put you upon providing props for your vines of about four feet long, which must be placed on the north side of the plant. In May, rub off such buds as you suspect will produce superfluous branches. When the grapes are about the size of birding-shot, break off the branches with your hand at the second joint above the fruit, and tie the rest to the prop: here it is most advisable to break, and not cut, your vine; because wounds made with a sharp instrument are not apt to heal, but cause the plants to bleed. See PRUNING.

The fourth year you will be likely to have three or four shoots to every plant; and, therefore, in December, cut off all the branches, except one of the strongest and most thriving, which leave for a standard about four feet high, paring away the rest very close to the body of the mother-plant, which tie to your prop till it is large enough to make a standard of itself. Neither must you suffer any shoot to break out, but such as sprout at the top, four feet from the ground; all which sprouts the French usually prune off every year, and absolutely trust to the new sprouts that are only bearing shoots.

In August, when the fruit begins to ripen, break off such shoots as you find too thick; and if you perceive any plant bleed, rub some ashes on it; or, if that will not do, sear it with a hot iron. When, upon stirring your vineyard, it appears to be poor, prune the vines as before directed; and spread good dung, mixed with lime, over the whole ground, letting it lie all the winter to wash into the earth, mixing about ten bushels of lime with a load of dung; and if some ashes and soot are likewise thrown on, it will do well. Turn in this manure about February, with a slight digging, but not too deep, which should be done in a dry season, and not in wet weather, lest it should make the ground bind too much, and occasion the growth of rank weeds.

VIOL, a stringed instrument resembling in shape and tone the violin, of which it was the origin; that impressive and commanding instrument being little more than an improvement of the old viol. This instrument formerly consisted of five or six strings, the tones of which were regulated by their being brought by the fingers into contact with the frets with which the neck was furnished. The viol was for a long while in such high esteem as to dispute the pre-eminence with the harp, especially in the early times of music in France; and, indeed, being reduced to four strings, and stript of the frets with which viols of all kinds seem to have been furnished till the sixteenth century, it still holds the first place among treble instruments, under the denomination of violin.

VIOLA, a tenor violin. This instrument is similar in its tone and formation to the violin; but its dimensions are somewhat greater, and its compass a fifth lower in the great scale of sounds. Its lowest note is C on the fourth space in the bass. The part it takes in concert is between that of the bass and the second violin.

VIOLA, a genus of plants of the class syngenesia, order monogynia; in the natural system arranged under the 29th order, campanaceæ. The calyx is pentaphyllous; the corolla five-petalled, irregular, with a nectarium behind, horn-shaped; the capsule is above the germen, three-valved, monolocular. There are 43 species, six of which are natives of Britain. The most important of these are:

1. The palustris, marsh violet. The leaves are smooth, reniform, two or three on each footstalk; flowers pale blue, small, inodorous. An infusion of the flowers is an excellent test of the presence of acids and alkalies.

2. The odorata, purple sweet violet, has leaves heart-shaped, notched; flowers deep purple, single; creeping scions. The flowers of this plant taken in the quantity of a dram or two, are said to be gently purgative or laxative, and, according to Bergius and some others, they possess an anodyne and pectoral quality. There is a variety with white flowers.

3. Tricolor, pansies, heart's-ease, or three faces under a hood. The stems are diffuse, procumbent, triangular; the leaves oblong, cut at the edges; stipulæ dentated; the flowers purple, yellow, and light blue, inodorous. This elegant little plant merits culture in every garden, for the beauty and great variety of its three-coloured flowers; and it will succeed any where in the open borders, or other compartments, disposed in patches towards the front, either by sowing the seed at once to remain, or by putting in young plants. They will begin flowering early in summer, and will continue shooting and flowering in succession till winter; and even during part of that season in mild weather. The common violet is propagated by parting the roots, sometimes by seed.

VIOLIN, or FIDDLE, a well-known stringed instrument of brilliant tone and active execution. When, or by what nation, this important and interesting instrument was first invented, is not at present known; nor can the form and character of the violin used in England in the time of Chaucer, who mentions it, be exactly ascertained. There is, however, much reason for supposing that from its first introduction it underwent continual alterations and improvements, since even towards the end of the sixteenth century its shape appears to have been vague and undetermined. It has, however, long attained its present excellence, and formed the leading instrument in concert. The four strings of which it consists are tuned in fifths from each other. The pitch of the lowest string is G, under the second ledger line in the treble stave; consequently that of the next is D, under the first line of the stave; the pitch of the next above that, A on the second space; and that of the upper string, E on the fourth space. During the Protectorship the violin was in little esteem, and gave way to the rising prevalence of the viol; but at the Restoration, viols began to be out of fashion, and violins resumed their former consequence. The antiquity of this instrument has long been a subject of dispute ith the learned. It is generally supposed, nd with much reason, that no instrument layed with the bow was known to the ancients.

VIOLONCELLO, a bass viol, containing four strings, the lowest of which is tuned to double C. The strings are in fifths, consequently the pitch of that next the gravest is G gamut; that of the next, D on the third line in the bass; and that of the upper string, A on the fifth line.

The violoncello was called the violono till the introduction of the double-bass, which assumed that name.

VIPER. See COLUBER.

VIRCETA, a genus of plants of the pentandria monogynia class and order. The calyx is five-notched; corolla funnel-form; stigma two-parted; capsule one-celled, many-seeded. There are two species, annuals of Guiana.

VIRGO, in astronomy, one of the signs or constellations of the zodiac, and the sixth according to order.

VISCERA. See ANATOMY.

VISCUM, a genus of plants of the class diœcia, order tetrandria, and in the natural system arranged under the 48th order, aggregatæ. The male calyx is quadripartite; the antheræ adhere to the calyx; the female calyx consists of four leaves; there is no style; the stigma is obtuse; there is no corolla; the fruit is a berry with one seed. There are 12 species, only one of which is a native of Britain, viz. the album, or common misseltoe. It is a shrub growing on the bark of several trees. The leaves are conjugate and elliptical; the stem forked; the flowers whitish in the alæ of the leaves. This plant was reckoned sacred among the druids.

VISION. See OPTICS.

VISITATION, in law, an act of jurisdiction whereby a superior, or proper officer, visits some corporation, college, church, or other public or private house, to see that the laws and regulations thereof are duly observed.

Among us, visitation is that office performed by the bishop in every diocese once in three years, or by the archdeacon every year, by visiting the churches and their rectors throughout the whole diocese, &c. The bishop's commissary also holds a court of visitation, to which he may cite all churchwardens and sidesmen; and to whom he exhibits his articles, and makes inquiry by them.

VISMEA, a genus of the dodecandria trigynia class and order of plants. The calyx is five-leaved, inferior; the corolla five-petalled; stigmas five; nect. two or three-celled. There is one species, a native of the Canaries.

VITEX, the *chaste-tree*, a genus of the didynamia angiospermia class of plants, with a monopetalous ringent, and bilabiated flower, each lip of which is trifid; the fruit is a quadrilocular, globose berry, containing four seeds. There are 14 species.

VITIS, a genus of the class pentandria, and order monogynia; and in the natural system arranged under the 46th order, pectoraceæ. The petals cohere at the top, and are withered; the fruit is a berry with five seeds. There are 12 species; the most important of which is the vinifera, or common vine, which has naked, lobed, sinuated leaves. There are a great many varieties; but a recital of their names would be tiresome without being useful. All the sorts are propagated either from layers or cuttings; the former of which methods is greatly practised in England, but the latter is much preferable.

In choosing the cuttings, you should always take such shoots of the last year's growth as are strong and well ripened; these should be cut from the old vine, just below the place where they were produced, taking a knot or piece of the two years' wood to each, which should be pruned smooth; then you should cut off the upper part of the shoots, so as to leave the cutting about 16 inches long. When the piece or knot of old wood is cut at both ends, near the young shoot, the cutting will resemble a little mallet; whence Columella gives the title of malleolus to the vine-cuttings. In making the cuttings after this manner, there can be but one taken from each shoot; but most persons cut them into lengths of about a foot, and plant them all.

When the cuttings are thus prepared, if they are not then planted, they should be placed with their lower part in the ground in a dry soil, laying some litter upon their upper parts to prevent them from drying. In this situation they may remain till the beginning of April (which is the best time for planting them); when you should take them out, and wash them from the filth they have contracted; and if you find them very dry, you should let them stand with their lower parts in the water six or eight hours, which will distend their vessels, and dispose them for taking root. If the ground is strong and inclined to wet, you should open a trench where the cuttings are to be planted, which should be filled with lime-rubbish, the better to drain off the moisture; then raise the borders with fresh light earth about two feet thick, so that it may be at least a foot above the level of the ground; then you should open the holes at about six feet distance from each other, putting one good strong cutting into each hole, which should be laid a little sloping, that their tops may incline to the wall; but it must be put in so deep, that the uppermost eye may be level with the surface of the ground; for when any part of the cutting is left above ground, most of the buds attempt to shoot, so that the strength of the cuttings is divided to nourish so many shoots, which must consequently be weaker than if only one of them grew; whereas, by burying the whole cutting in the ground, the sap is all employed on one single shoot, which consequently will be much stronger; besides, the sun and air are apt to dry that part of the cutting which remains above ground, and so often prevent the buds from shooting.

Having placed the cutting in the ground, fill up the hole gently, pressing down the earth with your foot close about it, and raise a little hill just upon the top of the cutting, to cover the upper eye quite over, which will prevent it from drying. Nothing more is necessary than to keep the ground clear from weeds until the cuttings begin to shoot; at which time you should look over them carefully, to rub off any small shoots, if such are produced, fastening the first main shoot to the wall, which should be constantly trained up, as it is extended in length, to prevent its breaking or hanging down. You must continue to look over these once in about three weeks during the summer season, constantly rubbing off all lateral shoots which are produced; and be sure to keep the ground clear from weeds, which, if suffered to grow, will exhaust the goodness of the soil, and starve the cuttings. The Michaelmas following, if your cuttings have produced strong shoots, you should prune them down to two eyes. In the spring, after the cold weather is past, you must gently dig up the borders to loosen the earth; but you must be very careful, in doing this, not to injure the roots of your vines; you should also raise the earth up to the stems of the plants, so as to cover the old wood but not so deep as to cover either of the eyes of the last year's wood. After this they will require no farther care until they begin to shoot; when you should rub off all weak dangling shoots, leaving no more than the two produced from the two eyes of the last year's wood, which should be fastened to the wall. From this time till the vines have done shooting, you should look them over once in three weeks or a month, to rub off all lateral shoots as they are produced, and to fasten the main shoots to the wall as they are extended in length; about the middle or latter end of July, it will be proper to nip off the tops of these two shoots, which will strengthen the lower eyes. During the summer season you must constantly keep the ground clear from weeds, nor should you permit any sort of plants to grow near the vines, which would not only rob them of nourishment, but shade the lower parts of the shoots, and prevent their ripening, which will not only cause their wood to be spongy and luxuriant, but render it less fruitful.

As soon as the leaves begin to drop in autumn, you should prune these young vines again, leaving three buds to each of the shoots, provided they are strong, otherwise it is better to shorten them down to two eyes, if they are good; for it is a very wrong practice to leave much wood upon young vines, or to leave their shoots too long, which greatly weakens the roots; then you should fasten them to the wall, spreading them out horizontal each way, that there may be room to train the new shoots the following summer, and in the spring the borders must be digged as before.

The uses of the fruit of the vine for making wine, &c. are well known. The vine was introduced by the Romans into Britain, and appears formerly to have been very common. From the name of vineyard yet adhering to the ruinous sites of our castles and monasteries, there seem to have been few in the country but what had a vineyard belonging to them. The county of Gloucester is particularly commended by Malmsbury, in the twelfth century, as excelling all the rest of the kingdom in the number and goodness of its vineyards. In the earlier periods of our history, the isle of Ely was expressly denominated the Isle of Vines by the Normans. Vineyards are frequently noticed in the descriptive accounts of doomsday; and those of England are even mentioned by Bede, as early as the commencement of the eighth century.

Doomsday exhibits to us a particular proof that wine was made in England during the period preceding the Conquest; and after the Conquest, the bishop of Ely appears to have received at least three or four tuns of wine annually as tithes, from the produce of the vineyards in his diocese, and to have made frequent reservations in his leases of a certain quantity of wine for rent. A plot of land in London, which now forms East Smithfield and some adjoining streets, was withheld from the religious house within Aldgate by four successive constables of the Tower, in the reigns of Rufus, Henry, and Stephen, and made by them into a vineyard, which yielded great emolument. In the old accounts of rectorial and vicarial revenues, and in the old registers of ecclesiastical suits concerning them, the tithe of wine is an article that frequently occurs in Kent, Surry, and other counties. And the wines of Gloucestershire, within a century after the Conquest, were little inferior to the French in sweetness. The beautiful region of Gaul, which had not a single vine in the days of Cæsar, had numbers so early as the time of Strabo. The south of it was particularly stocked with them; and they had even extended themselves into the interior parts of the country; but the grapes of the latter did not ripen kindly. France was famous for its vineyards in the reign of Vespasian, and even exported its wines to Italy. The whole province of Narbonne was then covered with vines; and the wine-merchants of the country were remarkable for knavish dexterity, tinging it with smoke, colouring it (as was suspected) with herbs and noxious dyes, and even adulterating the taste and appearance with aloes. And as our first vines would be transplanted from Gaul, so were in all probability those of the Allobroges in Franche-compté. These were peculiarly fitted for cold countries. They ripened even in the frosts of the advancing winter; and they were of the same colour, and seem to have been of the same species, as the black muscadines of the present day, which have lately been tried in this island, and found to be fittest for the climate. These were pretty certainly brought into Britain a little after the vines had been carried over all the kingdoms of Gaul, and about the middle of the third century, when the numerous plantations had gradually spread over the face of the latter, and must naturally have contributed to their progress into the former.

The Romans, even nearly to the days of Lucullus, were very seldom able to regale themselves with wine. Very little was then raised in the compass of Italy; and the foreign wines were so dear, that they were rarely produced at an entertainment; and when they were, each guest was indulged only with a single draught. But in the seventh century of Rome, as their conquests augmented the degree of their wealth, and enlarged the sphere of their luxury, wines became the object of particular attention. Many vaults were constructed, and good stocks of liquor were deposited in them; and this naturally gave encouragement to the wines of the country. The Falernian rose immediately into great repute; and a variety of others, that of Florence among the rest, succeeded it about the close of the century; and the more westerly parts of the European continent were at once subjected to the arms, and enriched with the vines, of Italy. See VINEYARD, and WINE.

VITMANNIA, a genus of plants of the class and order octandria monogynia. The calyx is four-cleft; corolla four petalled; nect. a scale of the base of each filament; nut semilunar, one-seeded. There is one species, a tree of the East Indies.

VITREOUS *humour of the eye*. See OPTICS.

VITRIOL, *martial*, or *sulphat of iron*. This salt was known to the antients, and is mentioned by Pliny under the names of misy, sory, and calchantum. In commerce it is usually denominated green vitriol or copperas. It is not prepared by dissolving iron in sulphuric acid, but by moistening the pyrites which are found native in abundance, and exposing them to the open air. They are slowly covered with a crust of sulphat of iron, which is dissolved in water, and afterwards obtained in crystals by evaporation. Sometimes the salt is found ready-formed, either in a state of solution in water, or mixed with decayed pyrites. In some cases it is found necessary to roast the pyrites before they can be made to undergo spontaneous decomposition. This is most probably owing to the compact state of the pyrites in these cases, and the absence of all uncombined iron. Pyrites is in fact a supersulphuret of iron. The roasting reduces it to the state of a sulphuret, which decomposes very readily.

Sulphat of iron has a fine green colour. Its crystals are transparent rhomboidal prisms, the faces of which are rhombs with angles of 79° 50′ and 100° 10′, inclined to each other at angles of 98° 37′ and 81° 23′. It has a very strong styptic taste, and always reddens vegetable blues. Its specific gravity is 1.8399. It is soluble in about two parts of cold water, and in $\frac{3}{4}$ths of its weight of boiling water. It is insoluble in alcohol.

VITRIOL, *blue*, or *sulphat of copper*. Sulphuric acid does not attack copper while cold, but at a boiling heat part of the acid is decomposed, the copper is oxidized, and combines with the remainder of the acid. But recourse is seldom had to this process, as the sulphat of copper is found native abundantly, dissolved in mineral waters connected with copper-mines. From these waters it is often obtained by evaporation; or it is formed by burning native sulphuret of copper, or by moistening that substance, and exposing it to the air. By either of these methods the sulphur is acidified, and the sulphat of copper formed. This salt appears to have been known to the antients. In commerce it is distinguished by the name of blue vitriol, and sometimes by that of blue copperas. It is, in fact, an oxysulphat. There are two varieties of this salt known, namely, supersulphat, and subsulphat.

VITRIOL, *white*, or *sulphat of zinc*. This salt, according to the best accounts, was discovered at Rammelsberg in Germany about the middle of the 16th century. Many ascribe the invention to Julius duke of Brunswick. Henkel and Newmann were the first chemists who proved that it contained zinc; and Brandt first ascertained its composition completely. It is generally formed for commercial purposes from sulphureted zinc; or blende, as it is called by mineralogists. This ore is roasted, which converts the sulphur into an acid; it is then dissolved in water, and concentrated so much, that on cooling it crystallizes very rapidly, and forms a mass not unlike loaf-sugar. This salt is usually called white vitriol. It is almost always contaminated with iron, and often with copper and lead. Hence the yellow spots which are visible on it, and hence also the reason that its solution in water lets fall a dirty-brown sediment; a circumstance very much complained of by surgeons when they use that solution in medicine. It may be easily purified by dissolving it in water, and putting into the solution a quantity of zinc-filings; taking care to agitate it occasionally. The zinc precipitates foreign metals, and takes their place. The solution is then to be filtered, and the sulphat of zinc may be obtained from it in crystals by proper evaporation.

We have inserted these three articles under the vulgar names in compliance with common prejudice. They are, however, noticed under their proper heads, and we trust the advancement of chemical knowledge will shortly banish these barbarous terms.

VITUS's DANCE. See MEDICINE.

VIVERRA, a genus of quadrupeds of the order of feræ. The generic character is, cutting-teeth six, sharpish; canine teeth longer; tongue in some smooth, in others aculeated backwards; body of a lengthened form. This genus comprehends all the animals of the weesel kind, which seem to be somewhat unnecessarily separated by Linnæus into two distinct genera, under the titles viverra and mustela; in which latter genus the otters are also included. In this particular Mr. Pennant seems to have acted more judiciously than Linnæus. We shall therefore follow his example, and unite the two genera, preserving the otters distinct under the term MUSTELA, which see.

The general character of the weesel tribe (of which there are about 31 species) is, a certain slenderness and length of body; with a sharpened visage, short legs, and, in most species, a longish tail (though in some few it is short).

1. Viverra ichneumon. The ichneumon is a species of which there seem to be two distinct varieties; one of which is a native of India, and the other of Africa. Both agree in their general appearance, but the Egyptian variety is considerably larger than the Indian, measuring more than forty inches from the nose to the end of the tail; whereas the Indian ichneumon scarcely exceeds two-thirds of this length. Exclusive of size alone, the Egyptian ichneumon is distinguished by having the tail slightly tufted at the end, which the other has not; and from this circumstance it is placed, in the Gmelinian edition of the Systema Naturæ, as a distinct species. The ichneumon is of a pale reddish-grey colour, each hair being mottled with brown or dusky, so that the whole appears speckled in the manner of the hair on some of the larger baboons. The eyes are of a bright red or flame-colour; the ears rounded, and almost naked; the nose long and slender; the body rather thicker than in most of this genus; and the tail is very thick at the base, and thence gradually tapers almost to a point; the legs are short; the hair on the whole animal is hard and coarse, and it varies somewhat as to the depth and cast of its colours in different individuals. In India, but still more in Egypt, the ichneumon has always been considered as one of the most useful and estimable of animals; since it is an inveterate enemy to serpents, rats, and other noxious creatures

hich infest those regions. In India it attacks, with the greatest eagerness and courage, that most dreadful reptile the cobra de capello, or hooded snake, and easily destroys it. It also diligently seeks for the eggs of crocodiles; for which reason, as well as for its general usefulness in destroying all manner of troublesome reptiles, it was held in such a high degree of veneration by the ancient Egyptians as to be regarded in the light of a minor deity, one of those benevolent beings proceeding from the parent of the universe. For the purposes above specified it is still domesticated by the Indians and Egyptians, in the same manner as the cat in Europe; and it has also the merit of being easily tamed, and of performing all the services of the cat with a still greater degree of vigour and alacrity. When in pursuit of prey, it sometimes springs suddenly upon it with the greatest agility; and at other times will glide along the ground like a serpent, without raising its body, till it arrives at a proper distance for its intended attack. Like many other animals of this tribe, it is a most dangerous enemy to several creatures larger than itself; over which it gains a ready victory, by fastening itself upon them, and sucking their blood. In a wild state, it is said principally to frequent the banks of rivers; and in times of flood to approach the higher grounds and inhabited places, in quest of prey. It is reported to swim and dive occasionally, in the manner of the otter, and to continue beneath the water for a great length of time.

The ichneumon is found not only in various parts of India, but in the Indian islands, as Ceylon and others. It also occurs in many parts of Africa besides Egypt, as in Barbary, and at the Cape of Good Hope, &c. As it is a native of warm countries, it is of course greatly injured by a removal to the colder regions of Europe, and generally falls a victim to the alteration of climate. See Plate Nat. Hist. fig. 418.

2. Viverra surikatta. The surikate is distinguished by a long sharp-pointed nose, depressed head, and inflated cheeks; the upper jaw is much longer than the lower, and on its upper part is black; the eyes are also surrounded by black; the ears are small and rounded; the tongue is oblong, blunt, and aculeated backwards; the length of the animal, exclusive of the tail, is about a foot, and of the tail about eight inches; the legs are short; the claws on the fore feet much exceed in length those of the hind feet. The general colour of the surikate is a deep grey; the tail is subferruginous, tipped with black. It is an inhabitant of the Cape of Good Hope, where it is called meer-rat. It feeds on flesh, and preys on mice, and other small animals. It commonly sits erect, in the manner of a squirrel; and when pleased makes a rattling noise with its tail, for which reason the Dutch inhabitants of the Cape call it klapper-maus. It is also found in the island of Java, where it is named surikatje by the Dutch, on account of a peculiarly acid scent, which it is said to emit. It is an animal of a capricious disposition when in a state of captivity. In having only four toes, it differs from most of this tribe.

3. Viverra nasua. The size of this animal is at least equal to that of a cat. Its general colour is a cinereous brown, or ash-colour, with a cast of reddish; the tail, which is of very considerable length, is annulated with distinct circles of black: its most remarkable character is the long, flexible snout, somewhat truncated at the end. By the assistance of this it turns up the earth, in the manner of a hog, in quest of earth-worms, &c. Like the polecat, it also preys on the smaller quadrupeds, birds, &c. It is a native of South America, and seems to have been first described by Marcgrave in his History of Brasil. There is a particularity sometimes observable in this animal, which seems worthy of notice, viz. a kind of prolongation of the skin at the back of the heel into several horny processes, of about a quarter of an inch in length: these in some specimens are scarcely visible. The tongue is marked on the upper part with several furrows, so disposed as to resemble the fibres of a leaf.

4. Viverra vulpecula. Coasse. This animal is about the size of the polecat, measuring 18 inches from nose to tail; the tail is long and full of hair: the whole animal is of a deep or blackish chocolate-colour, but the tail is sometimes mixed with white. It is a native of Mexico and many other parts of America, and possesses the power of emitting, when attacked or irritated, such powerfully offensive effluvia, as, in most instances, effectually to discomfit and repel its pursuers.

5. Viverra striata. Striated weesel. It has been imagined, and not without a degree of probability, that this animal is the female of viverra vulpecula, or coasse. It is of the same size and general aspect, but is distinguished by five parallel longitudinal white stripes on the back; the tail is very bushy or full of hair. In the different specimens of this animal there is some slight variation observable in the proportion of the dorsal stripes, as well as in the colour of the tail, which is sometimes marked with a pair of lateral white bands, and sometimes almost entirely white. Its manners and horrible vapour, when irritated, perfectly agree with the viverra vulpecula; and the same description of this offensive quality may be applied to this and some other species. If the accounts given of this odious vapour are not aggravated by the abhorrent recollection of those who have experienced its effects, every other ill smell which nature can produce is surpassed by the overpowering fœtor of these extraordinary quadrupeds. In consequence of the dreadful emanation, the dogs are said to relinquish their pursuit, and the men to fly with precipitation from the tainted spot; but if unfortunately the least particle of the fluid which the animal commonly discharges at this juncture, should happen to light on the clothes of the hunter, he becomes a general nuisance wherever he appears, and is obliged to divest himself of his dress, and practise all the arts of ablution, in order to be restored to the society of mankind.

To add to the history of these strange circumstances, it is affirmed that the animal is sometimes tamed, and rendered domestic; in which state it is pretended that it never emits its pestilential vapour, unless greatly displeased or irritated: if this is the case, it ought surely to be treated, as an eminent zoologist has well observed, with the highest attention.

6. Viverra capensis. The Cape weesel, is one of the larger animals of the genus, measuring two feet from nose to tail, which is eight inches long. Its colour is a cinereous grey above, and brownish black below; the two colours being separated along the whole length of the animal, from the base of the tail, by a stripe of black and white; the ears are scarcely visible; the tail rather thick; the legs short, and the head large; the snout short and somewhat pointed; the body seems of a thicker form than is usual in this genus.

This animal, when pursued, ejects a fetid liquid, accompanied by a smell as insufferable as that of some of the American weesels or skunks, and productive of the same effects.

7. Viverra civetta. Civet. The viverra civetta, commonly known by the name of the civet-cat, is a native of several parts of Africa and India. The general length of this animal, from nose to tail, is something more than two feet, and the tail measures fourteen inches. The ground colour of the body is yellowish ash-grey, marked with large blackish, or dusky spots, disposed in longitudinal rows on each side, and sometimes a tinge of ferruginous appears intermixed; the hair is coarse, and along the top of the back stands up, so as to form a sort of mane; the head is of a lengthened or sharpish form, with short rounded ears; the eyes are of a bright sky-blue; the tip of the nose black; the sides of the face, chin, breast, legs, and feet, are black; the remainder of the face, and part of the sides of the neck, are of a yellowish white; from each ear are three black stripes, terminating at the throat and shoulders; the tail is generally black, but sometimes is marked with pale or whitish spots on each side the base. It is an animal of a wild disposition, and lives in the usual manner of others of this genus, preying on birds, the smaller quadrupeds, &c. It is remarkable for the production of the drug called civet (sometimes erroneously confounded with musk). This substance is a secretion formed in a large double glandular receptacle, situated at some little distance beneath the tail, and which the animal empties spontaneously. When the civet-cats are kept in a state of confinement (as is usual with the perfumers at Amsterdam and other places), they are placed, from time to time, in strong wooden cages or receptacles, so constructed as to prevent the creature from turning round and biting the person employed in collecting the secreted substance; this operation is said to be generally performed twice a week, and is done by scraping out the civet with a small spatula, or spoon. This substance is of a yellowish colour, and of the consistence of an unguent; of an extremely strong and even unpleasant odour when fresh, so as sometimes to cause giddiness and head-ache, but becomes more agreeable by keeping: the quantity obtained each time amounts to about a dram.

Civet, though an article in the more antient materia medica, and though still employed by the Oriental physicians, is with us chiefly used in perfumes. It has a very fragrant smell, and a subacrid taste; it unites readily with oils, both expressed and distilled; in watery or spiritous menstrua it does not dissolve, but impregnates the fluids strongly with its odour. It may, however, be made to unite with, or be soluble in, water, by means of rubbing with mucilages.

8. Viverra zibetha. Zibet. This, which was figured as a variety by Gesner, and more precisely discriminated by Buffon, seems to be considered by modern naturalists as a distinct species. The zibet is chiefly found in India and the Indian islands. Its general aspect is the same with the former species, but its snout is somewhat sharper, and its tail longer. In short, this species may be called the Indian, and the former the African, civet-cat. In disposition and manners they both seem to agree; as well as in the secretion of the perfume before described, which is collected from both animals in the same manner.

9. Viverra genetta. The genet is one of the most beautiful animals of this genus. It is about the size of a very small cat, but is of a longer form, with a sharp-pointed snout, upright ears, slightly pointed, and very long tail. The colour of the genet is commonly a pale-reddish grey, with a black or dusky line running along the back, where the hair is rather longer than on the other parts, and forms the appearance of a very slight mane; along the sides of the body run several rows of roundish black spots, which sometimes incline a little to a squarish form; the muzzle is dusky; beneath each eye is a white spot; the cheeks, sides of the neck, and the limbs, are spotted in a proportionally smaller pattern than the body, and the tail is annulated with black.

The genet is an animal of a mild disposition, and easily tamed. In various parts of the East, as well as at Constantinople, it is domesticated like the cat, and is said to be equal, or superior, to that animal in clearing houses from rats or mice. It is a cleanly animal, and has a slight musky smell. It is a native of the western parts of Asia, but is said likewise to occur in Spain, and even occasionally in some parts of France.

10. Viverra fossa. The fossane appears to be so nearly allied to the genet, that it might almost pass for a variety of that animal. This animal is a native of Madagascar, Guinea, Bengal, Cochinchina, and the Philippine islands. It is said to be possessed of considerable fierceness, and to be with difficulty tamed. It destroys poultry in the manner of the common weesel. When young, it is said to be good food. Its size is that of the genet. See Plate Nat. Hist. fig. 419.

11. Viverra caudivolvula. Prehensile weesel. This animal, having a prehensile tail, is nineteen inches in length from the nose to the tail, which is seventeen inches long. The nose is short and dusky; the eyes small; the ears short, broad, and flapping, and placed at a great distance from each other; the head flat and broad; the cheeks swelling out; the tongue very long; the legs and thighs short and thick, with five toes to each foot; claws large, slightly hooked, and flesh-coloured. Its colour yellow, shaded with dusky. A blackish or dusky list runs down the back from head to tail, and a similar one half way down the belly. This animal is of gentle manners, active and playful, and hangs by its tail occasionally, in the manner of the prehensile-tailed monkeys. It is supposed to be a native of Jamaica.

12. Viverra foina. The marten is an animal of a highly elegant appearance. Its general length, from nose to tail, is about a foot and a half, and the tail is ten inches long. The marten is of a blackish tawny colour, with a white throat; and the belly is of a dusky brown; the tail is bushy, or full of hair, and of a darker colour than the other parts; the ears are moderately large and rounded, and the eyes lively. This animal is a native of most parts of Europe; inhabiting woods and fields, and preying on birds and other small animals. If taken young, it may be easily tamed, and even rendered domestic. It breeds in the hollows of trees, and brings forth from three to five young. The skin is used as a fur.

13. Viverra zibellina. The sable is greatly allied to the marten in its appearance, but has a longer or sharper head, and more lengthened ears. Its general colour is a deep glossy brown; the hair being ash-coloured at the roots and black at the tips; the chin is cinereous, and the edges of the ears yellowish. Its size is equal to that of the marten; but, exclusive of other differences, a principal one consists in the tail, which is much shorter in proportion than in the marten. The sable is an inhabitant of the northern parts of Asia, and is an extremely important article in the fur-trade. It principally lives in holes under ground, especially under the roots of trees, and sometimes, like the marten, forms its nest in the hollows of trees. It is an active, lively animal, preying, in the manner of the marten, on the smaller quadrupeds, birds, &c. Like the marten, it is also most lively during the night, and sleeps much by day. In autumn the sable is said to eat cranberries, whortles, &c. It brings forth early in the spring, and has from three to five young at a time. The chase of the sable, according to Mr. Pennant, was, during the more barbarous periods of the Russian empire, the principal task of the unhappy exiles who were sent into Siberia, and who, as well as the soldiers sent there, were obliged to furnish, within a given time, a certain quantity of furs; but as Siberia is now become more populous, the sable have in a great measure quitted it, and have retired farther to the north and east, into the desert, forests, and mountains.

Sables are numbered among the most valuable of furs. From an abstract drawn up by the late Dr. Forster, from Muller's account of its commercial history, it appears that the price varies, from one to ten pounds sterling and above. The blackest, and those which have the finest bloom or gloss, are reputed the best. The very best are said to come from the environs of Nertchisk and Yakutsk, and in this latter district the country about the river Ud sometimes affords sables of which a single fur is sold, at the rate of sixty or seventy rubles, or twelve or fourteen pounds sterling. Sometimes the furs of sables are fraudulently dyed, and otherwise prepared, in order to give them a more intense colour, but these are very inferior to the fine natural ones, and are distinguishable by a kind of withered or dull appearance of the hair itself when accurately inspected.

The sable occurs in North America, as well as in Asia; the American sables are said to be chiefly of a chesnut-colour, and more glossy, but coarser, than the Siberian sables. It is necessary to observe, that the sable varies in its cast of colour at different seasons and in different districts; instances have been known, though rarely, of its being found perfectly white.

14. Viverra putorius. The polecat is one of the most remarkable European species of the weesel tribe. Its colour is an extremely deep blackish-brown, with a tawny cast slightly intermixed; the ears are edged with white, and the space round the muzzle is also whitish. The general length of this animal is seventeen inches, exclusive of the tail, which measures about six inches. The polecat is found in most parts of Europe, as well in some of the Asiatic regions, as in Siberia, where it is said to be generally found with the rump of a whitish or yellowish tinge, surrounded with black.

The polecat commonly forms itself a subterraneous retreat, sometimes beneath the roots of large trees, and sometimes under hay-ricks, and in barns. It preys indiscriminately on the smaller animals, and is very destructive to poultry: it is also, like the ferret, a cruel enemy to rabbits, which it destroys by sucking their blood, instead of tearing them immediately in pieces. It steals into barns, pigeon-houses, &c. where it occasionally makes great havock; biting off the heads of fowls and pigeons, and then carrying them away to its retreat; and sometimes it carries off the heads alone. During the summer, however, it principally frequents rabbit-warrens, or the hollow trunks of trees, &c. &c. and prowls about in quest of young birds, rats, field-mice, &c. According to the count de Buffon, a single family of polecats is sufficient to destroy a whole warren of rabbits; and he observes, that this would be a simple method of diminishing the number of rabbits where they are too abundant. In Spain the ferret is said to have been formerly introduced for a similar purpose. The polecat also preys occasionally on fish, of which a curious instance is recorded in Mr. Bewick's History of Quadrupeds. During a severe storm, one of these animals was tracked in the snow from the side of a rivulet to its hole, at some distance from it; as it was observed to have made frequent trips, and as other marks were seen in the snow, which could not easily be accounted for, it was thought a matter worthy of more diligent enquiry; its hole was accordingly examined, the animal taken, and eleven fine eels were discovered to be the fruits of its nocturnal excursions; the unusual marks in the snow having been made by the motion of the eels while dragged along in the animal's mouth. That the polecat, however, sometimes feeds in this manner, is, in reality, no new observation; since Aldrovandus assures us that it will occasionally take up its residence in the hollow banks of rivulets, in order to lie in wait for, and prey upon, fish. The polecat is also delighted with milk, and will visit the dairy, in order to indulge in this article. It has been known to attack bee-hives in the winter season, and to feed on the honey. The spring is the season in which it breeds; the female producing three or four at a birth, which she is said to suckle but a short time, accustoming them early to suck the blood of the animals which she brings to them, as well as eggs, &c.

The polecat has been known to breed with the ferret; and it is said to be a practice with warreners, who keep these animals, to procure a mixed breed from time to time, which are of a colour between the ferret and the polecat, or of a dingy yellowish-brown.

The polecat is a strong and active creature, and will spring with great vigour and celerity when preparing to attack its prey, or to escape from pursuit, at which time it arches its back considerably, in order to assist its effort. It is of a smell proverbially fetid, being furnished, like several others of the weesel tribe, with certain receptacles which secrete a thickish fluid of a peculiarly strong and offensive odour. The fur, however, is beautiful, and the skin, when properly dressed, is numbered among the commercial furs, and used for tippets and other articles of dress. It is added by Aldrovandus, that the furriers endeavour to obtain skins taken from such animals as have been killed during the winter, as being far less fetid than those killed in the spring and summer.

15. Viverra fero. Ferret. Of similar manners to the polecat is the ferret, the natural history of which has been so well detailed by the count de Buffon, that it is scarcely possible to add any thing material to that elegant author's description. The ferret in general form resembles the polecat, but is a smaller animal; its usual length being about fourteen inches, exclusive of the tail, which is about five. Linnæus, in the twelfth edition of the Systema Naturæ, seems to entertain a doubt whether it is truly distinct from the polecat; it is, however, a native of Africa, and not of Europe, and supports with difficulty the cold of an European winter; whereas the polecat is found not only in the temperate, but also in the colder parts of the European regions; to which may be added, that, exclusive of its smaller size, it is of a more slender shape, and the snout is sharper in proportion than in the former animal. The ferret is used for rabbit-hunting in preference to the polecat, because it is more easily tamed; but it is necessary to keep it in a warm box, with wool, or some other substance, in which it may imbed itself. It sleeps almost continually, and when awake, immediately begins to search about for food: it is usually fed with bread and milk; but its favourite food is the blood of the smaller animals. It is by nature an enemy to the rabbit; and it is affirmed by Buffon, that whenever a dead rabbit is presented for the first time to a young ferret, he flies upon it in an instant, and bites it with great fury; but if it is alive, he seizes it by the throat, and sucks its blood. When let into the burrows of rabbits, the ferret is always muzzled, that it may not kill the rabbits in their holes, but only drive them out, in order to be caught in the nets. If the ferret is put in without a muzzle, or happens to disengage himself from it, he is often lost; for after sucking the blood of the rabbit, he falls asleep, and cannot be regained, except sometimes by smoking the hole, in order to oblige him to come out; but as this is a practice which does not always succeed, it continues to lead a rapacious and solitary life in the warren, as long as the summer continues, and perishes by the cold of the winter.

We are told by Strabo that the ferret was brought into Spain from Africa: and it is supposed that this was done in order to free that country from the vast number of rabbits with which it was over-run; and from Spain it was gradually introduced into other European countries. The ferret is an animal of an irascible nature, and, when irritated, his odour, which is at all times disagreeable, becomes far more so than usual. The general colour of the ferret is a very pale yellowish-brown, or cream-colour; and the eyes are of a bright and lively red.

16. Viverra vulgaris. The common weesel, is one of the smallest species in this numerous tribe of quadrupeds. Its general length is about seven inches, exclusive of the tail, which measures near two inches and a half. Its colour is a pale reddish, or yellowish-brown, and beneath it is entirely white; but below the corners of the mouth, on each side, is a brown spot: the ears are small and rounded, and the eyes are black. This little animal is possessed of a considerable degree of elegance in its aspect, and its motions are light and easy; but it has the same unpleasant smell with the stoat, and some other species. It is an inhabitant of the cavities under the roots of trees, as well as of banks near rivulets, &c. from which it occasionally sallies out in quest of birds, field-mice, &c. It even attacks young rabbits, and other animals of far superior size to itself; but its chief prey, at least in this country, seems to be the field-mouse, of which it destroys great multitudes. From the extreme flexibility of its body, and its wonderful activity, it readily ascends the sides of walls, and by this means pursues its prey into the most distant retirements; and is a frequent inhabitant of barns and granaries. The weesel produces four or five young at a time; preparing for them a bed of moss, grass, &c. An instance is given by the count de Buffon of a weesel's nest being found in the carcase of a wolf, which had been hung up near a wood; the nest was made in the cavity of the thorax. The count de Buffon, in his first description of the weesel, affirmed that it was a perfectly untameable animal; but he afterwards received very authentic accounts of weesels which had been so completely tamed as to exhibit every mark of attachment to their benefactors, and to be as familiar as a cat or lap-dog. An account of this kind is given by one of his correspondents in the seventh supplemental volume of his Natural History, which amply confirms the truth of this; and among other curious particulars, it is observed, that when asleep, the muscles of this little animal are in a state of extreme flaccidity, so that it may be taken up by the head, and swung backwards and forwards, in the manner of a pendulum, several times, before it wakes.

17. Viverra erminea. Stoat. This animal much resembles the weesel in its general appearance, as well as in colour, but is considerably larger; the body, exclusive of the tail, measuring ten inches, and the tail five and a half; the tip of the tail is also constantly black, whatever may be the gradation or cast of colour on the body; for the stoat, in the northern regions, becomes milk-white during the winter, in which state it is commonly called the ermine. It is sometimes found of this colour in our own country; and instances are not very uncommon in which it appears parti-coloured, or white in some parts and brown in others, the change of colour having not been completed. Its smell is strong and unpleasant. The stoat is similar in its manners to the weesel, living in hollows under the roots of trees, in banks near rivulets, &c. and preying on all manner of smaller animals, as well as on rabbits, &c. It does not, however, like the weesel, visit houses, but confines itself to the fields. It is an inhabitant both of the northern part of Europe and of Asia. It occurs in Kamtschatka and the Kurile isles. It is also said to be found in several parts of North America.

In Norway and in Siberia the skins are a great article of commerce; most of the ermines or white stoat-skins being brought thence. In Siberia the stoat is said to be found in the birch forests, but not in the pine forests; and the skins are sold on the spot, according to Mr. Pennant, at from two to three pounds sterling per hundred. The animals are either taken in traps or shot with blunt arrows.

18. Viverra maculata. Spotted weesel. This, which is described in governor Phillips's Voyage to Botany Bay, is said to be of the size of a large polecat, measuring 18 inches from nose to tail, and the tail nearly as much; and the visage is of a pointed shape. The colour is said to be black, marked all over, the tail not excepted, with irregular blotches of white; the tail is represented as thin, and gradually tapering to the end; the whiskers very long, and the general apparance of the animal such as to resemble the viverrine opossum in most particulars, except in the appearance of the tail.

VIVIPAROUS, in natural history, an epithet applied to such animals as bring forth their young alive and perfect, in contradistinction to those that lay eggs, which are called oviparous animals.

ULCER. See Surgery.

ULLAGE, in gauging, is so much of a cask, or other vessel, as it wants of being full. See Gauging.

ULMUS, a genus of plants of the class pentandria, and order digynia, and in the natural system arranged under the 53d order, scabridæ. The calyx is quinqued; there is no corolla. The fruit is a dry, compressed, membranaceous berry. There are six species, two of which are natives of Britain, viz. the campestris, common elm, and the montana, or wych elm. All the sorts of elm may be either propagated by layers or suckers taken from the roots of the old trees, the latter of which is generally practised by the nursery-gardeners; but as these are often cut up with indifferent roots, they often miscarry, and render the success doubtful; whereas those which are propagated by layers are in no hazard, and always make better roots, and come on faster, than the other, and do not send out suckers from their roots in such plenty, for which reason this method should be more universally practised. The elm delights in a stiff, strong soil. It is observable, however, that here it grows comparatively slow. In light land, especially if it is rich, its growth is very rapid; but its wood is light, porous, and of little value, compared with that which grows upon strong land, which is of a closer, stronger texture, and at the heart will have the colour, and almost the heaviness and the hardness, of iron. On such soils the elm becomes profitable, and is one of the trees which ought, in preference to all others, to engage the planter's attention.

ULNA. See ANATOMY.

ULVA, a genus of plants of the class cryptogamia, and order of algæ. The fructification is inclosed in a diaphanous membrane. There are 26 species of British plants. They are all sessile, and without roots, and grow in ditches, and on stones along the sea-coast. None of them are applied to any particular use different from the rest of the algæ, except the umbilicalis, which in England is pickled with salt, and preserved in jars, and afterwards stewed and eaten with oil and lemon juice. This species, called in English the navel laver, is flat, orbicular, sessile, and coriaceous.

UMBELLÆ, *umbels*, among botanists, the round tufts or heads of certain plants set thick together, and all of the same height.

UMBELLIFEROUS PLANTS, are such as have their tops branched and spread out like an umbrella, on each little subdivision of which there is growing a small flower; such are fennel, dill, &c. See BOTANY.

UMBER, or UMBRE, *umbria*, among painters, &c. a kind of dry dusky-coloured earth, which, diluted with water, serves to make a dark-brown colour, usually called with us a hair-colour. It is called umber, from umbra, a shadow, as serving chiefly for the shading of objects; or, perhaps, from Umbria a country of Italy, whence it used to be brought.

UMBER, or *grayling*, in ichthyology. See SALMO.

UNCARIA, a genus of plants of the class and order pentandria monogynia. The corolla is salver-shaped; germ. crowned with a gland; stigma two-grooved; peric. two-celled, many-seeded. There are two species.

UNCIA, in general, a Latin term denoting the twelfth part of any thing, particularly the twelfth part of a pound, called in English an ounce; or the twelfth part of a foot, called an inch. See MEASURE, and WEIGHT.

UNCIÆ, in algebra, the numbers prefixed before the letters of the members of any power produced from a binomial, residual, or multinomial root. Thus, in the fourth power of $a+b$, viz. $a^4+4a^3b+6a^2b^2+4ab^3+b^4$, the unciæ are 4, 6, and 4, being the same with what others call co-efficients. See ALGEBRA.

UNDECAGON, is a polygon of eleven sides. If the side of a regular undecagon is 1, its area will be $9{,}3656399 = \frac{11}{4} \times$ tang. of $73\frac{7}{11}$ degrees; and therefore if this number is multiplied by the square of the side of any other regular undecagon, the product will be the area of that undecagon.

UNGUIS. See ANATOMY.

UNGULA, in geometry, is a part cut off a cylinder, cone, &c. by a plane passing obliquely through the base, and part of the curve surface, so called from its resemblance to the (ungula) hoof of a horse, &c.

UNICORN-FISH. See MONODON.

UNIOLA, a genus of the triandria digynia class of plants, the corolla whereof consists of a bivalve glume; the valves are of a lanceolate-compressed figure, like those of the cup; the inner valve appears somewhat higher than the outer one; the corolla performs the office of a pericarpium, inclosing the seed, which is single, and of an ovated oblong figure. There are three species.

UNISON, in music, that consonance, or coincidence of sounds, proceeding from an equality in the number of vibrations made in a given time by two sonorous bodies; or the union of two sounds so directly similar to each other in respect of gravity, or acuteness, that the ear perceiving no difference, receives them as one and the same.

The antients were much divided in opinion respecting the question whether the unison is a consonance. Aristotle speaks in the negative; Muris Mersennus, and others, declare in the affirmative. The decision of the question, however, depends on the definition we give to the word consonance. If by a consonance we only understand two or more sounds agreeable to the ear, the unison is a consonance; but if we include in the consonance sounds of a different pitch, *i. e.* sounds less or more acute with respect to each other, the unison, by its own definition, is not a consonance.

UNISONI, (Ital. plu.,) a word implying that the parts in a score over which it is written, are in unison with each other; as violini unisoni, the violins in unison; flauti unisoni, the flutes in unison.

UNITY. See POETRY.

UNONA, a genus of the polyandria polygamia class and order of plants. The calyx is three-leaved, six-petals; berries two or three seeded. There are four species, trees of the East and West Indies.

UNXIA, a genus of plants of the class and order syngenesia polygamia superflua. The calyx is five-leaved, leaflets ovate; florets of disk and ray five, recept. naked. There is one species.

VOID AND VOIDABLE, in the law. Some things are absolutely void, and others only voidable. A thing is void which is done against law at the very time of doing it, and no person shall be bound by such an act; but a thing is only voidable which is done by a person who ought not to have done it, but who, nevertheless, cannot avoid it himself after it is done; though it may be by some act in law made void by his heir, &c. 2 Lil. Abr. 807.

VOLCANO, in natural history, a burning mountain, or one that occasionally vomits forth fire, flame, ashes, cinders, &c. Volcanoes are peculiar to no climate, and have no necessary connection with any other mountains, but seem to have some with the sea, being generally in its neighbourhood; they frequently throw out matters which belong to the sea, as the relics of fishes, sea-weed, and sometimes sea-water itself. Sir William Hamilton observes in the Phil. Trans. for 1776, that "the operations of Vesuvius are very capricious and uncertain, except that the smoke increases considerably and constantly when the sea is agitated, and the wind blows from that quarter. Volcanic mountains are of all heights; some, as that of Tanna, so low as 450 feet; Vesuvius is 3600 feet high; and Etna, 11000. They in general form lofty spires; and the volcano itself is internally shaped like an inverted cone, placed on a broader basis. This cone is called the crater, or bowl, and through it the lava generally passes, though sometimes it bursts through the sides, and even proceeds occasionally from the bottom of the mountain. Sometimes the crater falls in, and is effaced; sometimes, in extinguished volcanoes, it is filled with water. Submarine volcanoes have been observed, and from these some islands have derived their origin. Volcanic fires taking place at the bottom of the ocean, would frequently, by the expansive force of the steams which are generated, elevate those parts which were once at the bottom of the deep, and overflow those which were habitable earth. It is conjectured, that subterraneous convulsions operated more powerfully in the early ages of the world than at any later period; and indeed such an hypothesis is supported by the most probable reasoning, since we may well conceive that at the first consolidation of the earth, much heterogeneous matter would be included in the different masses, which might produce more frequent fermentations than at any after periods, when these have been, if we may so express it, purged off by frequent eruptions, and in many parts, perhaps, rectified and assimilated by slow and secret processes in the bowels of the earth. But history was not cultivated till a very late period, and the most eventful ages of nature have passed unrecorded.

The force of subterraneous fires, or rather of the steam which is generated by them, is so great, that considerable rocks have been projected by Vesuvius to the distance of eight miles. A stone was once thrown from the crater of that volcano twelve miles, and fell upon the marquis of Lauro's house at Nola, which it set on fire. One also, which measured twelve feet in height and forty-five in circumference, was carried, in 1767, by the projectile force of the steam, a quarter of a mile from the crater. In an eruption of Etna, a stone, fifteen feet long, was ejected from the crater to the distance of a mile, and buried itself eight feet deep in the ground.

A volcano broke forth in Peru in 1600, accompanied with an earthquake, and the sand and ashes which were ejected covered the fields ninety miles one way, and one hundred and twenty another. Dreadful thunders and lightning were heard and seen for upwards of ninety miles round Araquapa during this eruption, which seemed to denote some connection between the electric matter and these volcanic fires; and this fact is strongly confirmed by the very accurate observations of sir William Hamilton, which we shall afterwards have occasion to notice more at large.

Both the inside of the crater and the base of many volcanoes, consist of lava, either entire or decomposed, nearly as low as the level of the sea; but they finally rest either on granite, as in Peru, or schistus, as the extinguished volcanoes of Hesse and Bohemia, or on limestone, as those of Silesia, mount Vesuvius, &c. No ore is found in these mountains, except that of iron, of which lava contains from twenty to twenty-five parts in the hundred, and some detached fragments of the ores of copper, antimony, and arsenic. Vesuvius ejected, from the year 1779 to 1783, 309,658,161 cubic feet of matter of different kinds; we must therefore conclude the seat of these fires to be several miles below the level of the sea; and as iron makes from one-fourth to one-fifth of these ejections, we may infer that the internal parts of the earth abound much in this metal.

The origin of these subterraneous fires is not easily explained. Iron-filings mixed with powdered sulphur, and the whole moistened with water into a paste, will swell, become hot, and if the quantity is considerable, will throw out a blue flame. It is a mixture of this kind which is used for making an artificial earthquake; for such a quantity of inflammable gas is produced during the fermentation, that if the mass is buried in the earth, the gas will force a passage for its escape, and exhibit, on a small scale, the phenomena of an earthquake. M. Lemery seems to have been the first person who illustrated, in this manner, the origin of volanic fires and earthquakes. He mixed twenty-five pounds of iron-filings with an equal weight of sulphur, and having made them into a paste, with the addition of water, he put them into a pot, covered them with a cloth, and buried them a foot under ground. In about eight or nine hours time the earth swelled, became warm, and cracked, and hot sulphureous vapours were perceived. Now large beds of martial pyrites, sulphuret of iron, are known to exist in different parts of the earth; the only difficulty which attends this explanation of the origin of volcanoes, as well as of earthquakes, is, that the presence of air is in general necessary for the production of actual flame. It is well known, however, that sulphuret of iron, when moistened, acquires heat; and if we suppose it to have been in contact with black wad and petroleum, we may suppose the flame to arise, as we see it produced by art, from the desiccation of the former substance, and its mixture with mineral oil. Many minerals, when heated, afford oxygen gas, a very small quantity of which is sufficient to produce flame; this flame, once produced, may be supported from other ores, and the combustion be maintained by the presence of bituminous schistus, bitumen, and coal. Marl, schistus, horn-stone, schorl, with a further addition of iron, are the true sources of lava. It seems, however, after all, difficult to conceive that such extensive and intense fires should be maintained without the access of considerable quantities of air; that fluid may therefore be possibly supplied by a communication with some extensive caverns, which may themselves receive it by openings at the distance of many miles from the crater of the volcano. It does not seem improbable that the volcanoes, which now burn, may have a communication with the cavities and craters of extinguished volcanoes, and thence derive a supply of air sufficient to account for the inflammation of large beds of pyrites and bituminous matters. M. Buffon supposes, that the seat of volcanic fires is situated but a very little way below the bed of the mountains; but it appears more probable, that it is in general many miles below the surface of the earth, for the quantity of matter discharged from Etna alone is supposed, on a moderate calculation, to exceed twenty times the original bulk of the mountain, and therefore could not have been derived from its contents alone, but must come from the deeper recesses of the earth.

M. Condamine asserts, that all the mountains in the neighbourhood of Naples exhibit undoubted marks of a volcanic origin. He says, he could trace the lava, and other productions of subterraneous fire, from Naples to the very gates of Rome, pervading the whole soil, sometimes pure and sometimes differently combined. "Wherever I see," says he, "on an elevated plain, a circular bason, surrounded with calcined rocks, I am not deceived by the verdure of the adjacent fields; I can discover, beneath the snow itself, the traces of an extinguished fire. If there is a breach in the circle, I usually find out, by following the declivity of the ground, the traces of a rivulet, or the bed of a torrent, which seems as if it was hollowed in the rock, and this rock appears frequently to be pure lava. If the circumference of the bason has no breach, the rain and spring waters, which are collected there, generally form a lake in the very mouth of the volcano." The Appenines, as well as the Cordilleras of Peru and Chili, he supposes to have been a chain of volcanoes. The chain, in both instances, is interrupted, and many of the fires either extinguished or smothered, but many remain still actually burning. This intelligent author is, however, far from attributing to all mountains the same origin; and adds, that in that part of the Alps, which he travelled over, he could observe no such appearances.

The traces of volcanoes have been observed in Ireland by Mr. Whitehurst. Though no visible crater is remaining between Port Rush Strand and Ballycastle eastward, yet, he observes, that whole space, about twenty English miles, is one continued mass of lava. The cliffs, he says, are truly stupendous, and bear every possible mark of having been originally liquid fire. The elevation of that, at the foot of which the Giant's Causeway is situated, he presumes cannot be less than five or six hundred feet perpendicular above the level of the Atlantic ocean, and yet composed entirely of lava; the same appearances extend towards the south upwards of twenty miles.

The most remarkable volcanoes in Europe are Etna and Vesuvius; and as these are not too far distant, we have the most accurate descriptions of them from travellers of the first talents and reputation.

Etna, which is the most striking object in Sicily, and indeed one of the most magnificent productions of nature, rises from an immense base, and mounts equally on all sides to its summit. The ascent on each side is computed at about thirty miles, and the circumference of its base, at one hundred and thirty-three; but as it has never been measured with any great degree of accuracy, its dimensions are but imperfectly known.

The whole mountain is divided into three distinct regions, called La Region Culta, or Piedmontese, the fertile region; La Regiona Sylvosa, or Nemorosa, the woody region; and La Regiona Deserta, or Scoperta, the barren region. These differ as materially both in climate and production as the three zones of the earth, and perhaps with equal propriety might have been styled the torrid, the temperate, and the frigid zone.

The first region of Etna surrounds the base of the mountain, and constitutes the most fertile country in the world on all sides of it, to the extent of fourteen or fifteen miles, where the woody region begins. It is composed almost entirely of lava, which, in time, becomes the most fertile of all soils; but the roads, which are entirely over old lavas, now converted into orchards, vineyards, and corn-fields, are execrable. The lavas, which form this region, arise from a number of beautiful little mountains, every where scattered over the immense declivities of Etna. These are all either of a conical or hemispherical figure, and are in general covered with beautiful trees, and the most luxurious verdure. The formation of them is owing to the internal fires of Etna, which, raging for a vent, at so vast distance from the great crater, that it cannot possibly be carried to the height of twelve or thirteen thousand feet, which is probably the height of the summit of Etna, must necessarily be discharged at some other orifice. After shaking the mountain, and its neighbourhood, for some time, at length the fire bursts open its side, and this is called an eruption. At first it emits only a thick smoke and showers of ashes. These are followed by red-hot stones, and rocks of a great size, which are thrown to an immense height in the air. These stones, together with the quantities of ashes discharged at the same time, form those mountains, which cover all the declivities of Etna. The size of them is in proportion to the duration of the eruption. When it continues a considerable time, it sometimes forms an elevation of one thousand feet in perpendicular height, which at its base is seven or eight miles in circumference.

After the formation of the new mountain, the lava commonly bursts out from its lower side, and, sweeping every thing before it, is generally terminated by the sea. Sometimes it issues from the side of the mountain, without these attending circumstances, which is commonly the case with the eruptions of Vesuvius; in which the elevation being so much smaller, the melted matter is carried up into the crater, where it is dislodged without forming any new mountain, but only adding to the height of the old one; till at length the lava, rising near the summit, bursts the side of the crater. But Etna being upon a much larger scale, one crater is not sufficient to give vent to such immense oceans of liquid fire.

Many striking remains of the great eruption in 1669 are still to be seen, and will long continue as memorials of that dreadful event which overwhelmed Catania, and all the adjacent country. Tremendous earthquakes shook the island, and subterraneous bellowings were heard in the mountain. During some weeks, the sun ceased to appear, and the day seemed changed into night. Borelli, who was a witness to these terrible phenomena, says, that at length a rent, twelve miles in length, was opened in the mountain, in some places of which, when they threw down stones, they could not hear them reach the bottom. Burning rocks, sixty palms in length, were thrown to the distance of a mile, and lesser stones were carried three miles. After the most violent struggles, and a shaking of the whole island, an immense torrent of lava gushed from the rent, and sprung up into the air to the height of sixty palms, whence it poured down the mountain, and overwhelmed every object in its way in one promiscuous ruin.

This destructive torrent, which burst from the side of Etna, at a place called Ricini, rushed impetuously against the beautiful mountain of Montpelieri, and pierced into the ground to a considerable depth; then dividing and surrounding the mountain, it united again on the south side, and poured desolation upon the adjacent country. The progress of the torrent was at first at the rate of seven miles a day, but it afterwards took four days to travel sixteen: wherever it directed its course, the whole appearance of nature was changed, several hills were formed in places which were formerly valleys, and a large lake was so entirely filled up by the melted mass, as not to leave a vestige remaining. In its course it descended upon a vineyard, belonging to a convent of Jesuits, which was formed upon an antient, and probably a very thin, layer of lava, with a number of caverns and crevices under it. The liquid mass entering into these excavations soon filled them up, and by degrees bore up the vineyard, which in a short time, to the great astonishment of the spectators, began to move away, and was carried by the torrent to a considerable distance. In 1770 some remains of this vineyard were still to be seen, but the greater part of it was entirely destroyed.

After destroying several convents, churches, and villages, this fiery current directed its course to Catania, where it poured impetuously over the ramparts, which are near sixty feet in height, and covered up five of its bastions, with the intervening curtains. After laying waste a great part of this beautiful city, and entirely destroying several valuable remains of antiquity, its further progress was stopped by the ocean, over whose banks it poured its destructive current. In its course from the rent in the mountain, till its arrival in the sea, it is said to have totally destroyed the property of near thirty thousand persons. Twenty-four years after the fatal eruption of 1669, a violent earthquake, which extended along all the eastern coast, and destroyed in one hour more than sixty thousand persons, overthrew the remaining buildings of Catania, and buried a very considerable number of its inhabitants under the ruins of their houses and churches.

The celebrated bishop Berkeley has described an eruption of mount Vesuvius, of which he was a witness in the year 1717, and the reader will find his narrative in the first volume of Dr. Goldsmith's History of the Earth and Animated Nature, p. 94. But the most complete and philosophical account of this formidable phenomenon, a volcanic explosion, is that with which sir William Hamilton has favoured the public, in describing the dreadful eruption of that mountain in 1794, and this we shall endeavour to give, as nearly as possible, in his own words.

Sir William begins his narrative with remarking that the frequent slight eruptions of lava for some years past had issued from near the summit, and ran in small channels in different directions down the flanks of the mountain, and from running in covered channels, had often an appearance as if they came immediately out of the sides of Vesuvius, but such lavas had not sufficient force to reach the cultivated parts at the foot of the mountain. In the year 1779, the whole quantity of the lava in fusion having been at once thrown up with violence out of the crater of Vesuvius, and a great part of it falling, and cooling on its cone, added much to the solidity of the walls of this huge natural chimney, and had not of late years allowed of a sufficient discharge of lava to calm that fermentation, which by the subterraneous noises heard at times, and by the explosions of scoriæ and ashes, was known to exist within the bowels of the volcano. The eruptions, therefore, of late years, before this last, were simply from the lava having boiled over the crater, the sides being sufficiently strong to confine it, and oblige it to rise and overflow. The mountain had been remarkably quiet for seven months before the late eruption, nor did the usual vapour issue from its crater, but at times it emitted small clouds of smoke that floated in the air in the shape of little trees. It was remarked by father Antonio di Petrizzi, a Capuchin friar, (who printed an account of the late eruption,) from his convent close to the unfortunate town of Torre del Greco, that for some days preceding this eruption, a thick vapour was seen to surround the mountain, about a quarter of a mile beneath its crater, and it was observed by him and others at the same time that both the sun and the moon had often an unusual reddish cast.

The water of the great fountain at Torre del Greco began to decrease some days before the eruption, so that the wheels of a corn-mill, wrought by that water, moved very slowly; it was necessary in all the other wells of the town and its neighbourhood to lengthen the ropes daily, in order to reach the water; and some of the wells became quite dry. Although most of the inhabitants were sensible of this phenomenon, not one of them seems to have been sensible of the true cause. Eight days also before the eruption, a man and two boys being in a vineyard above Torre del Greco (and precisely on the spot where one of the new mouths opened, whence the principal current of lava that destroyed the town issued), were much alarmed by a sudden puff of smoke which issued from the earth close to them, and was attended with a slight explosion.

Had this circumstance, with that of the subterraneous noises heard at Resina for two days before the eruption (with the additional one of the decrease of water in the wells), been communicated at the time, it would have required no great foresight to have been certain that an eruption of the volcano was near at hand, and that its force was directed particularly towards that part of the mountain.

On the 12th of June 1794, in the morning, there was a violent fall of rain, and soon after the inhabitants of Resina, situated directly over the antient town of Herculaneum, were sensible of a rumbling subterraneous noise, which was not heard at Naples.

From the month of January to the month of May, the atmosphere had been generally calm, and there was continued dry weather. In the month of May there was a little rain, but the weather was unusually sultry. For some days preceding the eruption, the duke della Torre, a learned and ingenious nobleman, who published two letters upon the subject of the eruption, observed by his electrometers, that the atmosphere was charged with an excess of the electric fluid, and thus it continued for several days during the eruption.

About eleven o'clock on the night of the 12th of June, the inhabitants of Naples were all sensible of a violent shock of an earthquake; the undulatory motion was evidently from east to west, and appeared to have lasted near half a minute. The sky, which had been quite clear, was soon after covered with black clouds. The inhabitants of the towns and villages, which are very numerous at the foot of Vesuvius, felt this earthquake still more sensibly, and say, that the shock at first was from the bottom upwards, after which followed the undulation from east to west. This earthquake extended all over the Campagna Felice; and the royal palace at Caserta, which is fifteen miles from Naples, and one of the most magnificent and solid buildings in Europe (the walls being eighteen feet thick), was shaken in such a manner as to cause great alarm, and all the chamber bells rang. It was likewise much felt at Beneventum, about thirty miles from Naples; and at Ariano in Puglia, which is at a much greater distance; both these towns, indeed, have been often afflicted with earthquakes.

On Sunday the 15th of June, soon after ten o'clock at night, another shock of an earthquake was felt at Naples, but did not appear to be quite so violent as that of the 12th, nor did it last so long; at the same moment a fountain of bright fire, attended with a very black smoke and a loud report, was seen to issue, and to rise to a great height, from about the middle of the cone of Vesuvius. Soon after another of the same kind broke out at some little distance lower down; then, as is supposed, by the blowing up of a covered channel full of red-hot lava, it had the appearance as if the lava had taken its course directly up the steep cone of the volcano. Fresh fountains succeeded one another hastily, and all in a direct line, tending, for about a mile and a half, down towards the towns of Resina and Torre del Greco. Sir William Hamilton could count fifteen of them, but believes there were others obscured by the smoke. It seems probable, that all these fountains of fire, from their being in such an exact line, proceeded from one and the same long fissure down the flanks of the mountain, and that the lava and other volcanic matter forced its way out of the widest parts of the crack, and formed there the little mountains and craters that will be described in their proper place. It is impossible that any words can give an idea of the blazing scene, or of the horrid noises that attended this great operation of nature. It was a mixture of the loudest thunder, with incessant reports, like those from a numerous heavy artillery, accompanied by a continued hollow murmur, like that of the roaring of the ocean during a violent storm; and, added to these was another blowing noise, like that of the ascending of a large flight of sky-rockets, or rather like that which is produced by the action of the enormous bellows on the furnace of the Carron iron-foundry in Scotland. The frequent falling of the huge stones and scoriæ, which were thrown up to an incredible height from some of the new mouths, (one of which, having been since measured by the abbé Tata, was found to be ten feet high, and thirty-five in circumference), contributed undoubtedly to the concussion of the earth and air. As the lava did not appear to have yet a sufficient vent, and it was now evident that the earthquakes already felt had been occasioned by the air and fiery matter confined within the bowels of the mountain, and probably at no small depth, considering the extent of those earthquakes, sir William recommended to the company that was with him, who began to be much alarmed, rather to go and view the mountain at some greater distance, and in the open air, than to remain in the house, which was on the sea-side, and in the part of Naples which is nearest and most exposed to Vesuvius. They accordingly proceeded to Posilippo, and viewed the conflagration, now become still more considerable, from the sea-side under that mountain; but whether from the eruption having increased, or from the loud reports of the volcanic explosions being repeated by the mountain behind them, the noise was much louder and more alarming than that they had heard in their first position, at least a mile nearer to Vesuvius. After some time, about two o'clock in the morning of the 16th, it was observed that the lavas ran in abundance, freely, and with great velocity, having made a considerable progress towards Resina, the town which it first threatened, and that the fiery vapours which had been confined had now free vent through many parts of a crack of more than a mile and a half in length, as was evident from the quantity of inflamed matter and black smoke, which continued to issue from the new mouths. Our author therefore concluded that at Naples all danger from earthquakes, which had been his greatest apprehension, was totally removed, and he returned to his former station at St. Lucia near that city.

During all this time there was not the smallest appearance of fire or smoke from the crater on the summit of Vesuvius; but the black smoke and ashes issuing continually from so many new mouths or craters, formed an enormous and dense body of clouds over the whole mountain, and began to give signs of being replete with the electric fluid, by exhibiting flashes of that sort of zig-zag lightning, which in the volcanic language of the country is called ferilli, and which is the constant attendant on the most violent eruptions.

Sir William Hamilton proceeds to remark, that during a thirty years residence at Naples, and during which time he had been witness to many eruptions of Vesuvius, he never before saw the cloud of smoke replete with the electric fire, except in the two great eruptions of 1767, and in that of 1779. The electric fire, in the year 1779, which played constantly within the enormous black cloud over the crater of Vesuvius, and seldom quitted it, was exactly similar to that which is produced, on a very small scale, by the conductor of an electrical machine communicating with an insulated plate of glass, thinly spread over with metallic filings, &c. when the electric matter continues to play over it in zig-zag lines without quitting the surface. He was not sensible of any noise attending that operation in 1779; whereas the discharge of the electrical matter from the volcanic clouds during this eruption, and particularly on the second and third days, caused explosions like those of the loudest thunder; and indeed the storms raised evidently by the sole power of the volcano, resembled in every respect all other thunderstorms; the lightning falling, and destroying every thing in its course. The house of the marquis of Berio at St. Jurio, situated at the foot of Vesuvius, during one of these volcanic storms was struck with lightning, which having shattered many doors and windows, and damaged the furniture, left for some time a strong smell of sulphur in the rooms it passed through. Out of these gigantic volcanic clouds, besides the lightning, the author adds, he had, with many others, both during this eruption, and in 1779, seen balls of fire issue, and some of a considerable magnitude, which bursting in the air, produced nearly the same effect as that from the air-balloons in fireworks; the electric fire, as it came out, having the appearance of the serpents with which those firework-balloons are often filled. The day on which Naples was in the greatest danger from the volcanic clouds, two small balls of fire, joined together by a small link like a chain-shot, fell close to his casino at Posilippo; they separated, and one fell in the vineyard above the house, and the other in the sea, so close to it that he heard the splash in the water. The abbé Tata, in his printed account of this eruption, mentions an enormous ball of this kind which flew out of the crater of Vesuvius while he was standing on the edge of it, and which burst in the air at some distance from the mountain, soon after which he heard a noise like the fall of a number of stones, or of a heavy shower of hail.

About four o'clock in the morning of the 16th, the crater of Vesuvius began to shew signs of being open, by some black smoke issuing out of it; and at day-break another body of smoke, tinged with red, issued from an opening near the crater. On the other side of the mountain, and opposite the town of Ottaiano, it became evident that a new mouth had opened, from which a considerable stream of lava issued, and ran with great velocity through a wood, which it burnt; and having run about three miles in a few hours, it stopped before it arrived at the vineyards and cultivated lands. The crater, and all the conical part of Vesuvius, were soon involved in clouds and darkness, and remained so for several days; but above these clouds, although of a great height, fresh columns of smoke were seen from the crater, rising furiously still higher, until the whole mass remained in the usual form of a pine-tree; and in that gigantic mass of heavy clouds the ferilli, or volcanic lightning, was frequently visible, even in the daytime.

About five o'clock in the morning of the 16th, the lava which had first broken out from the several new mouths on the south side of the mountain, had reached the sea, and was running into it, having overwhelmed, burnt, and destroyed, the greatest part of Torre del Greco, the principal stream of lava having taken its course through the very centre of the town.

Soon after the beginning of this eruption, ashes fell thick at the foot of the mountain, all the way from Portici to Torre del Greco; and what is remarkable, although there were not at that time any clouds in the air, except those of smoke from the mountain, the ashes were wet, and accompanied with large drops of water, which to the taste were very salt; the road, which is paved, was as wet as if there had been a heavy shower of rain. These ashes were black and coarse, like the sand of the sea-shore; whereas those which fell there and at Naples some days after, were of a light-grey colour, and as fine as Spanish snuff, or powdered bark. They contained many saline particles; and those ashes which lay on the ground, exposed to the burning sun, had a coat of the whitest powder on their surface, which to the taste was extremely salt and pungent.

By the time that the lava had reached the sea, between five and six o'clock in the morning of the 16th, Vesuvius was so completely involved in darkness, that the violent operation of nature which was going on there could no longer be discerned, and so it remained for several days; but the dreadful noise, and the red tinge on the clouds over the top of the mountain, were evident signs of the activity of the fire underneath. The lava ran but slowly at Torre del Greco after it had reached the sea; and on the 17th of June in the morning, its course was stopped; excepting that at times a little rivulet of liquid fire issued from under the smoking scoriæ into the sea, and caused a hissing noise, and a white smoke; at other times a quantity of large scoriæ were pushed off the surface of the body of the lava into the sea, discovering that it was red-hot under that surface. Even to the latter end of August the centre of the thickest part of the lava that covered the town retained its red heat. The breadth of the lava that ran into the sea, and formed a new promontory there, after having destroyed the greatest part of the town of Torre del Greco, having been exactly measured by the duke della Torre, is 1204 English feet. Its height above the sea is twelve feet, and as many feet under water; so that its whole height is twenty-four feet: it extends into the sea 626 feet. The sea-water was boiling as in a cauldron, where it washed the foot of this new-formed promontory.

The rapid progress of the lava, however, was such, after it had altered its course from Resina, which town it first threatened, and had joined a fresh lava that issued from one of the new mouths in a vineyard, about a mile from the town, that it ran like a torrent over the town of Torre del Greco, allowing the unfortunate inhabitants scarcely time to save their lives. Their goods and effects were totally abandoned; and indeed several of the inhabitants, whose houses had been surrounded with lava while they remained in them, escaped from them, and saved their lives the following day, by coming out of the tops of their houses, and walking over the scoriæ on the surface of the red-hot lava. The lava over the cathedral, and in other parts of the town, is said to be upwards of forty feet in thickness; the general height of the lava during its whole course was about twelve feet, and in some parts not less than a mile, in breadth.

On Wednesday June 18, the wind having for a short space of time cleared away the thick cloud from the top of Vesuvius, it was now discovered that a great part of its crater, particularly on the west side opposite Naples, had fallen; in which it probably did about four o'clock in the morning of that day, as a violent shock of an earthquake was felt at that moment at Resina, and other parts at the foot of the volcano. The clouds of smoke, mixed with the ashes, were of such a density as to appear to have the greatest difficulty in forcing their passage out of the now widely-extended mouth of Vesuvius, which, since the top fell in, is described as not much short of two miles in circumference. One cloud heaped on another, and succeeded one another incessantly, formed in a few hours such a gigantic and elevated column of the darkest hue over the mountain, as seemed to threaten Naples with immediate destruction; having at one time been bent over the city, and appearing to be much too massive and ponderous to remain long suspended in the air. It was, besides, replete with the ferilli, or volcanic lightning, which was stronger than common lightning; just as Pliny the Younger describes it in one of his letters to Tacitus, when he says "fulgoribus illæ et similes et majores erant."

Vesuvius was at this time completely covered, as were all the old black lavas, with a thick coat of those fine light-grey ashes already fallen, which gave it a cold and horrid appearance; and in comparison of the enormous mass of clouds (which certainly, however it may contradict our idea of the extension of our atmosphere, rose many miles above the mountain), it appeared like a molehill, although the perpendicular height of Vesuvius, from the level of the sea, is more than three thousand six hundred feet. The abbé Braccini, as appears in his printed account of the eruption of mount Vesuvius in 1631, measured with a quadrant the elevation of a mass of clouds of the same nature, which was formed over Vesuvius during that great eruption, and found it to exceed thirty miles in height. Dr. Scotti, in his printed account of this eruption, says that the height of this threatening cloud of smoke and ashes, measured from Naples, was found to be of an elevation of thirty degrees.

The laudable curiosity of our author induced him to go upon mount Vesuvius, as soon as it was consistent with any degree of prudence, which was not until the 30th of June, and even then it was attended with some risk. The crater of Vesuvius, except at short intervals, had been continually obscured by the volcanic clouds from the 16th; and was so on that day, with frequent flashes of lightning playing in those clouds, and attended as usual with a noise like thunder; and the fine ashes were still falling on Vesuvius, but still more on the mountain of Somma. Sir William went up the usual way by Resina, and observed, in his way through that village, that many of the stones of the pavement had been loosened, and were deranged by the earthquakes, particularly by that of the 18th, which attended the falling in of the crater of the volcano, and which had been so violent as to throw many people down, and obliged all the inhabitants of Resina to quit their houses hastily, to which they did not dare to return for two days. The leaves of all the vines were burnt by the ashes that had fallen on them; and many of the vines themselves were buried under the ashes, and great branches of the trees that supported them had been torn off by their weight. In short, nothing but ruin and desolation was to be seen. The ashes at the foot of the mountain were about ten or twelve inches thick on the surface of the earth; but in proportion as he ascended, their thickness increased to several feet, not less than nine or ten in some parts; so that the surface of the old rugged lavas, which before was almost impracticable, was now become a perfect plain, over which he walked with the greatest ease. The ashes were of a light-grey colour, and exceedingly fine, so that by the footsteps being marked on them as on snow, he learnt that three small parties had been up before him. He saw likewise the track of a fox, which appeared to have been quite bewildered, to judge from the many turns he had made. Even the traces of lizards and other little animals, and of insects, were visible on these fine ashes. Sir William and his companion ascended to the spot whence the lava of the 15th first issued, and followed the course of it, which was still very hot (although covered with such a thick coat of ashes) quite down to the sea at Torre del Greco, which is more than five miles. It was not possible to get up to the great crater of Vesuvius, nor had any one yet attempted it. The horrid chasms that existed from the spot where the late eruptions first took place, in a straight line for near two miles towards the sea, cannot be imagined. They formed valleys more than two hundred feet deep, and from half a mile to a mile wide; and where the fountains of fiery matter issued during the eruption, were little mountains with deep craters. Ten thousand men, in as many years, could not make such an alteration on the face of Vesuvius. Except the exhalations of sulphureous vapours, which broke out from different spots of the line above-mentioned, and tinged the surface of the ashes and scoriæ in those parts with either a deep or pale yellow, with a reddish ochre-colour, or a bright white, and in some parts with a deep green and azure blue (so that the whole together had the effect of an iris), all had the appearance of a sandy desert. Our adventurers then went on the top of seven of the most considerable of the new-formed mountains, and looked into their craters, which on some of them appeared to be little short of half a mile in circumference; and although the exterior perpendicular height of them did not exceed two hundred feet, the depth of their inverted cone within was three times as great. It would not have been possible to have breathed on these new mountains near their craters, if they had not taken the precaution of tying a double handkerchief over their mouths and nostrils; and even with that precaution they could not resist long, the fumes of the sulphureous acid were so exceedingly penetrating, and of such a suffocating quality. They found in one a double crater, like two funnels joined together; and in all there were some little smoke and deposition of salts and sulphurs, of the various colours above-mentioned, as is commonly seen adhering to the inner walls of the principal crater of Vesuvius.

Two or three days after they had been there, one of the new mouths into which they had looked, suddenly made a great explosion of stones, smoke, and ashes, which would certainly have proved fatal to any person who might unfortunately have been present at the time of the explosion. While they were on the mountain, two whirlwinds, exactly like those that form water-spouts at sea, made their appearance; and one of them, which was very near, made a strange rushing noise; and having taken up a great quantity of the fine ashes, formed them into an elevated spiral column, which, with a whirling motion and great rapidity, was carried towards the mountain of Somma, where it broke and was dispersed. One of our author's servants, employed in collecting of sulphur, or sal ammoniac, which crystallizes near the fumaroli as they are called (which are the spots whence the hot vapour issues out of the fresh lavas), found to his great surprise, an exceeding cold wind from a fissure very near the hot fumaroli, upon his leg. In a vineyard not in the same line with the new-formed mountains just described, but in a right line from them, at the distance of little more than a mile from Torre del Greco, they found three or more of these new-formed mountains with craters, out of which the lava flowed; and by uniting with the streams that came from the higher mouths, and adding to their heat and fluidity, enabled the whole current to make so rapid a progress over the unfortunate town.

In the town of Somma, our author found four churches and about seventy houses without roofs, and full of ashes. The great damage on that side of the mountain, by the fall of the ashes and the torrents, happened on the 18th, 19th, and 20th of June, and on the 12th of July. The 19th, the ashes fell so thick at Somma, that unless a person kept in motion, he was soon fixed to the ground by them. This fall of ashes was accompanied also with loud reports, and frequent flashes of the volcanic lightning; so that, surrounded by so many horrors, it was impossible for the inhabitants to remain in the town, and they all fled; the darkness was such, although it was mid-day, that even with the help of torches it was scarcely possible to keep in the high road. On the 16th of July, signor Guiseppe Sacco went up to the crater; and, according to his account, which was printed at Naples, the crater is now of an irregular oval form, and as he supposes (not having been able to measure it) of about a mile and a half in circumference; the inside, as usual, in the shape of an inverted cone, the inner walls of which on the eastern side are perpendicular; but on the western side of the crater, which is lower, the descent was practicable, and Sacco with some of his companions actually went down one hundred and seventy-six palms; from which spot having lowered a cord with a stone tied to it, they found the whole depth of the crater to be about five hundred palms. Such observations, however, on the crater of Vesuvius, are of little consequence, as both its form and apparent depth are subject to great alterations from day to day.

On the 22d of July, one of the new craters, which is the nearest to the town of Torre del Greco, threw up both fire and smoke; which circumstance, added to that of the lava's retaining its heat much longer than usual, seemed to indicate that there was still some fermentation under that part of the volcano. The lava in cooling often cracks, and causes a loud explosion, just as the ice does in the glaciers in Swisserland; such reports were frequently heard at this time at the Torre del Greco; and a vapour was often seen to issue from the body of the lava, and taking fire in the air, fall like those meteors vulgarly called falling stars.

The archbishop of Taranto, in a letter to Naples, and dated from that city the 18th of June, observes: "We are involved in a thick cloud of minute volcanic ashes, and we imagine that there must be a great eruption either at mount Etna or of Stromboli. The bishop did not suspect their having proceeded from Vesuvius, which is about two hundred and fifty miles from Taranto. Ashes also fell, during the late eruption, at the very extremity of the province of Lecce, which is still farther off; and at Martino, near Taranto, a house was struck and much damaged by the lightning from one of the clouds. In the accounts of the great eruption of Vesuvius in 1631, mention is made of the extensive progress of the ashes from Vesuvius; and of the damage done by the ferilli, or volcanic lightning, which attended them in their course."

Our author in this place mentions a very extraordinary circumstance, which happened near Sienna, on the Tuscan state, about eighteen hours after the commencement of the late eruption of Vesuvius on the 15th of June, although he adds, that phenomenon must have no relation to the eruption; it was communicated to him in the following words by the earl of Bristol, bishop of Derry, in a letter dated from Sienna, July 12, 1794: "In the midst of a most violent thunder-storm, about a dozen stones of various weights and dimensions fell at the feet of different people, men, women, and children; the stones are of a quality not found in any part of the Siennese territory; they fell about eighteen hours after the enormous eruption of Vesuvius, which circumstance leaves a choice of difficulties in the solution of this extraordinary phenomenon: either these stones have been generated in this igneous mass of clouds, which produced such unusual thunder; or, which is equally incredible, they were thrown from Vesuvius at a distance of at least two hundred and fifty miles; judge then of its parabola." One of the largest stones, when entire, weighed upwards of five pounds. The outside of every stone that was found, and ascertained to have fallen from the cloud near Sienna, was evidently fresh-vitrified, and black, with indubitable signs of having passed through an extreme heat; when broken, the inside was found of a light-grey colour mixed with black spots, and some shining particles, supposed to be pyrites. Stones of the same nature, at least as far as the eye can judge of them, are frequently found on mount Vesuvius; and should similar stones be found there, with the same vitrified coat on them, the question would be decided in favour of Vesuvius; unless it could be proved that there had been, about the time of the fall of these stones in the Siennese territory, some nearer opening of the earth, attended with an emission of volcanic matter; which might very possibly happen, as the mountain of Radicofani, within fifty miles of Sienna, is certainly volcanic. The celebrated father Ambrogio Soldani, professor of mathematics in the university of Sienna, has printed there a dissertation upon this extraordinary phenomenon: and, it is said, has decided that those stones were generated in the air independantly of volcanic assistance. See METEORIC STONES.

Until after the 7th of July, when the last cloud broke over Vesuvius, and formed a tremendous torrent of mud, which took its course across the great road between Torre del Greco and the Torre dell' Annunziata, and destroyed many vineyards, the eruption could not be said to have finished, although the force of it was over the 22d of June. The power of attraction in mountains is well known; but whether the attractive power of a volcanic mountain is greater than that of any other mountain, is a question. During this eruption, however, it appeared that every watery cloud was evidently attracted by Vesuvius, and the sudden dissolution of those clouds left marks of their destructive power on the face of the country all round the basis of the volcano. After the mouth of Vesuvius was enlarged, our author says he has seen a great cloud passing over it, which not only was attracted, but even sucked in, and disappeared in a moment.

After every violent eruption of mount Vesuvius, we read of damage done by a mephitic vapour; which proceeding from under the ancient lavas, insinuates itself into low places, such as the cellars and wells of the houses situated at the foot of the volcano. After the eruption of 1767, there were several instances, as in this, of people, going into their cellars at Portici, and other parts of that neighbourhood, having been struck down by this vapour, and who would have expired if they had not been hastily removed. These occasional vapours, or mojete, are of the same quality as that permanent one in the Grotto del Cane, near the lake of Agnano, and which has been proved to consist chiefly of fixed air. The vapours which, in the volcanic language of Naples, are called fumaroli, are of another nature, and issue from spots all over the fresh and hot lavas while they are cooling; they are sulphureous, and so suffocating, that often the birds which are flying over them are overpowered, and fall down dead.

The interior of a volcano, that immense treasury of devastation, must undoubtedly be an object of philosophical curiosity: yet when we consider the nature of the attempt; that the incompact state of the materials, by affording no proper support, may hurry the incautious adventurer into the burning abyss; that the mephitic vapours may produce instantaneous suffocation; or that a sudden explosion may overwhelm him with destruction; we cannot wonder that so few have engaged in an exploit so replete with danger.

We should have remained ignorant of this state of this immense natural furnace, had not the spirit or temerity of eight Frenchmen, in the year 1801, enabled them successfully to explore this cavern of destruction. The mouth, or upper base, of the centre of Vesuvius, which is a little inclined to its axis, is represented by these travellers as 5720 feet in circumference. After walking round the aperture of the volcano, in order to chuse the most commodious part for descending, M. Dampiene, adjutant commandant, and M. Wickar, a painter, first descended without any accident at the determined point; when, however, they found themselves stopped by an excavation of 50 feet, which it was necessary to pass. Finding it impossible to obtain a fixed support on ashes so moveable, and being convinced that the friction of ropes would have destroyed both the point of support and the neighbouring masses, they resolved to return. Some stones at the same moment rolled from the summit, and occasioned a general agitation as they passed; the ground shook under their feet, and they had scarcely quitted it when it disappeared and fell in.

After walking once more round the mouth of the crater, they discovered at length a long declivity, smooth though steep, which appeared to conduct to the focus. When they had proceeded half-way, amidst a torrent of ashes which rolled down along with them, they found means to fix themselves on the edge of the precipice, twelve feet in height, which it was necessary to pass. With one of the lazaroni, however, they plunged down this precipice; and found themselves on the brink of another, which, however, not being quite so high, they passed with more ease. At length, amidst showers of falling lava, ashes, and stones, they reached the bottom of the crater.

They found the immense furnace still smoking in several places. The bottom of the crater, which from above appeared perfectly smooth, was found on the contrary, when they reached it, exceedingly rough and uneven. They passed over lava very porous, in general hard, but in some places, and particularly where they entered, still soft, so as even to yield under their feet. The spectacle, however, which most attracted them was the spiracles; which either at the bottom or interior sides, suffer the vapours to escape. These vapours, however, did not appear of a noxious quality. In traversing the crater they perceived a focus half-covered by a large mass of pumice stone, and which from its whole circumference emitted a strong heat. Reaumur's thermometer, on the summit of Vesuvius, stood at twelve degrees; in the crater it rose to sixteen; placed at one of the spiracles it indicated fifty-four, at another only twenty-two; and at the entrance of the focus it never rose higher than twenty-two degrees.

The volcanic productions in the crater were lava, exceedingly porous, and reduced by the fire in some places to scoriæ. It was of a dark-brown colour in general; and in some places reddish, with a very little white. The substances nearest the spiracles were covered or impregnated with sulphur, which sometimes was in a state of oxygenation. Some basaltic lava was also found, but in a small quantity. The burning focus produced the same results.

On the north side of the crater there were two large fissures, one of which was twenty feet in depth, the other fifteen. They were shaped like an inverted cone, and the matter with which they were covered was similar to the rest of the surface, but they emitted neither smoke nor heat.

The ascent of our adventurers was accomplished with more difficulty, though perhaps with less danger, than the descent. It also occupied a greater space of time; for they could only ascend one at a time after considerable intervals, for fear of burying, under torrents of dust and volcanic matters, those who immediately succeeded.

As the theory of volcanoes is by no means ascertained, we have thought it better to present our readers with facts than speculations, and the narrations which we have selected contain the most striking and best authenticated facts extant relative to these terrible phenomena. On these future philosophers may reflect, and possibly may elicit a more satisfactory explanation of them than any which has hitherto been presented to the public.

VOLKAMERIA, a genus of the didynamia angiospermia class of plants, the corolla whereof consists of a ringent, single petal: the tube is cylindric, and twice the length of the cup; the limb is divided into five plain segments; the fruit is a roundish bilocular capsule; the seed is a single bilocular nut. There are eight species.

VOLVOX, in zoology, a genus of animals belonging to the order of vermes infusoria. The body is round, simple, and pellucid. There are ten species, all of which live in water.

VOLUTA, in natural history, a genus of animals belonging to the class and order of vermes testacea. There are 144 species. The animals are of the slug kind; the shell is unilocular and spiral; the aperture narrow and without a beak; the columella plaited.

VOLUTE, a spiral scroll, used in the Ionic and composite capitals, whereof it makes the principal characteristic and ornament. See ARCHITECTURE.

VOMITING. See MEDICINE.

VORTEX, in the Cartesian philosophy, is a system or collection of particles of matter moving the same way, and round the same axis.

VORTICELLA, a genus of vermes infusoria. The generic character is, body contractile, naked, and furnished with ciliate rotatory organs. There are nearly sixty species of this genus. See Adams on the Microscope.

VOUCHER, a term of art, when the tenant in a writ of right calls another into the court who is bound to him to warranty, and that is either to defend the right against the demandant, or to yield him other lands, &c. in value, and extends to lands or tenements of freehold or inheritance. He that vouches is called voucher, and he that is vouched is called the vouchee. See RECOVERY.

VOWEL, in grammar, a letter which affords a complete sound in itself. In our language they are six in number.

The following views of the laxity with which the vowels are managed, and of their very great *convertibility*, in our language, have lately been given. Their different sounds are designated by the marks respectively used in these words:

Vowels:—án, àbly, ânt; béd, bè; ít, hìgh; ón, sò, ôff; ús, trùth, mūsic, fûll.

Diphthongs:—*oi*l; *ou*t.

Consonantal:—*w*it; *y*on.

I.

Sounds	Expressed by
á	e, (i), ai, au, ia
à	e, i, ai, ao, au, ay, ea, (ee), ei, ey, oy
â	(e), ai, au, (ea)
é	a, (i), (u), ai, ay, ea, ei, eo, ey, ie
è	i, y, ay, ea, ee, ei, eo, ey, ia, ie
í	a, e, o, u, y, ea, ee, eo, ie, ui
ì	y, ai, ay, ei, ey, (ia), ie, oi, oy, ui, ye, eye
ó	a, u, au, (aw), oa, ow
ò	aw, eo, ew, oa, oe, (oi), (oo), ou, ow, eau, (ewe), owe
ô	a, (ao), au, aw, (eo), oa, ou, awe
ú	(e), (i), o, (y), (ea), oe, oo, ou
ù	o, eo, eu, ew, oe, oo, ou, ow, ue, ui, eew
ū	eo, eu, ew, ue, ui, eau, ewe, ieu, iew
û	o, oo, ou
oi	oy, oie
ou	u, eo, ow
w	o, u
y	e, i

II.

Letters and Combinations.	Expressing
a	é, í, ó, ô
e	á, à, (â), í, (ú), *y*
i	(á), à, (é), è, (ú), *y*
o	í, ú, ù, û, *w*
u	(é), í, ó, *ou*, *w*
y	è, í, ì, (ú)
ai	á, à, â, é, ì
ao	à, (ô)
au	a, à, â, ó, ô
aw	(ó), ò, ô
ay	à, é, è, ì
ea	à, (â), é, è, í, (ú)
ee	(à), è, í
ei	à, é, è, ì
eo	é, è, í, ò, (ô), ù, ū, *ou*
eu	ù, ū
ew	ò, ù, ū
ey	à, é, è, ì
ia	á, è, (ì)
ie	é, è, í, ì
oa	ó, ò, ô
oe	ò, ú, ù
oi	ì, (ô)
oo	(ò), ú, ù, û
ou	ò, ô, ú, ù, û
ow	ó, ò, ù, *ou*
oy	à, ì, *oi*
ue	ù, ū
ui	í, ì, ù,
ye	ì
awe	ô
eau	ò, ū
eew	ù
ewe	(ô), ū
eye	ì
ieu	ū
iew	ū
oie	*oi*
owe	ò

The instances included within parentheses ( ) are found complete only with an *r* following them; as *e* in *clerk*, referred to the sound of *a* in *ant*.

UPUPA, in ornithology, a genus belonging to the order of picæ. The beak is arcuated, convex, and something blunt; the tongue is obtuse, triangular, entire, and very short; and the feet are fitted for walking. There are ten species, one of which, the epops, hoopoe, or dung-bird, is frequently seen in Britain. It may be readily distinguished from all others that visit this island by its beautiful crest, which it can erect or depress at pleasure. It is in length fifteen inches; the bill is black, two inches and a half long, slender, and incurvated; the irides are hazel: the crest consists of a double row of feathers, the highest about two inches long; the tips are black, their lower part of a pale orange colour: the neck is of a pale reddish brown, the breast and belly white; the lesser coverts of the wings are of a light brown; the back, scapulars, and wings, crossed with broad bars of white and black; the rump is white; the tail consists of only ten feathers, white marked with black, in form of a crescent, the horns pointing towards the end of the feathers. The legs are short and black; the exterior toe is closely united at the bottom to the middle toe. See Plate Nat. Hist. fig. 413.

According to Linnæus, it takes its name from its note, which has a sound similar to the word; or it may be derived from the French, huppé, or "crested:" it breeds in hollow trees, and lays two ash-coloured eggs: it feeds on insects, which it picks out of ordure of all kinds. Dr. Pallas affirms, that it breeds in preference in putrid carcases; and that he had seen the nest of one in the privy of an uninhabited house, in the suburbs of Tzaritsyn. Ovid says that Tereus was changed into this bird.

URANIA, a genus of the hexandria monogynia class and order of plants. There is no calyx; the corolla is two-petalled; nectarine two-leaved; capsule two-celled, many-seeded. There is one species.

URANIUM, a mineral found in Saxony, partly in a pure and partly in a mixed state. There are two varieties of these; the first of a blackish colour, quite opaque, tolerably hard, and with a specific gravity of about 7.5. The second is distinguished by a finer black colour, with here and there a reddish cast; by a stronger lustre, not unlike that of pitcoal; by an inferior hardness; and by a shade of green, which tinges its black colour when it is reduced to powder.

This fossil was called pechblende; and mineralogists, misled by the name, had taken it for an ore of zinc, till the celebrated Werner, convinced from its texture, hardness, and specific gravity, that it was not a blende, placed it among the ores of iron. Afterwards he suspected that it contained tungsten; and this conjecture was seemingly confirmed by the experiments of some German mineralogists, published in the Miners' Journal. But Klaproth, the most celebrated analyst in Europe, examined this ore in 1789, and found that it consists chiefly of sulphur combined with a peculiar metal, to which he gave the name of uranium.

Uranium is of a dark-grey colour; internally it is somewhat inclined to brown.

Its malleability is unknown. Its hardness is about 6. It requires a stronger heat for fusion than manganese. Indeed Klaproth only obtained it in very small conglutinated metallic grains, forming all together a porous and spongy mass. Its specific gravity is 6.440.

When exposed for some time to a red heat, it suffers no change. By means of nitric acid, however, it may be converted into a yellow powder. This is the peroxide or yellow oxide of uranium, which seems to be composed of about 56 parts of uranium and 44 of oxygen. This oxide is found native, mixed with the mineral above described. From the experiments of Proust, we learn that this metal is capable of forming only two oxides, but no description of the protoxide has been published; and the ore is so scarce that it is not every chemist who can gratify his curiosity by an examination of uranium.

Uranium is capable of combining with sulphur. The mineral from which Mr. Klaproth first obtained it is a native sulphuret of uranium.

URANOSCOPUS, star-gazer, a genus of fishes of the order jugulares. The generic character is, head large, depressed, rough; mouth furnished with an internal cirrus; gill-covers edged by a ciliated border; gill-membrane five-rayed.

Uranoscopus scaber, bearded star-gazer. The head of this fish is large, squarish, and covered by a strong bony case, roughened by an infinite number of small warts or protuberances: each side of this case is terminated above by two spines, the hindermost of which is the strongest, and covered by a skin: the under part has five spines, smaller than those above: the mouth, which is wide, opens in an almost vertical direction: the tongue is thick, short, and roughened with numerous small teeth: near the interior tip of the lower jaw is a membranaceous process which terminates in a long cirrus or beard extending to some distance beyond the lips, which are themselves edged with smaller ones: the eyes are situated very near each other on the top of the head: the body is of a somewhat squarish form as far as the vent, and thence becomes cylindric: it is covered with small scales, and marked near the back by a lateral line composed of small pores or points bending from the neck to the pectoral fins on each side, and thence in a straight line to the tail: on the back are two fins, of which the first is much shorter than the latter, and furnished with stronger spines: the pectoral fins are large, with soft rays: the ventral fins are small; the tail of moderate size, and rounded at the end. The colour of the body is brown, with a whitish or silvery cast towards the abdomen; the head, pectoral fins, and tail, having a strong ferruginous cast, and the first dorsal fin being marked towards its hind part by a large black spot.

The star-gazer is an inhabitant of the Mediterranean and northern seas, chiefly frequenting the shallow parts near the shores, where it lies concealed in the mud, with the tip of the head alone exposed: in this situation it waves the beards of the lips, and particularly the long cirrus of the mouth, in various directions, thus alluring the smaller fishes and marine insects which happen to be swimming near, and which mistaking these organs for worms, are instantly seized by their concealed enemy. The usual length of this fish is about twelve inches. It is in no esteem as an article of food, being generally considered as coarse and of an ill flavour: the gall was anciently considered as of peculiar efficacy in external disorders of the eyes. There are only two species, viz. the scaber and Japanicus.

UREA, the constituent and characteristic matter of urine, may be obtained by the following process: Evaporate by a gentle heat a quantity of human urine, voided six or eight hours after a meal, till it is reduced to the consistence of a thick syrup. In this state, when put by to cool, it concretes into a crystalline mass. Pour at different times upon this mass four times its weight of alcohol, and apply a gentle heat; a great part of the mass will be dissolved, and there will remain only a number of saline substances. Pour the alcohol solution into a retort, and distil by the heat of a sand-bath till the liquid, after boiling some time, is reduced to the consistence of a thick syrup. The whole of the alcohol is now separated, and what remains in the retort crystallizes as it cools. These crystals consist of the substance known by the name of urea.

Urea, obtained in this manner, has the form of crystalline plates crossing each other in different directions. Its colour is yellowish white: it has a fetid smell, somewhat resembling that of garlic or arsenic; its taste is strong and acrid, resembling that of ammoniacal salts; it is very viscid and difficult to cut, and has a good deal of resemblance to thick honey. When exposed to the open air, it very soon attracts moisture, and is converted into a thick brown liquid. It is extremely soluble in water; and during its solution a considerable degree of cold is produced. Alcohol dissolves it with facility, but scarcely in so large a proportion as water. The alcohol solution yields crystals much more readily on evaporation than the solution in water.

When nitric acid is dropt into a concentrated solution of urea in water, a great number of bright pearl-coloured crystals are deposited, composed of urea and nitric acid. No other acid produces this singular effect. The concentrated solution of urea in water is brown, but it becomes yellow when diluted with a large quantity of water. The infusion of nutgalls gives it a yellowish-brown colour; but causes no precipitate; neither does the infusion of tan produce any precipitate.

When heat is applied to urea, it very soon melts, swells up, and evaporates with an insupportably fetid odour. When distilled, there come over first benzoic acid, then carbonat of ammonia in crystals, some carbureted hydrogen gas, with traces of prussic acid and oil; and there remains behind a large residuum, composed of charcoal, muriat of ammonia, and muriat of soda. The distillation is accompanied with an almost insupportable fetid alliaceous odour. Two hundred and eighty parts of urea yield by distillation 200 parts of carbonat of ammonia, 10 parts of carbureted hydrogen gas, 7 parts of charcoal, and 68 parts of benzoic acid, muriat of soda, and muriat of ammonia. These three last ingredients Fourcroy and Vauquelin consider as foreign substances, separated from the urine by the alcohol at the same time with the urea. Hence it follows, that 100 parts of urea, when distilled, yield

92.027	carbonat of ammonia
4.608	carbureted hydrogen gas
3.225	charcoal
99.860	

Now 200 parts of carbonat of ammonia, according to Fourcroy and Vauquelin, are composed of 86 ammonia, 90 carbonic acid gas, and 24 water. Hence it follows that 100 parts of urea are composed of

39.5	oxygen
32.5	azote
14.7	carbon
13.3	hydrogen
100.0	

But it can scarcely be doubted that the water which was found in the carbonat of ammonia existed ready-formed in the urea before the distillation.

When the solution of urea in water is kept in a boiling heat, and new water is added as it evaporates, the urea is gradually decomposed, a very great quantity of carbonat of ammonia is disengaged, and at the same time acetic acid is formed, and some charcoal precipitates.

When a solution of urea in water is left to itself for some time, it is gradually decomposed. A froth collects on its surface; and air-bubbles are emitted which have a strong disagreeable smell, in which ammonia and acetic acid are distinguishable. The liquid contains a quantity of acetic acid. The decomposition is much more rapid if a little gelatine is added to the solution. In that case more ammonia is disengaged, and the proportion of acetic acid is not so great.

When the solution of urea is mixed with one-fourth of its weight of diluted sulphuric acid, no effervescence takes place; but, on the application of heat, a quantity of oil appears on the surface, which concretes upon cooling; the liquid which comes over into the receiver contains acetic acid, and a quantity of sulphat of ammonia remains in the retort dissolved in the undistilled mass. By repeated distillations, the whole of the urea is converted into acetic acid and ammonia.

When nitric acid is poured upon crystallized urea, a violent effervescence takes place, the mixture froths, assumes the form of a dark-red liquid, great quantities of nitrous gas, azotic gas, and carbonic acid gas, are disengaged. When the effervescence is over, there remains only a concrete white matter, with some drops of reddish liquid. When heat is applied to this residuum, it detonates like nitrat of ammonia. Into a solution of urea, formed by its attracting moisture from the atmosphere, an equal quantity of nitric acid, of the specific gravity 1.460, diluted with twice its weight of water, was added; a gentle effervescence ensued: a very small heat was applied, which supported the effervescence for two days. There was disengaged the first day a great quantity of azotic gas and carbonic acid gas; the second day, carbonic acid gas; and at last nitrous gas. At the same time with the nitrous gas the smell of the oxyprussic acid of Berthollet was perceptible. At the end of the second day, the matter in the retort, which was become thick, took fire, and burnt with a violent explosion. The residuum contained traces of prussic acid and ammonia. The receiver contained a yellowish acid liquor, on the surface of which some drops of oil swam.

Muriatic acid dissolves urea, but does not alter it. Oxymuriatic acid gas is absorbed very rapidly by a diluted solution of urea; small whitish flakes appear, which soon become brown, and adhere to the sides of the vessel like a concrete oil. After a considerable quantity of oxymuriatic acid had been absorbed, the solution, left to itself, continued to effervesce exceedingly slowly, and to emit carbonic acid and azotic gas. After this effervescence was over, the liquid contained muriat and carbonat of ammonia.

Urea is dissolved very rapidly by a solution of potass or soda, and at the same time a quantity of ammonia is disengaged; the same substance is disengaged when urea is treated with barytes, lime, or even magnesia. Hence it is evident, that this appearance must be ascribed to the muriat of ammonia, with which it is constantly mixed. When pure solid potass is triturated with urea, heat is produced, a great quantity of ammonia is disengaged, the mixture becomes brown, and a substance is deposited, having the appearance of an empyreumatic oil. One part of urea and two of potass, dissolved in four times its weight of water, when distilled, gives out a great quantity of ammoniacal water; the residuum contains acetat and carbonat of potass.

When muriat of soda is dissolved in a solution of urea in water, it is obtained by evaporation, not in cubic crystals, its usual form, but in regular octahedrons. Muriat of ammonia, on the contrary, which crystallizes naturally in octahedrons, is converted into cubes by dissolving and crystallizing it in the solution of urea.

URENA, a genus of the monadelphia polyandria class of plants, the corolla whereof consists of five oblong, obtuse, connated petals, broader than the apex, and narrower at the base; the fruit is a round echinated capsule, with five angles, consisting of five cells, and made up of five valves; the seeds are solitary, roundish, and compressed. There are eight species.

URETERS. See ANATOMY.

URETHRA. See ANATOMY.

URIC ACID. Uric or lithic acid was discovered by Scheele in 1776. It is the most common constituent of urinary calculi, and exists also in human urine. That species of calculus which resembles wood in its colour and appearance is composed entirely of this substance. It was called at first lithic acid; but this name, in consequence of the remarks made by Dr. Pearson on its impropriety, has been laid aside, and that of uric acid substituted in its place.

Uric acid in this state has a brown colour; it is hard, and crystallized in small scales. It has neither taste nor smell, is insoluble in cold water, but soluble in 360 parts of boiling water. The solution reddens vegetable blues, especially the tincture of turnsol. A great part of the acid precipitates again as the water cools. It combines readily with alkalies and earths; but the compound is decomposed by every other acid. Muriatic acid has no action on it, neither has sulphuric acid while cold, but when assisted by heat it decomposes it entirely.

When triturated with potass or soda, it forms a saponaceous paste, very soluble in water when there is an excess of alkali, but sparingly when the alkali is neutralized. The urat of potass or of soda is nearly tasteless. The last is found crystallized, constituting gouty concretions. Ammonia does not dissolve uric acid, but it combines with it, and forms a salt not more soluble than the pure acid, and resembling it in its external characters. Neither does uric acid dissolve in lime-water; the alkaline carbonats have no action whatever on it.

Nitric acid dissolves it readily; the solution is of a pink-colour, and has the property of tinging animal substances, the skin for instance, of the same colour. When this solution is boiled, a quantity of azotic gas, carbonic acid gas, and of prussic acid, is disengaged. When oxymuriatic acid gas is made to pass into water containing this acid suspended in it, the acid assumes a gelatinous appearance, then dissolves; carbonic acid gas is emitted, and the solution yields by evaporation muriat of ammonia, superoxalat of ammonia, muriatic acid, and malic acid.

When uric acid is distilled, about a fourth of the acid passes over a little altered, and is found in the receiver crystallized in plates; a few drops of thick oil make their appearance; $\frac{1}{8}$th of the acid of concrete carbonat of ammonia, some prussiat of ammonia, some water, and carbonic acid, pass over; and there remains in the retort charcoal, amounting to about $\frac{1}{80}$th of the weight of the acid distilled.

These facts are sufficient to shew us that uric acid is composed of carbon, azote, hydrogen, and oxygen; and that the proportion of the two last ingredients is much smaller than of the other two.

URINE. No animal substance has attracted more attention than this, both on account of its supposed connection with various diseases, and on account of the singular products obtained from it. In general, healthy urine is a transparent liquid of a light amber-colour, an aromatic smell, and a disagreeable bitter taste. Its specific gravity varies, according to Mr. Cruikshank, from 1.005 to 1.033. When it cools, the aromatic smell leaves it, and is succeeded by another, well known by the name of urinous smell. This smell is succeeded in two or three days by another, which has a considerable resemblance to that of sour milk. This smell gradually disappears in its turn, and is succeeded by a fetid alkaline odour.

Urine reddens paper stained with turnsole and with the juice of radishes, and therefore contains an acid.

If a solution of ammonia is poured into fresh urine, a white powder precipitates, which has the properties of phosphat of lime. The presence of this substance in urine was first discovered by Scheele. If lime-water is poured into urine, phosphat of lime precipitates in greater abundance than when ammonia is used; consequently urine contains phosphoric acid. Thus we see that the phosphat of lime is kept dissolved in urine by an excess of acid, or it is in the state of super-phosphat. This also was first discovered by Scheele. This substance is most abundant in the urine of the sick. Berthollet has observed, that the urine of gouty people is less acid than that of people in perfect health. The average quantity of phosphat of lime in healthy urine is, as Cruikshank has ascertained, about $\frac{1}{900}$ of the weight of the urine.

If the phosphat of lime precipitated from urine is examined, a little magnesia will be found mixed with it. Fourcroy and Vauquelin have ascertained that this is owing to a little phosphat of magnesia which urine contains, and which is decomposed by the alkali or lime employed to precipitate the phosphat of lime.

Proust informs us that carbonic acid exists in urine, and that its separation occasions the froth which appears during the evaporation of urine. Fourcroy and Vauquelin, on the other hand, consider this acid as formed during the evaporation, by the decomposition of the urea. The observations of Proust confirm those which had been made by Priestley and Percival.

Proust has observed, that urine kept in new casks deposits small crystals which effloresce in the air and fall to powder. These crystals possess the properties of carbonat of lime. Hence we must conclude that urine contains carbonat of lime; a very extraordinary fact, if we reflect that super-phosphat of lime is also present.

When fresh urine cools, it often lets fall a brick-coloured precipitate, which Scheele first ascertained to be crystals of uric acid. All urine contains this acid, even when no sensible precipitate appears when it cools. For if a sufficient quantity of clear and fresh urine is evaporated to $\frac{1}{178}$ of its weight, a subtle powder precipitates to the bottom, and attaches itself in part very firmly to the vessel. This part may be dissolved in pure alkali, and precipitated again by acetic acid. It exhibits all the properties of uric acid. The fact is, that the precipitate which usually falls when urine cools consists chiefly of phosphat of lime and uric acid. It may be dissolved in diluted nitric acid. If the solution is heated and evaporated to dryness, it assumes a fine rose-colour if uric acid is present. The proportion of uric acid varies considerably in urine. It crystallizes in small red prisms, partly on the surface, if urine is mixed with some nitric acid, and left exposed to the air.

During intermittent fevers, and especially during diseases of the liver, a copious sediment of a brick-red colour is deposited from urine. This sediment is the rosacic acid of Proust. Scheele considered this sediment as uric acid mixed with some phosphat of lime; and the same opinion has been entertained by other chemists: but Proust affirms that it consists chiefly of a different substance, to which he has given the name of rosacic acid from its colour, mixed with a certain proportion of uric acid and phosphat of lime. This rosacic acid, he informs us, is distinguished from the uric by the facility with which it dissolves in hot water, the violet precipitate which it occasions in muriat of gold, and by the little tendency which it has to crystallize.

If fresh urine is evaporated to the consistence of a syrup, and muriatic acid is then poured into it, a precipitate appears which possesses the properties of benzoic acid. Scheele first discovered the presence of benzoic acid in urine. He evaporated it to dryness, separated the saline part, and applied heat to the residuum. The benzoic acid was sublimed, and found crystallized in the receiver. Considerable quantities of benzoic acid may thus be obtained from the urine of horses and cows, where it is much more abundant than in human urine. In human urine it varies from $\frac{1}{1000}$ to $\frac{1}{10000}$ of the whole. Proust affirms that the acid obtained by Scheele's process is not the benzoic, but another possessed of similar properties; but differing in this circumstance, that nitric acid decomposes it, whereas it only whitens benzoic acid.

When an infusion of tan is dropt into urine, a white precipitate appears, having the properties of the combination of tan and albumen, or gelatine. Urine, therefore, contains albumen or gelatine. These substances had been suspected to be in urine, but their presence vas first demonstrated by Seguin, who discovered the above method of detecting them. Their quantity in healthy urine is very small. Cruikshank found that the precipitate afforded by tan in healthy urine amounted to $\frac{1}{240}$th part of the weight of the urine. It is to these substances that the appearance of the cloud, as it is called, or the mucilaginous matter, which is sometimes deposited as the urine cools, is owing. It is probable that healthy urine contains only gelatine, and not albumen, though the quantity is too small to admit of accurate examination; but in many diseases the quantity of these matters is very much increased. The urine of dropsical people often contains so much albumen, that it coagulates not only on the addition of acids, but even on the application of heat. In all cases of impaired digestion, the albuminous and gelatinous part of urine is much increased. This forms one of the most conspicuous and important distinctions between the urine of those who enjoy good and bad health.

If urine is evaporated by a slow fire to the consistence of a thick syrup, it assumes a deep brown colour, and exhales a fetid ammoniacal odour. When allowed to cool, it concretes into a mass of crystals, composed of all the component parts of urine. If four times its weight of alcohol is poured upon this mass at intervals, and a slight heat applied, the greatest part of it is dissolved. The alcohol, which has acquired a brown colour, is to be decanted off, and distilled in a retort in a sand-heat, till the mixture has boiled for some time, and acquired the consistence of a syrup. By this time the whole of the alcohol has passed off; and the matter, on cooling, crystallizes in quadrangular plates which intersect each other. This substance is urea, which composes $\frac{19}{20}$ of the urine, provided the watery part is excluded. To this substance the taste and smell of urine are owing. It is a substance which characterizes urine, and constitutes it what it is, and to which the greater part of the very singular phenomena of urine is to be ascribed. (See UREA.)

It may be detected by evaporating urine to the consistence of a syrup, and pouring into concentrated nitric acid. Immediately a great number of white shining crystals appear in the form of plates very much resembling crystallized boracic acid. These chrystals are urea combined with nitric acid.

The quantity of urea varies exceedingly in different urines. In the urine voided soon after a meal, very little of it is to be found, and scarcely any at all in that which hysterical patients void during a paroxysm.

According to Fourcroy and Vauquelin, the colour of urine depends upon the urea: the greater the proportion of urea, the deeper the colour. But Proust has detected a resinous matter in urine similar to the resin of bile; and to this substance he ascribes the colour of urine. If urine, evaporated to the consistence of an extract, is mixed with sulphuric acid and distilled, this resin, he informs us, separates during the distillation. What is first obtained is soft, but the last portions are in the state of a dry powder. The consistence and colour of this resin resemble castor: it is very soluble in alcohol, and precipitated from its solution by water: but it is also soluble in water; and, according to Proust, is the resin of bile, somewhat modified by its passage through the urinary organs.

If urine is slowly evaporated to the consistence of a syrup, a number of crystals make their appearance on its surface: these possess the properties of muriat of soda. Urine therefore contains muriat of soda. It is well known that muriat of soda crystallizes in cubes; but when obtained from urine it has the form of octahedrons. This singular modification of its form is owing to the action of urea. It has been long known that urine saturated with muriat of soda deposits that salt in regular octahedrons.

The saline residuum which remains after the separation of urea from crystallized urine by means of alcohol has been long known under the names of fusible salt of urine and microcosmic salt. Various methods of obtaining it have been given by chemists; from Boerhaave, who first published a process, to Rouelle and Chaulnes, who gave the method just mentioned. If the saline mass is dissolved in a sufficient quantity of hot water, and allowed to crystallize spontaneously in a close vessel, two sets of crystals are gradually deposited. The lowermost set has the figure of flat rhomboidal prisms; the uppermost, on the contrary, has the form of rectangular tables. These two may be easily separated by exposing them for some time to a dry atmosphere. The rectangular tables effloresce and fall to powder, but the rhomboidal prisms remain unaltered.

When these salts are examined, they are found to have the properties of phosphats. The rhomboidal prisms consist of phosphat of ammonia united to a little phosphat of soda; the rectangular tables, on the contrary, are phosphat of soda united to a small quantity of phosphat of ammonia. Urine, then, contains phosphat of soda and phosphat of ammonia.

When urine is cautiously evaporated, a few cubic crystals are often deposited among the other salts; these crystals have the properties of muriat of ammonia. Now the usual form of the crystals of muriat of ammonia is the octahedron. The change of its form in urine is produced also by urea. This salt is obtained in greater abundance when the crystals of urea obtained from the alcohol solution are distilled.

When urine is boiled in a silver bason it blackens the bason; and if the quantity of urine is large, small crusts of sulphuret of silver may be detached. Hence we see that urine contains sulphur. This sulphur exhales along with the carbonic acid when the urine putrefies; for the fumes which separate from urine in that state blacken paper stained with acetat of lead.

Urine, then, contains the following substances:

1. Water,
2. Phosphoric acid,
3. Phosphat of lime,
4. Phosphat of magnesia,
5. Carbonic acid,
6. Carbonat of lime,
7. Uric acid,
8. Rosacic acid,
9. Benzoic acid,
10. Gelatine and albumen,
11. Urea,
12. Resin,
13. Muriat of soda,
14. Phosphat of soda,
15. Phosphat of ammonia,
16. Muriat of ammonia,
17. Sulphur.

These are the only substances which are constantly found in healthy urine; but it contains also occasionally other substances. Very often muriat of potass may be distinguished among the crystals which form during its evaporation. The presence of this salt may always be detected by dropping cautiously some tartaric acid into urine. If it contains muriat of potass, there will precipitate a little tartar, which may easily be recognized by its properties.

Urine sometimes also contains sulphat of soda, and even sulphat of lime. The presence of these salts may be ascertained by pouring into urine a solution of muriat of barytes; a copious white precipitate appears, consisting of the barytes combined with phosphoric acid, and with sulphuric acid if any is present. This precipitate must be treated with a sufficient quantity of muriatic acid. The phosphat of barytes is dissolved, but the sulphat of barytes remains unaltered,

No substance putrefies sooner, or exhales a more detestable odour during its spontaneous decomposition, than urine; but there is a very great difference in this respect in different urines. In some, putrefaction takes place almost instantaneously as soon as it is voided; in others, scarcely any change appears for a number of days. Fourcroy and Vauquelin have ascertained that this difference depends on the quantity of gelatine and albumen which urine contains. When there is very little of these substances present, urine remains long unchanged; on the contrary, the greater the quantity of gelatine or albumen, the sooner does putrefaction commence. The putrefaction of urine, therefore, is in some degree the test of the health of the person who has voided it: for a superabundance of gelatine in urine always indicates some defect in the power of digestion.

The rapid putrefaction of urine, then, is owing to the action of gelatine on urea. We have seen already the facility with which that singular substance is decomposed; and that the new products into which it is changed are, ammonia, carbonic acid, and acetic acid. Accordingly, the putrefaction of urine is announced by an ammoniacal smell. Mucilaginous flakes are deposited, consisting of part of the gelatinous matter. The phosphoric acid is saturated with ammonia; and the phosphat of lime, in consequence, is precipitated. Ammonia combines with the phosphat of magnesia; and forms with it a triple salt, which crystallizes upon the sides of the vessel in the form of white crystals, composed of six-sided prisms, terminated by six-sided pyramids. The uric and benzoic acids are saturated with ammonia; the acetic acid, and the carbonic acid, which are the products of the decomposition of the urea, are also saturated with ammonia; and notwithstanding the quantity which exhales, the production of this substance is so abundant, that there is a quantity of unsaturated alkali in the liquid. Putrefied urine, therefore, contains chiefly the following substances, most of which are the products of putrefaction:

Ammonia,
Carbonat of ammonia,
Phosphat of ammonia,
Phosphat of magnesia and ammonia,
Urat of ammonia,
Acetat of ammonia,
Benzoat of ammonia,
Muriat of soda,
Muriat of ammonia;

besides the precipitated gelatine, and phosphat of lime.

The distillation of urine produces almost the same changes: for the heat of boiling water is sufficient to decompose urea, and to convert it into ammonia, carbonic, and acetic acids. Accordingly, when urine is distilled, there come over water, containing ammonia dissolved in it, and carbonat of ammonia in crystals; the acids contained in urine are saturated with ammonia, and the gelatine and phosphat of lime precipitate.

Such are the properties of human urine in a state of health: but this excretion is singularly modified by disease; and the changes to which it is liable have attracted the attention of physicians in all ages, because they serve in some measure to indicate the state of the patient and the progress of the disease under which he labours. The following are the most remarkable of these changes that have been observed:

1. In inflammatory diseases the urine is of a red colour, and peculiarly acrid; it deposits no sediment on standing, but with oxymuriat of mercury it yields a copious precipitate.

2. During jaundice the urine has an orange-yellow colour, and communicates the same tint to linen. Muriatic acid renders this urine green, and thus detects the presence of a little bile.

3. About the end of inflammatory diseases the urine becomes abundant, and deposits a copious pink-coloured sediment, composed of rosacic acid, a little phosphat of lime, and uric acid.

4. During hysterical paroxysms, the urine usually flows abundantly. It is limpid and colourless, containing much salt, but scarcely any urea or gelatine.

5. Mr. Berthollet observed that the urine of gouty persons contains usually much less phosphoric acid than healthy urine. But during a gouty paroxysm it contains much more phosphoric acid than usual; though not more than constantly exists in healthy urine.

6. In general dropsy, the urine is loaded with albumen, and becomes milky, or even coagulates, when heated, or at least when acids are mixed with it. In dropsy from diseased liver, no albumen is present, the urine is scanty, high-coloured, and deposits the pink-coloured sediment.

7. In dyspepsia, the urine always yields a copious precipitate with tan, and putrefies rapidly.

8. The urine of rickety patients is said to be loaded with phosphat of lime, or, according to others, with oxalat of lime.

9. In diabetes, the urine is sweet-tasted and often loaded with saccharine matter. In one case, the urine emitted daily by a diabetic patient, according to the experiments of Cruikshank, contained 29 ounces of sugar.

The urine of other animals differs considerably from that of man. For the analyses of the urine of quadrupeds hitherto made, we are chiefly indebted to Rouelle junior. The following facts have been ascertained by that chemist, and by the late experiments of Fourcroy and Vauquelin:

I. The urine of the horse has a peculiar odour: after exercise it is emitted thick and milky; at other times it is transparent, but becomes muddy soon after its emission. When exposed to the air, its surface becomes covered with a crust of carbonat of lime. It gives a green colour to syrup of violets, and has the consistence of mucilage. The following are its constituents as estimated by Fourcroy and Vauquelin from their experiments:

Carbonat of lime	0.011
Carbonat of soda	0.009
Benzoat of soda	0.024
Muriat of potass	0.009
Urea	0.007
Water and mucilage	0.940
	1.000

From the late experiments of Mr. Giese, we learn that the quantity of benzoat of soda varies considerably in the urine of horses. In some specimens he found it in abundance, and easily precipitated by muriatic acid. In others there was little or none. He could detect no benzoic acid in the food of horses. Hence he considers it as formed within the animal, and he thinks that it appears only in cases of disease.

II. The urine of the cow has a strong resemblance to that of the horse; it has nearly the same odour, and the same mucilaginous consistence It tinges syrup of violets green, and deposits a gelatinous matter. On standing, small crystals are formed on its surface. It contains, according to Rouelle,

1. Carbonat of potass,
2. Sulphat of potass,
3. Muriat of Potass,
4. Benzoic acid,
5. Urea.

III. The urine of the camel was also examined by Rouelle. Its odour resembles that of the urine of the cow; its colour is that of beer; it is not mucilaginous, and does not deposit carbonat of lime. It gives a green colour to syrup of violets, and effervesces with acids like the urine of the horse and cow. Rouelle obtained from it,

1. Carbonat of potass,
2. Sulphat of potass,
3. Muriat of potass,
4. Urea.

IV. The urine of the rabbit has been lately analysed by Vauquelin. When exposed to the air, it becomes milky, and deposits carbonat of lime. It gives a green colour to syrup of violets, and effervesces with acids. That chemist detected in it the following substances:

1. Carbonat of lime,
2. Carbonat of magnesia,
3. Carbonat of potass,
4. Sulphat of potass,
5. Sulphat of lime,
6. Muriat of potass,
7. Urea,
8. Gelatine,
9. Sulphur.

V. Vauquelin has also made some experiments on the urine of the guinea-pig, from which it appears that it resembles the urine of the other quadrupeds. It deposits carbonat of lime, gives a green colour to syrup of violets, and contains carbonat and muriat of potass, but no phosphat nor uric acid.

Thus it appears that the urine of the graminivorous quadrupeds agrees with the human in containing urea, but differs from it materially in being destitute of phosphoric acid, phosphats, and uric acid. Whether the urine of carnivorous quadrupeds contains these last substances has not been ascertained, but it is probable that it does.

URSA, the *bear*, in astronomy, a name common to two constellations of the northern hemisphere, near the pole, distinguished by major and minor. The ursa major, or the great bear, according to Ptolemy's catalogue, consists of thirty-five stars: according to Tycho's, of fifty-six: but in the Britannic catalogue we have two hundred and fifteen.

The ursa minor, or little bear called also Charles's wain, and by the Greeks cynosura, by its neighbourhood to the north pole, gives the denomination αρκτος, bear, thereto. Ptolemy and Tycho make it to consist of eight stars, but Flamsteed of fourteen.

URSUS, *bear*, a genus of quadrupeds of the order feræ: the generic character is, front teeth six both above and below: the two lateral ones of the lower jaw longer than the rest and lobed; with smaller or secondary teeth at their internal bases; canine teeth solitary; grinders five or six on each side, the first approximated to the canine teeth; tongue smooth; snout prominent; eyes furnished with a nictitating membrane. There are ten species.

1. Ursus arctos. The common bear, with some variation as to size and colour, is a native of almost all the northern parts of Europe and Asia, and is even said to be found in some of the Indian islands, as Ceylon, &c. It inhabits woods and unfrequented places, and feeds chiefly on roots, fruits, and other vegetable substances, but occasionally preys on animals. In the Alpine regions the bear is brown; in some other parts of Europe, black; and in some parts of Norway has been seen of a grey colour, and even perfectly white: this latter change of colour sometimes takes place, as is well known, in several other animals, and most frequently in such as are naturally black or of very dark colours. The brown, the black, the grey, and the white land bears are, therefore, to be considered as of the same species: yet it is observed that the brown and black varieties differ somewhat in their manner of life; the black confining itself almost entirely to vegetable food; the brown, on the contrary, frequently attacking and preying upon other animals, and destroying lambs, kids, and even sometimes cattle, and sucking the blood in the manner of the cat and weasel tribes. Linnæus adds, that the bear has a way of blowing up his prey, and of hiding or burying a part of it. Bears are reported to be particularly fond of honey, in search of which they will climb trees, in order to get at the nests of wild bees; for the bear, notwithstanding his awkward form, is expert in climbing, and sometimes takes up his residence in the hollow of a very large tree. The bear will also catch and devour fish, occasionally frequenting the banks of rivers for that purpose.

The bear passes a considerable part of the winter in a state of repose and abstinence; emerging only at distant intervals from his den, and again concealing himself in his retreat till the approach of the vernal season. The females are said to continue in this state much longer than the males, and it is during this period that they bring forth their young, which are commonly two in number. These the antients imagined to be nearly shapeless masses, gradually licked and fashioned into regular form by the parent; an opinion now sufficiently exploded. The young, however, though not shapeless, have a different aspect from the grown animal; the snout being much sharper, and their colour yellowish: they are said to be blind for nearly the space of a month.

2. Ursus Americanus, American bear. This, which is now considered as a distinct species, and not to be confounded with the black bear of Europe, has a long, pointed nose, and narrow forehead: the cheeks and throat of a yellowish-brown colour; the hair on the whole body and limbs of a glossy black, smoother and shorter than that of the European kind. It is also said to be, in general, smaller than the European bear, though instances have been known in which its size, at least, equalled the European, since Mr. Bartram assures us, that a bear was killed in Florida which weighed four hundred pounds.

This animal inhabits all the northern parts of America, migrating occasionally from the northern to the more southerly parts in quest of food, which is said to be entirely vegetable; and it is even affirmed, that, when pressed by extreme want, they will still neglect all animal food whenever they can obtain a supply of roots and grain. They, however, sometimes destroy fish, and particularly herrings, when these fish happen to come up into the creeks in shoals. They are said to continue in their winter retreats, either in dens beneath the snow under ground, or in the hollows of old trees, for the space of five or six weeks without food.

3. Ursus maritimus, polar bear. This is a far larger species than the common bear, and is said to have been sometimes found of the length of twelve feet. The head and neck are of a more lengthened form than in the common bear, and the body itself is longer in proportion. The whole animal is white, except the tip of the nose and the claws, which are jet-black: the ears are small and rounded; the eyes small; the teeth of extraordinary magnitude: the hair is of a great length, and the limbs are extremely large and strong. See Plate Nat. Hist. fig. 415. It seems confined to the very coldest parts of the globe; being found within 80 degrees of north latitude, as far as any navigators have yet penetrated. The shores of Hudson's-bay, Greenland, and Spitsbergen, are its principal places of residence; but it is said to have been accidentally carried on floating ice as far south as Newfoundland. This species seems to have been often confounded by authors with the white variety of the common bear, which is occasionally found in the northern regions.

The polar bear is an animal of tremendous strength and fierceness. Barentz, in his voyage in search of a north-east passage to China, had proofs of the ferocity of these animals, in the island of Nova Zembla, where they attacked his seamen, seizing them in their mouths, carrying them off with the utmost ease, and devouring them in the sight of their comrades. It is said that they will attack and attempt to board armed vessels, at a great distance from shore; and have sometimes been with much difficulty repelled. Their usual food consists of seals, fish, and the carcases of whales; but, when on land, they prey on deer, and other animals, as hares, young birds, &c. they also eat various kinds of berries which they happen to find. They are said to be frequently seen in Greenland in great droves, allured by the scent of the flesh of seals: and will sometimes surround the habitations of the natives, and attempt to break in; and it is added, that the most successful method of repelling them is by the smell of burnt feathers. They grow extremely fat, a hundred pounds of fat having been taken from a single beast. The flesh is said to be coarse, but the skin is valued for coverings of various kinds, and the Greenlanders often wear it as a clothing. The split tendons are said to form an excellent thread. During the summer they reside chiefly on the ice-islands, and pass frequently from one to another; being extremely expert swimmers. They have been seen on these ice-islands at the distance of more than eighty miles from land, preying and feeding as they float along. They lodge in dens, formed in the vast masses of ice, which are piled in a stupendous manner, leaving great caverns beneath: here they breed, and bring one or two young at a time, and sometimes, but very rarely, three. The affection between parent and young is so great, that they will sooner die than desert each other. They follow their dams a very long time, and grow to a large size before they quit them.

During winter they retire, and bed themselves deep beneath the snow, or else beneath the fixed ice of some eminence, where they pass in a state of torpidity the long and dismal arctic night, appearing only with the return of the sun.

The skins of the polar bear, says Mr. Pennant, were formerly offered by the hunters in the arctic regions to the high altars of cathedrals and other churches, for the priest to stand on during the celebration of mass in winter.

4. Ursus gulo, glutton. This animal is a native of the most northern parts of Europe and Asia, occurring in Sweden, Norway, Lapland, and Siberia, as well as in some of the Alpine regions, and in the forests of Poland and Courland. It is also found in the northern parts of America, being not uncommon about Hudson's-bay.

The glutton is considerably larger than a badger, measuring about a yard from nose to tail, and the tail about a foot; but it seems to vary in size, and is often less than this. The muzzle, as far as beyond the eyes, is blackish brown, and covered with hard shining hair: over the forehead, down the sides of the head, between the eyes and ears, runs a whitish or ash-coloured band or fillet: the top of the head and whole length of the back are black-brown, the colour widening somewhat over the sides as it passes on, and again lessening or contracting towards the tail. In the American variety a whitish or ash-coloured band or border runs along the body, in the same manner as the ferruginous one in the European kind.

The glutton, as its name imports, has the character of a very voracious animal, preying indiscriminately both on fresh prey and carrion. One of which was kept at Dresden would eat thirteen pounds of flesh in a day, without being satisfied. It attacks deer, birds, field-mice, &c. and even sometimes the larger cattle; and it is said to sit on the branches of trees, and suddenly to spring down on such animals as happen to pass beneath; tearing them, and sucking the blood, till they fall down through faintness, when it begins to devour the spoil. In winter it seeks out and catches ptarmigans under the snow. What it cannot devour at once, it is said to hide under ground, or in the cavity of some tree. It is said to be an animal of uncommon fierceness and strength; and will sometimes dispute the prey both with the wolf and bear. It is also extremely fetid. It breeds once a year, and brings from two to four young at a litter. The fur is much used for muffs, linings, &c. Those skins are said to be preferred which have least of the ferruginous tinge, and for this reason the Siberian variety, which is blacker than the rest, is most esteemed. The ursus luscus, or wolverene, appears to be a variety of this animal.

5. Ursus lotor, the raccoon, is a native of the new world, and is principally an inhabitant of the northern parts of that continent. It is also found in some of the West Indian islands. Its colour is grey; the face white; the eyes each imbedded in a large patch of black, which forms a kind of band across the forehead, and is crossed by a dusky stripe running down the nose. The visage is shaped like that of a fox, the forehead being broad and the snout sharp; the eyes are large and greenish: the ears short and slightly rounded; and the upper jaw is longer than the lower: the tail, which is covered with bushy hair, tapers to the end, and is annulated with several black bars: the body is broad, the back arched, the limbs rather short, and the fore legs shorter than the hinder; the animal is covered with thick and long hair, which has a somewhat upright growth: the feet are dusky, and have five toes with very sharp claws. The colour of the raccoon is generally a dark grey. The length of the animal is two feet from nose to tail, and the tail about one foot. See Plate Nat. Hist. fig. 414. The food of the raccoon, in its wild state, consists chiefly of maize, which it eats while the ears are tender, as well as sugar-canes, various sorts of fruit, as apples, chesnuts, &c. It is also supposed to devour birds and their eggs, and is, therefore, considered as an enemy to poultry. It chiefly feeds by night, and by day keeps in its hole, except in dull weather. In winter, and in very bad weather, it keeps altogether within, and is popularly believed to live like the bear, by sucking its paws. The raccoon, however, is an active and sprightly animal when taken into a state of domestication. It has a kind of oblique gait in walking, can leap and climb with great ease, and is very frequently seen on trees. It is easily tamed, and is frequently kept in houses by the Americans, and will live on bread, milk, fish, eggs, &c. It is particularly delighted with sweets of every kind, and has as great a dislike to acids. In eating, it commonly sits on its hind legs, and uses its fore feet in the manner of hands. It has a way of dipping

all manner of dry food that is given it into water before it eats it; as well as of rolling it between its paws for some time. When it kills birds, it proceeds exactly in the manner of a polecat; first biting off the head, and then sucking out the blood. It drinks but little, and is a very cleanly animal. It is extremely expert in opening oysters, on which, as well as on crabs and various other kinds of shell-fish, it frequently feeds in its wild state. It is, when tamed, extremely active and playful: but is of a capricious disposition, and not easily reconciled when offended. When angry, its voice is like a hoarse bark, and at other times soft and sharp. In its wild state it generally inhabits the hollows of trees; but in a domestic state shews no particular inclination for warmth; nor is it observed to be desirous of lying on straw, or any other substance, in preference to the bare ground. It sleeps from about midnight to noon, at which time it comes out for food and exercise. According to Linnæus, the raccoon has a wonderful antipathy to hogs' bristles, and is much disturbed at the sight of a brush. It produces from two to three young at a birth: this commonly takes place in the month of May. The fur of the raccoon is used by the hatters, and is considered as next in merit for this purpose to that of the beaver.

6. Ursus meles, the badger, is an inhabitant of all the temperate parts of Europe and Asia. Its usual length is about two feet from the nose to the tail, which measures six inches. It is an animal of very clumsy make, being thick-necked and thick-bodied, with very short legs. It commonly resides in a hole or den under ground, out of which it emerges by night in quest of food; feeding chiefly on roots and fruits; but it will also devour frogs, worms, &c. The badger is of an uniform grey colour on the upper parts; and the throat, breast, belly, and legs, are black: the face is white, and along each side of the head runs a long and somewhat triangular or pyramidal band of black, including the eyes and ears: the eyes are small, and the ears short and rounded: the claws on the fore feet are very long and straight, and it is principally from this circumstance that Mr. Pennant ranks it under a separate genus, instead of including it under that of ursus, or bear. Authors have sometimes made a distinction between what they call the sow badger and the dog badger; but this is supposed to be perfectly untenable, and if there is any perceptible variation, is probably no other than a mere sexual difference. The hair of the badger, both on the body, limbs, and tail, is very thick; and the teeth, legs, and claws, are very strong; so that he makes a very vigorous defence when attacked. When taken young, the badger may be easily tamed, and generally prefers raw flesh to every other food in a state of captivity. It is a very cleanly animal, and is observed to keep its subterraneous mansion extremely neat. The female produces about three or four young: this happens in summer; and, according to the count de Buffon, the parent seizes on young rabbits, which she drags out of their burrows, birds, eggs, snakes, and many other animals, in order to feed her young. Like the bear, this animal is also fond of honey, and will attack hives in order to obtain it. The badger sleeps a great deal, especially during winter, when he imitates the practice of the bear, confining himself to his den in a state of semi-torpidity.

7. Ursus labradorius, American badger. In its general appearance this extremely resembles the common badger, and might almost pass for a variety only: it is, however, somewhat smaller, and the black bands on the face are much narrower and do not include the eyes, but commence behind them, and run along the top of the neck: the ears are surrounded with black: the upper parts of the body are nearly of the same colour as in the common badger, but rather paler, and with a slight yellowish cast; and the breast and belly are of a light ash-colour, instead of black: the legs are of a dusky brown: the claws are at least as long and strong as in the European badger, if not more so. This species is rather scarce in America. It is found in the neighbourhood of Hudson's-bay, and in Terra di Librador, and as Mr. Pennant suspects, as low as Pennsylvania, where it is called the ground-hog.

URTICA, a genus of plants of the class monœcia, and order tetrandria; and in the natural system classed under the 53d order, scabridæ. The male flower has a calyx of four leaves; no corolla; a nectarium minute, central, urn-fashioned. The female a bivalve calyx; and a single, oval, glossy seed. There are 59 species, three of which are British plants: 1. The pilulifera, Roman nettle, has a stalk branched, two or three feet high. Leaves opposite, oval, serrated, stinging. Fruit globose. 2. The urens, less stinging nettle, has a stem a foot high. Leaves roundish, deeply serrated, opposite. The stings are very curious microscopic objects: they consist of an exceedingly fine-pointed, tapering, hollow substance, with a perforation at the point, and a bag at the base. When the spring is pressed upon, it readily perforates the skin, and at the same time forces up some of the acrimonious liquor contained in the bag into the wound. 3. The dioica, common nettle, has a square firm stem, three or four feet high. Leaves heart-shaped, long-pointed, serrated, beset with stings. Flowers in long catkins. The aculei, or stings of the nettle, have a small bladder at their base full of a burning corrosive liquor: when touched, they excite a blister, attended with a violent itching pain, though the sting does not appear to be tubular, or perforated at the top, nor any visible liquor to be infused into the puncture made by it in the flesh. It seems certain, however, that some of this liquor is insinuated into the wound, though invisibly, since the stings of the dried plant excite no pain.

Nettle-tops in the spring are often boiled and eaten by the common people instead of cabbage-greens. In Arran, and other islands, a rennet is made of a strong decoction of nettles: a quart of salt is put to three pints of the decoction, and bottled up for use. A common spoonful of this liquor will coagulate a large bowl of milk very readily and agreeably. The stalks of nettles are so like in quality to hemp, that in some parts of Europe and Siberia they have been manufactured into cloth, and paper has been made of them. The whole plant, particularly the root, is esteemed to be diuretic, and has been recommended in the jaundice and nephritic complaints. The roots boiled will dye yarn of a yellow colour. The larvæ, or caterpillars, of many species of butterflies, feed on the green plant; and sheep and oxen will readily eat it dried.

USAGE, in law, differs from custom and prescription: no man may claim a rent, common, or other inheritance, by usage, though he may by prescription. B. Co. 65.

USANCE, in commerce. See INTEREST.

USE, is a trust and confidence reposed in another who is tenant of the land, that he shall dispose of the land according to the intention of cestuy que use, or him to whose use it was granted, and suffer him to take the profits. 2 Black. 328.

By stat. 27 H. VIII. c. 10, commonly called the statute of uses, or the statute for transferring uses into possession, the cestuy que use is considered as the real owner of the estate; whereby it is enacted that, when any person is seized of lands to the use of another, the person intitled to the use in fee simple, fee-tail, for life or years, or otherwise, shall stand and be seized or possessed of the land, in the like estate, as he has of the use, trust, or confidence; and thereby the act makes cestuy que use complete owner both at law and in equity. 2 Black. 302.

USES, *superstitious*. See MORTMAIN.

USES *and customs of the sea*, are certain maxims or rules which form the basis of the maritime jurisprudence, by which the policy of navigation, and the commerce of the sea, are regulated.

These uses and customs consist of three kinds of regulations: the first called the laws or judgments of Oleron; the second, regulations made by the merchants of Wisbuy, a city in the island of Gothland, in the Baltic, antiently much famed for commerce; and the third, a set of regulations made at Lubec, by the deputies of the Hanse towns.

USQUEBAUGH, a strong compound liquor, chiefly taken by way of dram.

There are several different methods of making this liquor; but the following is esteemed one of the best: To two gallons of brandy, or other spirit, put a pound of Spanish liquorice, half a pound of raisins of the sun, four ounces of currants, and three of sliced dates; the tops of balm, mint, savoury, thyme, and the tops of the flowers of rosemary, of each two ounces; cinnamon and mace, well bruised, nutmegs, aniseeds, and coriander-seeds, bruised likewise, of each four ounces; citron, or lemon and orange peel, scraped, of each an ounce: let all these infuse forty-eight hours in a warm place, often shaking them together: then let them stand in a cool place for a week: after which the clear liquor is to be decanted off, and to it are to be put an equal quantity of neat white port, and a gallon of canary; after which it is to be sweetened with a sufficient quantity of double-refined sugar.

USTERIA, a genus of plants of the class and order monandria monogynia. The calyx is four-toothed; corolla funnel-form, four-toothed; capsule one-celled, two-seeded. There is one species, a shrub of North Guinea.

USURY, in a strict sense, is a contract upon the loan of money, to give the lender a certain profit for the use of it, upon all events;

whether the borrower made any advantage of it, or the lender suffered any prejudice for want of it, or whether it shall be repaid on the appointed time or not; and in a large sense, it seems, that all undue advantages, taken by a lender against a borrower, came under the notion of usury. Haw. 245.

The statute 12 Anne, c. 16, enacts that no person, upon any contract which shall be made, shall take for loan of any money, wares, &c. above the value of 5*l.* for the forbearance of 100*l.* for a year; and all bonds and assurances for the payment of any money to be lent upon usury, whereupon or whereby there shall be reserved or taken above five pounds in the hundred, shall be void; and every person who shall receive, by means of any corrupt bargain, loan, exchange, shift, or interest, of any wares or other things, or by any deceitful way, for forbearing or giving day of payment for one year, for their money or other things, above 5*l.* for 100*l.* for a year, &c. shall forfeit treble the value of the moneys or other things lent.

But if a contract, which carries interest, is made in a foreign country, our courts will direct the payment of interest according to the law of that country in which the contract was made. Thus Irish, American, Turkish, and Indian interest, have been allowed in our courts, to the amount each of 12*l.* per cent. For the moderation or exorbitance of interest depends upon local circumstances; and the refusal to enforce such contracts would put a stop to all foreign trade. 2 Black. 463.

In an action brought for usury, the statute made against it must be pleaded; and in pleading an usurious contract as a bar to an action, the whole matter is to be set forth specially, because it lies within the party's own privity; yet on an information on the statute for making such contract, it is sufficient to mention the corrupt bargain generally, because matters of this kind are supposed to be privily transacted; and such information may be brought by a stranger. 1 Hawk. P. C. 248. Likewise upon an information on the statute against usury, he that borrows the money may be a witness, after he has paid the same.

UTENSILS, in a military sense, are necessaries due to every soldier, and to be furnished by his host where he is in quarters, viz. bed with sheets, a pot, a glass or cup to drink out of, a dish, a place at the fire, and a candle.

Utensils, &c. directed to be provided for the use of regimental hospitals:

In page 19, of the Regulations for the Sick, it is stated, that each hospital ought to be furnished with a slipper-bath, or bathing-tub, two water-buckets, one dozen of Osnaburgh towels, one dozen of flannel cloths, half a dozen of large sponges, combs, razors, and soap; two large kettles, capable of making soup for 30 men, two large tea-kettles, two large tea-pots, two saucepans, 40 tin cans of one pint each, 40 spoons, one dozen of knives and forks, two close-stools, two bed-pans, and two urinals.

A regiment consisting of 1000 men, and provided with three medical persons, ought to be furnished with hospital necessaries and utensils for at least 40 patients. It should be provided with 40 cotton night-caps; 40 sets of bedding, in the proportion of four for every hundred men; each set consisting of one paillasse, one straw mattrass, one bolster, three sheets, two blankets, and one rug.

For regiments of smaller number, the quantity of hospital necessaries will of course be proportionally reduced.

Utensils, *bakery*. The following list of bakery utensils, being the proportion requisite for an army of 36,000 men, has been extracted from the British Commissary, to which useful treatise we refer the military reader for a specific description of field ovens, &c. and field bakery, page 16, &c.

12 double iron ovens, 11 feet long, 9 feet diameter, and 3 feet high; 28 troughs and their covers, 16 feet long, 3 feet wide, and 3 feet deep, to knead the dough.

12 large canvas tents (having double coverings), 32 feet long, and 24 feet wide, to make the bread in.

4 ditto, to cool and deposit the bread in.

2 ditto, to deposit the meal and empty sacks in.

2000 boards, 8 feet long, and 1½ foot wide, to carry the bread to the oven, and back when baked; 24 small scales to weigh the dough, with weights from half an ounce to 6lb.; 24 small lamps for night work; 24 small hatchets; 24 scrapers, to scrape the dough from the troughs; 12 copper kettles, containing each from ten to twelve pails of water; 12 trevets for ditto; 12 barrels with handles, to carry water, containing each from 6 to 7 pails.

12 pails, to draw water; 24 yokes and hooks, to carry the barrels by hand; 24 iron peles, to shove and draw the bread from the ovens; 24 iron pitchforks, to turn and move the firewood and coals in the ovens; 24 spare handles, 14 feet long, for the peles and pitchforks; 24 rakes, with handles of the same length, to clear away the coals and cinders from the ovens; 4 large scales, to weigh the sacks and barrels of meal, and capable of weighing 500lb.; 4 triangles for the said scales; to each must be added 500lb. of weights, 3 of 100lb. each, 2 of 50lb. each, and downwards to half a pound.

UTERUS. See Anatomy.

UTLAGATO *capiendo quando utlagatur in uno comitatu et postea fugit in alium.* A writ for the taking of an outlawed person in one county, who afterwards flies into another.

UTRICULARIA, a genus of plants of the class diandria, and order monogynia; and in the natural system arranged under the 24th order, corydales. The calyx is ringent, with a nectarium resembling a spur; the corolla diphyllous and equal; the capsule unilocular. There are 13 species, two of which are natives of Britain. They have been applied to no particular use.

UVARIA, a genus of plants of the class and order polyandria polygamia. The calyx is three-leaved; petals six; berries numerous, pendulous, four-seeded. There are eleven species, shrubs and trees of the East Indies.

VULTUR, a genus of birds belonging to the order of accipitres. The beak is straight, and crooked at the point; the head has no feathers, on the fore part there being only naked skin, and the tongue is generally bifid. There are twenty-one species. The most remarkable are,

1. Gryphus, the condor, which is not only the largest of this genus, but perhaps of all which are able to fly. The accounts of authors in regard to the strength of this bird, and its extent of wing, are various. From nine to eighteen feet from the tip of one wing to that of the other has been mentioned; and one gives it strength sufficient to carry off sheep, and boys of ten years old; while another ventures to affirm, that it can lift an elephant from the ground high enough to kill it by the fall! The account, however, given in Cook's Voyage, is very nearly, if not precisely, the truth, which states the extent of wing at about 11 feet. The bill is strong, moderately hooked, and blunt at the tip, which is white, the rest of it being of a dusky colour. On the top of the head runs a kind of carunculated substance, standing up like the comb of a cock. The head and neck are slightly covered with brown down, in some parts nearly bare, and here and there a carunculated part, as in the neck of a turkey. The lower part of the neck is surrounded with a ruff of a pure white and hairy kind of feathers. The upper parts of the body, wing, and garl, are black, except that the middle wing-coverts have whitish ends, and the greater coverts half black half white. The nine or ten first quills are black; the rest white, with the tips only black; and when the wings are closed, producing the appearance of the bird having the back white. The under parts of the body are rather slightly covered with feathers; but those of the thighs are pretty long. The legs are stout and brown; claws black and blunt.

These birds are said to make their nests among the inaccessible rocks, and to lay two white eggs, larger than those of a turkey; are very destructive to sheep, and will in troops often attempt calves; in which case, some of them first pick out the eyes, whilst others attack the poor animal on all sides, and soon tear him to pieces. This gives rise to the following stratagem, used by the peasants of Chili: One of them wraps himself up in the hide of a fresh-killed sheep or ox, and lies still on the ground; the condor, supposing it to be lawful prey, flies down to secure it, when the person concealed lays hold of the legs of the bird, his hands being well covered with gloves; and immediately his comrades, who are concealed at a distance, run in, and assist to secure the depredator, by falling on him with sticks till they have killed him.

2. The percnopterus, or Egyptian vulture. The appearance of this bird is as horrid as can well be imagined, viz. the face is naked and wrinkled; the eyes are large and black; the beak black and hooked; the talons large, and extending ready for prey; and the whole body polluted with filth: these are qualities enough to make the beholder shudder with horror. Notwithstanding this, the inhabitants of Egypt cannot be thankful enough to Providence for this bird. All the places round Cairo are filled with the dead bodies of asses and camels; and thousands of these birds fly about, and devour the carcases before they putrify and fill the air with noxious exhalations. The inhabitants of Egypt, and after them Maillet in his Description of Egypt, say, that they yearly follow the caravan to Mecca, and devour the

filth of the slaughtered beasts, and the carcases of the camels which die on the journey. They do not fly high, nor are they afraid of men. If one is killed, all the rest surround him in the same manner as do the Royston crows; they do not quit the places they frequent, though frightened by the explosion of a gun, but immediately return thither.

3. The aura, or carrion vulture, according to Latham, is about the size of a turkey, though it varies in size in different parts. The bill is white; the end black; irides bluish saffron-colour. The head, and part of the neck, are bare of feathers; and of a red, or rather rufous colour. The sides of the head warted, not unlike that of a turkey. The whole plumage is brown-black, with a purple and green gloss in different reflections; but in some birds, especially young ones, greatly verging to dirty-brown. The feathers of the quills and tail are blacker than the rest of the body. The legs are flesh-colour; the claws black.

4. The sagittarius, or secretary, is a most singular species, being particularly remarkable from the great length of its legs; which at first sight would induce one to think it belonged to the grallæ, or waders; but the characters of the vulture are so strongly marked, as to leave no doubt to which class it belongs. The bird, when standing erect, is full three feet from the top of the head to the ground. The bill is black, sharp, and crooked, like that of an eagle; the head, neck, breast, and upper parts of the body, are of a bluish ash-colour: the legs are very long, stouter than those of a heron, and of a brown colour; claws shortish, but crooked, not very sharp, and of a black colour; from the hind-head springs a number of long feathers, which hang loose behind like a pendant crest; these feathers arise by pairs, and are longer as they are lower down on the neck; this crest the bird can erect or depress at pleasure; it is of a dark colour, almost black; the webs are equal on both sides, and rather curled; and the feathers, when erected, somewhat incline towards the neck; the two middle feathers of the tail are twice as long as any of the rest. This singular species inhabits the internal parts of Africa, and is frequently seen at the Cape of Good Hope. It is also met with in the Philippine islands.

As to the manners of this bird, it is on all hands allowed that it principally feeds on rats, lizards, snakes, and the like; and that it will become familiar: whence Sonnerat is of opinion that it might be made useful in some of our colonies, if encouraged, towards the destruction of those pests. They call it at the Cape of Good Hope stangeater, *i. e.* snake-eater. A great peculiarity belongs to it, perhaps observed in no other; which is, the faculty of striking forwards with its legs, never backwards. Dr. Solander saw one of these birds take up a snake, small tortoise, or such-like, in its claws; when dashing it thence against the ground with great violence, if the victim was not killed at first, it repeated the operation till the end was answered; after which it ate it up quietly. Dr. J. R. Forster mentioned a further circumstance, which he says was supposed to be peculiar to this bird; that should it by any accident break the leg, the bone would never unite again.

The Editor of this work saw a secretary some years ago at Exeter-exchange. The dexterity with which it struck eels, &c. with its hard heel was surprising. How far it might have been tutored to this exercise is impossible to say.

5. The papa, or king vulture, inhabits South America; is the size of a hen turkey: feeds on serpents, lizards, frogs, rats and carrion; flies high. See Plate Nat. Hist. fig. 420.

VULVA. See Anatomy.

UVULA. See Anatomy.

UVULARIA, a genus of the hexandria monogynia class of plants, the flower of which consists of six very long lanceolated petals; and its fruit an ovate-oblong trilocular capsule, containing several roundish and compressed seeds. There are six species.

W.

W, or w, is the twenty-first letter of our alphabet.

WACHENDORFIA, a genus of plants of the class triandria, and order monogynia; and arranged in Linnæus's natural method of classification under the 6th order, ensatæ. The corolla is hexapetalous, unequal, and situated below the germen; the capsule trilocular and superior. There are five species, none of which are natives of Britain.

WACKEN, a mineral that occurs in mass; sometimes it forms strata, but more frequently it runs in veins. Colour dark greenish-grey, which often passes to mountain-green, or blackish-green. Specific gravity from 2.5 to 2.9. Easily melts before the blowpipe. Liable to spontaneous decomposition.

WAD, or Wadding, in gunnery, a stopple of paper, hay, straw, old rope-yarn, or tow, rolled firmly up like a ball, or a short cylinder, and forced into a gun upon the powder to keep it close in the chamber; or put up close to the shot, to keep it from rolling out, as well as, according to some, to prevent the inflamed powder from dilating round the sides of the ball, by its windage, as it passes along the chace, which it was thought would much diminish the effort of the powder. But, from the accurate experiments lately made at Woolwich, it has not been found to have any such effect.

WAFERS or Sealing-Wafers, are made thus: Take very fine flour, mix it with white of eggs, isinglass, and a little yeast; mingle the materials; beat them well together; spread, the batter being made thin with gum-water, on even tin plates, and dry them in a stove; then cut them out for use.

You may make them of what colours you please, by tinging the paste with brazil or vermilion for red; indigo or verditer, &c. for blue; saffron, tumeric, or gambooge, &c. for yellow.

WAGER OF LAW, is a particular mode of proceeding, whereby in an action of debt brought upon a simple contract between the parties, without any deed or record, the defendant may discharge himself by swearing in court in the presence of compurgators, that he owes the plaintiff nothing, in manner and form as he has declared, and his compurgators swear that they believe what he says is true. And this waging his law, is sometimes called making his law. 5 Bac. Abr. 428.

It being at length considered, that this waging of law offered too great a temptation to perjury, by degrees new remedies were devised, and new forms of action introduced, wherein no defendant is at liberty to wage his law.

Instead of an action of debt upon a simple contract, an action is now brought for the breach of a promise, or assumpsit; wherein though the specific debt cannot be recovered, yet damages may, equivalent to the specific debt; and this being an action of trespass, no law can be waged therein. So instead of an action of detinue to recover the very thing detained, an action of trespass upon the case, in trover and conversion, is usually brought, wherein though the specific thing cannot be had, yet the defendant shall pay damages for the conversion equal to the value thereof: and for this trespass also no wager of law is allowed. In the place of actions of account, a bill in equity is usually filed, wherein, though the defendant answers upon his oath, yet such oath is not conclusive to the plaintiff, but he may prove every article, by other evidence, in contradiction to what the defendant has sworn. So that wager of law is now quite out of use, being avoided by the mode of bringing the action, but still is not out of force. And therefore when a new statute inflicts a penalty, and gives an action of debt, it is usual to add that no wager of law will be allowed.

WAGERS. In general a wager may be considered as legal, if it is not an incitement to a breach of the peace, or to immorality; or if it does not affect the feelings or interest of a third person, or expose him to ridicule: or if it is not against sound policy. 2 Durnf. & East, 610. See Insurance.

WAGES, what is agreed upon by a master to be paid to a servant, or any other person that he hires to do his business for him. 2 Lil. Abr. 677. See MASTER AND SERVANT.

WAGTAIL, in ornithology. See MOTACILLA.

WAIFS, are goods which are stolen and waved by a felon in his flight from those who pursue him, which are forfeited; and though waif is generally spoken of goods stolen, yet if a man is pursued with hue and cry as a felon, and he flees and leaves his own goods, these will be forfeited as goods stolen; but they are properly fugitive's goods, and not forfeited till it is found before the coroner, or otherwise of record, that he fled for the felony. 2 Haw. 450. See ESTRAYS.

WAINAGE. The reasonableness of fines or amercements having been regulated by Magna Charta, that no person shall have a larger amercement imposed upon him than his circumstances or personal estate will bear, it is added, saving to the freeholder his contenement or land; to the trader his merchandize; and to the countryman his wainage, or team and instruments of husbandry. 4 Black. 379.

WAIVER, in law, signifies the passing by of a thing, or a refusal to accept it; sometimes it is applied to an estate, or something conveyed to a man, and sometimes to plea, &c. And a waiver or disagreement as to goods and chattels, in case of a gift, will be effectual. Lil. 710.

WAKE *of a ship*, is the smooth water astern when she is under sail: this shews the way she has gone in the sea, whereby the mariners judge what way she makes. For if the wake is right astern, they conclude she makes her way forwards; but if the wake is to leeward a point or two, then they conclude she falls to the leeward of her course. When one ship, giving chase to another, is got as far into the wind as she, and sails directly after her, they say she has got into her wake. A ship is said to stay to the weather of her wake, when in her staying she is so quick, that she does not fall to leeward upon a tack; but that when she is tacked, her wake is to the leeward; and it is a sign she feels her helm very well, and is quick of steerage.

WALE, or WALES, in a ship, those outermost timbers in a ship's side on which the sailors set their feet in climbing up. They are reckoned from the water, and are called her first, second, and third wale, or bend. See SHIP.

WALES. By stat. 27 H. VIII. c. 26, and other subsequent statutes, the dominion of Wales shall be incorporated with, and be part of, the realm of England; and all persons born in Wales shall enjoy all liberties and privileges as the subjects in England do. And the lands in Wales shall be inheritable after the English tenure, and not after any Welsh laws or customs. And the proceedings in all the law-courts shall be in the English tongue. A session is also to be held twice a year in every county, by judges appointed by the king, to be called the great sessions of the several counties in Wales; in which all pleas of real and personal actions shall be held, with the same form of process, and in as ample manner, as in the court of common-pleas at Westminster; and writs of error shall lie from judgments therein to the court of king's-bench at Westminster. But the ordinary original writs, or process of the king's courts at Westminster, do not run into the principality of Wales, though process of execution does, as also all prerogative writs, as writs of certiorari, quo minus, mandamus, and the like. 3 Black. 77.

Murders and felonies in any part of Wales may be tried in the next adjoining English county; the judges of assize having a concurrent jurisdiction throughout all Wales, with the justices of the grand sessions. Str. 553.

All local matters arising in Wales, triable in the king's-bench, are by the common law to be tried by a jury returned from the next adjoining county in England. Burr. 859.

No sheriff or officer in Wales shall, upon any process out of the courts at Westminster, hold any person to special bail, unless the cause of action is twenty pounds or upwards. 11 and 12 W. c. 9.

WALK. See GARDENING.

WALKERIA, a genus of plants of the class and order pentandria monogynia. The calyx is five-parted, inferior; corolla five-petalled; drupes five, one-seeded; nuts reniform. There is one species, a tree of the East Indies.

WALL, in gardening. Of all materials for building walls for fruit-trees, brick is the best, it being not only the handsomest, but the warmest and kindest for the ripening of fruit; and affording the best conveniency for nailing, as smaller nails will serve in brick than will in stone walls, where the joints are larger; and if the walls are caped with free-stone, and stone pilasters or columns at proper distances, to separate the trees, and break off the force of the winds; they are very beautiful, and the most profitable walls of any others. In some parts of England there are walls built both of brick and stone, which are found very commodious. The bricks of some places are not of themselves substantial enough for walls; and therefore some persons, that they might have walls both substantial and wholesome, have built these double, the outside being of stone, and the inside of brick; but there must be great care taken to bond the bricks well into the stone, otherwise they are very apt to separate one from the other, especially when frost comes after much wet.

There have been several trials made of walls built in different forms; some of them having been built semicircular; others in angles of various sizes; and projecting more towards the north, to screen off the cold winds; but there has not as yet been any method which has succeeded near so well as that of making the walls straight, and building them upright. Where persons are willing to be at the expence in the building of their walls substantial, they will find it answer much better than those which are slightly built, not only in duration, but in warmth; therefore a wall two bricks thick will be found to answer better than that of one brick and a half. The best aspect for ripening fruit is south, with a point to the east; and the next best due south. It is a great improvement to have a trellis of wood against the wall, to train the trees to, as it prevents the wall being spoiled by nails, &c.

WALLENIA, a genus of plants of the class and order tetrandria monogynia. The calyx is four-cleft; corolla tubular, four-cleft; berry one-seeded. There is one species, a tree of the West Indies.

WALRUS. See TRICHECUS.

WALNUT-TREE. See JUGLANS.

WALTHERIA, a genus of the monadelphia pentandria class of plants, the flower of which consists of five petals, vertically cordated and patent; the fruit is an unilocular bivalve capsule, vertically ovated; and the seed is single, obtuse, and broadest at the top. There are six species.

WANMANNIA, a genus of plants of the class octandria, order monogynia, and arranged in the natural classification with those plants the order of which is doubtful. The calyx is four-leaved, the corolla has four petals, and the capsule is bilocular and birostrated. There are four species, none of which are natives of Britain.

WAPENTAKE, from the Saxon, the same with what we call a hundred, and more especially used in the northern counties beyond the river Trent. There have been several conjectures as to the original of the word, one of which is, that antiently musters were made of the armour and weapons of the inhabitants of every hundred; and from those that could not find sufficient pledges of their good behaviour, their weapons were taken away, and given to others; whence it is said this word is derived. See HUNDRED.

WAR. The too frequent recurrence of this great and detestable calamity, unfortunately renders a definition of the word unnecessary. If we were called upon to define it, we should say, it is the wanton destruction, the cold-blooded slaughter, of the human race: we should call it an accumulation of every sin that degrades and vilifies mankind: we should mark it as a practice that diffuses misery and perpetuates vice: we should say, that if there is a burlesque upon the boasted reason of man it is this; when millions meet to murder each other for a quarrel in which, in general, they have not individually the smallest interest. The poet who wrote,

> "One murder makes a villain, millions a hero," &c.

deserves a statue of gold; and the writer of that verse may lift his head in the proudest assembly, and avow his principles in the face of the world.

The best and most respectable of the Christian sects have disclaimed war as inconsistent with their Christian calling and profession. There may however exist cases where war is self-defence; and if ever it is such, it is when an unprincipled tyrant, at the head of a disciplined banditti, endeavours to reduce the civilized world under one system of general despotism, and to plunder the property of unoffending nations and individuals, in the same manner as the highwayman, who by the laws of every well regulated community, is for such an offence destined to the rope. We leave our readers to make the application to the present circumstances of Europe, and we think they cannot long be at a loss.

In this view, as a means of defence, and as useful to the understanding of history, and not as giving our sanction to an irrational and antichristian practice, we insert the following article.

WAR, *art of*. As war, on the one hand, in respect to its effects, is intimately connected with the propriety and independance of nations; so, on the other, it requires infinite skill, combination, and management, when considered as an art. Its principles, founded on the sciences themselves, are fixed and certain: but these branch out into such a prodigious variety of ramifications, that men of extraordinary talents and genius only have been able to excel in it.

As two different elements constitute the theatre of its operations, war is naturally divided into naval and military arrangements.

Of naval warfare.

The art of arranging squadrons or fleets in order of battle, and regulating their movements in such a manner as may be deemed best calculated for attacking, defending, or retreating, to the greatest possible advantage, is termed naval tactics.

The antients seem to have excelled rather in land, than in sea engagements. On recurring to the history of remote periods, we are perpetually reminded of the state of savage nations at the present day; the canoes indeed of the Iroquois would have availed but little, yet the war-boats of Otaheite might not then have appeared contemptible.

The Mediterranean was the early scene of naval exploits; and galleys were the vessels originally used in engagements. These were propelled by the force of oars; and the combatants being made to approach, and sometimes to board each other by means of flying bridges, a battle at sea differed but little from a battle on land. But in progress of time, a superiority was attempted to be obtained by means of skill and management. The prows were armed with brazen spikes, or tridents, which were so contrived as to pierce the enemy's vessels under water, and by letting in the sea, expose them to the danger of sinking. Turrets were also erected between the poop and the forecastle, for the purpose of overlooking the foe, and annoying him by means of darts and slings. In process of time, other improvements took place, which we shall here endeavour briefly to enumerate.

1. The dolphin, which was a huge and massive piece of lead, formed into the shape of the fish from which it had derived its name. This being perfectly suspended by blocks and ropes from the mast-head or yard-arm, was allowed to drop, whenever an opportunity presented itself; and penetrating through the bottom of a vessel slightly constructed, it of course, by its own specific gravity, made a passage for the entering waves; and thus sometimes rendered even a retreat impossible.

2. Another engine in use, consisted of a scythe of iron, fixed at the top of a long pole; and was employed for the purpose of cutting asunder the slings of the sail-yards, so as to incommode during action, and prevent escape either then or afterwards.

3. Spears, or maces, of an extraordinary length, were constructed so as to annoy at a considerable distance; and thus, although stationary, to serve the purpose of a missile weapon.

4. The naval battering-ram, mentioned by Vegetius, consisted of a long beam, armed with a head of iron; and being suspended to the main-mast, was employed to good effect against the sides of the galleys.

5. A grappling-iron, which seized hold of any part of the opposing vessel, and facilitated the boarding of her.

6. The last, and most formidable of all their machines, was the balista; by which large stones could be thrown to a great distance, with a considerable degree of certainty, and the most terrible effects.

3

Having thus mentioned the engines made use of by the antients during naval combats, we next come to the disposition of their fleets. It was then, as now, considered a great advantage to obtain the weather-gage; and it was at the same time endeavoured to contrive so as to have the sun behind themselves, while it shone directly in the faces of their enemies. Instead of manœuvring by means of their sails, these were always lowered previously to action; and the prows being presented to the enemy, they advanced against each other by force of oars, and amidst the sound of trumpets. After expending their arrrows and javelins, recourse was at length had to the sword, so that courage alone decided the combat.

The code of signals, like the symbol by which they were regulated, was simple in the extreme. It consisted sometimes of a gilded shield, and sometimes of a red garment, or banner. During the elevation of this, the battle continued; its depression denoted defeat; and by its inclination either to one side or the other, an attack or retreat was pointed out.

In respect to the line of battle, the half-moon was generally the favourite position. During one memorable sea-fight, the galleys of the Romans were ranged so as to represent a wedge in front, while the Carthaginians drew up their fleet in such a manner as to form a rectangle on two sides of a square, for the purpose of annoying and inclosing the flank of the enemy; the former was the figure best calculated for attack, the latter for defence.

Notwithstanding the boasted greatness of the Roman people, yet when this country was invaded by Cesar, they appear to have obtained but little eminence in respect to naval affairs. A fleet on that occasion was not brought from the mouth of the Tiber, and the vessels built in Gaul exhibited nothing formidable or ingenious either in their management or construction. They must have been small and contemptible, in point of size, for they were drawn up on the beach, near to where the town of Deal now stands, and fortified like the camp, by means of a ditch and rampart.

On the departure of these invaders, who, as usual, at once conquered and civilized the barbarous tribes among whom they settled, the situation of the Britons must have been truly distressing. Reduced perhaps to the coracles, or boats made of skins stretched on osiers, they were able to derive little or no benefit from the ocean that surrounded them. On the neighbouring continent, however, the boats had made a greater progress, or at least left a deeper impression; for, doubtless, the keels of the Saxons must have appeared formidable to men whose vessels were ribbed with twigs.

The wars with the Danes rendered some attention to maritime affairs necessary; and Alfred is represented as having encouraged and employed foreign artificers and mariners, by means of whom he constructed vessels of a superior size. With these he scoured the coasts, which were then infested by pirates, freebooters, and enemies of all sorts: and this prince appears to have rescued his subjects from the incursions of pirates.

At length the depredations of the northern states became formidable. From being occasional visitors, for the sake of plunder, the Danes, and other nations bordering on the Baltic, began to think of settling in Britain, and in consequence of their power and numbers, they were finally enabled to place one of their own sovereigns on the throne. After this, either by land or sea, all contention necessarily ceased.

William the Norman obtained the crown by the gross mismanagement of Harold, in respect to both naval and military affairs: for on one hand he had detached his squadron to the northern parts of the kingdom, instead of keeping it on the southern shore to oppose the enemy; while on the other he put his whole stake to hazard on a single battle. The fleet conducted by the Conqueror to the coast of Sussex, (Sept. 28, 1066) consisted of no less than three hundred vessels; but they appear to have been contemptible in point of size, and to have been but ill calculated to cope with an enemy.

A long interval succeeded before any great progress, in respect to maritime affairs, occurred; and the crusades, the wars between the kings and the barons, the acquisition of Ireland, and the incorporation of Wales, all took place before the foundation of a national navy was laid. But commerce, the true nursery of sailors and of a fleet, began to be attended to; trade was no longer carried on solely by foreigners; while the wool of England, after being woven and spun where it had grown, was exported to distant countries, and brought back profitable returns. The ships of the cinque-ports now became formidable; they were regularly lent out, when required, to the kings of England; and assisted not only in their wars, but in the conveyance of their troops to the continent.

In 1217, Hubert de Burgh, governor of Dover-castle, after obtaining the weather-gage, defeated the French, in the first sea-fight that ever took place between the English and them.

It was not until the time of Edward I. however, that any great exertions seem to have taken place. That prince fitted out three squadrons at the same time.

In 1340, the English fleet appears to have been drawn up in two distinct lines, the larger ships being placed in the front, and the smaller in the rear, whence they were enabled to send fresh supplies of men, or otherwise grant their assistance, as occasion might serve. In this battle, which took place on the coast of Flanders, the French lost two hundred and thirty ships, and had two of their admirals slain. During the contest for the crown of France, the arms of England were eminently triumphant both by sea and land; but the wars between the rival houses of York and Lancaster so completely occupied the hands and the hearts of the nation, as to prevent any attention to foreign affairs.

At length Hen.VII. a wise and able prince, began to build ships of war, one of which cost him upwards of 14000*l*. His son, Henry VIII. notwithstanding those odious vices which rendered his memory odious, seems to have conceived a just notion of the true interests of the nation, in respect to maritime affairs. He accordingly instituted the navy-office, appointed commissioners, constructed several large ships, and laid the foundation of that naval power, which, in the time of his daughter, preserved the independance, and added not a little to the glory, of England.

Nor were the French at this period inattentive to their navy. During an engagement with the English in the Channel, their fleet appears to have assumed a regular and systematical arrangement. It consisted of three divisions, that in the centre being composed of thirty-six ships, and the van and rear of thirty each. The galleys, which had come from the Mediterranean, were considered in the same point of view as frigates are at the present day, and never entered the line of battle.

Meanwhile, the introduction of gunpowder had created an entire change in the weapons of war; and at this day the sword and the boarding-pike are perhaps the only ones that have been used in common, both by the antients and moderns. The Spaniards, who had become a great maritime nation, are said to have been the first who had recourse to cannon, during a sea-fight with the English and their allies, off Rochelle, in 1372: yet it has been asserted, that this instrument of destruction was actually recurred to by our ancestors in 1350. The same people soon after threatened an invasion, by means of an armada, which, whether we consider the size of the vessels, or the manner in which they were manned and equipped, must be considered as truly formidable. They entered the Channel in the form of a crescent, the horns of which extended to a prodigious distance, and were assuredly more than a match for any force that could be brought to oppose them. But lord Howard of Effingham, assisted by Drake, Hawkins, and Frobisher, (all of whom, but himself alone, had been bred in the merchant-service), so managed an inferior squadron, as to obtain a complete victory.

A competent idea may be formed of the fleet of England in those days, by observing, that on the demise of Elizabeth, it consisted of forty small ships only, of which number four did not exceed forty guns, and but two of these were of the burthen of a thousand tons; twenty-three others were below five hundred; of the rest, some did not exceed fifty, and some not even twenty, while the whole number of guns amounted to no more than 774.

But the long and bloody contest that afterwards took place with Holland for naval superiority, finally fixed the character of the English nation, in respect to maritime affairs. During three dreadful wars, there were no less than nineteen general engagements, in one of which the fight was renewed for three days in succession, in another for two days, and in a third for one; making in all no less than twenty-five days of general actions. What is still more extraordinary, De Witt on one side, and Monk and Blake on the other, were landsmen, yet they all fought with unrivalled skill and intrepidity. The last of these was the first who ever brought ships of war to oppose castles.

At the death of Charles II. the royal navy amounted in all to 113 sail. James II. while a subject, had commanded a fleet, and instituted, or rather improved and enlarged, the system of signals. At his abdication, England possessed 173 vessels of different descriptions. During the time of William and Mary, these were increased to 256; but their success was not proportionable to the public expectation. In the reign of Anne, however, the naval power of France received a deadly blow at Vigo, having lost no less than seventeen ships of war.

On the accession of the house of Brunswick, the fleet increased rapidly; and during the present reign, it has obtained an unexampled degree of prosperity: for towards the middle of the year 1806, it consisted of 132 sail of the line, 17 forty-four and fifty gun ships, 196 frigates, 106 sloops, &c. and 242 gun-brigs, forming a total of 753 in commission.

After these observations on the rise and progress of the British navy, it may be necessary to make some remarks on the manner in which it is conducted during action. As the skill and bravery of our seamen have always been eminent by comparison in close engagements between single ships, it necessarily follows, that the adoption of any system which would place fleets precisely in the same condition, could not fail to be attended with the most beneficial advantages. It was a long while, however, before this could be effected; for the opposite squadrons being usually disposed in right lines parallel to each other, every ship keeping close hauled upon a wind on the same tack, it necessarily followed, that the action in general, provided equal numbers were brought into contact, could neither be long nor decisive. Thus it frequently happened, that nothing decisive occurred, not so much as a single ship being lost or won on either side.

A great and sudden change was however effected. This occurred on the 12th of April 1782; when admiral sir George Bridges Rodney, instead of following the old system, pierced the French line, formed by the count De Grasse, and gained a complete victory. The same occurred under lord Howe, June 1, 1794.

A similar principle, viz. "the directing the greater part of the force of a fleet against a few ships," was put in practice by sir John Jervis, now earl St. Vincent, on the 13th of February, 1797.

At the battle of the Nile admiral sir Horatio, afterwards lord viscount, Nelson, contrived to double down on the enemy, and place part of their fleet between two fires: while during that of Trafalgar he advanced in two lines, and effected a disjunction with similar effect, but by different means. The principle, indeed, was exactly the same in all; that of bringing fleets into the same position as single ships, so that the sailors might be enabled to fight hand to hand, with the additional advantage, that the many would thus be enabled to attack the few.

It has already been observed, that some of our gallant naval commanders, during the civil wars, had been bred in the army; and it is not a little remarkable, that the great change which has taken place of late years, in respect to the management of fleets, appears to have originated with a landsman, who, according to his own account, had attained ten years of age, before he had ever seen a ship. The gentleman to whom we now allude is Mr. Clerk, of Eldin, author of an "Essay on Naval Tactics, Systematical and Historical, in four parts." The first edition of the first part appeared in 1790; and the second edition in 1804; and as this is the only treatise of the kind in our language, we shall here take some notice of it.

During the American war, the action between admiral Keppel and the French fleet, on the 27th of July, 1778, engaged Mr. Clerk's particular attention. The idea of the line of battle was in some parts novel, as it was an attack from the leeward; and he remarked, with surprise, that in the course of the two long trials which followed this indecisive fight, as well as that of admiral Matthews, in 1744, and of admiral Byng, in 1756, not a single hint escaped, "that it was possible any thing defective could be attributed to the system of the attack itself, or that any kind of improvement should be attempted;" such as the scheme since put in practice, "the cutting the enemy's line asunder; the directing the greater part of the force of a fleet against a few ships, either in the van or the rear, or even making a prize of the slower-sailing or crippled ships of the enemy."

During the engagement of admiral Byron off the island of Grenada, on July 6, 1779, the attack, like those made by Matthews and Byng, was from the windward; and from a consideration of all these cases, Mr. Clerk became induced to think, that the want of success was not to be attributed either to any abatement in the spirit of the seamen, or any defect in the shipping, or sailing of the fleets, but solely to the unskilful manner in which the general attacks were conducted.

Impressed with these ideas, he mentioned his suspicions, in January 1780, to a friend of sir George Rodney, to whom he at the same time communicated his theories of attack from both windward and leeward, and explained his doctrine of cutting the enemy's line. The propriety of these plans was not fully exemplified however, until two years after, (April 12, 1782;) when a victory, far more decisive and important than any which had been gained by our fleets during the last century, was obtained; for, on this occasion, the attack was from the leeward, which the author considers as more rare, ingenious, and effectual, than an attack from the windward; in addition to which, the enemy's line was at the same time cut in two.

In the Essay on Naval Tactics, the impropriety of a single ship to windward bearing down directly on an enemy to leeward, is pointed out by a diagram, accompanied with a demonstration: we are then presented with a comparative estimate of the effect of shot directed against the rigging of a ship, with its result when employed against the hull. In respect to fleets, an attack from the windward is supposed to be attended with a disadvantage in the ratio of twenty to one, as the fire of the whole line to leeward can be applied, on such an occasion, against the van of the assailants; a manœuvre which the French were well acquainted with, and put constantly in practice, until the new mode of combat was introduced.

These positions are illustrated by;

1. Admiral Matthews' engagement with the combined fleets of France and Spain, off Toulon, February 11, 1744.

2. Admiral Byng's action with the French fleet off Minorca, May 20, 1756.

3. Admiral Keppel's off Ushant, July 27, 1778.

4. Admiral Byron's off Grenada, July 6, 1779.

5. Admiral Barrington's, at St. Lucia.

6. Sir George Bridges Rodney's, off Capes Finisterre and St. Vincent.

7. ——————————— off the Pearl Rock, Martinico, April 17, 1780.

8. ——————————— to windward of Martinico, May 15, 1780.

9. ——————————— near the same place, May 19, 1780.

10. Admiral Arbuthnot's, off the Chesapeak, March 16, 1781.

11. Sir Samuel Hood's, off Fort Royal, Martinico, April 29, 1781.

12. Admiral Parker's, off the Doggerbank, August 5, 1781.

13. Commodore Johnstone's, at Port Praya, in the island of St. Julian.

14. Admiral Greaves's, off the Chesapeak, September 5, 1781.

From the particulars of this catalogue, Mr. Clerk deduces, as a general principle, that "where the British fleets being to windward, have endeavoured, by extending their line of battle, to stop, take, or destroy, the whole of the ships of the enemy's line to leeward, they have been disabled before they could reach a situation whence they could annoy the enemy; and, on the other hand, the French pursuing the British, in disorder, unsupported, and disabled, have made sail; and after throwing in the whole fire upon the van of the British fleet, ship by ship, as passing in succession, have formed a line to leeward, so as to be prepared in case another attack could be made."

He concludes by observing, "that the most artful management of sails, the closest approximation, or the most spirited cannonade, will avail nothing, under such circumstances; and that it is in vain to hope, that ever any thing material can be effected against an enemy's fleet keeping to windward, passing on contrary tacks, and desirous to go off, unless his line of battle can be cut in twain, or some such other step can be devised as has already been described."

Mr. Clerk, after this, proposes certain new modes, and points out their advantages:

1. The attack from the windward upon the rear of the enemy.

2. On the enemy's three sternmost ships.

He considers both of these as far preferable to the attempt of getting up with the enemy's van, with the view to carry the whole fleet; and thinks that we ought rather to content ourselves with the certainty of cutting off a few of their dullest-sailing vessels.

In Part II. we are presented with three cases of an attack: the 1st when made by the headmost ships of a squadron on the van of a retreating enemy; the 2d on or near the centre; and the 3rd upon the van, or any where ahead of the centre.

After due investigation, Mr. Clerk is of opinion, that the attack from the leeward quarter can be executed with the greatest number of advantages, particularly as the crippled ships remain under the protection of their friends; whereas, on the contrary, those appertaining to a fleet to windward, will fall immediately into the power of their enemies.

The battles which have taken place since the publication of this work, seem fully to justify all the positions laid down by this author, whose merits are acknowledged, and who, we are informed, has received encouragement and protection of the highest kind.

Of military arrangements.

The art of arranging armies in order of battle, and of regulating their movements in such a manner, as may be deemed most proper for attacking, defending, or retreating, to the greatest possible advantage, is termed military tactics. It has been generally recognised, and is at length received as an axiom, that there is no branch of human knowledge more difficult than that of which we are now about to treat; and both antients and moderns have been so well convinced of this fact, that it has been regularly taught in public schools, erected expressly for that purpose.

Two celebrated nations, the Greeks and the Romans, were particularly anxious to attain perfection in the science of war; and this accounts, in some measure, for their extraordinary success, when combating against enemies who, content with a blind obedience to a custom, placed their chief confidence, not in the discipline, but in the multitude of their combatants. They, on the contrary, were conscious that the strength of armies consists principally in the art with which they are managed, and the principles by which they are regulated; that multitudes are often more embarrassing than useful; and that a small body of troops, well regulated, and ably directed, is capable of overcoming a large one, deficient in respect to those advantages. Thence too they deduced a theory relative to the disposition of their soldiers, the order of battle, the manner of encamping, the best and most regular mode of marching, of forming, and of acting, in such a way, as to oppose the strong to the weak, while they at the same time anticipated all the stratagems, and prevented all the deceptions, of the enemy. On the other hand, they did not forget to regulate the different species of arms, to attain address in managing; and to adopt the most advantageous method of using them, whether offensively or defensively.

War, accordingly, was regarded as an art, of which it was necessary to become acquainted with the principles anterior to the practice. It is but little wonder, therefore, that so many great men were produced, and such wonderful effects ensured; more especially in Greece, where infinite pains were taken to attain a perfect system. The Romans too directed their attention to military affairs; and the order of the legion was supposed on the whole to be superior to that of the phalanx. Vegetius, indeed, after examining its formation, exclaims, that none but a God could have contrived such a powerful and admirable assemblage.

That wonderful nation too, laying prejudice aside, at once examined, studied, and adopted, those practices in which they were excelled by their enemies. A defeat was never lost on them; for after every reverse, they obtained an increase of their military knowledge. Thus the sharp-edged weapons of the Gauls, and the elephants of Pyrrhus, never surprised them but once; and they had no sooner become acquainted with the Spanish sword, than they immediately abandon their own. At the same time, they did not omit to employ Numidian horses, Cretan archers, slingers from the Balearic islands, and ships belonging to Rhodes. In fine, no people ever exhibited so much prudence in their preparations for a campaign, or carried on hostilities with such extraordinary audacity. We are the less inclined to wonder, therefore, at the observation of Josephus, who remarks, "that war with them was a meditation, and peace an exercise."

We accordingly find that they abound with great commanders; and what is still more extraordinary, that many of these commanders proved victorious without the benefit of experience. Scipio, at the age of twenty-seven, knew how to repair the faults committed by his father and his uncle, in consequence of previous study. When Lucullus marched into Asia for the purpose of attacking Mithridates, he instructed himself, according to Cicero, by reading Xenophon, and the best authors; while at a later period Narses, who had never before commanded, nor even served, replaced Belisarius, overcame Totila, and successfully concluded the struggle with the Goths.

It is evident, therefore, that war is to be regulated according to certain rules and principles; and that on the knowledge and application of these, depends the fate of a campaign, and perhaps of a nation. It necessarily follows, that a general ought to possess extraordinary talents and attainments. According to a celebrated author, "some qualities should be born with, and others acquired by, him." In addition to these, he should also possess a quick eye, so as to enable him to judge of an advantageous position for his troops, decide on a manœuvre to be made or to be avoided, of a country suitable or unsuitable to his army; and, above all, of a field of battle whence he can derive the greatest number of possible advantages at the least possible risk or inconvenience.

He should at the same time exhibit a sound and solid judgment; for the choice of officers to be employed on any particular exigency, depends in a great measure upon him, and therefore the best dispositions would prove fruitless if not ably seconded. As his orders too cannot, from the nature of things, be precise, it is expected therefore of those who command under him, to know how to take advantage of a wrong movement on the part of the enemy, to commence an attack themselves, or only to sustain the troops engaged, and to vary their conduct according to the varying nature of circumstances.

But these qualities in the chief without subordination on the part of those who are subject to his command would be of little avail, if order and discipline were not duly observed. Without these, the most numerous and best-composed army would soon become little better than a horde of Tartars, who, being united only by the hope of booty, separate as soon as that motive ceases to operate. Great art is necessary, however, in enforcing discipline, and a happy mean ought to be adopted. Too much severity disgusts the soldier, and not unfrequently produces mutinies; too much indulgence on the other hand sinks him into indolence, and induces him to neglect his duty; licentiousness makes good order appear burthensome; with his respect for, he also loses all his confidence in, his superior officer, so that the most fatal results are at length unavoidable.

Besides the above qualities, which are so essential, and even necessary, in a commander, a general who would aspire to the title of a hero, ought to unite in himself, not only all military, but all civil and political excellence. It is by a knowledge of the laws, customs, constitutions, produce, and nature of different states, that he is to regulate his operations, and make war with success. Nothing will escape him, because every thing is essential to his projects; the genius of the country points out the manner of his marches and his movements, and the knowledge of the inhabitants will lead him to anticipate whatever may be expected on their part. One nation is vehement, fiery, and formidable, at the first onset; another is not so hasty, but possesses more perseverance; with the former, a single instant determines success; with the latter, the action is not so rapid, but the event is less doubtful.

In former times, the art of war was different from what it is at present, although the grand principles are still the same. After the darts, javelins, and arrows, had been expended, the combat took place between opponents who engaged hand to hand; and as they advanced in deep order, with a view of overcoming all opposition by means of the impetus, the action was generally long and bloody. Some of the plans of battle were exactly the same then as now; and it is not a little remarkable, that Cæsar, at Pharsalia, drew up his troops according to the oblique order, while Epaminondas at Leuctra adopted that figure which, on account of its particular form, is called an echellon attack.

In the middle ages, war appears to have degenerated into a system of marauding, being carried on nearly in the same manner as among the Mahrattas at the present day. The troops, if troops they might be termed, were mounted on horseback; and the men at arms, as they were called, being cased in armour, placed their glory in standing erect in their stirrups, so as to resist the shock of an adversary. At length, during the crusades, a more regular system began to prevail; and the christians on the plains of Palestine, met with a master in the art of war, in the person of Saladin.

At the battle of Hastings, the Norman cross-bows appear to have galled and even to have surprised the English, whose ranks were close, and whose line could not be pierced. On perceiving this, William had recourse to stratagem, and conquered by pretending to fly, for he knew that regular order could not be preserved in a pursuit, and he was thus enabled to overcome an enemy which had been thrown into disorder.

At Cressy, the English army was formed in a masterly manner, having been posted to great advantage on a gentle ascent, near the village of that name, and drawn up so as to form three lines expressly according to the mode prevalent at the present day; while Edward III. was stationed with the reserve, so as to be able to see and to succour his troops, if occasion should require. The long bows of the English, at this memorable conflict, seem to have exhibited a marked superiority over the cross-bows of the Genoese, who had been many years considered as the best light troops in Europe. Since that period, the English, more especially when opposed hand to hand with the French, have uniformly maintained their superiority in the field, whenever equal numbers were engaged. We accordingly find, that whether with infantry or cavalry, the pike, the screwed bayonet, or sword, have in turn, while in their hands, been managed to advantage.

The introduction of gunpowder has made a great change in the art, without altering, however, any of its grand principles, which were exactly the same at the battles of Cannæ and of Austerlitz. This invention, however, has made modern wars infinitely more expensive, and modern armies far more difficult, in respect to their management. An immense quantity of baggage, ammunition, and artillery, has now become necessary, while the specific number rather than the individual excellence of the soldiers, is attended to. As much depends in the new system, on the regular supply of provisions, for men and horses, a plan of the campaign is formed beforehand, fortresses are considered as so many fundamental points, and the magazines being filled under their protection, they are termed the base whence the lines of operation are to be traced. It is thus, that strong places serve equally to protect retreats, and to favour attacks.

In ancient times, it was usual to assault the enemy in front, but it is now customary to act on the flank and the rear, to cut off convoys, and by annihilating his supplies, to destroy the resources on which he depends. It is usual, therefore, instead of assuming a position directly in front, to occupy a camp either to the right or left; for the centre, which is the strongest part of the line, is thus happily eluded, while on the contrary, the wings, which are necessarily the weakest portion, thus became exposed to insult.

Notwithstanding gunpowder is supposed by some to have been first used at the battle of Cressy, where two field-pieces are said to have been employed, yet it was not until the reign of Louis XIV. that towns began to be fortified according to the modern manner. Vauban, under the auspices of that monarch, rendered sieges long and expensive. During the war of the succession, Marlborough and Eugene perceived the necessity of obtaining possession of the fortresses on their flanks before they thought of advancing, while Charles XII. carried on war like a knight-errant, rather than a great general; for although the passage of the Dwina, the battle of Narva, and the actions in Poland displayed the talents of a master, yet his march into the Ukraine, at the solicitation of a Cossack chief, and his brilliant but delusive career, considered as one great whole, savour more of the adventurer than the hero.

It was about this period, that, in consequence of the frequency of sieges, the pike began to be entirely laid aside, and the bayonet adopted. The prince de Dessau soon after introduced three important changes, to two of which the Prussians were indebted for the battle of Molvitz. The first of these, the iron ramrod, by accelerating, tended not a little to render the fire of musquetry more fatal, and thus served to exempt it from the contempt in which it was held by the chevalier Folard and marshal Saxe. The second was the equal step, which enabled the whole line to advance in regular time, and thus produced one grand and uniform movement. The third, was the change effected in the order of battle, which was altered to consist of three instead of four lines.

It was on these foundations that Frederic II. erected a grand superstructure. It was he who, in addition to the practice of these improvements, introduced celerity into the motions of the infantry, and effected an entire change in the charge of the cavalry; before his time the squadrons never advanced with a quicker pace than a trot, and had recourse to fire-arms instead of the sabre. At the action of Sorr, his majesty was saved from destruction by the conduct of his horse; and he is supposed to have gained the battle of Friedburg by the able disposition of his infantry, on which occasion, he, for the first time, developed the system of the oblique line.

The dispute that arose out of the succession of Bavaria was too short to produce any grand changes, although the king of Prussia and prince Henry on the one hand, and the emperor Joseph and marshal Laudohn on the other, were in the field. The war was confined entirely to manœuvres, to marches, and countermarches, and ended without a battle.

The American contest produced a grand change in military tactics, the introduction of the tiralleurs or rifle-men. It is remarkable for the singular circumstance of the English gaining every general action, without being able to achieve a permanent conquest. But no sooner did the war arising out of the French revolution take place, than great and important changes were produced. At the battle of Jemappe, Dumourier introduced an immense number of heavy cannon, and a flying artillery was soon after brought into the field by his countrymen, which produced wonderful effects, and has been since imitated by every neighbouring nation. Pichegru and Moreau, in Holland, Germany, and Flanders, distinguished themselves by the quickness of their evolutions, and the successful manner in which they usually terminated their campaigns. Buonaparte, by the rapidity of his movements, and the enthusiasm with which he inspired the soldiers under him, performed wonders in Italy and Germany. To Dessaix, however, he was greatly indebted for the victory at Marengo, and he gained the battle of Austerlitz, partly by becoming the assailant instead of acting on the defensive, partly by the suddenness of his attack, and partly by piercing between the ill-connected columns of the allied army, the movements of which were neither uniform nor simultaneous.

After all, although war as a science has of late years been certainly carried to a great degree of perfection, yet it has varied but little in its principles; on the contrary, the maximum of the art seems now to be, to bring troops to attack with the bayonet, in the same manner as they were accustomed to do with the pike some centuries ago; and the English by their conduct in Flanders, Egypt, and Calabria have proved, that hand to hand they still preserve their antient reputation, and now as of old, are unequalled at a charge.

Meanwhile, military seminaries for the instruction of those destined to become officers have been established, able masters have been also provided, and the arts and sciences connected with war, are now publicly taught. By the institution of the volunteers, the genius of the nation has been also of late years directed in an eminent degree to military affairs; and it seems now to be established as a principle, that an army has become to the full as necessary as a fleet, for the defence of our own islands, as well as the annoyance of the dominions of our enemies.

Before we conclude this subject, it may be necessary to enumerate a few of the general principles, laid down by those who have treated of the art of modern warfare; observing at the same time, that they apply rather to a continent than an island.

1. It is necessary to have magazines for the supply of an army, and fortresses for the protection of these supplies.

2. There should be a range of fortresses on the same line, to serve as a base for future operations.

3. To undertake with safety an offensive operation against the enemy, it is necessary that the two fortresses at the extremities of this line, should be separate at such a distance from each other, that the two lines of operation proceeding from them may meet at the given object, and form an angle of at least 90 degrees.

4. It is easier to stop the progress of an enemy by occupying a frontier on his flank, than in his front.

5. The best way of opposing an offensive operation, is to act offensively.

6. The subsistence of the enemy's army, rather than the army itself, ought to be the chief object against which operations are to be directed.

7. It is always possible to avoid a combat, by preventing the enemy from approaching too near.

8. A general ought never to wait an attack, but to put himself in movement to act offensively, even if in possession of a strong position.

9. An enemy can never be drawn up so as to prevent his flank from being turned.

10. The front opposed to the enemy ought to extend beyond, so as to envelope him, and he may be enveloped by an inferior number, provided it is posted on his flanks.

11. The infantry ought to be constantly supported by the cavalry, and the best way of achieving this, is to draw up the latter in the rear.

12. A column is the best defensive figure that can be assumed against cavalry.

WARS. The following are the most remarkable wars in which this country has been engaged, since the

War with Scotland, 1068.

Peace with { ditto, 1113.
France, 1113.

War with France, 1116.

Peace with { ditto, 1118.
Scotland, 1139.

War with France, 1161.

Peace with ditto, 1186.

War again with France, with success, 1194.

Peace with ditto, 1195.

Civil war { renewed, 1215—ended, 1216.
with France, 1224-ended, 1234.
1262—ended, 1267.

War, civil { with France, 1294.
with Scotland, 1296.

Peace { with France, 1299.
with Scotland, 1323.

War { again with Scotland, 1327.
ended, 1328.
again with Scotland, 1333.
with France, 1339.

Peace with France, May 8, 1360.

War { with France, 1368.
civil, 1400.
with Scotland, 1400.

Peace with France, May 31, 1420.

War { with France, 1422.
civil, between York and Lancaster, 1452.

Peace with France, October 1471.

War { civil, 1486.
with France, Oct. 6, 1492.

Peace { with ditto, Nov. 3, 1492.
with Scotland, 1502.

War { with France, Feb. 4, 1512.
with Scotland, 1513.

Peace with France, Aug. 7, 1514.

War with { ditto, 1522.
Scotland, 1522.

Peace with { France, 1527.
Scotland, 1542.

War with Scotland directly after.

Peace with France and Scotland, June 7, 1546.

War with { Scotland, 1547.
France, 1549.

Peace with both, March 6, 1550.

War { civil, 1553.
with France, June 7, 1557.
with Scotland, 1557.

Peace with { France, April 2, 1559.
Scotland, 1560.

War } with France { 1562.
Peace } 1564.

War with { Scotland, 1570.
Spain, 1588.

Peace with ditto, Aug. 18, 1604.

War with { Spain, 1624.
France, 1627.

Peace with Spain and France, April 14, 1629.

War { civil, 1642.
with the Dutch, 1651.

Peace with ditto, April 5, 1654.

War with Spain, 1655.

Peace with Spain, Sept. 10, 1660.

War with { France, Jan. 26, 1666.
Denmark, Oct. 19, 1666.

Peace with the French, Danes, and Dutch, Aug. 24, 1667.

Peace with Spain, Feb. 13, 1668.

War with the Algerines, Sept. 6, 1669.

Peace with ditto, Nov. 19, 1671.

War with the Dutch, March, 1672.

Peace with ditto, Feb. 28, 1674.

War with France, May 7, 1689.

Peace, general, of Rhyswick, Sep. 20, 1697.

War with France, May 4, 1702.

Peace of Utrecht, March 13, 1713.

War with Spain, Dec. 1718.

Peace with ditto, 1721.

War with { Spain, 1739.
France, March 31, 1744.

War with { France, 1756.
Spain, Jan. 4, 1762.

Peace with France and Spain, Feb. 10, 1763.

War with the Caribbs of St. Vincent in 1773.

War { civil, in America, commenced July 14, 1774.
with France, Feb. 6, 1778.
with Spain, April 17, 1780.
with Holland, 1780.

Peace with { France,
Spain,
Holland,
America, } Sept. 3, 1783.

War with France by the English, Prussians, Austrians, and other German powers, in 1793.

Peace between Prussia and the French Republic, 1795.

Peace between Spain and the French Republic, 1795.

Peace between the French and the Sardinians in 1796.

Peace between the French and the Austrians in 1797.

War between the British and Tippoo Saib in India, in 1797.

War with the French Republic by the Austrians, Russians, Neapolitans, &c. 1798.

War with the Turks, and the invasion of Egypt, in 1798.

Peace between the French and the Russians in 1799.

Peace between the French and Austrians in 1800.

Preliminaries of peace commenced between the French and the Ottoman empire in consequence of the reduction of Egypt by the British forces in 1801.

Preliminaries of peace between France and Great Britain, &c. 1801.

Peace between France and England, 1802.

War with France, 1803.

Wars, *different kinds of.* There are four different kinds of war, each of which is to be conducted differently the one from the other, viz. the offensive; the defensive; that between equal powers; and the auxiliary, which is carried on out of our own territories to succour a prince or ally, or to assist a weaker whom a more powerful prince has attacked.

Offensive war must be long meditated on in private before it is openly entered upon; when the success will depend upon two essential points; that the plan shall be justly formed, and the enterprise conducted with order. It should be well and maturely considered and digested, and with the greatest secrecy; lest, however able the prince or his council may be, some of the precautions necessary to be taken, should be discovered. These precautions are infinite both at home and abroad.

Abroad, they consist in alliances, and security not to be disturbed in the meditated expedition, foreign levies, and the buying up of warlike ammunition, as well to increase your own stores as to prevent the enemy from getting them.

The precautions at home, consist in providing for the security of our distant frontiers, levying new troops, or augmenting the old ones, with as little noise as possible; furnishing your magazines with ammunition; constructing carriages for artillery and provisions; buying up horses, which should be done as much as possible among your neighbours; both to prevent their furnishing the enemy, and to preserve your own for the cavalry and the particular equipages of the officers.

Defensive war may be divided into three kinds. It is either a war sustained by a prince, who is suddenly attacked by another superior to him in troops and in means; or a prince makes this sort of war by choice on one side of his frontiers, while he carries on offensive war elsewhere; or it is a war become defensive by the loss of a battle.

A defensive war which a prince attacked by a superior enemy sustains, depends entirely on the capacity of his general. His particular application should be, to choose advantageous camps to stop the enemy, without however being obliged to fight him; to multiply small advantages; to harass and perplex the enemy in his foraging parties, and to oblige them to do it with great escorts; to attack their convoys; to render the passages of rivers or defiles as difficult to them as possible; to force them to keep together; if they want to attack a town, to throw in succours before it is invested; in short, in the beginning his chief aim should be, to acquire the enemy's respect by his vigilance and activity, and by forcing him to be circumspect in his marches and manner of encampment, to gain time himself, and make the enemy lose it. An able general, carefully pursuing these maxims, will give courage to his soldiers, and to the inhabitants of the country; he gives time to his prince to take proper precautions to resist the enemy who attacks him; and thus changes the nature of this vexatious kind of warfare.

The management of a defensive war requires more military judgment than that of an offensive one.

A war between equal powers, is that in which the neighbouring princes take no part, so long as the belligerent parties obtain no great advantage, the one over the other. This sort of war never should last long if you want to reap any advantages from it. As to its rules, they are entirely conformable to those already given; but we may look on it as a certain maxim in this sort of war, that the general who is the most active and penetrating, will ever in the end prevail over him, who possesses these qualities in a less degree; because, by his activity and penetration, he will multiply small advantages, till at last they procure him a decisive superiority. A general who is continually attentive to procure himself small advantages, ever obtains his end, which is to ruin the enemy's army; in which case he changes the nature of the war, and makes it offensive; which should ever be the chief object of his prince.

Auxiliary war, is that in which a prince succours his neighbours, either in consequence of alliances or engagements entered into with them, or sometimes to prevent their falling under the power of an ambitious prince.

If it is in virtue of treaties, he observes them religiously, in furnishing the number of troops prescribed, and even offering to augment his quota if required; or in making a diversion by attacking the common enemy, or his allies.

If it is to prevent a neighbouring prince from being crushed by a power, who after this conquest may become dangerous to yourself, there are several measures to be taken for your own particular interest. One of the chief is, to exact from those you succour, the possession of some place in security, lest they make their peace without your knowledge, or to your prejudice.

The general, therefore, who is chosen for the command of this auxiliary corps, should have wisdom, penetration, and foresight; wisdom, to preserve a proper discipline in his corps, that the allied prince may have no cause to complain of him; foresight and penetration, to prevent his troops suffering for want of subsistence, or being exposed to the perils of war, but in proportion to their numbers with those of the allied prince; and finally, that nothing shall pass without his knowledge, which may be prejudicial to his master.

War, *council of*, is an assembly of great officers, called by a general, or commander, to deliberate with him on enterprises and attempts to be made. On some occasions, council of war is also understood of an assembly of officers, sitting in judgment on delinquent soldiers, deserters, coward officers, &c.

WARD, in law-books, a word of divers significations; thus, a ward in London, is a part of the city committed to the special charge of one of the aldermen of the city. There are twenty-six wards in London, which are as hundreds, and the parishes thereof as towns. A forest is also divided into wards, and so are most of our hospitals.

WARDEN, one who has the charge or keeping of any person, or thing, by office. Such is the warden of the Fleet, the keeper of the Fleet-prison; who has the charge of the prisoners there, especially such as are committed from the court of chancery for contempt.

Warden, in an university, is the head of a college, answering to what in other colleges we call the master. Warden, or lord-warden of the cinque-ports, is the governor of these noted havens, who has the authority of an admiral, and sends out writs in his own name. Warden of the mint, is an officer whose business it is to receive the gold and silver bullion brought by the merchants to pay them for it, and oversee the other officers. He is called keeper of the exchange and mint.

Warden, *church*. See Church-wardens.

WARDMOTE, in London, is a court so called which is kept in every ward of the city, answering to the curiata comitia in antient Rome.

WARDS, was a court first erected in the reign of Henry VIII, and afterwards augmented by him with the issue of liveries; whence it was styled the court of wards and liveries, but dissolved by 12 Car. II.

WARDSHIP. In our antient customs, when the tenant died, and his heir was under the age of twenty-one being a male, or fourteen being a female, the lord was entitled to the wardship of the heir, and was called the guardian in chivalry. This wardship consisted in having the custody of the body and lands of such heir, without any account of the profits, till the age of twenty-one in males, and fourteen (which was afterwards advanced to sixteen) in females. For the law supposed the heir male unable to perform knight's service till twenty-one; but as for the female, she was supposed capable at fourteen to marry, and then her husband might perform the office. 2 Black. 67. This privilege of the lord's was abolished under the Commonwealth, and the abolition confirmed by stat. 12 C. II. c. 24.

WARNING-WHEEL, in a clock, is the third or fourth, according to its distance from the first wheel. See Clock-work.

WARP, in the manufactures, is the threads, whether of silk, wool, linen, hemp, &c. that are extended lengthwise on the weaver's loom; and across which the workman by means of his shuttle passes the threads of the woof, to form a cloth, ribband, fustian, or other stuff.

For a woollen stuff to have the necessary qualities, it is required that the threads of the warp should be of the same kind of wool, and of the same fineness, throughout; that they are sized with Flanders or parchment-size, well prepared; and that they should be in sufficient number with regard to the breadth of the stuff to be wrought.

To warp a ship is to shift her from one place to another, when the wind and tide will permit it without danger.

WARRANT, a præcipe under hand and seal to some officer, to bring any offender before the person granting it; and warrants of commitment are issued by the privy council, a secretary of state, or justice of the peace, &c. where there has been a private information, or a witness had deposed against an offender. Wood's Inst. 614.

Any one under the degree of nobility may be arrested for a misdemeanour, or any thing done against the peace of the kingdom, by warrant from a justice of the peace; but if the person is a peer of the realm, he must be apprehended for a breach of the peace by warrant out of B. R. Dalt. Just. 263.

A constable ought not to execute a justice's warrant, where the warrant is unlawful, or the justice has no jurisdiction; if he does he may be punished. Plowd. 394.

But if any person abuses it, by throwing it in the dirt, &c. or refuses to execute a lawful warrant, it is a contempt of the king's process, for which the offender may be indicted and fined. Crompt. 149.

A general warrant to apprehend all persons suspected, without naming or particularly describing any person in special, is illegal and void for its uncertainty; for it is the duty of the magistrate, and ought not to be left to the officer, to judge of the ground of the suspicion. Also a warrant to apprehend all persons guilty of such a crime, is no legal warrant; for the point upon which its authority rests, is a fact to be decided on a subsequent trial; namely, whether the person apprehended thereupon is guilty or not guilty. 4 Black. 291.

A warrant may be lawfully granted by any justice for treason, felony, or præmunire, or any other offence against the peace; and it seems clear, that where a statute gives any one justice a jurisdiction over any offence, or a power to require any person to do a certain thing ordained by such a statute, it impliedly gives a power to every such justice to make out a warrant to bring before him any one accused of such offence, or compelled to do any thing ordained by such statute; for it cannot but be intended, that a statute which gives a person jurisdiction over an offence, means also to give him the power incident to all courts, of compelling the party to come before him. 2 Haw. 84.

But in cases where the king is not a party, or where no corporal punishment is appointed, as in cases for servants' wages and the like, it seems that a summons is the more proper process; and for default of appearance, the justice may proceed; and so indeed it is often directed by special statutes.

A warrant from any of the justices of the court of king's bench extends over all the kingdom, and is tested or dated England; but a warrant of a justice of peace in one county, must be backed, that is, signed, by a justice of another county, before it can be executed there. And a warrant for apprehending an English or a Scotch offender, may be indorsed in the opposite kingdom, and the offender carried back to that part of the united kingdom in which the offence was committed. 4 Black. 291.

WARRANT *of attorney*, is an authority and power given by a client to his attorney, to appear and plead for him; or to suffer judgment to pass against him by confessing the action, by nil dicit, non sum informatus, &c. And although a warrant of attorney given by a man in custody to confess a judgment, no attorney being present, is void as to the entry of judgment; yet it may be a good warrant to appear and file common bail. 2 Lit. Abr. 629.

WARRANTIA CHARTÆ, a writ that lies where a man is enfeoffed of lands with warranty, and then he is sued or impleaded. And if the feoffee is impleaded in assize, or other action, in which he cannot vouch or call to warranty, he shall have this writ against the feoffer, or his heirs, to compel them to warrant the land to him; and if the land is recovered from him, he shall recover as much lands in value against the warrantor, &c.; but the warrantia chartæ ought to be brought by the feoffee, depending the first writ against him, or he has lost his advantage. F. N. B. 134.

WARRANTIA DIEI, a writ lying in cases where a man, having a day assigned personally to appear in court to any action wherein he is sued, is in the mean time employed in the king's service, so that he cannot come at the day assigned. This writ is directed to the justices to this end, that they neither take nor record him in default for that day.

WARRANTY, a promise or covenant by deed, made by the bargainor, for himself and his heirs, to warrant or secure the bargainee and his heirs against all men, for the enjoying any thing agreed on between them.

Warranty is either real or personal; real, when it is annexed to lands or tenements granted for life, &c. And this is either in deed, as by the word warrantizo expressly; or in law, as by the word dedi, or some other amplification. Personal, which either respects the property of the thing sold, or the quality of it. Cowel.

Warranties in their more general divisions are of two kinds; first, a warranty in deed, or an express warranty, which is when a fine, or feoffment in fee, or a lease for life, is made by deed, which has an express clause of warranty contained in it; as when a conusor, feoffor, or lessor, covenants to warrant the land to the conusee, feoffee, or lessee; secondly, a warrant in law, or an implied warranty, which is, when it is not expressed by the party, but tacitly made and implied by the law. 1 Inst. 365.

A warranty in deed is either lineal or collateral. A lineal warranty is a covenant real, annexed to the land by him, who either was owner of or might have inherited the land, and from whom his heir lineal or collateral, might possibly have claimed the land as heir from him that made the warranty. A collateral warranty is made by him that had no right, or possibility of right, to the land, and is collateral to the title of the land. 1 Inst. 370.

WARREN, is a franchise or place privileged, by prescription or grant from the king, for the keeping of beasts and fowls of the warren; which are coneys, partridges, pheasants, and some add quails, woodcocks, and water-fowl. 1 Inst. 233.

These were looked upon as royal game, and the franchise of free warren was invented to protect them, by giving the grantee a sole and exclusive power of killing such game, so far as his warren extended, on condition of his preventing other persons; for, by the common law, no man, not even a lord of a manor, could justify killing game on another man's soil, unless he had the liberty of free warren. 2 Black. 39.

WARREN, *rabbit*. In setting up a warren, great caution is to be used for the fixing upon a proper place, and a right situation. It should always be upon a small ascent, and exposed to the east or the south. The soil that is most suitable, is that which is sandy; for when the soil is clayey or tough, the rabbits find greater difficulty in making their burrows, and never do it so well; and if the soil is boggy or moorish, there would be very little advantage from the warren, for wet is very destructive of these animals.

All due precautions must be taken, that the warren may be so contrived, that the rabbits may habituate themselves to it with ease. Many would have it that warrens should be enclosed with walls; but this a very expensive method, and seems not necessary or advisable; for we find but very few that are so, and those do not succeed at all the better for it.

WART. See SURGERY.

WASH, among distillers, the fermentable liquor used by the malt-distillers. See DISTILLATION.

WASHING, *in design*. See WATER-COLOURS.

WASP. See VESPA.

WASTE, is the committing any spoil or destruction in houses, lands, &c. by tenants, to the damage of the heir, or of him in reversion or remainder; whereupon the writ or action of waste, is brought for the recovery of the thing wasted, and damages for the waste done. 5 Bac. Abr. 459.

There are two kinds of waste, voluntary or actual, and negligent or permissive. Voluntary waste may be done by pulling down or prostrating houses, or cutting down timber trees; negligent waste may be, by suffering a house to be uncovered, by which the spars or rafters, planches, or other timber of the house, are rotten. 1 Inst. 53.

A writ of waste, to punish the offence after it has been committed, is an action partly founded upon the common law, and partly upon the statute of Gloucester; and may be brought by him that has the immediate estate of inheritance in reversion or remainder, against the tenant for life, tenant in dower, tenant by the courtesy, or tenant for years. 3 Black. 227.

This action of waste is a mixed action; partly real, so far as it recovers land, and partly personal, so far as it recovers damages: for it is brought for both those purposes; and if the waste is proved, the plaintiff shall recover the thing or place wasted, and also treble damages by the said statute. 6 Ed. I. c. 5.

The writ of waste, calls upon the tenant to appear and shew cause why he has committed waste and destruction in the place named, to the dishersion of the plaintiff. And if the defendant makes default, or does not appear at the day assigned him, then the sheriff is to take with him a jury of twelve men, and go in person to the place alleged to be wasted, and there enquire of the waste done, and the damages; and make a return or report of the same to the court, upon which report the judgment is founded. 3 Black. 228.

WASTE *of the forest*, is properly where a man cuts down his own woods within the forest, without licence of the king or lord chief justice in eyre.

WASTE is also taken for those lands which are not in any man's occupation, but lie common.

They seem to be so called, because the lord cannot make such profit of them as of his other lands, by reason of the use others have thereof, for passing to and fro. Upon this none may build, cut down trees, dig, &c. without the lord's licence.

WATCH, in the art of war, a number of men posted at any passage, or a company of the guards who go on the patrole. At sea, the term watch denotes a measure or space of four hours, because half the ship's company watch and do duty in their turns, so long at a time; and they are termed starboard watch, and larboard watch.

WATCH AND WARD. Watching is properly intended in the night, and warding for the day time. Dalt. 104.

Persons aggrieved by assessments for watch and ward, may appeal to the mayor. 11 G. I. c. 18.

WATCH is also used for a small portable movement or machine for the measuring of time, having its motion regulated by a spiral spring

Watches, strictly taken, are all such movements as shew the parts of time; as clocks are such as publish it, by striking on a bell, &c. But, commonly, the name watch is appropriated to such as are carried in the pocket, and clock to the large movements, whether they strike or not. See CLOCK.

The several members of the watch part are: 1. The balance, consisting of the rim, which is its circular part; and the verge, which is its spindle, to which belong the two pallets or levers that play in the teeth of the crown-wheel. 2. The potence, or pottance, which is the strong stud in pocket-watches, whereon the lower pivot of the verge plays, and in the middle of which one pivot of the balance-wheel plays; the bottom of the potence is called the foot, the middle part the nose, and the upper part the shoulder. 3. The cock, which is the piece covering the balance. 4. The regulator, or pendulum-spring, which is the small spring in new pocket-watches, underneath the balance. 5. The pendulum, whose parts are the verge, pallets, cocks, and the bob. 6. The wheels, which are the crown-wheel in pocket-pieces, and swing-wheel in pendulums, serving to drive the balance or pendulum. 7. The contrate-wheel, which is that next the crown-wheel, &c. and whose teeth and hoop lie contrary to those of other wheels, whence the name. 8. The great or first wheel, which is that the fusee, &c. immediately drives; after which are the second wheel, third wheel, &c. 9. Lastly, between the frame and dial-plate, is the pinion of report, which is that fixed on the arbor of the great wheel, and serves to drive the dial-wheel, as that serves to carry the hand.

Spring or pendulum watches are pretty much upon the same principle with pendulum clocks, whence their denomination. If a pendulum describing little arches of a circle makes vibrations of unequal lengths in equal times, it is because it describes the greater with a greater velocity. For the same reason a spring put in motion, and making greater or less vibrations, as it is more or less stiff, and as it has a greater or less degree of motion given it, performs them nearly in equal times. Hence, as the vibrations of the pendulum had been applied to large clocks, to rectify the inequality of their motions, so to correct the unequal motions of the balance of watches, a spring is added, by the isochronism of whose vibrations the correction is to be effected.

The spring is usually wound into a spiral, that, in the little compass allotted it, it may be as long as possible, and may have strength enough not to be mastered and dragged about by the inequalities of the balance it is to regulate. The vibrations of the two parts, viz. the spring and balance, should be of some length, only so adjusted as that the spring, being more regular in the length of its vibrations than the balance, may on occasion communicate its regularity thereto.

The invention of spring or pocket watches is owing to the artists of the present age. It is true, we find mention made of a watch presented to Charles V. in the history of that prince; but this in all probability was no more than a kind of clock to be set on a table, some resemblance whereof we have still remaining in the antient pieces made before the year 1670.

In effect, it is between Dr. Hooke and Mr. Huygens, that the glory of this excellent invention lies, but to which of them it properly belongs, is greatly disputed; the English ascribing it to the former, and the French, Dutch, &c. to the latter. Mr. Derham, in his Artificial Clock-maker, says plainly that Dr. Hooke was the inventor; and adds, that he contrived various ways of regulation. One way was with a loadstone. Another with a tender straight spring, one end whereof played backwards and forwards with the balance, so that the balance was to the spring as the bob to a pendulum, and the spring as the rod of it. A third method was with two balances, of which there were divers sorts, some having a spiral spring to the balance for a regulator, and others without. But the way that prevailed and continues in mode, was with one balance, and one spring running round the upper part of the verge; though this has a disadvantage which those of two springs, &c. were free from, in that a sudden jerk or confused shake will alter its vibrations, and put it in an unusual hurry.

We shall conclude this article with an account of the mechanism of a common pocket-watch.

The Plate Watch-work, explains the construction of a common pocket-watch. The moving power is a spiral steel spring (fig. 3), which is coiled up close by a tool used for the purpose, and put into a brass box (fig. 2) called the barrel: the spring has a hook at its outer end which is put through a hole in the side of the barrel and riveted; the inner end has an oblong opening cut through it, to receive a hook upon the barrel arbor (fig. 6); this arbor goes through the bottom of the barrel, and is square to hold a worm-wheel *d*, (fig. 5) which is turned round by a worm *b*; the ends of the arbor project below this, and it is pivoted into the lower plate A (fig. 8) of the watch: the top of the barrel has a cover put over it, through which the pivot of the arbor projects, and works in a socket in the upper plate D.

The barrel thus mounted has a steel chain *a*, (figs. 1 and 8) hooked to its upper end, and coiled round it; the other end of this chain is hooked to the lower part of the fusee E (figs. 1 and 8). It is evident that when the fusee is turned by the watch-key, it will wind the chain off the barrel on itself; and as one end of the spring is fastened to the barrel, and the other is hooked to the arbor (which is prevented from turning by the worm-wheel beneath), the spring will be coiled up into a smaller compass than it was before, and by its re-action will, when the watch-key is taken off, turn the fusee and keep the watch going. The fusee has a spiral groove cut round it, as shewn in fig. 4, in which the chain lies: this groove is cut by an engine, so that the chain shall pull from the smallest part of the fusee, when the spring is wound up, and act with its greatest force; and gradually increases in size as the spring unwinds and acts with less power, so that the effect upon the great wheel *e* (figs. 1, 8, and 7) may be always the same, and cause the watch to go with regularity; and this effect can be at any time increased or diminished by turning the worm *b*, (fig. 5) which coils the spring up closer, and causes it to act with greater force, or vice versa.

The fusee (fig. 4) has a ratchet wheel, at its lower end, which takes into a click fixed in a hollow cut in the great wheel (fig. 7), in order that when the watch is winding up, the fusee may slip round without the great wheel; and that when the spring draws it round in the other direction, it may move the great wheel with it, and the other wheels of the watch. The great wheel *e*, has 48 teeth on its circumference, which take into and turn a pinion of 12 teeth, fixed on the same arbor with the centre wheel *g*, and fig. 9, which has 54 teeth to turn a pinion of six leaves on the arbor of the third wheel *h*, and fig. 10; the third wheel has 48 teeth, and turns a pinion of six on the arbor of the contrate wheel *i*, and fig. 11, which has 48 teeth cut parallel to its axis, by which it turns a pinion of six leaves, fixed to the balance-wheel *k*, fig. 8, 12, and 14. The pivots of the arbor of this wheel turn, one in a frame F, (fig. 8, and fig. 15) called the pottance, fixed to the upper plate; and the other in a small piece fixed to the upper part, called the counter-pottance, so that when the two plates are put together, the balance-wheel pinion may work into the teeth of the contrate weel. The balance wheel has 15 teeth, by which it impels the balance *l*, (figs. 8 and 16, and fig. 13); the arbor of the balance, which is called the verge, has two pallets projecting from it nearly at right angles to each other; these are acted upon by the balance wheel, as shewn in fig. 14, where the lower pallet is supposed to be in contact with one of the teeth of the balance wheel, which, as it turns round, pushes the pallet round and the balance with it, till the balance has made about a quarter of a turn: the tooth of the balance wheel then slips off and escapes; in this position the watch would run down if it were not for the upper pallet at that instant taking another tooth on the opposite side of the balance wheel, which, as it moves in a contrary direction, pushes the balance back again, till the tooth escapes the pallet; the lower pallet then engages the wheel as before. But for the better regulation of the time, the balance has a very fine spring *m* (fig. 16), called the pendulum spring, with the inner end fixed to the verge just beneath the balance, and the outer end pinned to a stud fixed to the top of the upper plate of the watch, so that the balance will rest only in one position, and if it is moved either way by the balance wheel, the spring will have a tendency to bring it to the same position again. When the lower pallet, for instance, has just liberated a tooth of the balance wheel, the pendulum spring is strained, and returns the balance to its point of rest instantaneously, the balance wheel following the upper pallet by the action of the main spring; and when the balance wheel comes to push the balance beyond its point of rest the other way, it moves slowly, because it has the elasticity of the pendulum spring to overcome.

It is evident that by strengthening or weakening this spring, the velocity of the balance can be regulated, which is done by a contrivance shewn in fig. 16, and the under side of it in fig. 17. It is a plate of brass screwed to the top of the upper plate, close under the balance; and at one place it is hollowed out to receive a wheel *n*, of 20 teeth, which turns a segment of a wheel *p*, called the curb, which moves round in a circular groove: it has a projecting leaf *q*, with a notch in it to receive the pendulum spring; so that by turning the wheel with a key put on a square part of its arbor, the spring is lengthened or shortened, so as to give it a different power, and make the balance vibrate quicker or slower; the arbor of the wheel *n*, has a dial *r*, (fig. 16) upon it, with divisions to set it by. The upper pivot of the verge runs in a cock screwed to the upper plate, as shewn in fig. 8, which covers the balance and protects it from violence; and the lower pivot works in the bottom of the pottance; the socket for the pivot of the balance wheel is made in a small piece of brass, which slides in a groove made in the pottance, as shewn in fig. 15, so that by drawing the slide in or out, the teeth of the balance wheel shall just clear one pallet before it takes the other.

The watch is so adjusted by the pendulum spring, that the balance shall vibrate so as to turn the centre wheel round once in an hour: the spindle of this projects through the lower plate (fig. 8), and has a tube fitted on it, which is square at the top, and carries the minute hand; the other end of this tube has a pinion of 12 teeth on it, which turns the minute wheel *s*, (figs. 8 and 18) of 48, and its pinion of 16, which moves the hour wheel *t*, of 48 teeth: the spindle of this is a tube which is put over the tube of the minute hand, and has the hour hand fixed on it to indicate the time upon the dial-plate.

WATCH, *striking*, one which, besides the common watch-work for measuring time, has a clock part for striking the hours, so that, properly speaking, they are pocket-clocks. See CLOCK.

WATCH, *repeating*, one that by only pulling a string, pushing in a pin, &c. repeats the hour, quarter, or minute, at any time of the day or night.

Watches made by artificers are to have the makers' names, under the penalty of 20*l*. 9 and 10 W. III. c. 28.

WATCHING. See MEDICINE.

WATER was universally considered as a simple elementary substance, till the chemists of the present age proved, by experiments, the substance of which has been stated in a preceding article (see CHEMISTRY), that it is in reality a compound body. Its principles have been ascertained both by composition and decomposition; and one hundred parts of water are found to consist of eighty-five parts of oxygen, and fifteen of hydrogen, with a certain portion of caloric.

This very useful and necessary fluid presents itself to our notice in three distinct forms, namely, in its liquid state, in the state of vapour or steam, and, lastly, in its frozen state. See FREEZING, EVAPORATION, STEAM, &c.

Water, when fluid, is not in its most simple state; for its fluidity depends on a certain quantity of caloric, which enters into combination with it, and insinuating itself between the particles of the water, renders them capable of moving in all directions.

We are supplied with water either from the atmosphere, whence it descends in the form of rain, hail, or snow, or from the earth, which sends it forth in springs and rivulets. In the former case, the watery exhalations drawn from the sea, and the surface of the earth by the sun's heat, form clouds, whose particles being afterwards condensed, fall back again in showers. In the latter, the water which falls on the tops of mountains, and other lofty situations, penetrates the earth, and, after passing downwards, breaks forth at some fissure or aperture at a distance from its source.

WATER, *common*. Good water is as transparent as crystal, and entirely colourless. It has no smell, and scarcely any taste; and in general the lighter it is, so much the better. If we compare the different waters which are used for the common purposes of life with each other, and judge of them by the above standard, we shall find them to differ considerably from each other, according to the circumstances of their situation. These waters may be reduced under four heads, namely, 1. Rain water; 2. Spring and river water; 3. Well water; 4. Lake water.

1. Rain water, unless when near a town, or when collected at the commencement of the rain, possesses the properties of good water in perfection, and is as free from foreign ingredients as any native water whatever. The substances which it holds in solution are air, carbonic acid, carbonat of lime, and, according to Bergman, it yields some traces of nitric acid, and a little muriat of lime. The quantity of air in good water does not exceed $\frac{1}{28}$th of the bulk. One hundred cubic inches of water contain generally about one cubic inch of carbonic acid gas. It is to the presence of these two elastic fluids that water owes its taste, and many of the good effects which it produces on animals and vegetables. Hence the vapidness of newly-boiled water from which these gases are expelled. Snow water, when newly melted, is also destitute of gaseous bodies. Hence the reason that fish cannot live in it, as Carradori has ascertained. Hassenfratz, indeed, has endeavoured to prove, that snow water holds oxygen gas in solution; but in all probability the water which he examined had absorbed air from the atmosphere.

The quantity of muriat of lime contained in rain water must be exceedingly minute; as Morveau has ascertained that rain water may be rendered sufficiently pure for chemical purposes by dropping into it a little barytic water, and then exposing it for some time to the atmosphere, and allowing the precipitate formed to deposit. According to that very accurate philosopher, the rain water which drops from the roofs of houses, after it has rained for some time, contains only a little sulphat of lime, which it has dissolved as it trickled over the slates.

2. The water of springs is nothing else than rain water, which, gradually filtring through the earth, collects at the bottom of declivities, and makes its way to the surface. It is therefore equally pure with rain water, provided it does not meet with some soluble body or other in its passage through the soil. But as this is almost always the case, we generally find, even in the purest spring water, a little carbonat of lime and common salt, besides the usual proportion of air and carbonic acid gas. Sometimes also it contains muriat of lime or a little carbonat of soda. Bergman found the springs about Upsal, which are reckoned exceedingly pure, to contain the following foreign bodies:

1. Oxygen gas,	5. Common salt,
2. Carbonic acid,	6. Sulphat of potass,
3. Carbonat of lime,	7. Carbonat of soda,
4. Silica,	8. Muriat of lime.

The whole of these ingredients amounted at an average to 0.00004 parts; and the proportion of each of the solid bodies was as follows:

Carbonat of lime	5.0	Muriat of lime	0.5
Common salt	3.0	Sulphat of potass	0.25
Silica - -	0.5	Carbonat of soda	0.25

River waters may be considered as merely a collection of spring and rain water, and therefore are usually possessed of a degree of purity at least equal to these. Indeed, when their motion is rapid, and their bed siliceous sand, they are generally purer than spring water; depositing during their motion every thing which was merely mechanically suspended, and retaining nothing more than the usual proportion of air and carbonic acid gas, and a very minute quantity of carbonated lime and common salt. When their bed is clayey, they are usually opal-coloured, in consequence of the particles of clay which they hold in suspension.

3. By well water is meant the water which is obtained by digging deep pits, which is not in sufficient quantity to overflow the mouth of the well, but which may be obtained in abundance by pumping. It is essentially the same with spring water, being derived from the very same source; but it is more liable to be impregnated with foreign bodies from the soil, in consequence of its stagnation or slow filtration. Hence the reason that well water is often of that kind which is distinguished by the name of hard water, because it does not dissolve soap, and cannot be used for dressing several kinds of food. These properties are owing to the great proportion of earthy salts which it holds in solution. The most common of these salts is sulphat of lime. These earthy salts have the property of decomposing common soap: their acid unites with the alkali of the soap, while the earthy basis forms with the oil a soap not soluble in water, which envelopes the soap and gives it a greasy feel. These waters may be in general cured by dropping into them an alkaline carbonat. Mr. Sennebier has shewn that well water usually contains a greater proportion of carbonic acid gas than spring or river water.

4. The water of lakes is merely a collection of rain water, spring water, and river water, and of course contains precisely the same heterogeneous salts: but it is seldom so transparent as river water, being usually contaminated with the remains of animal and vegetable bodies which have undergone putrefaction in it. For as lake water is often nearly stagnant, it does not oppose the putrefaction of these bodies, but rather promotes it; whereas in river water, which is constantly in motion, no putrefaction takes place. Hence the reason of the slimy appearance and the brownish colour which often distinguish lake water.

Marsh water contains a still greater proportion of animal and vegetable remains than lake water, because it is altogether stagnant. Moss water is strongly impregnated with those vegetable bodies which constitute mosses, and usually also contains iron.

WATERS, *mineral*. All waters which are distinguished from common water by a peculiar smell, taste, colour, &c. and which in consequence of these properties cannot be applied to the purposes of domestic economy, have been distinguished by the appellation of mineral waters. These occur more or less frequently in different parts of the earth, constituting wells, springs, or fountains; sometimes of the temperature of the soil through which they pass, sometimes warm, and in some cases even at the boiling temperature. Many of these mineral springs attracted the attention of mankind in the earliest ages, and were resorted to by those who laboured under diseases, and employed by them either externally or internally as a medicine. But it was not till towards the end of the 17th century that any attempt was made to detect the ingredients of which these waters were composed, or to discover the substances to which they owed their properties.

The substances hitherto found in mineral waters amount to about 38, and may be reduced under the four following heads: 1. Air and its component parts, oxygen and azotic gas. 2. Acids. 3. Alkalies and earths. 4. Salts.

I. 1. Air is contained in by far the greater number of mineral waters: its proportion does not exceed 1-28th of the bulk of the water. 2. Oxygen gas was first detected in waters by Scheele. Its quantity is usually inconsiderable; and it is incompatible with the presence of sulphureted hydrogen gas or iron. 3. Azotic gas was first detected in Buxton water by Dr. Pearson. Afterwards it was discovered in Harrowgate waters by Dr. Garnet, and in those of Lemington Priors by Mr. Lambe.

II. The only acids hitherto found in waters, except in combination with a base, are the four following: carbonic, sulphurous, boracic, and sulphureted hydrogen gas. 1. Carbonic acid was first discovered in Pyrmont water by Dr. Brownrigg. It is the most common ingredient in mineral waters, 100 cubic inches of the water generally containing from six to 40 cubic inches of this acid gas. According to Westrum, 100 cubic inches of Pyrmont water contain 187 cubic inches of it, or almost double its own bulk. 2. Sulphurous acid has been observed in several of the hot mineral waters in Italy, which are in the neighbourhood of volcanoes. 3. The boracic acid has also been observed in some lakes in Italy. 4. Sulphureted hydrogen gas constitutes the most conspicuous ingredient in those waters which are distinguished by the name of hepatic or sulphureous.

III. The only alkali which has been observed in mineral waters, uncombined, is soda; and the only earthy bodies are silica and lime. 1. Dr. Black detected soda in the hot minerals of Geyzer and Rykum in Iceland; but in most other cases the soda is combined with carbonic acid. 2. Silica was first observed in waters by Bergman. It was afterwards detected in those of Geyzer and Rykum by Dr. Black, and in those of Carlsbad by Kalproth. Hassenfratz observed it in the waters of Pougues, and Brezé in those of Pu. It has been found also in many other mineral waters. 3. Lime is said to have been found uncombined in some mineral waters; but this has not been proved in a satisfactory manner.

IV. The only salts hitherto found in mineral waters, are the following sulphats, nitrats, muriats, carbonats, and hydrosulphurets:

1. Sulphat of soda
2. . . . . ammonia
3. . . . . lime
4. . . . . magnesia
5. . . . . alumina
6. . . . . iron
7. . . . . copper
8. Nitrat of potass
9. . . . . lime
10. . . . . magnesia
11. Muriat of potass
12. . . . . soda
13. . . . . ammonia
14. . . . . barytes
15. . . . . lime
16. . . . . magnesia
17. . . . . alumina
18. . . . . manganese
19. Carbonat of potass
20. . . . . soda
21. . . . . ammonia
22. . . . . lime
23. . . . . magnesia
24. . . . . alumina
25. . . . . iron
26. Hydrosulphuret of lime
27. . . . . . . potass
28. And likewise borax.

Of these genera the carbonats and muriats occur by far most commonly, and the nitrats most rarely.

1. Sulphat of soda is not uncommon, especially in those mineral waters which are distinguished by the epithet saline. 2. Sulphat of ammonia is found in mineral waters near volcanoes. 3. Sulphat of lime is exceedingly common in water. Its presence seems to have been first detected by Dr. Lister in 1682. 4. Sulphat of magnesia is almost constantly an ingredient in those mineral waters which have purgative properties. It was detected in Epsom waters in 1610, and in 1696 Dr. Grew published a treatise on it. 5. Alum is sometimes found in mineral waters, but it is exceedingly rare. 6. Sulphat of iron occurs sometimes in volcanic mineral waters, and has even been observed in other places. But sulphat of copper is only found in the waters which issue from copper mines. 7. Nitre has been found in some springs in Hungary; but it is exceedingly uncommon. 8. Nitrat of lime was first detected in water by Dr. Home of Edinburgh, in 1756. It is said to occur in some springs in the sandy deserts of Arabia. 9. Nitrat of magnesia is said to have been found in some springs. 10. Muriat of potass is uncommon; but it has lately been discovered in the mineral springs of Uhleaborg in Sweden, by Julin. 11. Muriat of soda is so exceedingly common in mineral waters, that hardly a single spring has been analysed without detecting some of it. Muriat of ammonia is uncommon; but it has been found in some mineral springs in Italy, and in Siberia. 13. Muriat of barytes is still more uncommon; but its presence in mineral waters has been announced by Bergman. 14. Muriats of lime and magnesia are common ingredients. 15. Muriat of alumina has been observed in waters by Dr. Withering; but it is very uncommon. 16. Muriat of manganese was mentioned by Bergman as sometimes occurring in mineral waters. It has lately been detected by Lambe in the waters of Lemington Priors, but in an extremely limited proportion. 17. The presence of carbonat of potass in mineral waters has been mentioned by several chemists: if it does occur, it must be in a very small proportion. 18. But carbonat of soda is, perhaps, the most common ingredient of these liquids, if we except common salt and carbonat of lime. 19. Carbonat of ammonia has been discovered in waters; but it is uncommon. 20. Carbonat of lime is found in almost all waters, and is usually held in solution by an excess of acid. It appears from the different experiments of chemists, as stated by Mr. Kirwan, and especially from those of Berthollet, that water saturated with carbonic acid is capable of holding in solution 0.002 of carbonat of lime. Now water saturated with carbonic acid at the temperature of 50°, contains very nearly 0.002 of its weight of carbonic acid. Hence it follows that carbonic acid, when present in such quantity as to saturate water, is capable of holding its own weight of carbonat of lime in solution. Thus we see that 1000 parts by weight of water, when it contains two parts of carbonic acid, is capable of dissolving two parts of carbonat of lime. When the proportion of water is increased, it is capable of holding the carbonat of lime in solution, even when the proportion of carbonic acid united with it is diminished. Thus 24,000 parts of water are capable of holding two parts of carbonat of lime in solution, even when they contain only one part of carbonic acid. The greater the proportion of water, the smaller a proportion of carbonic acid is necessary to keep the lime in solution; and when the water is increased to a certain proportion, no sensible excess of carbonic acid is necessary. It ought to be remarked also, that water, how small a quantity soever of carbonic acid it contains, is capable of holding carbonat of lime in solution, provided the weight of the carbonic acid present exceeds that of the lime. These observations apply equally to the other earthy carbonats held in solution by mineral waters. 21. Carbonat of magnesia is also very common in mineral waters, and is almost always accompanied by carbonat of lime. 22. Carbonat of alumina is said to have been found in waters; but its presence has not been properly ascertained. 23. But carbonat of iron is by no means uncommon; indeed it forms the most remarkable ingredient in those waters which are distinguished by the epithet of chalybeate. 24. The hydrosulphurets of lime and of soda have been frequently detected in those waters which are called sulphureous or hepatic. 25. Borax exists in some lakes in Persia and Thibet; but the nature of these waters has not been ascertained.

Besides these substances, certain vegetable and animal matters have been occasionally observed in mineral waters. But in most cases these are rather to be considered in the light of accidental mixtures than of real component parts of the waters in which they occur.

From the above enumeration, we are enabled to form a pretty accurate idea of the substances which occur in mineral waters; but this is by no means sufficient to make us acquainted with these liquids. No mineral water contains all of these substances. Seldom are there more than five or six of them present together, and hardly ever do they exceed the number of eight or ten. The proportion too in which they enter into mineral waters is generally small, and in many cases extremely so. Now in order to understand the nature of mineral waters, it is necessary to know the substances which most usually associate together, and the proportion in which they commonly associate. In the greater part of mineral waters there is usually some substance present which, from its greater proportion or its greater activity, stamps, in a manner, the character of the water, and gives it those properties by which it is most readily distinguished. This substance of course claims the greatest attention; while the other bodies which enter in a smaller proportion may vary or even be absent altogether, without producing any sensible change in the nature of the water. This circumstance enables us to divide mineral waters into classes, distinguished by the peculiar substance which predominates in each. Accordingly they have been divided into four classes, namely:

1. Acidulous, 3. Hepatic,
2. Chalybeate, 4. Saline.

1. The acidulous waters contain a considerable proportion of carbonic acid. They are easily distinguished by their acid taste, and by their sparkling like champaign wine when poured into a glass. They contain almost constantly some common salt, and in general also a greater or smaller proportion of the earthy carbonats.

2. The chalybeate waters contain a portion of iron, and are easily distinguished by the property which they have of striking a black with the tincture of nutgalls. The iron is usually held in solution by carbonic acid. It very often happens that this acid is in excess; in which case the waters are not only chalybeate but acidulous. This is the case with the waters of Spa and Pyrmont. In some instances the iron is in the state of a sulphat; but this is uncommon. Waters containing the sulphat of iron may be readily distinguished by the property which they have of continuing to strike a black with tincture of nutgalls even after being boiled and filtred; whereas boiling decomposes the carbonat of iron, and causes its base to precipitate.

3. The hepatic or sulphureous waters are those which contain sulphureted hydrogen gas. These waters are easily distinguished by the odour of sulphureted hydrogen gas which they exhale, and by the property which they have of blackening silver and lead. The nature of the waters belonging to this class long puzzled chemists. Though they often deposit sulphur spontaneously, yet no sulphur could be artificially separated from them. The secret was at last discovered by Bergman. These waters are of two kinds: in the first the sulphureted hydrogen is uncombined; in the second it is united to lime or an alkali. They are frequently also impregnated with carbonic acid, and usually contain some muriats or sulphats.

4. Saline waters are those which contain only salts in solution, without iron or carbonic acid in excess. They may be distinguished into four different orders. The waters belonging to the first order contain salts whose base is lime, and generally either the carbonat or the sulphat. They are known by the name of hard waters, and have but a slight disagreeable taste. The waters belonging to the second order are those in which common salt predominates. They are readily recognized by their salt taste, and like sea water usually contain some magnesian and calcareous salts. The waters of the third order contain sulphat of magnesia. They have a bitter taste and are purgative. Finally, the waters of the fourth order are alkaline, containing carbonat of soda. They are easily distinguished by the property which they have of tinging vegetable blues green.

The following table exhibits a synoptical view of the component parts of a considerable number of mineral waters as analysed by different chemists. See Dr. Saunders's Treatise on the Chemical History and Medical Powers of the most celebrated Mineral Waters.

		Gases. Cubic Inches.				Carbonats of				Muriats of				Sulphats of					
	Water.	oxygen.	Carbonic acid.	Sulph. hydr.	Azotic.	Soda.	Lime.	Mag.	Iron.	Soda.	Lime.	Mag	Potass.	Soda.	Lime.	Mag	Silica.	Alumina.	Resin.
Seltzer - -	8949	.35	13.068	—	—	5.22	78.3	6.32	—	13.74	—	—	—	—	—	—	—	—	—
Spa - - -	8933	—	9.8	—	—	1.85	1.85	4.35	0.70	0.21	—	—	—	—	—	—	—	—	—
Pyrmont -	8950	—	19.6	—	—	—	4.3	9.8	0.70	1.7	—	—	—	—	8.38	5.44	—	—	—
Aix la Chap.	8940	—	—	13.06	—	15.25	5.98	—	—	6.21	—	—	—	—	—	—	—	—	—
Medvi - -	8933	—	6.53	8.71	—	—	—	—	0.92	—	0.11	—	—	—	—	—	—	—	—
Carlsbad -	25320	—	50.	—	—	38.5	12.5	—	$0.1\frac{1}{4}$	32.5	—	—	—	66.75	—	—	2.25	—	—
Lem. Priors	5816	—	.5	—	3.5	—	—	—	.75	430.	—	11.5	—	15.2	11.2	—	—	—	—
Pouges - -	9216	—	16.7	—	—	10.4	12.4	1.2	—	2.2	—	—	—	—	—	—	3.2	0.35	—
Enghien - -	92160	—	8.5	70.0	—	—	21.4	1.35	—	2.4	—	8.0	—	—	33.3	15.8	—	—	—
Lu - - -	36864	—	5.	2.	—	—	10.22	—	—	36.74	9.25	—	—	—	14.03	—	0.23	—	—
Geyzer - -	10000	—	—	—	—	0.95	—	—	—	2.46	—	—	—	1.46	—	—	5.4	0.48	—
Uhleaborg -	42250	—	0.	—	—	—	1.9	—	1.2	5.7	—	—	1	—	0.8	—	1.7	—	—
Teplisz - -	22540	—	—	—	—	13.25	16.5	—	32.5	61.3	28.5	—	—	—	—	—	15.1	—	—
Kilburn - -	138240	—	84.	36.	—	—	2.4	1.25	$.3\frac{1}{8}$	6.0	.6	12.8	—	28.2	13.0	91.0	—	—	.6
Bristol - -	103643	3.	30.	—	—	—	13.5	—	—	4.	—	7.25	—	11.25	11.75	—	—	—	—
Tunbridge -	103643	1.4	10.6	—	4.	—	—	—	1.	0.5	—	2.25	—	—	1.25	—	—	—	—
Cheltenham	103643	—	30.368	—	15.	—	—	—	5.	5.	—	25.	—	480.	40.	—	—	—	—
Harrogate -	103643	—	8.	19.	7.	—	18.5	5.5	—	615.5	13.	91.	—	—	—	10.5	—	—	—
Moffat - -	103643	—	1.	10.	4.	—	—	—	—	3.6	—	—	—	—	—	—	—	—	—

One pint of the Bath water contains (according to the laborious and delicate analysis of Mr. Phillips),

Carbonic acid - -	$1\frac{1}{5}$	inch.
Muriat of soda - -	$3\frac{1}{2}$	grains.
Sulphat of soda - -	$3\frac{1}{2}$	do.
Sulphat of lime - -	9	do.
Carbonat of lime - -	$\frac{9}{10}$	do.
Silica - - - -	$\frac{1}{5}$	do.
Oxide of iron - -	$\frac{1}{83}$	do.

Waters, *the method of analysing*. The analysis of waters, or the art of ascertaining the different substances which they hold in solution, and of determining the proportion of these substances, is one of the most difficult things in chemistry. The difficulty arises, not only from the diversity of the bodies which occur in waters, but from the very minute quantities of some of the ingredients. Though many attempts had been made to analyse particular waters, and several of these were remarkably well conducted, no general mode of analysis was known till Bergman published his Treatise on Mineral Waters in 1778. This admirable tract carried the subject all at once to a very high degree of perfection. The Bergmannian method has been followed by succeeding chemists, to whom we are indebted not only for a great number of very accurate analyses of mineral waters, but likewise for several improvements in the mode of conducting the analysis. Mr. Kirwan has in 1799 published an essay on the general analysis of waters, no less valuable than that of Bergman; containing all that has hitherto been done on the subject, and enriched by the numerous experiments of Mr. Kirwan himself, which are equally important and well conducted. Mr. Kirwan has given a new method of analysis, which will probably be adopted hereafter; not only because it is shorter and easier than the Bergmannian, but because it is susceptible of a greater degree of accuracy.

The analysis of waters resolves itself into two different branches: 1. The method of ascertaining all the different bodies contained in the water which we are examining. 2. The method of determining the exact proportion of each of these ingredients.

The different bodies which are dissolved and combined in water, are discovered by the addition of certain substances to the water which is subjected to examination. The consequence of the addition is some change in the appearance of the water; and this change indicates the presence or the absence of the bodies suspected. The substances thus employed are distinguished by the name of tests, and are the instruments by means of which the analysis of water is accomplished. They were first introduced into chemistry by Boyle, and were gradually increased by succeeding chemists; but Bergman was the first who ascertained with precision the degree of confidence which can be placed in the different tests. They still continued rather uncertain and precarious, till Mr. Kirwan shewed how they might be combined and arranged in such a manner as to give certain and precise indications whether or not any particular substance constitutes a component part of water. Let us consider by what means the presence or the absence of all the different substances which occur in waters may be ascertained.

I. The gaseous bodies contained in water are obtained by boiling it in a retort luted to a pneumatic apparatus. The method of separating and examining these different bodies shall be described hereafter.

II. The presence of carbonic acid, not combined with a base, or combined in excess, may be detected by the following tests: 1. Lime-water occasions a precipitate soluble with effervescence in muriatic acid. 2. The infusion of litmus is reddened; but the red colour gradually disappears, and may be again restored by the addition of more of the mineral water. 3. When boiled it loses the property of reddening the infusion of litmus.

III. The mineral acids when present, uncombined in water, give the infusion of litmus a permanent red, even though the water has been boiled. Bergman has shewn that paper, stained with litmus, is reddened when dipt into water containing 1-3521 of sulphuric acid.

IV. Water containing sulphureted hydrogen gas is distinguished by the following properties: 1. It exhales the peculiar odour of sulphureted hydrogen gas. 2. It reddens the infusion of litmus fugaciously. 3. It blackens paper dipt into a solution of lead, and precipitates the nitrat of silver black or brown.

V. Alkalies, and alkaline and earthy carbonats, are distinguished by the following tests: 1. The infusion of turmeric, or paper stained with turmeric, is rendered brown by alkalies, or reddish-brown if the quantity is minute. This change is produced when the soda in water amounts only to 1-2217th part. 2. Paper stained with Brazil wood, or the infusion of Brazil wood, is rendered blue; but this change is produced also by the alkaline and earthy carbonats. Bergman ascertained that water containing 1-9945th part of carbonat of soda renders paper stained with Brazil wood blue. 3. Litmus paper reddened by vinegar is restored to its original blue colour. This change is produced by the alkaline and earthy carbonats also. 4. When these changes are fugacious, we may conclude that the alkali is ammonia.

VI. Fixed alkalies exist in water which occasions a precipitate with muriat of magnesia after being boiled. Volatile alkali may be distinguished by the smell, or it may be obtained in the receiver by distilling a portion of the water gently, and then it may be distinguished by the above tests.

VII. Earthy and metallic carbonats are precipitated by boiling the water containing them; except carbonat of magnesia, which is only precipitated imperfectly.

VIII. Iron is discovered by the following tests: 1. The addition of tincture of nutgalls gives water containing iron a purple or black colour. This test indicates the presence of a very minute portion of iron. If the tincture has no effect upon the water after boiling, though it colours it before, the iron is in the state of a carbonat. The following observations of Westrum on the colours which iron gives to nutgalls, as modified by other bodies, deserve attention:

A violet indicates an alkaline carbonat or earthy salt.

Dark purple indicates other alkaline salts.

Purplish red indicates sulphureted hydrogen gas.

Whitish and then black indicates sulphat of lime.

2. The prussian alkali occasions a blue precipitate in water containing iron. If an alkali is present, the blue precipitate does not appear unless the alkali is saturated with an acid.

IX. Sulphuric acid exists in waters which form a precipitate with the following saline solutions:

1. Muriat, nitrat, or acetat of barytes
2. - - - - - strontian
3. - - - - - lime
4. Nitrat or acetat of lead.

Of these the most powerful by far is muriat of barytes, which is capable of detecting the presence of sulphuric acid uncombined, when it does not exceed the millionth part of the water. Acetat of lead is next in point of power. The muriats are more powerful than the nitrats. The calcareous salts are least powerful. All these tests are capable of indicating a much smaller proportion of uncombined sulphuric acid than when it is combined with a base. To render muriat of barytes a certain test of sulphuric acid, the following precautions must be observed: 1. The muriat must be diluted. 2. The alkalies, or alkaline carbonats, if the water contains any, must be previously saturated with muriatic acid. 3. The precipitate must be insoluble in muriatic acid. 4. If boracic acid is suspected, muriat of strontian must be tried, which is not precipitated by boracic acid. 5. The hydrosulphurets precipitate barytic solutions, but their presence is easily discovered by the smell.

X. Muriatic acid is detected by nitrat of silver, which occasions a white precipitate, or a cloud in water containing an exceedingly minute portion of this acid. To render this test certain, the following precautions are necessary: 1. The alkalies or carbonats must be previously saturated with nitric acid. 2. Sulphuric acid, if any should be present, must be previously removed by means of nitrat of barytes. 3. The precipitate must be insoluble in nitric acid.

XI. Boracic acid is detected by means of acetat of lead, with which it forms a precipitate insoluble in acetic acid. But to render this test certain, the alkalies and earths must be previously saturated with acetic acid, and the sulphuric and muriatic acids removed by means of acetat of strontian and acetat of silver.

XII. Barytes is detected by the insoluble white precipitate which it forms with diluted sulphuric acid.

XIII. Lime is detected by means of oxalic acid, which occasions a white precipitate in water containing a very minute proportion of this earth. To render this test decisive, the following precautions are necessary: 1. The mineral acids, if any should be present, must be previously saturated with an alkali. 2. Barytes, if any is present, must be previously removed by means of sulphuric acid. 3. Oxalic acid precipitates magnesia but very slowly, whereas it precipitates lime instantly.

XIV. Magnesia and alumina. The presence of these earths is ascertained by the following tests: 1. Pure ammonia precipitates them both, and no other earth, provided the carbonic acid has been previously separated by a mineral alkali and boiling. 2. Lime-water precipitates only these two earths, provided the carbonic acid is previously removed, and the sulphuric acid also, by means of nitrat of barytes.

The alumina may be separated from the magnesia after both have been precipitated together, either by boiling the precipitate in pure potass, which dissolves the alumina and leaves the magnesia; or the precipitate may be dissolved in muriatic acid precipitated by an alkaline carbonat, dried in the temperature of one hundred degrees, and then exposed to the action of diluted muriatic acid, which dissolves the magnesia without touching the alumina.

XV. Silica may be ascertained by evaporating a portion of the water to dryness, and redissolving the precipitate in muriatic acid. The silica remains behind undissolved.

Such is the method of detecting the different substances commonly found in waters. But as these different substances are almost always combined together, so as to constitute particular salts, it is not sufficient to know in general what the substances are which are found in the water we are examining; we must know also in what manner they are combined. Thus it is not sufficient to know that lime forms an ingredient in a particular water, we must know also the acid with which it is united. Mr. Kirwan first pointed out how to accomplish this difficult task by means of tests. Let us take a short view of his method.

I. To ascertain the presence of the different sulphats.

The sulphats which occur in water are seven; but one of these, namely, sulphat of copper, is so uncommon, that it may be excluded altogether. The same remark applies to sulphat of ammonia. It is almost unnecessary to observe, that no sulphat need be looked for unless both its acid and base have been previously detected in the water.

1. Sulphat of soda may be detected by the following method: Free the water to be examined of all earthy sulphats by evaporating it to one-half, and adding lime-water as long as any precipitate appears. By this means the earths will be all precipitated except lime, and the only remaining earthy sulphat will be sulphat of lime, which will be separated by evaporating the liquid till it becomes concentrated, and then dropping into it a little alcohol, and after filtration adding a little oxalic acid.

With the water thus purified, mix solution of lime. If a precipitate appears either immediately or on the addition of a little alcohol, it is a proof that sulphat of potass or of soda is present; which of the two, may be determined by mixing some of the purified water with acetat of barytes. Sulphat of barytes precipitates. Filtre and evaporate to dryness. Digest the residuum in alcohol. It will dissolve the alkaline acetat. Evaporate to dryness, and the dry salt will deliquesce if it is acetat of potass, but effloresce if it is acetat of soda.

2. Sulphat of lime may be detected by evaporating the water suspected to contain it to a few ounces. A precipitate appears, which, if it is sulphat of lime, is soluble in 500 parts of water; and the solution affords a precipitate with the muriat of barytes, oxalic acid, carbonat of magnesia, and with alcohol.

3. Alum may be detected by mixing carbonat of lime with the water suspected to contain it. If a precipitate appears it indicates the presence of alum, or at least of su l

phat of alumina; provided the water contains no muriat of barytes or metallic sulphats. The first of these salts is incompatible with alum. The second may be removed by the alkaline prussiats. When a precipitate is produced in water by muriat of lime, carbonat of lime, and muriat of magnesia, we may conclude that it contains alum, or sulphat of alumina.

4. Sulphat of magnesia may be detected by means of hydrosulphuret of strontian, which occasions an immediate precipitate with this salt and with no other; provided the water is previously deprived of alum, if any should be present, by means of carbonat of lime; and provided also that it contains no uncombined acid, nor even carbonic acid.

5. Sulphat of iron is precipitated from water by alcohol, and then it may be easily recognised by its properties.

II. To ascertain the presence of the different muriats.

The muriats found in waters amount to eight or nine, if muriat of iron is included. The most common by far is muriat of soda.

1. Muriat of soda and of potass may be detected by the following method: Separate the sulphuric acid by alcohol and nitrat of barytes. Decompose the earthy nitrats and muriats by adding sulphuric acid. Expel the excess of muriatic and nitric acids by heat. Separate the sulphats thus formed by alcohol and barytes-water. The water thus purified can contain nothing but alkaline nitrats and muriats. If it forms a precipitate with acetat of silver, we may conclude that it contains muriat of soda or of potass. To ascertain which, evaporate the liquid thus precipitated to dryness; dissolve the acetat in alcohol. Evaporate to dryness. The salt will deliquesce if it is acetat of potass, but effloresce if it is acetat of potass.

2. Muriat of barytes may be detected by sulphuric acid, as it is the only barytic salt hitherto found in waters.

3. Muriat of lime may be detected by the following method: Free the water of sulphat of lime and other sulphats, by evaporating it to a few ounces, mixing it with spirit of wine, and adding last of all nitrat of barytes as long as any precipitate appears. Filtre off the water, evaporate to dryness, treat the dry mass with alcohol. Evaporate the alcohol to dryness, and dissolve the residuum in water. If this solution gives a precipitate with acetat of silver and oxalic acid, it may contain muriat of lime. It must contain it in that case, if, after being treated with carbonat of lime, it gives no precipitate with ammonia. If it does, separate the lime by means of oxalic acid, filtre and distil with a gentle heat. If the liquid in the receiver gives a precipitate with nitrat of silver, muriat of lime existed in the water.

4. Muriat of magnesia may be detected by separating all the sulphuric acid by means of nitrat of barytes. Filtre, evaporate to dryness, and treat the dry mass with alcohol. Evaporate the alcohol solution to dryness, and dissolve the residuum in water. The muriat of magnesia, if the water contained any, will be found in this solution. Let us suppose that, by the tests formerly described, the presence of muriatic acid and of magnesia in this solution has been ascertained. In that case, if carbonat of lime affords no precipitate, and if sulphuric acid and evaporation, together with the addition of a little alcohol, occasion no precipitate, the solution contains only muriat of magnesia. If these tests give precipitates, we must separate the lime which is present by sulphuric acid and spirit of wine, and distil off the acid with which it was combined. Then the magnesia is to be separated by the oxalic acid and alcohol; and the acid with which it was united is to be distilled off. If the liquid in the retort gives a precipitate with nitrat of silver, the water contains muriat of magnesia.

5. Muriat of alumina may be discovered by saturating the water, if it contains an excess of alkali, with nitric acid, and separating the sulphuric acid by means of nitrat of barytes. If the liquid thus purified gives a precipitate with carbonat of lime, it contains muriat of alumina. The muriat of iron or of manganese, if any is present, is also decomposed, and the iron precipitated by this salt. The precipitate may be dissolved in muriatic acid, and the alumina, iron, and manganese, if they are present, may be afterwards separated.

III. To ascertain the presence of the different nitrats. The nitrats but seldom occur in waters; when they do they may be detected by the following rules:

1. Alkaline nitrats may be detected by freeing the water examined from sulphuric acid by means of acetat of barytes, and from muriatic acid by acetat of silver. Evaporate the filtred liquid, and treat the dry mass with alcohol; what the alcohol leaves can consist only of the alkaline nitrats and acetat of lime. Dissolve it in water. If carbonat of magnesia occasions a precipitate, lime is present. Separate the lime by means of carbonat of magnesia. Filtre and evaporate to dryness, and treat the dried mass with alcohol. The alcohol now leaves only the alkaline nitrats, which may be easily recognised, and distinguished by their respective properties.

2. Nitrat of lime. To detect this salt, concentrate the water, and mix with it alcohol to separate the sulphats. Filtre and distil off the alcohol; then separate the muriatic acid by acetat of silver. Filtre, evaporate to dryness, and dissolve the residuum in alcohol. Evaporate to dryness, and dissolve the dry mass in water. If this solution indicates the presence of lime by the usual tests, the water contained nitrat of lime.

3. To detect nitrat of magnesia, the water is to be freed from sulphats and muriats exactly as described in the last paragraph. The liquid thus purified is to be evaporated to dryness, and the residuum treated with alcohol. The alcohol solution is to be evaporated to dryness, and the dry mass dissolved in water. To this solution potass is to be added as long as any precipitate appears. The solution, filtred, and again evaporated to dryness, is to be treated with alcohol. If it leaves a residuum consisting of nitre (the only residuum which it can leave), the water contained nitrat of magnesia.

Such are the methods by which the presence of the different saline contents of waters may be ascertained. The labour of analysis may be considerably shortened, by observing that the following salts are incompatible with each other, and cannot exist together in water except in very minute proportions:

Salts.	Incompatible with
1. Fixed alkaline sulphats.	Nitrats of lime and magnesia, Muriats of lime and magnesia.
2. Sulphat of lime.	Alkalies, Carbonat of magnesia, Muriat of barytes.
3. Alum.	Alkalies, Muriat of barytes, Nitrat, muriat, carbonat of lime, Carbonat of magnesia.
4. Sulphat of magnesia.	Alkalies, Muriat of barytes. Nitrat and muriat of lime.
5. Sulphat of iron.	Alkalies, Muriat of barytes, Earthy carbonats.
6. Muriat of barytes.	Sulphats, Alkaline carbonats, Earthy carbonats.
7. Muriat of lime.	Sulphats, except of lime, Alkaline carbonats, Carbonat of magnesia.
8. Muriat of magnesia.	Alkaline carbonats, Alkaline carbonats,
9. Nitrat of lime.	Alkaline sulphats, Carbonat of magnesia and alumina, Sulphats, except of lime.

Besides the substances above described, there is sometimes found in water a quantity of bitumen combined with alkali, and in the state of soap. In such waters acids occasion a coagulation; and the coagulum collected on a filtre discovers its bituminous nature by its combustibility.

Water also sometimes contains extractive matter; the presence of which may be detected by means of nitrat of silver. The water suspected to contain it must be freed from sulphuric and nitric acid by means of nitrat of lead. After this, if it gives a brown precipitate with nitrat of silver, we may conclude that extractive matter is present.

The proportion of saline ingredients, held in solution by any water, may be in some measure estimated from its specific gravity. The lighter a water is, the less saline matter does it contain; and, on the other hand, the heavier it is, the greater is the proportion of saline contents. Mr. Kirwan has pointed out a very ingenious method of estimating the saline contents of a mineral water whose specific gravity is known; so that the error does not exceed one or two parts in the hundred. The method is this: Subtract the specific gravity of pure water from the specific gravity of the mineral water examined (both expressed in whole numbers), and multiply the remainder by 1.4. The product is the saline contents, in a quantity of the water denoted by the number employed to indicate the specific gravity of distilled water. Thus let the water be of the specific gravity 1.079, or in whole numbers 1079. Then the specific gravity of distilled water will be 1000. And $\overline{1079 - 1000} \times 1.4 = 110.6$ = saline contents in 1000 parts of the water in question; and consequently 11.06 in 100 parts of the same water. This formula will often be of considerable use, as it serves as a kind of standard to which we may compare our analysis. The saline contents indicated by it are supposed to be freed from their water of crystallization; in which state only they ought to be considered, as Mr. Kirwan has very properly observed, when we speak of the saline contents of a mineral water.

Having by this formula ascertained pretty nearly the proportion of saline contents in the water examined, and having by the tests described in the last section, determined the particular substances which exist in it, let us now proceed to ascertain the proportion of each of these ingredients.

I. The different aerial fluids ought to be first separated and estimated. For this purpose a retort ought to be filled two-thirds with the water, and connected with a jar full of mercury, standing over a mercurial trough. Let the water be made to boil for a quarter of an hour. The aerial fluids will pass over into the jar. When the apparatus is cool, the quantity of air expelled from the water may be determined either by bringing the mercury within and without the jar to a level; or if that cannot be done, by reducing the air to the proper density. The air of the retort ought to be carefully subtracted, and the jar must be divided into cubic inches and tenths.

The only gaseous bodies in water are common air, oxygen gas, azotic gas, carbonic acid, sulphureted hydrogen gas, and sulphurous acid. The last two never exist in water together. The presence of either of them must be ascertained previously by the application of the proper tests. If sulphureted hydrogen gas is present, it will be mixed with the air contained in the glass jar, and must be separated before air is examined. For this purpose, the jar must be carried into a tub of warm water, and nitric acid introduced, which will absorb the sulphureted hydrogen. The residuum is then to be again put into a mercurial jar and examined.

If the water contains sulphurous acid, this previous step is not necessary. Introduce into the air a solution of pure potass, and agitate the whole gently. The carbonic acid and sulphurous acid gas will be absorbed, and leave the other gases. Estimate the bulk of this residuum; this, subtracted from the bulk of the whole, will give the bulk of the carbonic acid and sulphurous acids absorbed.

Evaporate the potass slowly nearly to dryness, and leave it exposed to the atmosphere. Sulphat of potass will be formed, which may be separated by dissolving the carbonat of potass by means of diluted muriatic acid and filtring the solution. One hundred grains of sulphat of potass indicate thirty grains of sulphurous acid, or 42.72 cubic inches of that acid in the state of gas. The bulk of sulphurous acid gas ascertained by this method, subtracted from the bulk of the gas absorbed by the potass, gives the bulk of the carbonic acid gas. Now one hundred cubic inches of carbonic acid, at the temperature of 60°, and barometer at 30 inches, weigh 46.393 grains. Hence it is easy to ascertain its weight.

The air which remains after the separation of the carbonic acid gas is to be examined by the different eudiometrical methods.

When a water contains sulphureted hydrogen gas, the bulk of this gas is to be ascertained in the following manner: Fill three-fourths of a jar with the water to be examined, and invert it in a water trough, and introduce a little nitrous gas. This gas, mixing with the air in the upper part of the jar, will form nitrous acid, which will render the water turbid, by decomposing the sulphureted hydrogen and precipitating sulphur. Continue to add nitrous gas at intervals as long as red fumes appear, then turn up the jar and blow out the air. If the hepatic smell continues, repeat this process. The sulphur precipitated indicates the proportion of hepatic gas in the water; one grain of sulphur indicating the presence of 3.33 cubic inches of that gas.

II. After having estimated the gaseous bodies, the next step is to ascertain the proportions of the earthy carbonats. For this purpose it is necessary to deprive the water of its sulphureted hydrogen, if it contains any. This may be done, either by exposing it to the air for a considerable time, or by treating it with litharge. A sufficient quantity of the water thus purified (if necessary) is to be boiled for a quarter of an hour, and filtred when cool. The earthy carbonats remain on the filtre.

The precipitate thus obtained may be carbonat of lime, of magnesia, of iron, of alumina, or even sulphat of lime. Let us suppose all of these substances to be present together. Treat the mixture with diluted muriatic acid, which will dissolve the whole except the alumina and sulphat of lime. Dry this residuum in a red heat, and note the weight. Then boil it in carbonat of soda; saturate the soda with muriatic acid, and boil the mixture for half an hour. Carbonat of lime and alumina precipitate. Dry this precipitate, and treat it with acetic acid. The lime will be dissolved and the alumina will remain. Dry it and weigh it. Its weight subtracted from the original weight gives the proportion of sulphat of lime.

The muriatic solution contains lime, magnesia, and iron. Add ammonia as long as a reddish precipitate appears. The iron and part of the magnesia are thus separated. Dry the precipitate, and expose it to the air for some time in a heat of 200°; then treat it with acetic acid to dissolve the magnesia, which solution is to be added to the muriatic solution. The iron is to be redissolved in muriatic acid, precipitated by an alkaline carbonat, dried, and weighed.

Add sulphuric acid to the muriatic solution as long as any precipitate appears; then heat the solution and concentrate. Heat the sulphat of lime thus obtained to redness, and weigh it. One hundred grains of it are equivalent to 70 of carbonat of lime dried. Precipitate the magnesia by means of carbonat of soda. Dry it and weigh it. But as part remains in solution, evaporate to dryness, and wash the residuum with a sufficient quantity of distilled water to dissolve the muriat of soda and the sulphat of lime, if any should be still present. What remains behind is carbonat of magnesia. Weigh it, and add its weight to the former. The sulphat of lime, if any, must also be separated and weighed.

III. Let us now consider the method of ascertaining the proportion of mineral acids or alkalies, if any should be present uncombined. The acids which may be present, (omitting the gaseous) are the sulphuric, muriatic, and boracic.

1. The proportion of sulphuric acid is easily determined. Saturate it with barytes water, and ignite the precipitate. One hundred grains of sulphat of barytes thus formed indicate 23.5 of real sulphuric acid.

2. Saturate the muriatic acid with barytes-water, and then precipitate the barytes by sulphuric acid. One hundred parts of the ignited precipitate are equivalent to 21 grains of real muriatic acid.

3. Precipitate the boracic acid by means of acetat of lead. Decompose the borat of lead by boiling it in sulphuric acid. Evaporate to dryness. Dissolve the boracic acid in alcohol, and evaporate the solution; the acid left behind may be weighed.

4. To estimate the proportion of alkaline carbonat present in a water containing it, saturate it with sulphuric acid, and note the weight of real acid necessary. Now 100 grains of real sulphuric acid saturate 121.48 potass, and 78.32 soda.

IV. Let us now consider the method of ascertaining the proportion of the different sulphats. These are six in number; the alkaline sulphats, and those of lime, alumina, magnesia, and iron.

1. The alkaline sulphats may be estimated by precipitating their acid by means of nitrat of barytes, having previously freed the water of all other sulphats. For 170 grains of ignited sulphat of barytes indicate 100 grains of dried sulphat of soda; while 136.36 grains of sulphat of barytes indicate 100 of dry sulphat of potass.

2. Sulphat of lime is easily estimated by evaporating the liquid containing it to a few ounces (having previously saturated the earthy carbonats with nitric acid), and precipitating the sulphat of lime by means of weak alcohol. It may be then dried and weighed.

3. The quantity of alum may be estimated by precipitating the alumina by carbonat of lime or of magnesia (if no lime is present in the liquid). Twelve grains of the alumina heated to incandescence indicate one hundred of crystallized alum, or forty-nine of the dried salt.

4. Sulphat of magnesia may be estimated, provided no other sulphat is present, by precipitating the acid by means of a barytic salt, as 100 parts of ignited sulphat of barytes indicate 52.11 of sulphat of magnesia. If sulphat of lime, and no other sulphat accompanying it, this last may be decomposed, and the lime precipitated by carbonat of magnesia. The weight of the lime thus obtained enables us to ascertain the quantity of sulphat of lime contained in the water. The whole sulphuric acid is then to be precipitated by barytes. This gives the quantity of sulphuric acid; and subtracting the portion which belongs to the sulphat of lime, there remains that which was combined with the magnesia, from which the sulphat of magnesia may be easily estimated.

If sulphat of soda is present, no earthy nitrat or muriat can exist. Therefore, if no other earthy sulphat is present, the magnesia may be precipitated by soda, dried, and weighed; 36.68 grains of which indicate 100 grains of dried sulphat of magnesia. The same process succeeds when sulphat of lime accompanies these two sulphats; only in that case the precipitate, which consists both of lime and magnesia, is to be dissolved in sulphuric acid, evaporated to dryness, and is to be treated with twice its weight of cold water; which dissolves the sulphat of magnesia, and leaves the other salt. Let the sulphat of magnesia be evaporated to dryness, exposed to a heat of 400° and weighed. The same process succeeds if alum is present instead of sulphat of lime. The precipitate in that case, previously dried, is to be treated with acetic acid, which dissolves the magnesia and leaves the alumina. The magnesia may be again precipitated, dried, and weighed. If sulphat of iron is present, it may be separated by exposing the water to the air for some days, and mixing with it a portion of alumina. Both the oxide of iron and the sulphat of alumina thus formed, precipitate in the state of an insoluble powder. The sulphat of magnesia may then be estimated by the rules above explained.

5. Sulphat of iron may be estimated by precipitating the iron by means of prussic alkali, having previously determined the weight of the precipitate produced by the prussiat in a solution of a given weight of sulphat of iron in water. If muriat of iron is also present, which is a very rare case, it may be separated by evaporating the water to dryness, treating the residuum with alcohol, which dissolves the muriat, and leaves the sulphat. Or the sulphat may be estimated with great precision by the rules laid down by Mr. Kirwan.

V. Let us now consider the method of estimating the quantity of the different muriats which may exist in waters.

If muriat of potass or of soda, without any other salt, exists in the water, we have only to decompose them by nitrat of silver, and dry the precipitate; for 217.65 of muriat of silver indicate one hundred of muriat of potass, and two hundred and thirty-five of muriat of silver indicate one hundred of common salt.

The same process is to be followed if the alkaline carbonats are present; only these carbonats must be previously saturated with sulphuric acid, and we must precipitate the muriatic acid by means of sulphat of silver instead of nitrat. The presence of sulphat of soda does not injure the success of this process.

If muriat of ammonia accompanies either of the fixed alkaline sulphats without the presence of any other salt, decompose the sal ammoniac by barytes-water, expel the ammonia by boiling, precipitatethe barytes by diluted sulphuric acid, and saturate the muriatic acid with soda. The sulphat of barytes thus precipitated indicates the quantity of muriat of ammonia; one hundred grains of sulphur indicating 49.09 grains of that salt. If sulphats are present in the solution, they ought to be previously separated.

If common salt is accompanied by muriat of lime, muriat of magnesia, muriat of alumina, or muriat of iron, or by all of these together without any other salts, the earths may be precipitated by barytes-water, and redissolved in muriatic acid. They are then to be separated from each other by the rules formerly laid down; and their weight being determined indicates the quantity of every particular earthy muriat contained in the water. For fifty grains of lime indicate one hundred of dried muriat of lime; thirty grains of magnesia indicate one hundred of the muriat of the earth; and 21.8 grains of alumina indicate one hundred of the muriat of alumina. The barytes is to be separated from the solution by sulphuric acid, and the muriatic acid expelled by heat, or saturated with soda; the common salt may then be ascertained by evaporation, subtracting in the last case the proportion of common salt indicated by the known quantity of muriatic acid from which the earths had been separated.

When sulphats and muriats exist together, they ought to be separated either by precipitating the sulphats by means of alcohol, or by evaporating the whole to dryness, and dissolving the earthy muriats in alcohol. The salts thus separated may be estimated by the rules already laid down.

When alkaline and earthy muriats and sulphat of lime occur together, this last salt is to be decomposed by means of muriat of barytes. The precipitate ascertains the weight of sulphat of lime contained in the water. The estimation is then to be conducted as when nothing but muriats are present; only from the muriat of lime that proportion of muriat must be deducted which is known to have been formed by the infusion of the muriat of barytes.

When muriats of soda, magnesia, and alumina, are present together with sulphats of lime and magnesia, the water to be examined ought to be divided into two equal portions. To the one portion add carbonat of magnesia till the whole of the lime and alumina is precipitated. Ascertain the quautity of lime which gives the proportion of sulphat of lime. Precipitate the sulphuric acid by muriat of barytes. This gives the quantity contained in the sulphat of magnesia and sulphat of lime; subtracting this last portion, we have the quantity of sulphat of magnesia.

From the second portion of water precipitate all the magnesia and alumina by means of lime-water. The weight of these earths enables us to ascertain the weight of muriat of magnesia and of alumina contained in the water, subtracting that part of the magnesia which existed in the state of sulphat, as indicated by the examination of the first portion of water. After this estimation precipitate the sulphuric acid by barytes water, and the lime by carbonic acid. The liquid evaporated to dryness leaves the common salt.

VI. It now only remains to explain the method of ascertaining the proportion of the nitrats which may exist in waters.

1. When nitre accompanies sulphats and muriats without any other nitrat, the sulphats are to be decomposed by acetat of barytes, and the muriats by acetat of silver. The water after filtration, is to be evaporated to dryness, and the residuum treated with alcohol, which dissolves the acetats, and leaves the nitre; the quantity of which may be easily estimated. If an alkali is present, it ought to be previously saturated with sulphuric or muriatic acid.

2. If nitre, common salt, nitrat of lime, and muriat of lime or of magnesia, are present together, the water ought to be evaporated to dryness, and the dry mass treated with alcohol, which takes up the earthy salts. From the residuum, redissolved in water, the nitre may be separated, as estimated as in the last case. The alcohol solution is to be evaporated to dryness, and the residuum redissolved in water. Let us suppose it to contain muriat of magnesia, nitrat of lime, and muriat of lime. Precipitate the muriatic acid by nitrat of silver, which gives the proportion of muriat of magnesia and of lime. Separate the magnesia by means of carbonat of lime, and note its quantity. This gives us the quantity of muriat of magnesia. And subtracting the muriatic acid contained in that salt from the whole acid indicated by the precipitate of silver, we have the proportion of muriat of lime. Lastly, saturate the lime added to precipitate the magnesia with nitric acid. Then precipitate the whole of the lime by sulphuric acid; and subtracting from the whole of the sulphat thus formed that portion formed by the carbonat of lime added, and by the lime contained in the muriat, the residuum gives us the lime contained in the original nitrat; and 35 grains of lime form 100 of dry nitrat of lime.

Water-sea. See Sea.

WATER-COLOURS. Painting in water-colours, is an art capable of affording the highest delight to the eye, since no mode of representation can display the appearances of nature with greater splendour. It is an art which has of late been carried forward with unprecedented success, and may be said at present to be the most perfect species of design or painting, which is in practice amongst our artists. To this the facility of the materials employed in it, contributes in no small degree. It is not attended with the embarrassments to which oil-painting, or most other kinds of painting, are liable, but proceeds by ready and uninterrupted. progress to the completion of its task.

Ths preliminary parts of study requisite for the young student in the attainment of this art, have been treated at large under the article of drawing. See Drawing. We can recommend no more advantageous method for his farther progress, than the carefully studying and copying the various works of excellence by the hands of the best masters, until he shall be able to follow, if not to rival them, in the imitation of nature. We shall now endeavour to furnish him with the best means for this purpose, by describing the colours which are employed in washing, and by giving the most approved directions for preparing and using them.

The materials and implements necessary for the practice of water-colours (or washing, as it is sometimes called) are,—gum-colours, of which we shall treat hereafter more particularly; camels'-hair pencils, fitches, a pallette, and penknife.

The general or simple colours, and the various species of each, fit for painting in water-colours, are as follow:

Whites.	*Browns.*
Ceruse	Spanish brown
Constant white	Spanish liquorice
White lead	Umber
Spanish white	Bistre
Flake white	Burnt Terra de Sienna
Spodium	Unburnt ditto

Blacks.	*Reds.*
Burnt cherry-stones	Native cinnabar
Ivory-black	Burnt ochre
Keating's black	Indian red
Lamp-black	Red lead
Greens.	Minium
Green bice	Lake
Green verditer	Vermilion
Grass-green	Carmine
Sap-green	Red ink
Verdigrise distilled	Indian lake
Blues.	*Yellows.*
Sanders blue	English ochre
Terre-blue	Gall-stone
Blue verditer	Gamboge
Indigo	Masticot
Litmus	Ochre de luce
Smalt	Orpiment
Prussian blue	Roman ochre
Light ditto	Dutch pink
Ultramarine	Saffron-water
Ultramarine ashes	King's yellow
Blue bice	Gold yellow
	French berries.

Directions for preparing the following single colours.

Whites. The best white for painting in water-colours is flake-white; some recommend a white made of pearl and oyster-shells, brought to an impalpable powder, called a pearl-white, which will mix well with any colour. If you use white lead, clarify it with white-wine vinegar; after the white is settled, pour off the vinegar, and wash it with water thus: Put the powder into a glass of water, stir it, and presently pour the water off, while it is white, into another clean glass; when it is settled, pour off the water, and you will have an excellent white; to which add as much gum as is necessary, to give it a gloss.

It has been often noticed, that white lead will turn black, if mixed with water that comes from iron or clay; so that, in the space of a month or two, you may perceive it; and it will also change any colour with which it is mixed.

Some therefore recommend the powder of egg-shells, of the brightest and whitest sort, well ground with gum-water, to the state of an impalpable powder, to which they add one-twentieth part of white sugar-candy; others esteem it most when clarified in spirit of wine, and then use it with gum-water.

It has been found, by repeated experience, that this egg-shell powder is extremely serviceable as a white, in water-colours; and that this, and the oyster-shell powder, rectified and well bruised, will make an excellent mixture with other colours, to keep them from changing.

A fine white, for water-colours, may be made by dissolving filings of silver, or silver-leaf, in aqua-fortis, evaporating the aqua-fortis till it appears like crystal in the bottom of the glass; decant the other part of the aqua-fortis, and wash the silver four or five times in pure water, till it is entirely cleaned from the aqua-fortis, drying it for use. It must be used with the waters of gum and sugar-candy.

A good white for water-colours, proper for miniature, is made thus: Take a pound of the shreddings of glove-leather, and steep them in water; boil them with twelve quarts of water, till it wastes to two; strain it through a linen cloth, into a well-glazed earthen pan; this is called glue or size, and proper to use with colours in candle-light pieces; to know if this is strong enough, try if it is stiff, and firm under your hand.

The glue being melted, reduce some white chalk to a powder, and while it is hot, add such a quantity of the chalk as will bring it to the consistency of a paste, letting it steep for a quarter of an hour; stir it with a brush made of hog's bristles.

In order to make this white brighter, add more glue. Be careful to observe that every layer is dry, before you put on another. If you work upon wood, you must put on a dozen; but six or seven are sufficient if your paper is thick. Afterwards dip a soft brush in some water, draining it with your fingers; rub the work with it, in order to make it the smoother. When your brush is full of white, you must wash it again; and also change the water when it is too white. Or you may use a wet linen rag, instead of a brush.

Yellows. In some objects there may be seen a shining, like that of gold, through colours of red, blue, or green; such as some sorts of flies or beetles, and the cantharides. This gold or transparency may be well imitated by laying some leaf-gold on the shaded side of the drawing, giving a little to the light side. To lay on the gold-leaf, press it smooth and close with cotton, after you have washed it with strong gum-water; but care must be taken, that in laying on the gum, you do not exceed the limits through which you would have the gold appear. In this case, the gold is only to shine through the transparent colour, which is to be laid over it.

As leaf-gold will not receive water-colours regularly, it is necessary to be provided with water of ox-gall, and with this liquor to stroke over the gold-leaf; by which it will receive any colour you are desirous of laying over it, and will also retain it.

In some manuscripts there may be seen gold letters, which seem to rise above the surface of the paper. The composition which raises them, is made of vermilion and the white of an egg, beaten to the consistence of an oil, and fixed to the paper with gum-arabic; on this figurative letter, wash some strong gum-water, with a camel's-hair pencil; lay on the gold-leaf close with some cotton; and when dry, rub it again with cotton, and burnish it with a dog's tooth, and it will appear as if it was cast in gold.

There is also another way of working in gold, which is perfomed by shell-gold (but then it must be pure, and not that brought from Germany, which turns green in a few days). Cover the shady parts with vermilion, before you use this gold, and when you have rectified it with spirit of wine, lay it on; when dry, burnish it as before directed.

In laying on this gold, it is best to leave the lights without it, as it will appear to a much greater advantage than if all the objects were covered: but, provided the whole performance should chance to be covered, the best way of setting it off, is to trace over the shady parts with gall-stone, or the yellow made of French berries, (of which we shall treat hereafter), heightened with minium.

Of yellows in general. Gamboge is, beyond doubt, one of the mellowest colours nature has produced; it is of so mild a temperature, that when it is touched with any fluid, it instantly dissolves; so that, consequently, it wants neither gumming nor grinding; it is productive of a variety of the most agreeable and pleasant yellow tints, that fancy or art could ever imagine; it will generally shade itself, though sometimes it requires help.

Gall-stone is a very rich deep yellow, tending towards a brown; it is exceedingly useful in many cases, needs but little gumming or grinding, works free, but will not shade itself.

Mr. Boyle says, if you cut the roots of berberries, and put them into a strong lixivium, made of pearl-ashes and water, from them will proceed a very agreeable yellow. This experiment has often been made, and as often attended with success.

He also gives an account of another fine transparent yellow, by boiling the root of a mulberry-tree, well cleansed, in the foregoing lixivium.

Yellow ochre makes a very good pale yellow: and, being ground with gum-water, will prove extremely useful.

Another very useful yellow, is made by infusing the plant celandine in clear water, gently pressing it, adding to the liquor some alum-water, letting it boil.

The virtue of the yellow extracted from French berries is so well known, that we need only give the directions for preparing it: In a quart of the preceding lixivium, boil two ounces of French berries, till the liquor is of a fine yellow; strain it from the yellow berries, and when cold it is fit for use. To the berries put a pint of the same lixivium, and boil it till the liquor is as strong as gall-stones; with which you may shade any yellows; this you may boil till it comes to a brown, and will, with the addition of a little ox-gall, serve to shade the gold-leaf.

You may likewise make a yellow, by infusing saffron in pure water. When this is steeped in rectified spirit of wine, there is nothing higher; but it is very apt to fly, unless it is high-gummed.

A good yellow, for the illumination of prints, may be extracted from the roots of ginger; which make a good green, when mixed with transparent verdigrise.

Those yellows called English and Dutch pinks, are made with French berries, ground to a fine powder, and then boiled.

King's yellow, a fine body-colour, is much used in heightening the ochre for gold lace, &c.

Orange colour. This colour is made of a mixture of vermilion and gamboge, the latter most predominant, in which you have a serviceable colour in painting lilies, and all other orange-coloured flowers. Orpiment is likewise a pleasing colour.

Reds.

Red-lead, or minium, is a strong heavy colour. Mr. Boyle has given us the following directions for preparing it: Put four ounces in a glass, to a quart of rain-water, and when it has been thoroughly stirred, pour off the water; and by a frequent repetition of this, there will remain at the bottom of the glass a beautiful red, when dry, which is to be used with gum-water. When the colour has been thus prepared, you must not expect above twenty grains to remain out of four ounces.

Carmine affords the brightest and most perfect crimson, and is the most beautiful of all reds; for with this colour and lake you may make the shades as strong as you please. This colour should never be purchased but by day-light; for if not good, it will but spoil your work.

Lake is a fine transparent colour, not much inferior to carmine; but in painting with carmine on that part of the print on which the light is supposed to strike, lay on the first tint as light as possible, working it stronger as it grows darker, and touch it in the darker parts with lake.

Lake may be bought at most colour-shops, ready prepared for water-colours; but if you are desirous of making it yourself, it is necessary to adhere to the following directions: Having prepared a lixivium, made with the ashes of vine-twigs, to three pints of it add a pound of the best ground brazil wood; boil it till half the lixivium is evaporated; strain of off; boil it again with the addition of four ounces of fresh brazil wood, two ounces of cochineal, half an ounce of terra marita, and a pint of fair water; let it evaporate as before; add half an ounce of burnt alum (reduced to an impalpable powder), a quarter of a drachm of arsenic; dissolve them in it, by stirring it with a stick; when settled, strain it. To give this a body, reduce two cuttle-fish bones to a powder, and putting it in, let it dry leisurely. Grind it in a quantity of fair water, in which you may let it steep; strain it through a cloth, and making it into a few cakes, set it by for use, after drying it on a piece of marble.

If you would have this lake redder, add some of the juice of a lemon; and to make it deeper, add oil of tartar.

Another lake: Boil the shreds of superfine scarlet cloth in a lye made of the ashes of burnt tartar; when sufficiently boiled, add some cochineal, powdered mastich, and roche alum; boil this again; while it is quite hot, strain it through a bag several times. The first time, the bag must be strained from top to bottom, and the remaining gross matter being taken out, let the bag be well washed; after this, strain the liquor through the bag again, and you will find a paste remaining on the sides, which divide into small cakes, and set by for use.

Another lake: Steep four ounces of the best brazil wood in a pint and a half of the finest distilled vinegar, for three weeks at least, though the longer it remains the better it is; seethe the whole in balneum mariæ, till it boils up three or four times; let it settle for a day or two; put it to an ounce of powdered alum, and into a clean pan with the liquor; let it remain for twenty-four hours; heat the composition, and stir it till it is cold; when it has stood about twelve hours, strain it, and add two cuttle-fish bones, prepared as before.

A liquid colour of a very good crimson, is made as follows: In twelve ounces of pale stale beer, boil one ounce of ground brazil wood, till the colour is as strong as you desire; strain it through a linen cloth, and bottle it up for use. If you want to bring this colour to a body, take some dried ox-blood, reduced to a powder, and mix it with the colour.

We have the following directions from Mr. Boyle, for extracting a fine crimson from the berry-bearing spinach, which, being pressed, affords a very agreeable juice; to which add a fourth part of alum; boil it, and when cold it is fit for use.

Or you may extract a very beautiful red from the red beet-root, baked with a little strong vinegar and alum: when cold it is fit for use.

Another way to make a crimson: Put twenty or more grains of bruised cochineal into a gallipot, with as many drops of the lye of tartar as will make it give forth its colour; add to this mixture about half a spoonful of water, or more, and you will have a very agreeable purple; reducing some alum to a very fine powder, put it to the purple liquor, and you will have a beautiful crimson; strain it through a fine cloth; use it as soon as possible: for though this is a colour which, if soon used, looks extremely well, yet by long standing it is subject to decay.

Indian lake is far superior to any other of the kind, for the deep shade of reds of all kinds, and works as free as gamboge. The best is brought from China, in pots, and has the appearance of raspberry-jam, but very bitter to the taste: it requires no gum.

Purples. Take eight ounces of logwood, a pint of rain water, and an ounce of alum; infuse it well over a slow fire, in a well glazed pan or pipkin, for about twenty-four hours; add a quarter of an ounce of gum-arabic, let it stand for a week: strain it through a piece of fine cloth. Keep it close, or it will mould.

Or you may make a redder purple, by adding to one ounce of the above, four ounces of brazil wood, and a pint of stale beer, boiling it till the liquor is as strong as you desire. It may be made darker, by adding more logwood.

The richest purple is made by blending carmine and Prussian blue, or indigo, to what shade you please.

Blues. Ultramarine is the best and brightest blue. Prepare it by heating six ounces of the lapis lazuli till it is red; cool it in strong vinegar; grind it with a stone and muller to an impalpable powder; then make a composition of bees'-wax, resin, linseed-oil, and turpentine, of each three ounces; incorporate the whole together over a slow fire, till it is near boiling; pour them into a pan well glazed. This is called the paste of ultramarine. The lapis lazuli being prepared, add to it an equal quantity of the pastil, or paste; mix them together thoroughly, and let them remain twelve hours. To extract the ultramarine from the paste, pours clear water upon it; on pressing the paste with your hands, the ultramarine will come out for its reception, place a glass tumbler under your hand; let it settle in this water till the ultramarine sinks to the bottom.

If the colour seems foul, cleanse it thus: Dissolve some tartar in water; add as much of it to the ultramarine as will cover it; let it stand twelve hours; wash it in warm water, and you will have your colour well clarified and perfectly clean. Let your ultramarine be of a high colour, and well ground.

Next to ultramarine in beauty, is Prussian blue; but it does not grind kindly with water, on account of its oily substance.

Blue bice is a colour of a very good body, and flows very agreeably in the pencil; wash it according to the rules laid down for ultramarine.

Blue verditer is a very bright pleasant blue, of a good body, and works well when ground with gum-water. It is a little inclinable to, and makes a very good green, when ground with gamboge, or French berries. This blue is mostly used for a sky, or a garment.

Sanders blue is extremely serviceable in the shading of ultramarine, where no very dark shades appear; when they do, you may add a little indigo to it.

Litmus is a very agreeable blue. To prepare it, take a quart of small-beer wort, in which boil two ounces of litmus, till the colour is as strong as you require; pour the liquor into a glazed pipkin, and it will soon congeal. See Archil.

Indigo is the darkest blue, is a soft free colour, and runs very warm in the pencil; it requires to be well washed and ground; and may be made darker or lighter, by the addition of more or less gum-water. Care is required in using this colour; for, as we before hinted, its running so free may be a means of deceiving the student, and prove too dark for his purpose.

Mr. Boyle has given us the following directions for making a very fine colour of the blue leaves of rue: by pressing, bruising, and infusing both leaves and juice in pure water, for a fortnight, washing them every day, incorporating them and the water till they become a pulp, letting them dry gradually. These will produce an excellent blue for shading, which runs free in the pencil; put it into the powder of gum-arabic, which will be a means of making it keep; add of the gum as you would have it more or less stiff in working.

A fine transparent blue (from the preceding author), equal to a tint of ultramarine: The flower from which this blue is extracted, is the centauria cyanus, or blue cornbottle, possessed of two blues, the outer leaves being light, and the inner dark; the latter is held in preference; pick both from the buttons and cases in which they grow, the same day they were gathered. Having prepared a quantity of the middle leaves, press out as much juice as possible; with the addition of a little alum, you will be possessed of a fine, durable, transparent blue, little inferior to ultramarine. The procuring of the flowers, and the pressure of the juice, should be done with all possible expedition, lest the flowers should lose their perfection. It has been thought by some, if the leaves of these flowers were cured as those of saffron, there would proceed from them a much greater quantity of colour, from which might be pressed more tincture than when fresh from the field. In curing of each it would appear, that each time the cake was turned, the flowers would be darker, till they become a dark blue. Great care is required in this operation, that the fire is kept very constant and gentle, that the flowers may not be scorched, which will be an incontestable way of bringing the flowers to perfection. Therefore, to put this operation in execution, a kiln must be procured, as for curing saffron, the top of which is to be covered with hair-cloth; upon this lay several sheets of paper; afterwards a parcel of the inner leaves of the flowers, two or three inches thick, pressing them close, and sprinkling them with gum-water; after which, a small charcoal fire must be made in the kiln, o as to communicate the heat to the top. over the cake with a few sheets of paper, nd a board, with a small weight upon it; fter a few minutes, the cake is to be turned; hen it is placed, take off the upper paper, prinkle the cake again with gum-water, lay n the board a weight as before for a few mi- utes; and so repeat the turning and sprin- ling several times, till the cake is united, and f the thickness of a cake of saffron.

Blacks. The proper blacks for water-co- ours are as follow:

Ivory-black, which is prepared in the fol- owing manner: Let the ivory-black be tho- oughly ground, and there will naturally pro- eed from it a liquor of an oily substance; ix as much of it as will make it work freely the pencil. It has a fine gloss, and is ex- emely serviceable in painting of shining bjects.

There is another very agreeable and useful ack, called Keating's black, which may be ad at most colour-shops ready-prepared.

Indian ink is a very good black, and of eat service, as it may be laid on to any hade, and will always shade itself; on which count it is often used for drawings.

Greens. Sap-green is a colour extremely rviceable, and the best green for water-co- urs our age affords, being of a gummy sub- ance, and diluting easily in water. It pro- uces an endless variety of tints, and has the lvantage of shading itself. In purchasing is colour, remember to observe that it oks very black and bright.

A sea or artificial green, is made by mix- g indigo and sap-green, which may be made rker or lighter by adding more or less digo; it is a very serviceable colour, easily orked, and productive of many tints. This olour, as well as sap-green, shades itself. he indigo must be well ground before you ix it.

Another is made with indigo and gamboge, ell ground together, extremely useful in inting of trees, grass, vegetables, &c. With e addition of sap-green, it is very service- le in flowers, and shading in of garments.

A transparent green is made by mixing rdigrise and yellow to various tints, by aving either predominant.

Browns. Burnt and unburnt terra de Si- na, are the warmest brown for front grounds, ad leaves, &c. work very free, and are of neral use.

Bistre is a good and serviceable colour. e best sort is very bright and close; as it a colour difficult to work of itself, mix a tle Spanish liquorice with it, that will mel- w and take off its harshness. It must be ll ground; and the higher it is gummed, e better for use.

Spanish liquorice is allowed, by the best asters, to be productive of a great variety of own tints, of a very agreeable colour; it ll not shade itself, but works as free as any m-colours by diluting it in fair water.

A brown mixture is made by incorporating -green and carmine, which is of an extra- dinary soft nature; it is a colour extremely viceable in painting flowers in water-co- rs.

Another, by blending vermilion and bistre oroughly; the bistre must be extremely ll ground before you incorporate it with vermilion, and it will produce a very good own.

Directions for preparing the following mixed colours.

Ash colour. Ceruse, Keating's black, and white, shaded with cherry-stone black.

Bay. Lake and flake white, shaded with carmine; bistre and vermilion, shaded with black.

Changeable silk. Red lead and masticot-water, shaded with sap-green and verdigrise.

Another. Lake and yellow, shaded with lake and Prussian blue.

Cloud colour. Light masticot, or lake and white, shaded with blue verditer.

Another. Constant white and Indian ink, a little vermilion.

Another. White, with a little lake and blue verditer, makes a very agreeable cloud-colour, for that part next the horizon.

Crimson. Lake and white, with a little vermilion, shaded with lake and carmine.

Flame colour. Vermilion and orpiment, heightened with white.

Another. Gamboge, shaded with minium and red-lead.

Flesh colour. Ceruse, red lead, and lake, for a swarthy complexion, and yellow-ochre.

Another. Constant white and a little carmine, shaded with Spanish liquorice, washed with carmine.

French green. Light pink and Dutch bice, shaded with green pink.

Glass grey. Ceruse, with a little blue of any kind.

Hair colour. Masticot, ochre, umber, ceruse, and cherry-stone black.

Lead colour. Indigo and white.

Light blue. Blue bice, heightened with flake white.

Another. Blue verditer, and white of any sort, well ground.

Light green Pink, smalt, and white.

Another. Blue verditer and gamboge.

Another. Gamboge and verdigrise. The chief use of this green is to lay the ground-colours for trees, fields, &c.

Lion tawny. Red lead, and masticot, shaded with umber.

Murrey. Lake and white lead.

Orange. Red lead and a little masticot, shaded with gall-stone and lake.

Orange tawny. Lake, light pink, a little masticot, shaded with gall-stone and lake.

Pearl colour. Carmine, a little white, shaded with lake.

Popinjay green. Green and masticot; or pink and a little indigo, shaded with indigo.

Purple. Indigo, Spanish brown, and white; or blue bice, red and white lead; or blue bice and lake.

Russet. Cherry-stone black and white.

Scarlet. Red lead and lake, with or without vermilion.

Sea green. Bice, pink, and white, shaded with pink.

Sky colour. Light masticot and white, for the lowest and lightest parts; second, red ink and white; third, blue bice and white; fourth, blue bice alone. These are all to be softened into one another at the edges, so as not to appear harsh.

Sky colour for drapery. Blue bice and ceruse, or ultramarine and white, shaded with indigo.

Straw colour. Masticot and a very little lake, shaded with Dutch pink.

Violet colour. Indigo, white, and lake; or fine Dutch bice and lake, shaded with indigo; or litmus, smalt, and bice, the latter most predominant.

Water. Blue and white, shaded with blue, and heightened with white.

Another. Blue verdigrise, shaded with indigo, and heightened with white.

Directions for using the colours.

Your pencils must be fast in the quills, and sharp-pointed (after you have drawn them through your mouth), not apt to part in the middle.

Before you begin, have all your colours ready, and a pallette for the conveniency of mixing them; a paper to lay under your hand, as well as to try your colours upon; also a large brush, called a fitch, to wipe off the dust from them.

Being prepared according to the foregoing method, proceed in your painting; which if a landscape, lay on first dead colours freely all over your piece, leaving no part uncovered.

Having laid your dead colours, begin next with the lighter parts, as the sky, sun-beams, &c.; then the yellowish beams, with masticot and white; next the blueness of the sky, with blue verditer alone; for purple clouds, mix only lake and white, making your colours deeper as they go upwards from the horizon, except in tempestuous skys. The tops of distant mountains must be worked so faint, that they may seem to lose themselves in the air.

Bring your colours forward as your distance decreases: painting your first ground next the horizon, downwards, of a bluish sea-green; and as you advance forward, of a darker green, till you come to the fore-ground itself; which, as it is the darkest part of all, with dark green, worked in such a manner as to give the appearance of shrubbery, &c.

In painting trees, having first laid a verdigrise green for a dead colour, proceed with working it so as to give a leafy appearance. Bring some of your leaves forward with masticot and white; for the trunk, work the brown with sap-green; if you should introduce oak-trees, lay on some touches to express leaves of ivy twined about it.

All distinct objects are to be made imperfect, as they appear to the eye.

In painting flesh, the following are the best directions for preparing your work so as afterwards more readily to produce the effects of colours seen in nature:

Take flake-white and a little lake, blend them together, and with that lay the ground-colour; then shade with red-ochre, cherry-stone black, and a little lake, mixed together, touching the lips, cheeks, &c. with a tint of carmine, and heighten the flesh with white and a little carmine. Remember that you are never to heighten it with pure white, which will always give it a cold appearance.

The peculiar management of tints in the representation of other various kinds of objects, such as animals, flowers, fruits, &c. will require some attention from the student, but is unnecessary to be given here in detail, as practice will soon instruct him in all that is requisite on this head.

It may be recommended to the student in general, whatever is the subject of his drawing, not to finish any one part first, but to work up every part gradually alike, until he finds nothing wanting to complete the whole.

Wherever he lays on strong touches, he must be careful in those places to bring up his work to an equal roundness and strength, tempering and sweetening the colours with a sharper pencil than the first, that no lumps or harsh edges may be left, but that the shadows may all lie dispersed, soft and smooth, and gliding gently into one another.

The occasional roughness of your work need not discourage you: for it is easily softened by degrees, with other tints and shadows; observing only to sweeten, mellow, and heighten them, according as the light happens to fall.

A method has been lately discovered of combining the effects of water-colours with those of crayon-painting, by means of wax crayons. It is an ingenious and pleasing mode of practice. See Wax Crayons.

Various receipts for the use of those who paint in water-colours.

Boil two ounces of the best and clearest glue, with one pint of clear water, and half an ounce of the finest roche-alum, till dissolved. This is a very serviceable liquor, with which you may temper those colours intended for sky, as it will prevent them from cracking.

To make a solution of gum. Dissolve an ounce of the best white gum-arabic, and half an ounce of double refined sugar, in a quart of spring water; strain it through a piece of muslin, then bottle it off for use, keeping it free from dust.

Another method. Take the whitest sort of gum-arabic, bruise and tie it in a piece of woollen cloth, steep it in spring water till dissolved. If too stiff, which is known by the shining of the colours, add more water; if too weak, more gum. With this water you may temper most of your colours, using such a quantity of it, that the colours, when dry, being touched, will come off.

To keep the flies from your work. Having prepared your gum-water according to either of the preceding directions, add a little coloquintida, which, if your performance should be exposed, will keep it from being damaged by the flies.

To prepare alum-water. Take four ounces of roche-alum, and a pint of pure spring water; boil it till the alum is thoroughly dissolved; filtre it through blotting-paper, and it is fit for use.

Before you lay on the colours, take some of this water hot, and with a sponge wet the back of the paper, which, if not good, must be wetted three or four times. This will not only prevent the sinking of the colours, but will also keep them from fading, and give an additional beauty and lustre. Remember that the paper must be dried each time before you wet it again.

To make lime-water. Put some unslacked lime in a well-glazed pan; cover it with pure water one inch above the lime; let it remain so for one day, then strain off the water, and keep it for use. By the means of this water, you may change sap-green into blue.

To make a lixivium of pearl-ashes. Steep half an ounce of pearl-ashes in clear water for one day; strain off the water as clean as possible; this infusion will prove extremely serviceable in many colours, particularly brazil wood, to which it will give an additional beauty and lustre.

To recover decayed colours. Take double-distilled rosemary-water, or pure essence of rosemary, and with a few drops temper your colours, which, however dead or faded, will recover their primitive brilliancy. This essence will prevent the bubbles which are troublesome in grinding white and umber.

To prepare a liquid gold for vellum-painting, fans, &c. Having procured some of the finest leaf gold, grind it with strong gum-water, adding more gum-water as you see requisite; when thoroughly ground, temper it with a small quantity of mercury sublimate, binding it in the shell with a little dissolved gum; spread it equally over the shell, and use it with fair water only.

A liquid silver, for the same use. The manner of making this is the same as that of liquid gold, only remembering to temper it with glaire of eggs, and not water.

To make the glaire of eggs. Beat the whites with a spoon till they rise in a foam; let them stand 12 hours, and they will be clarified into good glaire.

To recover liquid silver that has contracted rust. If your silver becomes rusty, cover that part of the performance with the juice of garlic, which will recover it effectually.

To make a single ground to lay silver or gold upon. Take the new shreds of parchment (they being preferable to glove-leather), boil them in a quart of spring-water till consumed to a pint; strain the size from the shreds, and put it into a well-glazed pan; use it before it is cold. Be careful, when you lay on your silver or gold, that your size is not too moist, nor too dry, for in either case you will be in danger of impairing your performance.

The method of making size for candle-light pieces, has already been described.

WATER COURSE. A water course does not begin by prescription, nor assent, but begins ex jure naturæ, having this course naturally; and cannot be diverted. 3 Bulst. 340.

WATERMEN. In London the lord mayor and court of aldermen have much power in governing the company of watermen, and appointing the fares for plying on the river Thames; and justices for Middlesex, and other adjoining counties, have also power to hear and determine offences, &c. See 10 G. II. c. 31.

WATER-SPOUT, an extraordinary aqueous meteor, most frequently observed at sea. It is a truly formidable phenomenon, and is indeed capable of causing great ravages. It commonly begins by a cloud, which appears very small, and which mariners call the squall; which augments in a little time into an enormous cloud of a cylindrical form, or that of a reversed cone, and produces a noise like an agitated sea, sometimes emitting thunder and lightning, and also large quantities of rain or hail, sufficient to inundate large vessels, overset trees and houses, and every thing which opposes its violent impetuosity.

These water-spouts are more frequent at sea than by land; and sailors are so convinced of their dangerous consequences, that when they perceive their approach, they frequently endeavour to break them by firing a cannon before they approach too near the ship. They have also been known to commit great devastations by land: though, where there is no water near, they generally assume the harmless form of a whirlwind. To enable the reader to understand their nature, we shall preface the different theories by a short description of one of these wonderful appearances, as given by the celebrated M. Tournefort in his Voyage to the Levant:

"The first of these," says this traveller, "that we saw, was about a musket-shot from our ship. There we perceived the water began to boil, and to rise about a foot above its level. The water was agitated and whitish; and above its surface there seemed to stand a smoke, such as might be imagined to come from wet straw before it begins to blaze. It made a sort of a murmuring sound, like that of a torrent heard at a distance, mixed, at the same time, with a hissing noise, like that of a serpent: shortly after we perceived a column of this smoke rise up to the clouds, at the same time whirling about with great rapidity. It appeared to be as thick as one's finger; and the former sound still continued. When this disappeared, after lasting for about eight minutes, upon turning to the opposite quarter of the sky, we perceived another, which began in the manner of the former; presently after a third appeared in the west; and instantly beside it still another arose. The most distant of these three could not be above a musket-shot from the ship. They all continued like so many heaps of wet straw set on fire, that continued to smoke and to make the same noise as before. We soon after perceived each, with its respective canal, mounting up in the clouds; and spreading, where it touched the cloud, like the mouth of a trumpet; making a figure, to express it intelligibly, as if the tail of an animal was pulled at one end by a weight. These canals were of a whitish colour, and so tinged, as I suppose, by the water which was contained in them; for, previous to this, they were apparently empty, and of the colour of transparent glass. These canals were not straight, but bent in some parts, and far from being perpendicular, but rising in their clouds with a very inclined ascent. But what is very particular, the cloud to which one of them was pointed happening to be driven by the wind, the spout still continued to follow its motion without being broken; and passing behind one of the others, the spouts crossed each other, in the form of a St. Andrew's cross. In the beginning they were all about as thick as one's finger, except at the top, where they were broader, and two of them disappeared; but shortly after the last of the three increased considerably, and its canal, which was at first so small, soon became as thick as a man's arm, then as his leg, and at last thicker than his whole body. We saw distinctly, through this transparent body, the water, which rose up with a kind of spiral motion; and it sometimes diminished a little of its thickness, and again resumed the same; sometimes widening at top, and sometimes at bottom; exactly resembling a gut filled with water, pressed with the fingers, to make the fluid rise or fall; and I am well convinced that this alteration in the spout was caused by the wind, which pressed the cloud, and compelled it to give up its contents. After some time its bulk was so diminished as to be no thicker than a man's arm again, and thus swelling and diminishing, it at last became very small. In the end, I observed the sea which was raised bout it to resume its level by degrees, and ie end of the canal that touched it to become s small as if it had been tied round with a ord; and this continued till the light, striking through the cloud, took away the view. still, however, continued to look, expecting that its parts would join again, as I had efore seen in one of the others, in which the pout was more than once broken, and yet gain came together; but I was disappointed, or the spout appeared no more."

Whirlwinds and water-spouts are by the majority of philosophers referred to the same rigin, and some have endeavoured to account for them on electrical principles. They bserve that the effluent matter proceeds rom a body actually electrified towards one which is not so; and the affluent matter proceeds from a body not electrified towards one which is actually so. These two currents occasion two motions analogous to the electrical attraction and repulsion. If the current of the effluent matter is more powerful than the affluent matter, which in this case is composed of particles exhaled from the earth, the particles of vapours which compose the cloud are attracted by this effluent matter, and form the cylindrical column, called the descending water-spout; if, on the contrary, the affluent matter is the strongest, it attracts a sufficient quantity of aqueous particles to form gradually into a cloud, and this is commonly termed the ascending water-spout. It is farther observed of water-spouts, that the convergence of winds, and their consequent whirling motion, was a principal cause in producing that effect; but there are appearances which can hardly be solved by supposing that to be the only cause. They often vanish, and presently appear again in the same place: whitish or yellowish flames have sometimes been seen moving with prodigious swiftness about them, and whirlwinds are observed to electrify the apparatus very strongly. The time of their appearance is generally those months which are peculiarly subject to thunder-storms; and they are commonly preceded, accompanied, or followed, by lightning, the previous state of the air being alike in both cases. And the long-established custom which the sailors have of presenting sharp swords to disperse them, is no inconsiderable circumstance in favour of the supposition of their being electrical phenomena. Perhaps the ascending motion of the air, by which the whirling is produced, may be the current known to issue from electrified points, as the form of the protuberance in the sea is somewhat pointed, and the electrified drop of water may afford considerable light in explaining this appearance.

A different theory is, however, adopted by other respectable philosophers; and it is possible after all, that there may really be two kinds of water-spouts, the one the effect of the electrical attraction, as digested above, and the other caused by a vacuum, or extreme and sudden rarefaction of the air.

It is well known that even a common fire produces a kind of circulation of the air in a room, but in a different form. It is therefore not difficult to conceive, that when any part of the column of air upon the surface of the earth or water is suddenly rarefied, either by electricity or any other cause, a vacuum, at least comparatively to the rest of the air, will immediately take place, and the circumambient air rushing in at once from every quarter to fill the void, a conflict of winds ensues, and consequently a circular motion, by which light bodies will be taken up and turned round with considerable velocity; this violent rushing of the air on all sides into the vacuum then forms what is commonly called at land a whirlwind.

When this vacuum takes place at sea, from the nature of fluids, the water will rise to a certain height by the pressure of the atmosphere, as in a common pump; but as the vacuum is not quite perfect, the water will be divided into drops; and as these vacuums are generally caused by heat, it will be rarefied when it reaches the upper regions of the atmosphere, and assume the appearance of a cloud.

Mr. Oliver, whose theory we have adopted with little variation, illustrates the phenomenon by a very easy experiment. In a stiff paper card he made a hole just large enough to insert a goose quill; after cutting the quill off square at both ends, he laid the card upon the mouth of a wine glass, filled with water to within a fifth or sixth part of an inch from the lower orifice of the quill; then applying his mouth to the upper part, he drew the air out of the quill, and in one draught of his breath drew in about a spoonful of water; and this he was able to repeat, the quill remaining as before. The water, he adds, did not ascend to his mouth in a stream, as it would have done had the quill reached the water, but broken, and confusedly mixed with the air which ascended with it. The usual phenomena of water-spouts are exactly agreeable to this theory. They appear at a distance like an inverted cone, or the point of a sword, which is owing to the water rising in large drops at the first, and being expanded as it ascends; and a cloud is generally suspended over the body of the phenomenon. The water which is taken up is undoubtedly salt at the first, but by the rarefaction in the superior regions, it undergoes a kind of natural distillation, and loses all the heavy saline particles with which it was charged. Water-spouts have been observed at land, of which two very remarkable instances are recorded in the Philosophical Transactions. Other phenomena have been remarked, which can be explained upon these principles only. Accounts have been given of red and yellow rain, of frogs and tadpoles, and even of small fishes; having been rained upon the tops of houses. The red and yellow rain was probably composed of the blossoms of vegetables, or of insects, taken up by one of these aerial tubes; and the frogs and fishes were probably part of the contents of some pond, in which the water-spout originated, or over which it might have passed in its perambulation.

The point or cone of the water-spout is generally oblique, depending on the force and direction of the wind which drives it along.

Dr. Perkins, of Boston, is disposed to adopt a different theory of water-spouts. Capt. Melling informed him, that in a voyage from the West Indian islands to Boston, a water-spout came across the stern of the vessel where he then was, a flood of water fell upon him with such violence as almost to beat him down, and the spout immediately passed off with a roaring noise into the sea. The water from the spout was perfectly fresh. Mariners in general affirm that water descends from the clouds through the water-spout into the sea, and hence it is inferred that a whirlwind cannot be the cause of a water-spout, nor can both of these phenomena proceed from the same cause.

Water-works, in general, denote all manner of machines moved by, or employed in raising or sustaining water; in which sense water-mills of all kinds, sluices, aqueducts, &c. may be called water-works. See Mill, &c.

WATSONIA, a genus of the class and order triandria monogynia. The calyx is six-parted; stigmas three, bifid; capsules triangular. There are six species, bulbs of the Cape.

WAVED. See Wavey.

WAX. The upper surface of the leaves of many trees is covered with a varnish, which may be separated and obtained in a state of purity, and is found to possess all the properties of bees'-wax: hence it is justly inferred that wax is a vegetable product, and that the bees extract it unaltered from the leaves of trees and other vegetable substances that contain it. Several plants contain wax in such abundance as to make it worth while to extract it from them. We shall now consider the properties of bees'-wax.

Wax, when pure, is of a whitish colour: it is destitute of taste, and has scarcely any smell. Bees'-wax indeed has a pretty strong aromatic smell; but this seems chiefly owing to some substance with which it is mixed; for it disappears almost completely by exposing the wax, drawn out into thin ribands, for some time to the atmosphere. By this process, which is called bleaching, the yellow colour of the wax disappears, and it becomes very white. Bleached wax is not affected by the air. Its specific gravity is 0.9600.

Wax is insoluble in water; nor are its properties altered though kept under that liquid.

When heat is applied to wax it becomes soft; and at the temperature of 142°, if unbleached, or of 1550° if bleached, it melts into a colourless transparent fluid, which concretes again, and resumes its former appearance as the temperature diminishes. If the heat is still farther increased, the wax boils and evaporates: and if a red heat is applied to the vapour, it takes fire and burns with a bright flame. It is this property which renders wax so useful for making candles.

Wax is scarcely acted on by alcohol when cold, but boiling alcohol dissolves a portion of it. This was first observed by Dr. Pearson, and has been since verified by Dr. Bostock. Rather more than 20 parts of alcohol are necessary to dissolve one part of wax; and as the solution cools the greater part of the wax precipitates, and the remainder is thrown down by water.

Ether has but little action on wax while cold; but when assisted by heat, it takes up about $\frac{1}{20}$ of its weight of it, and lets the greatest part precipitate on cooling.

Wax combines readily with fixed oils when assisted by heat, and forms with them a substance of greater or less consistency according to the quantity of oil. This composition, which is known by the name of cerate, is much employed by surgeons.

The volatile oils also dissolve it when heated. This is well known, at least, to be the case with oil of turpentine. A part of the wax precipitates usually as the solution cools, but of a much softer consistence than usual, and therefore containing oil.

The fixed alkalies combine with it, and form a compound which possesses all the properties of common soap. When boiled with a solution of fixed alkalies in water, the liquid becomes turbid, and after some time the soap separates and swims on the surface. It is precipitated from the alkali by acids in the state of flakes, which are the wax very little altered in its properties. Punic wax, which the antients employed in painting in encaustic, is a soap composed of 20 parts of wax and one of soda. Its composition was ascertained by Mr. Lorgna.

When boiled with liquid ammonia, it forms a kind of soapy emulsion. As the mixture cools, the greatest part of the compound rises to the surface in the state of white flakes. This soap is scarcely soluble in water.

The acids have but little action on wax; even oxymuriatic acid, which acts so violently on most bodies, produces no other change on it than that of rendering it white. This property which wax possesses, of resisting the action of acids, renders it very useful as a lute, to confine acids properly in vessels, or to prevent them from injuring a common cork.

Mr. Lavoisier, by means of the apparatus which he employed in the analysis of alcohol and oils, contrived to burn wax in oxygen gas. The quantity of wax consumed was 21.9 grains. The oxygen gas employed in consuming that quantity amounted to 66.55 grains. Consequently the substances consumed amounted to 88.45 grains. After the combustion, there were found in the glass vessel 62.58 grains of carbonic acid, and a quantity of water which was supposed to amount to 25.87 grains. These were the only products.

Now 62.58 grains of carbonic acid gas contain

44.56 of oxygen, and	18.02	of carbon; and 25.87 grains of water contain
21.99 of oxygen, and	3.88	of hydrogen
66.55	21.90	

Consequently 21.9 parts of wax are composed of 18.02 of carbon and 3.88 of hydrogen. And 100 parts of wax are composed of

82.28	carbon
17.72	hydrogen
100.00	

But this analysis can only be considered as an approximation to the truth; the quantity of water being only estimated, and that of the gas being liable to uncertainty. There can be no doubt, from the litttle action of acids on wax, that it contains oxygen as an ingredient. We must therefore consider it as a triple compound of carbon, hydrogen, and oxygen; but the proportions are unknown.

If wax is distilled with a heat greater than 212°, there comes over a little water, some acid, a little very fluid and odorous oil: the oil, as the distillation advances, becomes thicker and thicker, till at last it is of the consistency of butter, and for this reason has been called butter of wax. There remains in the retort a small quantity of coal, which is not easily reduced to ashes. When the butter of wax is repeatedly distilled, it becomes very fluid, and assumes the properties of volatile oil.

Wax possesses all the essential properties of fixed oil. We must therefore consider it as a fixed oil rendered concrete. Now that species of fixed oils, distinguished by the epithet fat, have the property of becoming concrete, and assuming the appearance of wax when exposed long to the air; in consequence, it is supposed, of the absorption of oxygen. Hence probably the difference between wax and fixed oils consists in the oxygen which it contains as a component part. The wax at its first formation was in all probability in the state of a fixed oil; but by the absorption of oxygen it gradually concreted into wax. Wax, then, may be considered as a fixed oil saturated with oxygen.

It is natural to suppose, if this theory is just, that fixed oil will occur in plants in various states of hardness: and this accordingly is the case. Sometimes it is of the consistency of butter, and this is denominated a butter; thus we have the butter of cacao, the butter of coco, the butter of galam. Sometimes it is of a greater consistency, and then is denominated tallow; thus we have the tallow of the croton, extracted by boiling water from the fruit of the croton sebifera. When its consistency is as great as possible, it then takes the appellation of wax. Thus we have the myrtle wax of America extracted from the berries of the myrica cerifera, and the pela of the Chinese. The species of wax, then, which exist in the vegetable kingdom, may possibly be as numerous as the fixed oils. Let us take a view of some of the most remarkable.

Bees'-wax is the species whose properties have been described in the former part of this article. It is supposed that the bees collect it from plants; but it has been very well ascertained, that in many cases at least they manufacture it from honey, and even from sugar: for bees confined and fed solely upon these substances produce wax. Its consistency is said to be less when the bees are confined to sugar than when they are allowed honey.

The myrtle wax of North America is obtained from the myrica cerifera. We are indebted to Dr. Bostock and Mr. Cadet for a very exact account of its properties and extraction. The myrica cerifera is a shrub which grows abundantly in Louisiana and other parts of North America. It produces a berry about the size of a pepper-corn. A very fertile shrub yields nearly seven pounds. The berries are picked off, thrown into a kettle, and covered with water to the depth of about half a foot. The kettle is then boiled, and the berries stirred and squeezed against the sides of the vessel. The wax which they contain is melted out and swims on the surface. It is skimmed off, passed through a cloth, dried, melted again, and cast into cakes. From the observations of Cadet we learn that the wax forms the outer covering of the berries. The wax thus obtained is of a pale green colour. Its specific gravity is 1.0150. It melts at the temperature of 109°; when strongly heated it burns with a white flame, produces little smoke, and during the combustion emits an agreeable aromatic odour. Water does not act upon it. Alcohol, when hot, dissolves $\frac{1}{20}$th of its weight but lets most of it fall again on cooling.

Wax Crayons. The art of painting in wax crayons is a late discovery, and when skilfully practised, is capable of producing the most pleasing effect. It is, however, rather to be considered as an adjunct to the art of water-colours, than as a distinct branch of the art of design or painting, as will appear from the nature of the materials employed in it. Instead of the substances used in conjunction with the respective colours, to form the body of common crayons, such as plaister of Paris, pipe-clay, calcined alabaster, &c. all the colours used on this new mode of painting are to be incorporated with wax. This mixture gives them the superior advantage of being particularly calculated for the execution of minute works in crayons, as they are not liable to moulder away, or to be rubbed off from the paper; but works thus executed require the assistance of various washes in water-colours to improve and perfect their effect, as, from the nature of wax, the frequent workings over of these crayons would produce an excessive smoothness, or glassiness, which would prevent the colours from attaching or taking proper hold of the surface of the work in the heightenings and last finishings, and would disappoint the artist in his endeavours to produce the greatest requisite strength of effect.

It is to be observed, therefore, that water-colours are to be used in beginning your picture, and in finishing it. When the crayons are judiciously worked over the water-colours, they will produce the appearance of an elegantly finished stippled engraving, coloured in the plate; the grain of the paper catching the crayons in dots, (when gradually laid on with a light hand) in a wonderfully pleasing manner.

We shall comprize the instructions requisite for the student's practice under the following heads, namely:

1. The kind of wax to be used in making the crayons;
2. The colours fit to be incorporated with it;
3. The choice of proper paper;
4. The method of using the crayons.

Wax. The wax proper to be used in making crayons, must be bleached bees'-wax, entirely free from adulteration. It must likewise be of the hardest kind, of which the Russian wax is the best, although in colour not quite so fine as either the American or English wax; but its hardness gives a firmness to the crayons, and prevents a greasiness which softer wax would create.

Colours. The colours proper for mixing into crayons, are the following, viz. for yellows, king's yellow or yellow oker; for blues, Antwerp or Prussian; for reds, carmine, lake, and Chinese vermilion; for browns, umber burnt and unburnt; for blacks, lamp-black only. As to compound tints, they are to be produced by a judicious management of the water-colours over the crayons; and this rule with respect to the colours proper to be used for crayons, is to be particularly observed: that none are fit for the purpose, but such as, in their dry unmixed state, will mark on paper pretty freely: for the reader may easily judge, that the tenacity of the wax would completely prevent any hard colour from working that was incorporated with it.

Having procured the kind of wax already mentioned, you are to have a nice glazed white pipkin, perfectly clean and free from any greasy particles; and having previously ground your colours on a flag with your muller, perfectly fine, in fair water, and dried, put a small quantity of wax into the pipkin, which you are to place over a very slow fire; when the wax is entirely dissolved by the gentle heat (for if it bubbles it is spoiled), gradually sprinkle in your colour, stirring it with an ivory pencil-handle, until you find it perfectly mixed; at the same time observing that you do not overload the wax with colour, as it will make the crayons too brittle; nor are you to put in too little colour, as it makes them faint and work greasy; so a medium is to be observed, to ascertain which practice only will conduce. There are some colours, such as vermilion, which, if they receive too great a heat, turn black; and that must be very cautiously observed, as vermilion, in this kind of painting, is a highly useful colour: as is also lamp-black, a harder kind of crayon from which is to be made by mixing some of it, in its raw state, with strong glue, letting it harden, and then burning it in a crucible (as directed in calcining colours for miniature painting); then pulverizing it on your flag, and mixing it with your wax, as before mentioned. This kind of black crayon is most excellent for giving sharp touches in dark parts, as it is also for making sketches to refresh the memory: is much superior to Italian chalk, as nothing will cause it to rub or spoil, it remaining as immoveable as writing-ink, and working extremely pleasant.

Paper. The paper fit to be used in wax-crayon painting, must be of the wove or vellum kind; but as of this there are several sorts, it is necessary to mention, that it must be of a middling fineness, for if too coarse, the grain will catch the crayons in dots so remote from each other, as to make your work look unpleasant; and if the paper is too fine it will not catch the crayons as it ought, but clog your painting without producing any effect. The only rule therefore for choosing your paper is to go to the stationer's, and taking a small bit of soft black crayon, by gently rubbing the crayon on a few sheets of different kinds of wove paper, you will become a judge of what is the best for your purpose, at a trifling expence. Having procured this necessary article to your satisfaction, you then proceed to work.

Method. The desk you are to work on must be much larger than the one mentioned for miniature painting, (see Miniature,) this kind of work being often used for larger sizes than that style of painting is.

Having your sitter placed in the same manner as pointed out in the article on Miniature Painting, with a soft piece of charcoal sketch faintly the distances and forms of the features: then touch them in more strongly with your crimson or black crayon, still altering until you are perfectly certain you have a correct outline, which in this kind of painting is absolutely necessary; for if in your fair drawing you commit an error in your outline, you never can alter it, the crayons being in their nature so adhesive, that nothing will remove them. Having, on your first sheet, made your outline correct, rub the back of the face part with crimson crayon, the hair part with a suitable-coloured one, and the drapery, if white, with black; then laying the paper on a fair sheet go over the lines of your sketch with a tracer, when you will transfer, in a very neat manner, your outline ready to colour in. You are then to mark in the features of your sitter more strongly with crayon or water-colour, and a fine pencil; ever observing, when you use it, to work over with a suitable-coloured crayon, as it is that which will give it the beautiful dotted appearance so much to be admired.

Having marked in the features sufficiently strong to put the likeness out of danger of being spoiled, make a wash of yellow oker entirely over the fleshy parts, deepening its tint according to your subject: wash-in the colour of the eyes, lips, hair, &c. all which being dry, work with your different-coloured crayons on the parts, until you produce the effects required; filling up any interstices of the crayons with dots of water-colours and a fine pencil. As to the tint for your linen shades, the black crayon will produce that in every degree, the paper answering for the lights of any-coloured drapery; for then you are to wash-in and shadow it with the crayons. Your paper is to be perfectly dry, otherwise the work will appear glazy; but even should that be the case, hold it before the fire, and the shining appearance will instantly vanish.

With respect to your back grounds, as this style of painting is intended to be light and sketchy, sky and back grounds are to be preferred; to manage which, the best way is to stump them in with dry colour, to whatever tint you find pleasing, which will give a proper value to the appearances of your wax crayons. Your drawing, either of portrait or landscape, being finished, have ready a large flat board, on which you are to stretch a sheet of royal paper; and having pasted the back of your drawing with some flour paste mixed with isinglass, lay it on the royal paper, and carefully press it in all directions with a soft towel or handkerchief, when your work is completed.

WAY. A way may be by prescription, as if the owners and occupiers of such a farm have immemorially used to cross another's ground; for this immemorial usage supplies an original grant. A right of way may also arise by act and operation of law; for if a man grants to another a piece of ground in the middle of his field, he at the same time tacitly gives him a way to come at it, for where the law gives any thing to any person, it gives implied whatever is necessary for enjoying the same. 2 Black. 35.

Way *of a ship*, is sometimes used for her wake or track. But more commonly the term is understood of the course or progress which she makes on the water under sail: thus when she begins her motion, she is said to be under way; when that motion increases, she is said to have fresh way through the water; when she goes apace, they say she has a good way; and the account of her rate of sailing by the log, they call, keeping an account of her way. And because most ships are apt to fall a little to the leeward of their true course, it is customary, in casting up the log-board, to allow something for her leeward way, or lee way. Hence also a ship is said to have head-way, and stern-way.

WAYGHTES, or Waits. This noun formerly signified hautboys; and, which is remarkable, has no singular number. From the instruments its signification was, after a time, transferred to the performers themselves; who being in the habit of parading the streets by night with their music, occasioned the name to be applied generally to all musicians who followed a similar practice. Hence those persons who annually, at the approach of Christmas, salute us with their nocturnal concerts, were, and are to this day, called wayghtes.

WAYWISER, an instrument for measuring the road, or distance travelled; called also Perambulator, and Pedometer. See those two articles.

Mr. Lovell Edgworth communicated to the Society of Arts, &c. an account of a way-wiser of his invention; for which he obtained a silver medal. This machine consists of a nave, formed of two round flat pieces of wood, one inch thick and eight inches in diameter. In each of the pieces there are cut eleven grooves, $\frac{5}{8}$ of an inch wide, and $\frac{3}{8}$ deep; and when the two pieces are screwed together, they enclose eleven spokes, forming a wheel of spokes, without a rim: the circumference of the wheel is exactly one pole; and the instrument may be easily taken to pieces, and put up in a small compass. On each of the spokes there is driven a ferule, to prevent them from wearing out; and in the centre of the nave, there is a square hole to receive an axle. Into this hole is inserted an iron or brass rod, which has the thread of a very fine screw worked upon it from one end to the other; upon this screw hangs a nut which, as the rod turns round with the wheel, advances towards the nave of the wheel or recedes from it. The nut does this, because it is prevented from turning round with the axle, by having its centre of gravity placed at some distance below the rod, so as always to hang perpendicularly like a plummet. Two sides of this screw are filed away flat, and have figures engraved upon them, to shew by the progressive motion of the nut, how many circumvolutions of the wheel and its axle have been made: on one side the divisions of miles and furlongs are in a direct order, and on the other side the same divisions are placed in a retrograde order.

If the person who uses this machine places it at his right-hand side, holding the axle loosely in his hands, and walks forward, the wheel will revolve, and the nut advance from the extremity of the rod towards the nave of the wheel. When two miles have been measured, it will have come close to the wheel. But to continue this measurement, nothing more is necessary than to place the wheel at the left hand of the operator; and the nut will, as he continues the course, recede from the axletree, till another space of two miles is measured.

It appears from the construction of this machine, that it operates like circular compasses; and does not, like the common wheel waywiser, measure the surface of every stone and molehill, &c. but passes over most of the obstacles it meets with, and measures the chords only, instead of the arcs of any curved surfaces upon which it rolls.

WEASEL. See VITERRA.

WEATHER. See METEROLOGY.

WEATHER-GLASSES, are instruments contrived to indicate the state or disposition of the atmosphere, and the various alterations in the weather: such are barometers, thermometers, hygrometers, &c.

WEAVERS. The wages of journeymen weavers in London are to be settled by the lord mayor, recorder, and aldermen. Masters giving more wages than is appointed, to forfeit 50*l.* and journeymen demanding, or combining to demand more, to forfeit 40*s.* or be imprisoned three months.

WEAVING-LOOM. See LOOM.

WEB, a tissue, or texture, formed of threads interwoven with each other; some whereof are extended in length, and called the warp; and others drawn across, and called the woof. See WARP, &c.

WEB, *spider's*, or *cobweb*. See ARANEA.

WEBERA, a genus of plants of the class and order pentandria monogynia. It is contorted; berry inferior, two-celled; cells one-seeded; stigma club-shaped; calyx five-cleft. There are three species, shrubs of the East Indies.

WEEVER. See TRACHINUS.

WEIGELIA, a genus of plants of the class and order pentandria monogynia. The calyx is five-leaved; corolla funnel-form; style from the base to the germ; stigma peltate; seed one. There are two species, shrubs of Japan.

WEIGH, WAY, or WEY, *waga*, a weight of cheese, wool, &c. containing 256 pounds avoirdupoise. Of corn, the weigh contains forty bushels; of barley or malt six quarters. In some places, as Essex, the weigh of cheese is 300 pounds.

WEIGHT, *gravity*, in physics, a quality in natural bodies whereby they tend downwards, towards the centre of the earth. Or weight may be defined in a less limited manner, to be a power inherent in all bodies whereby they tend to some common point, called the centre of gravity; and that with a greater or less velocity, as they are more or less dense, or as the medium they pass through is more or less rare.

In the common use of language, weight and gravity are considered as one and the same thing. Some authors, however, make a difference between them, and hold gravity only to express a nisus, or endeavour to descend, but weight an actual descent. But there is room for a better distinction. In effect, one may conceive gravity to be the quality as inherent in the body; and weight the same quality, exerting itself either against an obstacle, or otherwise. Hence, weight may be distinguished, like gravity, into absolute and specific. See GRAVITY.

Sir Isaac Newton demonstrates, that the weights of all bodies, at equal distances from the centre of the earth, are proportionable to the quantities of matter each contains Whence it follows, that the weights of bodies have not any dependance on their forms or textures, and that all spaces are not equally full of matter. Hence also it follows, that the weight of the same body is different on the surface of different parts of the earth, as its figure is not a sphere, but a spheroid.

WEIGHT, *pondus*, in mechanics, is any thing to be raised, sustained, or moved by a machine, or any thing that in any manner resists the motion to be produced.

WEIGHT, in commerce, denotes a body of a known weight, appointed to be put in the balance against other bodies, whose weight is required.

The security of commerce depending, in good measure, on the justness of weights, which are usually of lead, iron, or brass, most nations have taken care to prevent the falsification of them, by stamping or marking them by proper officers, after being adjusted by some original standard. Thus in England, the standard of weights is kept in the exchequer, by a particular officer, called the clerk of the market.

WEIGHTS *and* MEASURES, *regulation of.* This is a branch of the king's prerogative. For the public convenience, these ought to be universally the same throughout the nation, the better to reduce the prices of articles to equivalent values. But as weight and measure are things in their nature arbitrary and uncertain, it is necessary that they are reduced to some fixed rule or standard. It is, however, impossible to fix such a standard by any written law or oral proclamation; as no person can, by words only, give to another an adequate idea of a pound weight, or foot rule. It is therefore expedient to have recourse to some visible, palpable, material standard, by forming a comparison with which all weights and measures may be reduced to one uniform size. Such a standard was antiently kept at Winchester; and we find in the laws of king Edgar, near a century before the Conquest, an injunction that that measure should be observed throughout the realm.

Most nations have regulated the standard of measures of length from some parts of the human body; as the palm, the hand, the span, the foot, the cubit, the ell (ulna or arm), the pace, and the fathom. But as these are of different dimensions in men of different proportions, antient historians inform us, that a new standard of length was fixed by our king Henry the First; who commanded that the ulna, or antient ell, which answers to the modern yard, should be made of the exact length of his own arm.

A standard of long measure being once gained, all others are easily derived from it; those of greater length by multiplying that original standard, those of less by dividing it. Thus, by the statute called compositio ulnarum et perticarum, $5\frac{1}{2}$ yards make a perch; and the yard is subdivided into three feet, and each foot into twelve inches, which inches will be each of the length of three barleycorns. But some, on the contrary, derive all measures by composition, from the barleycorn.

Superficial measures are derived by squaring those of length: and measures of capacity by cubing them.

The standard of weights was originally taken from grains or corns of wheat, whence our lowest denomination of weights is still called a grain; thirty-two of which are directed, by the statute called compositio mensurarum, to compose a pennyweight, twenty of which make an ounce, and twelve ounces a pound, &c.

Under king Richard the First it was ordained, that there should be only one weight and one measure throughout the nation; and that the custody of the assize or standard of weights and measures, should be committed to certain persons in every city and borough; from whence the antient office of the king's ulnager seems to have been derived. These original standards were called pondus regis, and mensura domini regis, and are directed by a variety of subsequent statutes to be kept in the exchequer chamber, by an officer called the clerk of the market, except the wine gallon, which is committed to the city of London, and kept in Guildhall.

The Scottish standards are distributed among the oldest boroughs. The elward is kept at Edinburgh, the pint at Stirling, the pound at Lanark, and the firlot at Linlithgow.

The two principal weights established in Great Britain, are troy weight and avoirdupois weight, as before mentioned. Under the head of the former it may farther be added, that a carat is a weight of four grains; but when the term is applied to gold, it denotes the degree of fineness. Any quantity of gold is supposed divided into twenty-four parts. If the whole mass is pure gold, it is said to be twenty-four carats fine; if there are twenty-three parts of pure gold, and one part of alloy or base metal, it is said to be twenty-three carats fine, and so on.

Pure gold is too soft to be used for coin. The standard coin of this kingdom is 22 carats fine. A pound of standard gold is coined into $44\frac{1}{2}$ guineas, and therefore every guinea should weigh 5 dwts. $9\frac{39}{89}$ grains.

A pound of silver for coin contains 11 oz. 2 dwts. pure silver, and 18 dwts. alloy; and standard silver plate 11 ounces pure silver, with one ounce alloy. A pound of standard silver is coined into 62 shillings, and therefore the weight of a shilling should be 3 dwts. $20\frac{28}{31}$ grains.

WEIGHTS may be distinguished into antient and modern, foreign and domestic.

WEIGHTS, *Antient.* 1. Those of the antient Jews, reduced to the English troy weights, will stand as in the following table:

			lb.	oz.	dwt.	gr.
Shekel			00	00	09	$02\frac{4}{7}$
60	Maneh		02	03	06	$10\frac{2}{7}$
3000	50	Talent	113	10	01	$10\frac{2}{7}$

2. Grecian and Roman weights, reduced to English troy weight, will stand as in the following table:

										oz.	dwt.	gr.
Lentes										00	00	$\frac{85}{112}$
4	Siliquæ									00	00	$03\frac{1}{28}$
12	3	Obolus								00	00	$09\frac{3}{28}$
24	6	2	Scriptulum							00	00	$18\frac{3}{14}$
72	18	6	3	Drachma						00	02	$06\frac{9}{14}$
96	24	8	4	$1\frac{1}{3}$	Sextula					00	03	$00\frac{6}{7}$
144	56	12	6	2	$1\frac{1}{2}$	Sicilicus				00	04	$13\frac{2}{7}$
192	48	16	8	$2\frac{2}{3}$	2	$1\frac{1}{3}$	Duella			00	06	$01\frac{5}{7}$
576	144	48	24	8	6	4	3	Uncia		00	18	$05\frac{1}{7}$
6912	1728	576	288	96	72	48	36	12	Libra	10	18	$13\frac{5}{7}$

The Roman ounce is the English avoirdupois ounce, which they divided into seven denarii, as well as eight drachms: and since they reckoned their denarius equal to the Attic drachm, this will make the Attic weights one-eighth heavier than the corresponding Roman weights.

WEIGHTS, *Modern European.* 1. English weights: By the twenty-seventh chapter of Magna Charta, the weights all over England are to be the same; but for different commodities, there are two different sorts, viz. Troy weight and avoirdupois weight. The origin from which they are both raised, is a grain of weight gathered in the middle of the ear.

In troy weight, twenty-four of these grains make a pennyweight sterling; twenty pennyweights make one ounce; and twelve ounces one pound.

By this weight we weigh gold, silver, jewels, grains, and liquors. The apothecaries also use the troy pound, ounce, and grain; but they differ from the rest in the intermediate divisions. They divide the ounce into eight drachms; the drachm into three scruples, and the scruple into twenty grains.

In avoirdupois weight, the pound contains sixteen ounces, but the ounce is less by near one-twelfth than the troy ounce; this latter containing 490 grains, and the former only 448. The ounce contains 16 drachms: 80 ounces avoirdupois are only equal to 73 ounces troy; and 17 pounds troy equal to 14 pounds avoirdupois.

By avoirdupois weight are weighed mercury, and grocery wares, base metals, wool, tallow, hemp, drugs, bread, &c.

Table of Troy Weight as used by the Goldsmiths.

Grains.			
24	Pennyweight.		
480	20	Ounce.	
5760	240	12	Pound.

Apothecaries.

Grains.				
20	Scruple.			
60	3	Drachm.		
480	24	8	Ounce.	
5760	288	96	12	Pound.

Table of Avoirdupois Weight.

Scruples.					
3	Dram.				
24	8	Ounce.			
384	128	16	Pound.		
43008	14336	1792	112	Quintal, or hundred	
860160	286720	35840	2240	20	Ton.

Mr. Ferguson gives the following comparison between troy and avoirdupois weight.

175 troy pounds are equal to 144 avoirdupois pounds.

175 troy ounces are equal to 192 avoirdupois ounces.

1 troy pound contains 5760 grains.

1 avoirdupois pound contains 7000 grains.

1 avoirdupois ounce contains $437\frac{1}{2}$ grains.

1 avoirdupois dram contains 27.34375 grains.

1 troy pound contains 13 oz. 2.651428576 drams avoirdupois.

1 avoirdupois lb. contains 1 lb. 2 oz. 11 dwts. 16 gr. troy.

Therefore the avoirdupois lb. is to the lb. troy as 175 to 144, and the avoirdupoise oz. is to the troy oz. as $437\frac{1}{2}$ is to 480

The moneyers, jewellers, &c. have a particular class of weights for gold and precious stones, viz. *carat* and *grain*; and for silver, the *pennyweight* and *grain*. The moneyers have also a peculiar subdivision of the troy grain: thus, dividing

the grain into 20 mites,
the mite into 24 droits,
the droit into 20 periots,
the periot into 24 blanks.

The dealers in wool have likewise a particular set of weights; viz. the *sack, weigh, tod, stone,* and *clove*; the proportions of which are as below; viz.

the sack containing 2 weighs,
the weigh - - - $6\frac{1}{2}$ tods,
the tod - - - - 2 stones,
the stone - - - 2 cloves,
the clove - - - 7 pounds.

Also 12 sacks make a last, or 4368 pounds.

Farther,

56 lb. of old hay, or 60 lb. new hay, make a truss.

40 lb. of straw make a truss.

36 trusses make a load, of hay or straw.

14 lb. make a stone.

5 lb. of glass a stone.

Other nations have also certain weights peculiar to themselves: thus, Spain has its arrobas, containing 25 Spanish pounds, or one-fourth of the common quintal: its quintal macho, containing 150 pounds, or one-half common quintal, or 6 arrobas: its adarme, containing one-sixteenth of its ounce. And for gold, it has its castillan, or one-hundredth of a pound; and its tomin, containing 12 grains, or one-eighth of a castillan. The same are in use in the Spanish West Indies.

Portugal has its arroba, containing 32 Lisbon arratals, or pounds: Savary also mentions its faratelle, containing 2 Lisbon pounds; and its rottolis, containing about 12 pounds. And for gold, its chego, containing four carats. The same are used in the Portuguese East Indies.

Italy, and particularly Venice, have their migliaro, containing four mirres; the mirre containing 30 Venice pounds: the saggio, containing a sixth part of an ounce. Genoa has five kinds of weights, viz. large weights, whereby all merchandizes are weighed at the custom-house; cash weights for piastres, and other specie; the cantara, or quintal, for the coarsest commodities; the large balance for raw silks, and the small balance for the fine commodities. Sicily has its rottolo, 32 and a half pounds of Messina. Germany, Flanders, Holland, the Hanse towns, Sweden, Denmark, Poland, &c. have their schippondt, which at Antwerp and Hamburgh, is 300 pounds; at Lubeck, 320 and at Coningsberg, 400 pounds. In Sweden, the schippondt for copper is 320 pounds; and the schippondt for provisions 400 pounds. At Riga and Revel, the schippondt is 400 pounds; at Dantzic, 340 pounds; in Norway, 300 pounds: at Amsterdam, 300; containing 20 lyspondts, each weighing 15 pounds.

In Muscovy, they weigh their large commodities by the bercheroct, or berkewits, containing 400 of their pounds They have also the poet, or poede, containing 40 pounds, or one-tenth of the bercheroct.

In order to shew the proportion of the several weights used throughout Europe, we shall add a reduction of them to one standard, viz. the London and Amsterdam pound.

1. Proportion of the weights of the principal places of Europe.

The 100 lb. of England, Scotland, and Ireland, are equal to

lb.	oz.	
91	8	of Amsterdam, Paris, &c.
96	8	of Antwerp or Brabant.
88	0	of Rouen, the viscounty weight.
106	0	of Lyons, the city weight.
90	9	of Rochelle.
107	11	of Toulouse and Upper Languedoc.
113	0	of Marseilles or Provence.
81	7	of Geneva.
93	5	of Hamburgh.
89	7	of Francfort, &c.
96	1	of Leipsick, &c.
137	4	of Genoa.
132	1	of Leghorn.
153	11	of Milan.
152	0	of Venice.
154	10	of Naples.
97	0	of Seville, Cadiz, &c.
104	13	of Portugal.
96	5	of Liege.
112	$\frac{2}{3}$	of Russia.
107	$\frac{1}{24}$	of Sweden.
89	$\frac{1}{2}$	of Denmark.

2. Proportion of the weights of the chief cities in Europe, to those of Amsterdam.

100 pounds of Amsterdam are equal to

lb.		lb.	
108	of Alicant.	$113\frac{1}{2}$	of Dantzic.
105	of Antwerp.	100	of Dort.
120	of Archangel, or 3 poedes.	97	of Dublin.
105	of Arschot.	97	of Edinburgh.
120	of Avignon.	143	of Florence.
98	of Basil in Switzerland.	98	Francfort on the Maine.
100	of Bayonne in France.	105	of Gaunt.
166	of Bergamo.	89	of Geneva.
97	of Bergen-op-zom.	163	of Genoa, cash-weight.
$95\frac{1}{4}$	of Bergen in Norway.	102	of Hamburgh.
111	of Bern.	106	of Leyden.
100	of Besançon.	105	of Leipsic.
100	of Bilboa.	105 $\frac{1}{2}$	of Liege.
105	of Bois le duc.	114	of Lisle.
151	of Bologna.	143	of Leghorn.
100	of Bourdeaux.	106 $\frac{1}{2}$	of Lisbon.
104	of Bourg en Bresse.	109	of London, avoirdupois weight.
103	of Bremen.	105	of Lovaine.
125	of Breslaw.	105	of Lubec.
105	of Bruges.	141 $\frac{1}{2}$	of Lucca, light weight.
105	of Brussels.	116	of Lyons, city do.
105	of Cadiz.	114	of Madrid.
105	of Cologne.	105	of Marlines.
125	of Coningsberg.	123 $\frac{1}{2}$	of Marseilles.
$107\frac{1}{2}$	of Copenhagen.	154	of Messina, light weight
87	rottos of Constantinople.	168	of Milan.

lb.		lb.	
120	of Montpelier.	96	of Rouen, viscounty weight.
125	bercheroctsof Muscovy.	100	of St. Malo.
100	of Nantes.	100	of St. Sebastian.
106	of Nancy.	158½	of Saragossa.
169	of Naples.	106	of Seville.
98	of Nuremberg.	114	of Smyrna.
100	of Paris.	110	of Stetin.
112½	of Revel.	81	of Tholouse and Upper Languedoc.
109	of Riga.	151	of Turin.
100	of Rochelle.	158 ¼	of Valencia.
146	of Rome.	182	of Venice, small weight.
100	of Rotterdam.		

We shall now notice the correspondence between English weights and some modern weights in France and other countries:

English Weights.

Troy Weight.

lb.	*oz.*	*drms.*	*scruples.*	*grains.*	*grammes.*
1 =	12 =	96 =	288 =	5760 =	372.96
	1 =	8 =	24	480 =	31.08
		1 =	3 =	60 =	3.885
			1 =	20 =	1.395
				1 =	0.06475

Avoirdupois Weight.

lb.	*oz.*	*drms.*	*grains.*	*grammes.*
1	16 =	256 =	7000 =	453.25
	1 =	16 =	437.5 =	28.32
		1	27.975 =	1.81

German.

71 lbs. or grs. English troy, = 74 lbs. or grs. German apothecaries' weight.

1 oz. Nuremberg, medic. weight, = 7 dr. 2 sc. 9 grains English.

1 mark Cologne, = 7 oz. 2 dwt. 4 gr. English troy.

Dutch.

1 lb. Dutch, = 1 lb. 3 oz. 16 dwt. 7 gr. English troy.

787½ lbs. Dutch, = 1038 lbs. English troy.

Swedish Weights, *used by Bergman and Scheele.*

The Swedish pound, which is divided like the English apothecary, or troy, pound, weighs 6556 grains troy.

The kanne of pure water, according to Bergman, weighs 42250 Swedish grains, and occupies 100 Swedish cubical inches. Hence the kanne of pure water weighs 48088.719444 English troy grains, or is equal to 189.9413 English cubic inches; and the Swedish longitudinal inch is equal to 1.238435 English longitudinal inches.

From these data, the following rules are deduced:

1. To reduce Swedish longitudinal inches to English, multiply by 1.2384, or divide by 0.80747.
2. To reduce Swedish to English cubical inches, multiply by 1.9, or divide by 0.5265.
3. To reduce the Swedish pound, ounce, dram, scruple, or grain, to the corresponding English troy denomination, multiply by 1.1382, or divide by 8.786.
4. To reduce the Swedish kannes to English wine pints, multiply by .1520207, or divide by 6.57804.
5. The lod, a weight sometimes used by Bergman, is the 32d part of the Swedish pound: Therefore, to reduce it to the English troy pound, multiply by .03557, or divide by 28.1156.

Correspondence of English Weights with those used in France before the Revolution.

The Paris pound, poids de marc of Charlemagne, contains 9216 Paris grains; it is divided into 16 ounces, each ounce into 8 gros, and each gros into 72 grains. It is equal to 7561 English troy grains.

The English troy pound of 12 ounces contains 5760 English troy grains, and is equal to 7021 Paris grains.

The English avoirdupois pound of 16 ounces contains 7000 English troy grains, and is equal to 85 , Paris grains.

To reduce Paris grains to English troy grains, divide by - - To reduce English troy grains to Paris grains, multiply by - -	1.2189
To reduce Paris ounces to English troy, divide by - - - To reduce English troy ounces to Paris, multiply by - -	1.015734

Or the conversion may be made by means of the following tables:

I. *To reduce French to English Troy Weight.*

The Paris pound	= 7561	English troy grains.
The ounce	= 472.5625	
The gros	= 59.0703	
The grain	= .8204	

II. *To reduce English troy to Paris weight.*

The English troy pound of 12 ounces - -	= 7021.	Paris grains.
The troy ounce - -	= 585.0893	
The dram of 60 grains -	= 73.1354	
The pennyweight, or denier, of 24 grains -	= 29.2541	
The scruple of 20 grains -	= 24.3784	
The grain - - - -	= 1.2189	

III. *To reduce English avoirdupois to Paris weight.*

The avoirdupois pound of 16 ounces, or 7000 troy grains - - -	= 8538.	Paris grs.
The ounce - - - -	= 533.6250	

Table, *shewing the Comparison between French and English Grains.* (*Poid de Marc.*)

French grs.	= Eng. grs.	Eng. grs.	= French grs.
1	0.8203	1	1.2189
2	1.6407	2	2.4378
3	2.4611	3	3.6568
4	3.2815	4	4.8757
5	4.1019	5	6.0947
6	4.9223	6	7.3136
7	5.7427	7	8.5325
8	6.5631	8	9.7515
9	7.3835	9	10.9704
10	8.203	10	12.189
20	16.407	20	24.378
30	24.611	30	36.568
40	32.815	40	48.757
50	41.019	50	60.947
60	49.223	60	73.136
70	57.427	70	85.325
80	65.631	80	97.515
90	73.835	90	109.704
100	82.03	100	121.89
200	164.07	200	243.78
300	246.11	300	365.68
400	328.15	400	487.57
500	410.19	500	609.47
600	492.23	600	731.36
700	574.27	700	853.25
800	656.31	800	975.15
900	738.35	900	1097.04
1000	820.3	1000	1218.9
2000	1640.7	2000	2437.8
3000	2461.1	3000	3656.8
4000	3281.5	4000	4875.7
5000	4101.9	5000	6094.7
6000	4922.3	6000	7313.6
7000	5742.7	7000	8532.5
8000	6563.1	8000	9751.5
9000	7383.5	9000	10970.4
10,000	8203.0	10,000	12189.0

New French Weights, (calculated by Dr. Duncan, jun)

		English grains.		Avoirdupois. *lb.*	*oz.*	*dr.*
Milligramme	=	.0154				
Centigramme	=	.1544				
Decigramme	=	1.5444				
Gramme	=	15.4440				
Decagramme	=	154.4402	=	0	0	5.65
Hecatogramme	=	1544.4023	=	0	3	8.5
Kilogramme	=	15444.0234	=	2	3	5
Myriogramme	=	154440.2344	=	22	1	2

Weights *used in the several parts of Asia, the East Indies, China, Persia,* &c. In Turkey, at Smyrna, &c. they use the batman, or battemant, containing six occos, the occo weighing three pounds four-fifths English. They have another batman much less, consisting, as the former, of six occos; but the occo only containing fifteen ounces English; 44 occos of the first kind make the Turkish quintal. At Cairo, Alexandretta, Aleppo, and Alexandria, they use the rotto, rotton, or rottoli; at Cairo, and other parts of Egypt, it is 144 drachms, being somewhat over an English pound. At Aleppo there are three sorts of rottos; the first 720 drachms, making about seven pounds English, and serving to weigh cottons, galls, and other large commodities; the second is 624 drachms, used for all silks but white ones, which are weighed by the third rotto of 700 drachms. At Seyda the rotto is 600 drachms.

The other ports of the Levant, not named here, use some of these weights, particularly the occo, or ocqua, the rottoli, and rotto.

The Chinese weights are the piece, for large commodities; it is divided into 100 catis, or cattis, though some say into 125; the cati into 16 taels, or tales, each tale equivalent to 1⅓ of an ounce English, or the weight of one rial and $\frac{1}{12}$, and containing 12 mas, or masses, and each mas 10 condrins. So that the Chinese piece amounts to 137 pounds English avoirdupois, and the cadi to 1 pound 8 ounces. The picol for silk contains 66 catis and ¾: the bahar, bakaire, or barr, contains 300 catis.

Tonquin has also the same weights, measures, &c. as China. Japan has only one weight, viz. the cati, which, however, is different from that of China, as containing 20 taels. At Surat, Agra, and throughout the states of the Great Mogul, they use the man, or maund, whereof they have two kinds, the king's man, or king's weight, and the man simply; the first used for the weighing of common provisions, containing 40 seers, or seres, and each seer a just Paris pound. The common man, used in the weighing of merchandise, consists likewise of 40 seers, but each seer is only estimated at 12 Paris ounces, or ¾ of the other seer.

The man may be looked on as the common weight of the East Indies, though under some difference of name, or rather of pronunciation, it being called mao at Cambaya, and in other places mein, and maun. The seer is properly the Indian pound, and of universal use; the like may be said of the bahar, tael, and catti above-mentioned.

The weights of Siam are the piece containing two shans, or cattis; but the Siamese catti is only half the Japanese, the latter containing 20 taels; and the former only 10; though some make the Chinese catti only 16 taels, and the Siamese 8. The tael contains 4 baats or ticals, each about a Paris ounce; the baat 4 selings, or mayons; the mayon 2 fouangs; the fouang 4 payes; the paye 2 clams; the sompaye half a fouang.

It is to be observed, that these are the names of their coins as well as weights; silver and gold being commodities there sold, as other things, by their weights.

In the isle of Java, and particularly at Bantam, they use the gantan, which amounts to near three Dutch pounds. In Golconda, at Visapour, and Goa, they have the furatelle containing 1 pound 14 ounces English; the mangalis or mangelin for weighing diamonds and precious stones, weighing at Goa 5 grains, at Golconda, &c. $5\frac{1}{2}$ grains. They have also the rotolo containing $14\frac{1}{4}$ ounces English; the metricol containing the sixth part of an ounce; the wall for piasters and ducats, containing the 73d part of a rial.

In Persia they use two kinds of batmans or mans, the one called cahi or cheray, which is the king's weight; and the other batman of Tauris. The first weighs 13 pounds 10 oz. English; the second $6\frac{1}{2}$ pounds, Its divisions are the ratel, or a 16th; the derhem, or drachm. which is the 50th; the meschal, which is half the derhem; the dung, which is the 6th part of the meschal, being equivalent to six carat-grains; and, lastly, the grain, which is the fourth part of the dung. They have also the vakie, which exceeds a little our ounce; the sah-cheray, equal to the 1170th part of the derhem; and the toman, used to weigh out large payments of money without telling; its weight is that of 50 abassis.

African and American weights. We have little to say as to the weights of America; the several European colonies there making use of the weights of the states or kingdoms of Europe they belong to. For, as to the aroue of Peru, which weighs 27 pounds, it is evidently no other than the Spanish arroba, with a little difference in the name.

As to the weights of Africa, there are few places that have any, except Egypt, and the countries bordering on the Mediterranean, whose weights have been already enumerated among those of the ports of the Levant. The island of Madagascar indeed has weights, but none that exceed the drachm, nor are they used for any thing but gold and silver.

Weights *and* Measures. The standard of measures was originally kept at Winchester, which measure was by the law of king Edgar, ordained to be observed through the kingdom.

By. stat. 35 G. III. c. 102, the justices in quarter-sessions in every county, are required to appoint persons to examine the weights and balances within their respective jurisdictions. These inspectors may seize and examine weights in shops, &c. and seize false weights and balances, and the offender, being convicted before one justice, shall be fined from 5*s*. to 20*s*. Persons obstructing the inspectors to forfeit from 5*s*. to 40*s*. Inspectors to be recompensed out of the county-rate. Standard weights to be purchased by the sessions out of the county-rate, and produced to all persons paying for the production thereof. Informations to be within one month.

Universal standard for weights and measures. Philosophers, from their habits of generalizing, have often made speculations for forming a general standard for weights and measures through the whole world. These have been devised chiefly of a philosophical nature, as best adapted to universality. After the invention of pendulum clocks, it first occurred that the length of a pendulum which should vibrate seconds, would be proper to be made a universal standard for length; whether it should be called a yard, or any thing else. But it was found that it would be difficult in practice, to measure and determine the true length of such a pendulum, that is, the distance between the point of suspension and the point of oscillation. Another cause of inaccuracy was afterwards discovered, when it was found that the seconds pendulum was of different lengths in all the different latitudes, owing to the spheroidal figure of the earth; which causes that all places in different latitudes are at different distances from the centre, and consequently the pendulums are acted upon by different forces of gravity, and therefore require to be of different lengths. In the latitude of London this is found to be $39\frac{1}{8}$ inches.

The Society of Arts of London, among their many laudable patriotic endeavours, offered a handsome premium for the discovery of a proper standard for weights and measures. This brought them many frivolous expedients, as well as one which was an improvement on the method of the pendulum, by Mr. Hatton. This consisted in measuring the difference of the lengths of two pendulums of different times of vibration, which could be performed more easily and accurately than that of the length of one single pendulum. This method was put in practice, and fully explained and illustrated, by the late Mr. Whitehurst, in his attempt to ascertain an universal standard of weights and measures. But still the same kind of inaccuracy of measurement, &c. obtains in this way, as in the single pendulum, though in a smaller degree.

Another method that has been proposed for this purpose is the space that a heavy body falls freely through in one second of time. But this is an experiment more difficult than the former to be made with accuracy, on which account different persons will all make the space fallen to be of different quantities, which would give as many different standards of length. Add to this, that the spheroidal form of the earth here again introduces a diversity in the space, owing to the different distances from the centre, and the consequent diversity in the force of gravity by which the body falls. This space has been found to be 193 inches, or $16\frac{1}{12}$ feet, in the latitude of London; but it will be a different quantity in other latitudes.

Many other inferior expedients have also been proposed for the purpose of universal measures and weights; but there is another which now has the best prospect of success, and is at present under particular experiments, by the philosophers both of this and the French nation. This method is by the measure of the degrees of latitude, which would give a large quantity, and admit of more accurate measure, by subdivision, than what could be obtained by beginning from a small quantity, or measure, and thence to proceed increasing by multiples. This measure might be taken either from the extent of the whole compass of the earth, or of all the 360 degrees, or a medium degree among them all, or from the measure of a degree in the medium latitude of 45 degrees. It will also be most convenient to make the subdivisions of this measure, when found, to proceed decimally, or continually by 10ths.

The universal standard for lengths being once established, those of weights, &c. would easily follow. For instance: a vessel, of certain dimensions, being filled with distilled water, or some other homogeneous matter, the weight of that may be considered as a standard for weights.

WEINMENNIA, a genus of plants of the class and order octandria digynia. The calyx is four-leaved; corolla four-petalled; caps. two-celled, two-beaked. There are six species, trees of the southern climates.

WELDING HEAT, in smithery, a degree of heat given to iron, &c. sufficient to make any two bars or pieces of iron unite by a few strokes of the hammer, and form one piece. See Iron.

WEN. See Surgery.

WESTRINGIA, a genus of plants of the didynamia gymnospermia class and order. The calyx is half five-cleft, five-sided; corolla reversed; four segments, longest erect; cloven stam. distant, two shorter abortive. There is one species, a shrub of New South Wales.

WHALE. See Balæna.

WHEAT. See Triticum, and Husbandry.

Wheat-ear. See Motacilla.

WHEEL, in mechanics, a simple machine, consisting of a round piece of wood, metal, or other matter, which revolves on an axis. The wheel is one of the principal mechanic powers; it has place in most engines; in effect, it is of an assemblage of wheels that most of our engines are composed. See Mechanics.

Wheels, *of coaches, carts, waggons, &c.* With respect to wheels of carriages, the following particulars are collected from the experiments and observations of Desaguliers, Beighton, Camus, Ferguson, Jacob, &c.

1. The use of wheels in carriages is twofold, viz. that of diminishing or more easily overcoming the resistance or friction from the carriage; and that of more easily overcoming obstacles in the road. In the first case, the friction on the ground is transferred in some degree from the outer surface of the wheel to its nave and axle; and in the latter, they serve easily to raise the carriage over obstacles and asperities met with on the roads. In both these cases, the height of the wheel is of material consideration, as the spokes act as levers, the top of an obstacle being the fulcrum, their length enables the carriage more easily to surmount them; and the greater proportion of the wheel to the axle serves more easily to diminish or to overcome the friction of the axle.

2. The wheels should be exactly round; and the fellies at right angles to the naves, according to the inclination of the spokes.

3. It is the most general opinion, that the spokes are somewhat inclined to the naves, so that the wheels may be dishing or concave. Indeed if the wheels were always to roll upon smooth and level ground, it would be best to make the spokes perpendicular to the naves, or to the axles; because they would then bear the weight of the load perpendicularly. But because the ground is commonly uneven, one wheel often falls into a cavity or rut, when the other does not, and then it bears much more of the weight than the other does;

in which case it is thought best for the wheel to be dished, because the spokes become perpendicular in the rut, and therefore have the greatest strength when the obliquity of the road throws most of the weight upon them; whilst those on the high ground have less weight to bear, and therefore need not be at their full strength.

4. The axles of the wheels should be quite straight, and perpendicular to the shafts, or to the pole. When the axles are straight, the rims of the wheels will be parallel to each other, in which case they will move the easiest, because they will be at liberty to proceed straight forwards. But in the usual way of practice, the ends of the axles are bent downwards, which always keeps the sides of the wheels that are next the ground nearer to one another than their upper sides are; and this not only makes the wheels drag sideways as they go along, and gives the load a much greater power of crushing them than when they are parallel to each other, but also endangers the overturning the carriage when a wheel falls into a hole or rut, or when the carriage goes on a road that has one side lower than the other, as along the side of a hill.

5. Large wheels are found more advantageous for rolling than small ones, both with regard to their power as a longer lever, and to the degree of friction, and to the advantage in getting over holes, rubs, and stones, &c. If we consider wheels with regard to the friction upon their axles, it is evident that small wheels, by turning oftener round, and swifter about the axles, than large ones, must have more friction. Again, if we consider wheels as they sink into holes or soft earth, the large wheels, by sinking less, must be more easily drawn out of them, as well as over stones and obstacles, from their greater length of lever or spokes.

It is a fact, however, that the draught ought not to be horizontal, but rather inclined: because in the horizontal draught the collar presses against the chest of the horse, instead of bearing on his shoulders, as in an inclined draught; and because in this latter circumstance the wheels pass more easily over obstacles than when the draught is horizontal. Hence it appears, that wheels are the more advantageous as they are larger, provided they are not so high as to make the draught horizontal; and when they are very large also, they become too heavy; or if they are made light, their strength is proportionably diminished, and the length of the spokes renders them more liable to break; besides, horses applied to such wheels would not be capable of exerting their utmost strength, for the reasons already assigned, small wheels occasioning the horses to draw upwards.

6. Carriages with four wheels, as waggons or coaches, are much more advantageous than carriages with two wheels, as carts and chaises: for with two wheels it is plain the tiller-horse carries part of the weight, in one way or other; in going down hill, the weight bears upon the horse; and in going up hill, the weight falls the other way, and lifts the horse, which is still worse. Besides, as the wheels sink into the holes in the roads, sometimes on one side, sometimes on the other, the shafts strike against the tiller's sides, which destroys many horses: moreover, when one of the wheels sinks into a hole or rut, half the weight falls that way, which endangers the overturning of the carriage.

7. It would be much more advantageous to make the four wheels of a coach or waggon nearly of a height, than to make the fore-wheels of only half the diameter of the hind-wheels, as is used in many places. The fore-wheels have commonly been made of a less size than the hind ones, both on account of turning short, and to avoid cutting the braces. Crane-necks have also been invented for turning yet shorter; and the fore-wheels have been lowered, so as to go quite under the bend of the crane-neck.

When a horse draws hard, it is observed that he bends forward, and brings his breast near the ground, and then if the wheels are high, he is pulling the carriage against the ground. A horse tackled in a waggon will draw two or three ton, because the point or line of traction is below his breast, by the lowness of the wheels. It is also common to see, when one horse is drawing a heavy load, especially up hill, his fore-feet will rise from the ground; in which case it is usual to add a weight on his back, to keep his fore-part down, by a person mounting on his back or shoulders, which will enable him to draw that load which he could not move before. The greatest stress, or main business of drawing, is to overcome obstacles; for on level plains the drawing is but little, and then the horse's back need be pressed but with a small weight.

8. The utility of broad wheels, in amending and preserving the roads, has been so generally believed, as to have occasioned the legislature to enforce their use. At the same time, the proprietors and drivers of carriages seem to be convinced by experience, that a narrow-wheeled carriage is more easily and speedily drawn by the same number of horses, than a broad-wheeled one of the same burthen; probably because they are much lighter, and have less friction on the axle; and the owners of broad-wheeled waggons contrive in general to make them as destructive to roads as narrow-wheeled ones, by making the rim of the wheel of unequal diameters, and the waggon consequently to go generally on a sharp and narrow edge.

Wheel-animals, *brachionus*, a genus of animalcules which have an apparatus of arms for taking their prey. This apparatus has been supposed, by microscopical writers, to be a kind of wheels; and they thence named the creatures that are possessed of it, wheel-animals.

WHIRLPOOL, an eddy, vortex, or gulph, where the water is continually turning round. These in rivers are very common, from various accidents, and are usually very trivial, and of little consequence. In the sea they are more rare, but more dangerous. Sibbald has related the effects of a very remarkable marine whirlpool among the Orcades, which would prove very dangerous to strangers, though it is of no consequence to the people who are used to it. This is not fixed to any particular place, but appears in various parts of the limits of the sea among those islands. Wherever it appears, it is very furious; and boats, &c. would inevitably be drawn in and perish with it; but the people who navigate them are prepared for it, and always carry an empty vessel, a log of wood, or large bundle of straw, or some such thing, in the boat with them; as soon as they perceive the whirlpool, they toss this within its vortex, keeping themselves out; this substance, whatever it may be, is immediately received into the centre, and carried under water; and as soon as this is done, the surface of the place where the whirlpool was becomes smooth, and they row over it with safety; and in about an hour they see the vortex begin again in some other place, usually at about a mile distance from the first.

WHIRLWIND. This phenomenon is well defined by its name. Its nature may be illustrated by recurring to the same kind of motion in a denser fluid. When water is flowing through an aperture in the bottom of a vessel, we may observe that the meeting of the currents which proceed from all sides towards the opening, gives rise at length to a circular motion just over it; at first confined to a small space, but spreading by degrees, until it occupies a large portion of the surrounding water. At this time, the centrifugal force becoming greater every instant, the water absolutely quits the central space, leaving a hole through it, which, together with the whirling motion, continues during the remaining time of the discharge. Now, as the water descends by its gravity, and the other effect depends on a lateral impulse, given by the most powerful of the confluent streams, so the heated air, over some particular tract, ascending by the lateral pressure of surrounding colder and heavier air, may at any time give rise to a whirlwind of greater or less extent and force, according to the quantity of air required to be thus transmitted to a higher station, in order that the equilibrium of the atmosphere may be restored. There is wanted for this purpose only a sudden impulse from some quarter, sufficient to disturb the uniform motion of the ascending stream. The effects of whirlwinds are sometimes tremendous; not only large quantities of hay, and other light bodies, but even the limbs of trees, the roofs of houses, and other ponderous matters, having been lifted up and carried off by them. Their effects are no where more conspicuous than in the vast pillars of sand, so much dreaded by travellers, which they raise from the moveable surface of the deserts in the East, and of which we have a good account in Bruce's Travels. Dr. Franklin, in whom sagacity of observation was eminently united with the power of simple and plain description, has left us the following account of a moderate whirlwind, of which he was an eye-witness close at hand.

"Being in Maryland (says the doctor) riding with colonel Parker, and some other gentlemen, to his country-seat, we saw in the vale below us a small whirlwind, beginning in the road, and shewing itself by the dust it raised and contained: it appeared in the form of a sugar-loaf, spinning on its point, moving up the hill towards us, enlarging as it came forward. When it passed by us, its smaller part, near the ground, appeared no bigger than a common barrel, but widening upwards, it seemed at 40 or 50 feet high, to be 20 or 30 feet in diameter. The rest of the company stood looking after it, but my curiosity being stronger, I followed it, riding close by its side, and observed it licking up, in its progress, all the dust that was under its smaller part. As it is a common opinion, that a shot fired through a water-spout will break it, I tried to break this little whirlwind, by striking my whip frequently through it, but without any effect. Soon after it quitted the road, and took into the woods, growing every moment larger and stronger, raising, instead of dust, the old dry leaves, with which the ground was thick-covered, and making a great noise with them and the branches of trees, bending some tall trees round in a circle swiftly, and very surprisingly; though the progressive motion of the whirl was not so swift, but that a man on foot might have kept pace with it; but the circular motion was amazingly rapid. By the leaves it was now filled with, I could plainly perceive that the current of air they were driven by, moved upwards in a spiral line; and when I saw the passing whirl continue entire after leaving the trunks and bodies of large trees which it had enveloped, I no longer wondered that my whip had no effect on it in its smaller state. I accompanied it about ¾ of a mile, till some limbs of dead trees, broken off by the whirl, flying about, falling near me, made me more apprehensive of danger; and then I stopped, looking at the top of it, as it went on, which was visible, by means of the leaves contained in it, for a very great height above the trees. Many of the leaves, as they got loose from the upper and widest part, were scattered in the wind; but so great was their height in the air, that they appeared no bigger than flies. My son, who by this time was come up with me, followed the whirlwind till it left the woods, and crossed an old tobacco field, where, finding neither dust nor leaves to take up, it gradually became invisible below, as it went away over that field. The course of the general wind then blowing was along with us as we travelled; and the progressive motion of the whirlwind was in a direction nearly opposite, though it did not keep a straight line; nor was its progressive motion uniform, it making little sallies as it went on either side, proceeding sometimes faster and sometimes slower, and seeming sometimes, for a few seconds, stationary; then starting forwards pretty fast again. When we rejoined the company again, they were admiring the vast height of the leaves now brought by the common wind over our heads. These leaves accompanied us as we travelled, some falling now and then round about us, and some not reaching the ground till we had gone near three miles from the place where we saw the whirlwind begin.

WHISPERING-PLACES depend upon this principle: If the vibrations of the tremulous body are propagated through a long tube, they will be continually reverberated from the sides of the tube into its axis, and by that means prevented from spreading, till they get out of it; whereby they will be exceedingly increased, and the sound rendered much louder than it would otherwise be. See Sound.

Hence it is, that sound is conveyed from one side of a whispering-gallery to the opposite one, without being perceived by those who stand in the middle. The form of a whispering-gallery is that of a segment of a sphere, or a similar arched figure.

WHIST, a well-known game at cards, which requires great attention and silence; hence the name. This game is played by four persons, who cut for partners; the two highest and the two lowest are together, and the partners sit opposite to each other; the person who cuts the lowest card is to deal first, giving one at a time to each person, till he comes to the last card, which is turned up for the trump, and remains on the table till each person has played a card. The person on the left-hand side of the dealer plays first, and whoever wins the trick is to play again, thus going on till the cards are played out. The ace, king, queen, and knave, of trumps, are called honours; in case any three of these honours have been played between, or by either of the two partners, they reckon for two points towards the game; and if the four honours have been played between or by either of the two partners, they reckon for four points towards the game, the game consisting of ten points. The honours are reckoned after the tricks; all above six tricks reckoning also towards the game.

In Hoyle's Games may be seen the general rules for playing whist, which are too long for insertion here.

WHITING. See Gadus.

WICKLIFFISTS, or Wickliffites, a religious sect which sprung up in England in the reign of Edward III. and took its name from John Wickliff, doctor and professor of divinity in the university of Oxford, who maintained that the substance of the sacramental bread and wine remained unaltered after consecration; and opposed the doctrine of purgatory, indulgences, auricular confession, the invocation of saints, and the worship of images. He maintained that children may be saved without being baptised; that priests may administer confirmation; that there ought to be only two orders in the church, that of priests, and that of deacons. He made an English version of the Bible, and composed two volumes, called Alethia, that is, Truth, from which John Husse learned most of his doctrines. In short, to this reformer we owe the first hint of the reformation which was effected about two hundred years after.

WIDOW, a woman who has lost her husband by death. In London, and throughout the province of York, the widow of a freeman, is by custom entitled to her apparel, and the furniture of the bed-chamber, called the widow's chamber.

WIFE. After marriage, all the will of the wife, in judgment of law, is subject to the will of the husband, and it is commonly said a feme covert has no will. See Husband and Wife.

WILDERNESS, in gardening, a kind of grove of large trees, in a spacious garden, in which the walks are commonly made either to intersect each other in angles, or have the appearance of meanders and labyrinths.

Wildernesses, says Mr. Miller, should always be proportioned to the extent of the gardens in which they are made; for it is very ridiculous to see a large wilderness planted with tall trees in a small spot of ground; and, on the other hand, nothing can be more absurd, than to see little paltry squares, or quarters of wilderness-work, in a magnificent large garden. As to the situation of wildernesses, they should never be placed too near the habitation, nor so as to obstruct any distant prospect of the country, there being nothing so agreeable as an unconfined prospect; but where, from the situation of the place, the sight is confined within the limits of the garden, or there is any thing unsightly to be concealed, nothing can so agreeably terminate the prospect as a beautiful scene of the various kinds of trees judiciously planted; and if it is so contrived, that the termination is planted circularly, with the concave towards the sight, it will have a much better effect, than if it ends in straight lines or angles. The plants should always be adapted to the size of the plantation; for it is very absurd for tall trees to be planted in the small squares of a little garden; and in large designs small shrubs will have a mean appearance.

As to the walks, those that have the appearance of meanders, where the eye cannot discover more than twenty or thirty yards in length, are generally preferable to all others, and these should now and then lead into an open circular piece of grass; in the centre of which may be placed either an obelisk, statue, or fountain; and, if in the middle of the wilderness there is contrived a large opening, in the centre of which may be erected a dome or banqueting-house, surrounded with a green plot of grass, it will be a considerable addition to the beauty of the whole. From the sides of the walks and openings, the trees should rise gradually one above another to the middle of the quarters, where should always be planted the largest-growing trees, so that the heads of all the trees may appear to view, while their stems will be hid from the sight. Thus those parts which are planted with deciduous trees, roses, honey-suckles, spiræas, and other kinds of low-flowering shrubs, may be planted next the walks and openings, and at their feet, near the sides of the walks, with primroses, violets, daffodils, &c. not in a straight line, but so as to appear accidental, as in a natural wood. Behind the first row of shrubs should be planted syringas, hibisrus, mezereons, and other flowering shrubs of a middle growth; and these may be backed with many other sorts of trees, rising gradually to the middle of the quarters.

The part planted with evergreens may be disposed in the following manner, viz. In the first line next the great walks, may be placed the laurustinus, boxes, spurge-laurel, juniper, savin, and other dwarf evergreens. Behind these may be placed laurels, hollies, arbutuses, and other evergreens of a larger growth. Next to these may be planted alaternuses, phyllireas, yews, cypresses, Virginian cedars, and other trees of the same growth; behind these may be planted Norway and silver firs, the true pine, and other sorts of the fir growth; and in the middle should be planted Scotch pines, pinaster, and other of the larger-growing evergreens, which will afford a most delightful prospect, if the different shades of the greens are curiously intermixed.

But beside the grand walks and openings, there should be some smaller walks through the middle of the quarters, where persons may retire for privacy; and by the sides of those private walks may also be scattered some wood flowers and plants, which, if artfully planted, will have a very good effect.

In the general design for these wildernesses, there should not be a studied and stiff correspondency between the several parts; for the greater diversity there is in the distribution of these, the more pleasure they will afford.

WILL AND TESTAMENT, in law. Every person capable of binding himself by contract, is capable of making a will.

Also a male infant of the age of 14 years and upwards, and female of 12 years and upwards, are capable of making a will respecting personal estates only.

But a married woman cannot make a will unless a power is reserved in a marriage settlement; but wherever personal property, however, is given to a married woman for her sole and separate use, she may dispose of it by will.

If a feme sole makes her will, and afterwards marries, such marriage is a legal revocation of the will.

Wills are of two kinds, written and verbal; the former are most usual and secure.

It is not absolutely necessary that a will should be witnessed; and a testament of chattles, written in the testator's own hand, though it should have neither the testator's name nor seal to it, nor witnesses present at his publication, will be good, provided sufficient proof can be had that it is his hand-writing. Gilb. 260.

By stat. 29 Car. II. c. 3, all devises of lands, and tenements, shall not only be in writing, but shall also be signed by the party so devising the same, or by some other person in his presence, and by his express direction, and shall be witnessed and subscribed in the presence of the person devising, by three or four credible witnesses, or else the devise will be entirely void, and the land will descend to the heir at law.

A will, even if made beyond sea, bequeathing land in England, must be attested by three witnesses. 2 Pere Wms. 293.

A will, however, devising copyhold land, does not require to be witnessed: it is sufficient to declare the uses of a surrender of such copyhold land made to the use of the will. The party to whom the land is given becomes entitled to it by means of the surrender, and not by the will. 2 Atk. 37.

A codicil is a supplement to a will, or an addition made by the person making the same, annexed to, and to be taken as part of, the will itself, being for its explanation or alteration, to add something to, or take something from, the former disposition, and which may also be either written or verbal, under the same restrictions as regard wills.

If two wills are found, and it does not appear which was the former or latter, both will be void; but if two codicils are found, and it cannot be ascertained which was the first, but the same thing is devised to two persons, both ought to divide; but where either wills or codicils have dates, the latter is considered as valid, and revokes the former. See ADMINISTRATOR, EXECUTOR, and LEGACY.

WILL WITH A WISP, or *Jack with a lanthorn.* See METEOR.

WILLICHIA, a genus of plants of the class and order triandria monogynia. The calyx is four-cleft; corolla ditto; capsule two-celled, many-seeded. There is one species, an annual of Mexico.

WILLUGHBEIA, a genus of plants of the pentandria monogynia class and order. It is contorted; corolla salver-shaped; stigma headed; fruit one or two celled, berry or pumpkin. There are two species, trees of Guiana.

WIND, a sensible current in the atmosphere. The motions of the atmosphere are subject, in a certain degree, to the same laws as those of denser fluids. If we remove a portion of the water in a large reservoir, we see the surrounding water flow in to restore the equilibrium. If we impel, in any direction, a certain portion, an equal quantity moves in a contrary direction from the same cause. If a portion, being rarified by heat, or condensed by cold, ascends or descends, a counter-current in another part is the necessary and visible result. It is thus in the atmosphere. No wind can blow without a counter-current in an opposite direction; or arise without a previous destruction of the equilibrium, the general causes of which are, 1. The ascent of the air over certain tracts, heated by the sun. 2. Evaporation causing an actual increase in the volume of the atmosphere. 3. Rain, &c. causing an actual decrease in volume by the destruction of the vapour. Currents thus produced may be permanent and general, extending over a large portion of the globe; periodical as in the Indian ocean; or variable, and as it were occasional, or at least uncertain, as the winds in temperate climates.

General or permanent winds blow always nearly in the same direction. In the Atlantic and Pacific oceans, under the equator, the wind is almost always easterly; it blows, indeed, in this direction, on both sides of the equator to the latitude of 28°. More to the northward of the equator, the wind generally blows between the north and east; and the farther north we proceed, we find the wind to blow to a more northern direction; more to the southward of the equator it blows between the south and east; and the farther to the south, the more it comes in that direction.

Between the parallels of 28° and 40° south lat. in that tract which extends from 30° west to 100° east longitude from London, the wind is variable, but it most frequently blows from between the N. W. and S. W. so that the outward-bound East India ships generally run down their easting on the parallel of 36° south.

Navigators have given the appellation of trade-winds to these general winds.

Periodical winds. Those winds, which blow in a certain direction for a time, and at certain stated seasons change and blow for an equal space of time from the opposite point of the compass, are called monsoons. During the months of April, May, June, July, August, and September, the wind blows from southward over the whole length of the Indian ocean, viz. between the parallels of 28° N. and 28° S. lat. and between the eastern coast of Africa and the meridian which passes through the western part of Japan; but in the other months, October, November, December, January, February, and March, the winds in all the northern parts of the Indian ocean shift round, and blow directly contrary to the course they held in the former six months. For some days before and after the change, there are calms, variable winds, and tremendous storms, with thunder, &c.

Philosophers differ in their opinions respecting the cause of these periodical winds; but a more probable theory of the general trade-winds is, that they are occasioned by the heat of the sun in the regions about the equator, where the air is heated to a greater degree, and consequently rarefied more, than in the more northern parts of the globe. From this expansion of the air in these tropical regions, the denser air, in higher latitudes, rushes violently towards the equator from both sides of the globe. By this conflux of the denser air, without any other circumstances intervening, a direct northerly wind would be produced in the northern tropic, and a southern one in the other tropic; but as the earth's diurnal motion varies the direct influence of the sun over the surface of the earth, and as by that motion this influence is communicated from east to west, an easterly wind would be produced if this influence alone prevailed. On account of the co-operation of these two causes at the same time, the trade-winds blow naturally from the N. E. on the north, and from the S. E. on the south of the Line, throughout the whole year; but as the sun approaches nearer the tropic of Cancer in our summer season, the point towards which these winds are directed will not be invariably the same, but they will incline more towards the north in that season, and more towards the south in our winter.

The land and sea breezes in the tropical climates may be considered as partial interruptions of the general trade-winds; and the cause of these it is not very difficult to explain. From water being a better conductor of heat than earth, the water is always of a more even temperature. During the day, therefore, the land becomes considerably heated, the air rarefied, and consequently in the afternoon a breeze sets in from the sea, which is less heated at that time than the land. On the other hand, during the night the earth loses its surplus heat, while the sea continues more even in its temperature. Towards morning, therefore, a breeze regularly proceeds from the land towards the ocean, where the air is warmer, and consequently more rarefied, than on shore.

The cause of the monsoons is not so well understood as that of the general trade-winds, but what has been just remarked, suggests, at least, a probable theory on the subject. It is well known, that at the equator the changes of heat and cold are occasioned by the diurnal motion of the earth, and that the difference between the heat of the day and the night is almost all that is perceived in those tropical regions; whereas in the polar regions the great vicissitudes of heat and cold are occasioned by the annual motion of the globe, which produces the sensible changes of winter and summer; consequently, if the heat of the sun was the only cause of the variation of the winds, the changes, if any, that would be produced by those means in equatorial regions, ought to be diurnal only, but the changes about the pole should be experienced only once in six months. As the effects arising from the heat of the sun upon the air must be greater at the equator than at the poles, the changes of the wind arising from the expansion of the air by the sun's rays must be more steady in equatorial than in polar regions. The incontrovertible evidence of navigators proves this truth, that winds are more variable towards the poles, and more constant towards the equator. But in summer, the continual heat, even in high latitudes, comes to be sensibly felt, and produces changes on the wind, which are distinctly perceptible. In our own cold region, the effects of the sun on the wind are felt during the summer months; for while the weather in that season of the year is fine, the wind generally becomes stronger as the time of the day advances, and dies away towards the evening, and assumes that pleasing serenity so delightful to our feelings. Such are the diurnal changes of the wind in northern climates. The annual revolution of the sun produces still more sensible effects. The prevalence of the western winds during summer we may attribute to this cause, which is still more perceptible in France and Spain; because the continent of land to the eastward, being heated more than the waters of the Atlantic ocean, the air is drawn, during that season, towards the east, and consequently produces a western wind.

But these effects are much more perceptible in countries near the tropics than with us. For when the sun approaches the tropic of Cancer, the soil of Persia, Bengal, China, and the adjoining countries, becomes so much more heated than the sea to the southward of those countries, that the current of the general trade-wind is interrupted, so as to blow, at that season, from the south to the north, contrary to what it would do if no land was there. But as the high mountains of Africa, during all the year, are extremely cold, the low countries of India, to the eastward of it, become hotter than Africa in summer, and the air is naturally drawn thence to the eastward. From the same cause it follows, that the trade-wind in the Indian ocean, from April till October, blows in a north-east direction, contrary to that of the general trade-wind in open seas in the same latitude; but when the sun retires towards the tropic of Capricorn, these northern parts become cooler, and the general trade-wind assumes its natural direction.

Having given the most obvious causes of the periodical monsoons in the Indian seas, it is necessary to observe, that no monsoon takes place to the southward of the equator, except in that part of the ocean adjoining to New Holland. There the same causes concur to produce a monsoon as in the northern tropic, and similar appearances take place. From October till April the monsoon sets in from the N. W. to S. E. opposite to the general course of the trade-wind on the other side of the Line; and here also the general trade-wind resumes its usual course during the other months, which constitute the winter season in these regions. It may not be improper to conclude this account of the tropical winds, by enumerating some of the principal inflections of the monsoons.

Between the months of April and October the winds blow constantly from W. S W. in all that part of the Indian ocean which lies between Madagascar and cape Comorin, and in the contrary direction from October till April, with some small variation in different places; but in the bay of Bengal these winds are neither so strong nor so constant as in the Indian ocean. It must also be remarked, that the S. W. winds in those seas are more southerly on the African side, and more westerly on the side of India; but these variations are not so great as to be repugnant to the general theory. The cause of this variation is, as was before intimated, that the mountainous lands of Africa are colder than the flatter regions of Arabia and India; consequently the wind naturally blows from these cold mountains, in the summer season, towards the warmer lands of Asia, which occasions those inflections of the wind to the eastward during the summer months. The peninsula of India, lying so much farther to the south than the kingdoms of Arabia and Persia, adds greatly to this effect; because the wind naturally draws towards them, and produces that easterly variation of the monsoon which takes place in this part of the ocean, while the sandy deserts of Arabia draw the winds more directly northward, near the African coast. A similar chain of reasoning will serve to explain any other inflections or variations that may occur in the perusal of books of travels, &c.

Winds, *variable.* In the temperate zones the direction of the winds is by no means so regular as between the tropics. Even in the same degree of latitude we find them often blowing in different directions at the same time; while their changes are frequently so sudden and so capricious, that to account for them has hitherto been found impossible. When winds are violent, and continue long, they generally extend over a large tract of country; and this is more certainly the case when they blow from the north or east than from any other points. By the multiplication and comparison of meteorological tables, some regular connection between the changes of the atmosphere in different places may in time be observed, which will at last lead to a satisfactory theory of the winds. It is from such tables chiefly, that the following facts have been collected:

In Virginia, the prevailing winds are between the south-west, west, north, and north-west; the most frequent is the south-west, which blows more constantly in June, July, and August, than at any other season. The north-west winds blow most constantly in November, January, and February. At Ipswich, in New England, the prevailing winds are also between the south-west, west, north, and north-east; the most frequent is the north-west. But at Cambridge, in the same province, the most frequent wind is the south-east. The predominant winds at New York are the north and west; and in Nova Scotia north-west winds blow for three-fourths of the year. The same wind blows most frequently at Montreal in Canada; but at Quebec the wind generally follows the direction of the river St. Lawrence, blowing either from the north-east or south-west. At Hudson's-bay westerly winds blow for three-fourths of the year; the north-west wind occasions the greatest cold, but the north and north-east are the vehicles of snow.

It appears from these facts, that westerly winds are most frequent over the whole eastern coast of North America; that in the southern provinces, south-west winds predominate; and that the north-west become gradually more frequent as we approach the frigid zone.

In Egypt, during part of May, and during June, July, August, and September, the wind blows almost constantly from the north, varying sometimes in June to the west, and in July to the west and the east; during part of September, and in October and November, the winds are variable, but blow more regularly from the east than any other quarter; in December, January, and February, they blow from the north, north-west, and west; towards the end of February they change to the south, in which quarter they continue till near the end of March; during the last days in March and in April, they blow from the south-east, south, and south-west, and at last from the east; and in this direction they continue during a part of May.

In the Mediterranean the wind blows nearly three-fourths of the year from the north; about the equinoxes there is always an easterly wind in that sea, which is generally more constant in spring than in autumn. These observations do not apply to the gut of Gibraltar, where there are seldom any winds except the east and the west. At Bastia, in the island of Corsica, the prevailing wind is the south-west.

In Syria the north wind blows from the autumnal equinox to November; during December, January, and February, the winds blow from the west and south-west; in March they blow from the south, in May from the east, and in June from the north. From this month to the autumnal equinox, the wind changes gradually as the sun approaches the equator; first to the east, then to the south, and lastly to the west. At Bagdad, the most frequent winds are the south-west and north-west; at Pekin, the north and the south; at Kamtschatka, on the north-east coast of Asia, the prevailing winds blow from the west.

In Italy, the prevailing winds differ considerably according to the situation of the places where the observations have been made: at Rome and Padua, they are northerly, at Milan easterly. All that we have been able to learn concerning Spain and Portugal is, that on the west coast of these countries, the west is by far the most common wind, particularly in summer; and that at Madrid the wind is north-east for the greatest part of the summer, blowing almost constantly from the Pyrenean mountains. At Berne in Switzerland, the prevailing winds are the north and west; at St. Gothard, the north-east; at Lausanne, the north-west and south-west.

Father Cotte has given us the result of observations made at 86 different places of France; from which it appears, that along the whole south coast of that kingdom the wind blows most frequently from the north, north-west and north-east; on the west coast, from the west, south-west, and north-west; and on the north coast from the south-west. That in the interior parts of France, the south-west wind blows most frequently in 18 places; the west wind in 14; the north in 13; the south in 6; the north-east in 4; the south-east in 2; the east and north-west each of them one. On the west coast of the Netherlands, as far as Rotterdam, the prevailing winds are probably the south-west, at least this is the case at Dunkirk and Rotterdam. It is probable also, that along the rest of this coast, from the Hague to Hamburgh, the prevailing winds are the north-west, at least these winds are most frequent at the Hague and at Franeker. The prevailing wind at Delft is the south-east; and at Breda, the north and the east.

In Germany, the east wind is most frequent at Gottingen, Munich, Weissemburgh, Dusseldorf, Saganum, Erford, and at Buda in

Hungary; the south-east at Prague and Wirtzburg; the north-east at Ratisbon; and the west at Manheim and Berlin.

From an average of ten years of the register kept by order of the Royal Society, it appears that at London the winds blow in the following order:

Winds.	Days.	Winds.	Days.
South-west	112	South-east	32
North-east	58	East	26
North-west	50	South	18
West	53	North	16

It appears, from the same register, that the south-west wind blows at an average more frequently than any other wind during every month of the year, and that it blows longest in July and August; that the north-east blows most constantly during January, March, April, May, and June, and most seldom during February, July, September, and December; and that the north-west wind blows oftener from November to March, and more seldom during September and October than any other months. The south-west winds are also most frequent at Bristol, and next to them are the north-east.

The following table of the winds at Lancaster has been drawn up from a register kept for seven years at that place:

Winds.	Days.	Winds.	Days.
South-west	92	South-east	35
North-east	67	North	30
South	51	North-west	26
West	41	East	17

The following table is an abstract of nine years observations made at Dumfries by Mr. Copland:

Winds.	Days.	Winds.	Days.
South	82½	North	36½
West	69	North-west	25½
East	68	South-east	28½
South-west	50½	North-east	14½

The following table is an abstract of seven years observations made by Dr. Meek at Cambuslang, near Glasgow:

Winds.	Days.	Winds.	Days.
South-west	174	North-east	104
North-west	40	South-east	47

It appears, from the register from which this table was extracted, that the north-east wind blows much more frequently in April, May, and June, and the south-west in July, August, and September, than at any other period. The south-west is by far the most frequent wind all over Scotland, especially on the west coast. At Saltcoats, in Ayrshire, for instance, it blows three-fourths of the year; and along the whole coast of Murray, on the north-east side of Scotland, it blows for two-thirds of the year. East winds are common over all Great Britain during April and May; but their influence is felt most severely on the eastern coast.

The following table exhibits a view of the number of days during which the westerly and easterly winds blow in a year at different parts of the island. Under the term westerly are included the north-west, west, south-west, and south; the term easterly is taken in the same latitude.

Years of Observ.	Places.	Wind. Westerly.	Easterly
10	London - -	233	132
7	Lancaster - -	216	149
51	Liverpool - -	190	175
9	Dumfries - -	227.5	137.5
10	Branxholm, 54 miles south-west of Berwick - - -	232	133
7	Cambuslang - -	214	151
8	Hawkhill, near Edinburgh - - -	229.5	135.5
	Mean	220.3	144.7

In Ireland, the south-west and west, are the grand trade-winds; blowing most in summer, autumn, and winter, and least in spring. The north-east blows most in spring, and nearly double to what it does in autumn and winter. The south-east and north-west are nearly equal, and are most frequent after the south-west and west.

At Copenhagen the prevailing winds are the east and south-east; at Stockholm, the west and north. In Russia, from an average of a register of 16 years, the winds blow from November to April in the following order:

	W.	N.W.	E.	S.W.	S.	N.E.	N.	S.E.
Days	45	26	23	22	20	19	14	12

And during the other six months,

	W.	N.W.	E.	S.W.	S.	N.E.	N.	S.E.
Days	27	27	19	24	22	15	32	18

The west wind blows during the whole year 72 days; the north-west 58; the south-west and north 46 days each. During summer it is calm for 41 days, and during winter for 21. In Norway, the most frequent winds are the south, the south-west, and south-east. The wind at Bergen is seldom directly west, but generally south-west, or south-east; a north-west, and especially a north-east wind, are but little known there.

From the whole of these facts, it appears that the most frequent winds on the south coasts of Europe are the north, the north-east, and north-west; and on the western coast, the south-west: that in the interior parts which lie most contiguous to the Atlantic ocean, south-west winds are also most frequent; but that easterly winds prevail in Germany. Westerly winds are also most frequent on the north-east coast of Asia.

It is probable that the winds are more constant in the south temperate zone, which is in a great measure covered with water, than in the north temperate zone, where their direction must be frequently interrupted and altered by mountains and other causes.

M. De la Caille, who was sent thither by the French king to make astronomical observations, informs us, that at the Cape of Good Hope the main winds are the south-east and north-west; that other winds seldom last longer than a few years; and that the east and north-east winds blow very seldom. The south-east wind blows in most months of the year, but chiefly from October to April; the north-west prevails during the other six months, bringing along with it rain, and tempests, and hurricanes. Between the Cape of Good Hope and New Holland, the winds are commonly westerly, and blow in the following order: north-west, south-west, west, north.

In the Great South Sea, from latitude 30° to 40° south, the south-east trade-wind blows most frequently, especially when the sun approaches the tropic of Capricorn; the wind next to it in frequency is the north-west, and next to that is the south-west. From south latitude 40° to 50°, the prevailing wind is the north-west, and next the south-west. From 50° to 60°, the most frequent wind is also the north-west, and next to it is the west.

Thus it appears that the trade-winds sometimes extend farther into the south temperate zone than their usual limits, particularly during summer; that beyond their influence the winds are commonly westerly, and that they blow in the following order: north-west, south-west, west.

Such is the present state of the history of the direction of the winds. In the torrid zone they blow constantly from the north-east on the north side of the equator, and from the south-east on the south side of it. In they north temperate zone they blow most frequently from the south-west; in the south temperate zone from the north-west, changing, however, frequently to all points of the compass; and in the north temperate zone blowing, particularly during spring, from the north-east.

As to the velocity of the wind, its variations are almost infinite; from the gentlest breeze, to the hurricane which tears up trees and blows down houses. It has been remarked, that our most violent winds take place when neither the heat nor the cold is greatest; that violent winds generally extend over a great tract of country, and that they are accompanied by sudden and great falls in the mercury of the barometer. The reason appears to be, that violent winds succeed the precipitation in rain of a large quantity of vapour, which previously constituted a part of the bulk of the atmosphere; and this precipitation cannot take place when the general temperature approaches to either extreme. The wind is sometimes very violent at a distance from the earth, while it is quite calm at its surface. On one occasion Lunardi went at the rate of 70 miles an hour in his balloon, though it was quite calm at Edinburgh when he ascended, and continued so during his whole voyage. The same thing happened lately to Garnerin and his companion in their aerostatic voyage to Colchester. This again may be illustrated by the motions of dense fluids, which are always impeded in the parts contiguous to the sides and bottom of the vessels; and the same thing happens in tide-rivers, where the boatman, when he wishes to proceed with the tide, commits himself to the middle of the stream: but when he has to strive against it, he keeps close to the shore. It is, therefore, not the upper parts of the atmosphere which are accelerated, but the lower are retarded by friction against the surface of the earth.

The following table, drawn up by Mr. Smeaton, will give the reader a pretty precise idea of the velocity of the wind in different circumstances:

Miles per Hour.	Feet per Second.	Perpendicular Force on one square Foot, in Avoirdupois Pounds and Parts.	
1	1.47	.005	Hardly perceptible
2.	2.93	.020	Just perceptibe
3	4.4	.044	
4	5.87	.079	Gently pleasant
5	7.33	.123	
10	14.67	.492	Pleasant, brisk
15	22.	1.107	
20	29.34	1.968	Very brisk
25	36.67	3.075	
30	44.01	4.429	High wind
35	51.34	6.027	
40	58.68	7.873	Very high wind
45	66.01	9.963	
50	73.35	12.300	Storm or tempest
60	88.02	17.715	Great storm
80	117.36	31.490	Hurricane
100	146.7	49.200	Hurricane, that tears up trees, and carries buildings before it.

WINDMILL, a kind of mill, the internal parts of which are much the same with those of a water-mill; from which, however, it differs in being moved by the impulse of the wind upon its vanes, or sails, which are to be considered as a wheel on the axle.

There are various kinds of windmills. We shall content ourselves with describing the horizontal windmill, the construction of which is not so generally known as that of the others.

Plate Windmill, represents an horizontal windmill erected about 50 years ago at a distillery near Battersea, for grinding malt and corn. AA (fig. 1) is the main shaft, which turns on a gudgeon working in a socket supported by solid masonry: this shaft has several wheels, as BB, attached to its upper part, as shewn in fig. 2, for carrying a great number of float-boards DD, similar to a water-wheel, except being a little conical. This wheel is inclosed in a frame EE, composed of several circular rings, connected by upright timbers, and strengthened by transverse braces, and which has timbers across the top to support the upper gudgeon of the shaft AA. Within the frame EE, are a great number of boards extending from top to bottom, as shewn at FF: the boards turn on a centre at the edge nearest the wheel, so that they can be set open, as in fig. 2, or be shut up so as to touch one another, and to allow no air to pass between them.

When the boards FF are set, as in fig. 2, it will be evident, from inspecting the figure, that let the wind blow in any direction, it will always enter the building on one side, the other being in such a position that the wind cannot enter, and striking on the floats of the wheel will turn it round. The quantity of wind which strikes the wheel can be regulated by closing or opening the boards, FF, all at once, which is done by a contrivance, shewn in fig. 3. HH represents a plan of a part of the circular sill at the bottom of the frame EE, (figs. 1 and 2); FF are the wind-boards, which move on a centre at the edge *f*; the boards have levers, GG, nailed to their lower ends, by which they can be turned about on the centre; II are rods, joined to the levers GG, the other ends of which are jointed to a circular ring, of which KK is a segment: this ring rests upon rollers fixed in the floor beneath the sails.

When this ring is turned round one way, the rods II push the ends of the levers GG, and close up the boards; on the contrary, when it is turned the other way, it opens them.

The ring K has at one part of its under side a short cast iron segment with cogs, which work in a pinion, moving on centres fixed to the floor. The axis of this pinion goes through the mill and into the open air, and is connected by ropes with a handle below the ground-floor of the mill.

When the miller turns this handle, it also turns the ring K (fig. 3), and, as before described, opens or closes the boards FF, and regulates the mill's velocity.

The main shaft, AA, has a large cog-wheel, O, fixed upon it, which turns two trundles on the shafts, LM, on which the wheels NN are also fixed: each of these wheels turns three pinions (only one of which is represented) on the axis of the mill-stones, which are arranged round the wheels NN, at proper intervals, like those described under the article FLOUR-MILL. The shaft L has a beveled wheel at its upper end, which turns another, *m*, on the shaft *n*; which has riggers, as P, fixed on it, and by means of straps turns the bolting-mills; for a description of which see FLOUR-MILL.

With regard to the common windmills, we must observe that a patent has lately been taken out by Mr. Sutton, for a peculiar construction of the sails. For a full account of these, we can with pleasure refer to a work entitled "A Sketch of the Properties and Advantages of Sutton's Patent Gravitated Sails for Windmills," by W. S. Hefleden.

WIND-SAILS, in a ship, are made of the common sail-cloth, and are usually between 25 and 30 feet long, according to the size of the ship, and are of the form of a cone ending obtusely: when they are made use of, they are hoisted by ropes to about two-thirds or more of their height, with their basis distended circularly by hoops, and their apex hanging downwards in the hatchways of the ship; above each of these, one of the common sails is so disposed, that the greatest part of the air rushing against it is directed into the wind-sail, and conveyed, as through a funnel, into the upper parts of the body of the ship.

WIND-TACKLE-BLOCKS, in a ship, are the main double blocks, which, being made fast to the end of a small cable, serve for hoisting goods into the ship, &c.

To WIND, or WEND, *a ship*, signifies to bring her head about. How winds or wends a ship? is a question asked by mariners concerning a ship under sail; signifying as much as, upon what point of the compass does she lie with her head?

WIND-WARD, in the sea language, denotes any thing towards that point from which the wind blows in respect of a ship: thus windward tide is the tide which runs against the wind.

Large WIND. In the sea language, to sail with a large wind, is the same as with a fair wind.

WINDAGE *of a gun, mortar, or howitzer*. The difference between the diameter of the bore, and the diameter of the shot or shell. In England, the diameter of the shot is supposed to be divided into 20 equal parts, and the diameter of the bore into 21 of those parts. The French divide the shot into 26, and the bore into 27. The Prussians divide the shot into 24, and the bore into 25. The Dutch nearly the same as the English. The general windage of shells in England is a quarter of an inch, let them be large or small, which is contrary to all reason. It is evident, that the less windage a shot or shell has, the farther and truer it will go; and having less room to bounce from side to side, the gun will not be spoiled so soon.

It is true that some artillery-officers say, that the windage of a gun should be equal to the thickness of the ladle; because, when it has been loaded for a while, the shot will not come out without being loosened thereby, in order to unload it; and when this cannot be done, it must be fired away, and so lost; but the most advantageous windage would be in dividing the shot in 24 equal parts, and the bore into 25, on account of the convenient scale it affords, not only to construct guns by, but also their carriages. Hence, agreeable to this plan, the windage of a 9-pounder will be .166 of an inch, consequently a sufficient thickness for a ladle; and those of a higher calibre become still thicker in proportion; but suppose this thickness is not enough, the loss of a shot is a mere trifle, in respect to the advantage otherwise gained.

WINDING STAIRS. See STAIRS.

WINDLASS, or WINDLACE, a machine used to raise large weights, as guns, stones, anchors, &c. See MECHANICS.

WINDLASS, in a ship, is an instrument, in small ships placed upon the deck, just abaft the foremast. It is made of a piece of timber six or eight feet square, in form of an axle-tree, whose length is placed horizontally upon two pieces of wood at the ends, and upon which it is turned about by the help of handspikes put into holes made for that purpose. This instrument serves for weighing anchors, or hoisting of any weight in or out of the ship, and will purchase much more than any capstan, and that without any danger to those who heave; for if in heaving the windlass about, any of the handspikes should happen to break, the windlass would pall of itself.

WINDOW. See ARCHITECTURE.

WINE. It is known that no substances, except such as contain the saccharine principle, are susceptible of the vinous fermentation; and that in order to be susceptible of it, these saccharine substances must always contain a certain portion of extractive matter; for Lavoisier has proved, that sugar alone cannot ferment, he having always been obliged to add to it a quantity of yeast in order to make it undergo this change.

The principles of which yeast consists are oxygen, hydrogen, carbon, and azote. The process of fermentation decomposes them, and gives rise to new products, namely:

Water, carbonic acid, alcohol, acetous acid, saccharine residuum, and a residuum of the yeast.

The effects of the vinous fermentation consist, therefore, in separating the sugar, which is an oxide, into two parts; in oxygenating the one, at the expence of the other, to form carbonic acid; in disoxygenating the other in favour of the first, to form a combustible substance termed alcohol; so that was it possible to combine these two substances, the alcohol and the carbonic acid, one might reproduce sugar. It is necessary to remark, that the hydrogen and carbon do not exist in the state of oil in alcohol, being combined with a portion of oxygen, which renders them miscible with water. These three principles, therefore, the oxygen, the hydrogen, and the carbon, are here in a kind of equilibrium; and, in fact, by causing them to pass through a red-hot tube of glass or porcelain, we may re-combine them two and two together, and the product will be water, hydrogen, carbonic acid, and carbon.

The analysis of wine commences in the cask, after which it successively deposits tartar, lees, and its colouring principle, till at length hardly any thing remains besides alcohol and a small quantity of extractive matter, dissolved in a proportion of water more or less abundant. But this accurate analysis, which exhibits to us the principles of wines in their separate states, throws very little light upon their real nature, a deficiency which we shall endeavour to supply by a more rigorous method of investigation.

We shall distinguish in all wines an acid, alcohol, tartar, an extractive matter, aroma, and a colouring principle; the whole being diluted or dissolved in a smaller or larger proportion of water.

1. *The acid.* An acid exists in all wines; and we have never met with any in which we could not discover some traces of its presence. The sweetest, as well as the most watery wines, impart a red tinge to blue paper that is kept for some time immersed in them; but all wines are not acid in the same degree. Of some wines, a natural acidity is the principal characteristic; those produced from grapes not perfectly ripe, or that grow in moist climates, are of this kind; whilst such as are the product of the fermentation of grapes that have attained complete maturity and sweetness, contain but a very small quantity of acid. The proportion of acid appears, therefore, to be in the inverse ratio of the saccharine principle, and consequently of the alcohol, which is produced by the decomposition of the sugar.

This acid exists in great abundance in verjuice; it is also found in must, though in less quantity. All fermented liquors, such as cyder, perry, beer, and fermented farinaceous substances, contain this acid in like manner. It is even found in melasses. Indeed, it is only for the purpose of completely saturating it, that lime, ashes, and other earthy or alkaline bases, are used in refining sugar; otherwise the presence of the acid would impede the crystallization of this salt.

If we concentrate wine by distillation, the extract which remains is in general of a sour pungent taste. Water, or even alcohol, poured upon this extract, will be sufficient to dissolve and raise the acid. This acid has a slightly empyreumatic smell, leaves a bitterish taste in the mouth, &c.

This acid, well filtrated and left to stand in a flask, deposits a considerable quantity of extractive matter; it afterwards becomes covered with mould, and seems to approach to the nature of the acetous acid; by distillation it may be purified of a great quantity of the extractive matter, after which it becomes less liable to be decomposed by the putrefactive fermentation.

This acid precipitates the carbonic acid in its combinations; it dissolves most of the metallic oxides with facility; forms insoluble salts with lead, silver, and mercury; and separates the metals from all their solutions by acids.

This acid forms also an insoluble salt with lime. When we mix a large quantity of lime-water with wine, the acid is precipitated from it, and carries with it the whole of the colouring principle.

This acid, therefore, is of the nature of the malic acid; it is always mixed with a small proportion of nitric acid; for, if it is digested upon the oxide of lead, besides the insoluble precipitate that is formed, a citrate is always produced which can be demonstrated by the known methods.

This malic acid disappears when the wine is converted into vinegar; it no more exists in well-prepared vinegar than it does in the acetous acid. This transformation of the malic acid into acetous acid, affords a natural explanation why wine that has begun to sour cannot be employed in the preparation of the acetite of lead; in this case an insoluble precipitate is produced.

The existence, in different proportions, of the malic acid in wine, enables us to account for a phenomenon of the utmost importance, relative to the distillation of wines, and the properties of the vinous spirits which result from this process. Every one knows, not only that all wines do not yield the same proportion of spirit, but likewise that the distilled spirits produced from different kinds of wine differ very widely from each other in their quantities. It is also well known that beer, cyder, perry, and fermented farinaceous substances, yield but a small quantity of spirit, and that always of a bad quality. Careful and repeated distillations may indeed correct these faults to a certain degree, but they can never take them away altogether. These constant results, from a long course of experience, have been attributed to the superabundance of the extractive matter contained in these weak spirituous liquors; the combustion of a portion of this matter, by distillation, seemed to be the immediate consequence, and the acrid empyreumatic taste its natural effect. But, upon a more accurate investigation of this phenomenon, it is found that, besides the causes dependant upon the superabundance of the extractive principle, another ought to be attended to, namely, the presence of the malic acid in almost all these cases.

Those wines which contain the largest proportion of malic acid, afford the worst-conditioned spirit. It appears even that the quantity of alcohol is less in proportion as that of the acid is more considerable. If we separate this acid by means of lime-water, lime, chalk, or some fixed alkali, we can only draw off a very small quantity of alcohol by distillation; and, in every case, the spirit acquires a disagreeable fiery taste, which does not tend to meliorate its quality.

The difference of the spirits obtained by distillation from different wines, depends, therefore, principally upon the different proportions in which these wines contain malic acid; but no process has been hitherto discovered by which we can with certainty destroy the bad effects which the admixture of this acid with vinous spirits produces.

This acid, which we find in the grape at the period of its growth, and which does not disappear in wines till they have completely degenerated into vinegar, ought in preference to be denominated the vinous acid: however, for the sake of avoiding innovation, we shall retain the usual term of malic acid.

2. *Alcohol.* Alcohol forms the true characteristic of wine. It is the product of the decomposition of sugar; and its quantity is always proportionate to that of the sugar that has been decomposed.

Alcohol abounds more in some wines than it does in others; those of hot climates contain a large quantity of it, whilst those of cold climates contain scarcely any. Ripe and sweet grapes produce it in abundance; but the wines made of grapes that are unripe, watery, and sour, yield very little.

Some wines produced in the southern parts of our hemisphere, yield alcohol in the proportion of one-third of their quantity; whilst many of those manufactured in more northern latitudes contain not more than one-fifteenth.

It is the proportion of alcohol contained in them that renders wines more or less generous; and upon the same circumstance depends their disposition or resistance to the acetous fermentation. The less a wine contains of alcohol, the more easily it turns sour; the proportion of extractive matter contained in it being supposed the same in both cases.

The richer in spirit a wine is, the less it contains of malic acid; and this is the reason why the best wines, in general, furnish the best brandies; as they are then exempt from the presence of this acid, which gives them a disagreeable flavour.

It is by distillation that we extract from wines the whole of the alcohol they contain.

When wines are distilled, the operation is carried on till the liquor which passes over is no longer inflammable.

Wines furnish more or less brandy in proportion to their different degrees of spirituosity. A very generous wine furnishes about a third of its weight: the mean proportion of the brandy, furnished by the wines of the southern provinces of France, is about one-fourth of the whole; some even yield as much as one-third.

Old wines yield better brandy than new ones, but in less quantity, particularly when the decomposition of the saccharine principle has been completed before they are subjected to the process of distillation.

That which remains in the boiler, after the brandy has been extracted, is called vinasse; and is a confused mixture of tartar, the colouring principle, lees, &c. This residuum is generally thrown away as useless: nevertheless, after drying it in the air, or by means of a stove, a tolerably pure alkali may be extracted from it by combustion.

In some distilleries the vinasse is suffered to turn sour, in order afterwards to distil, and extract the small quantity of vinegar that has been formed in it.

Brandy is the more spirituous in proportion as it is mixed with a smaller proportion of water; and as it is of importance in commerce, that we should be able easily to ascertain the degrees of spirituosity, attention has long been paid to the means by which this may be performed.

The distiller judges of the spirituosity of brandy by the number, the magnitude, and the permanency, of the bubbles which form themselves upon agitating the liquor. With this view it is poured from one vessel into another, or suffered to fall from a certain height, or, which is the more general practice, it is inclosed in an oblong flask, so as to fill about two-thirds of the whole, and violently agitated, the mouth of the flask being kept tightly closed by the pressure of the thumb. This last apparatus is called the sound.

The test by combustion, in the manner it is usually practised, is very faulty. The regulation of the year 1729 directs to put gunpowder into a boiler, and, after covering it with the liquid, to apply fire to it. The brandy is supposed to be of good quality if it sets fire to the powder, and bad in the contrary event. But the same quantity of liquor either does, or does not, set fire to gunpowder, according to the proportion in which it is employed: a small proportion always does it, and a large one never; for, in the latter case, the water contained in the liquid is sufficient to wet the powder, and prevent its taking fire.

Salt of tartar (carbonat of potass) is also employed as a test for brandy. This alkali is soluble in water, but not in alcohol; so that upon dissolving it in brandy, the alcohol swims at the top of the solution.

The defective nature of these processes has rendered it necessary to have recourse to means capable of determining the spirituosity of a liquor by ascertaining its specific gravity.

A drop of oil poured upon alcohol fixes itself upon the surface, or falls to the bottom, according to the degree of spirituosity which the liquor possesses. This method has been adopted and proposed by the Spanish government in the year 1770; but it is subject to inaccuracy, as the effect depends upon the height from which it falls, the weight of the oil, the size of the drop, the temperature of the atmosphere, the dimensions of the vessel, &c.

In the year 1772, this important subject was resumed by two able philosophers, namely, Borie and Proujet de Cette, who introduced in Languedoc, an hydrometer, to which they adapted a thermometer, the different degrees of which constantly indicate the corrections requisite to be made in the graduation of the hydrometer, on account of the very variable temperature of the atmosphere.

By the aid of this hydrometer, one may not only ascertain the degree of spirituosity, but also bring the brandy to any degree that is thought proper. For this purpose different weights are used, the heaviest of which is marked Holland-proof, and the highest 3—7; so that if we see, at the lower extremity of the stalk of the aräometer, Holland-proof, and plunge the instrument into a liquor 3—7, it sinks much too deep; but we may raise it again to the level of Holland-proof, by adding four-sevenths of water.

If, on the contrary, we have the weight 3—7, and plunge the aräometer into a liquor Holland-proof, it will rise in the liquor above this last term, to which it may easily be reduced by adding alcohol of a higher degree of spirituosity.

When brandies are to be distilled for the purpose of extracting their alcohol, the compound bath is usually employed. The heat is then more gentle and equal, and the product of the distillation of a better quality. This is what is called spirit of wine in commerce.

3. *The tartar*. Tartar exists in verjuice, as also in must; it contributes to facilitate the formation of alcohol, as we have already observed, according to the experiments of Bouillon. When left at rest in casks, it deposits itself upon the sides, forming a crust, more or less thick, with crystals of irregular forms. Some time before the vintage, when the casks are to be got ready for receiving the new wine, they are staved, and the tartar detached from them, in order to be employed in the different uses of commerce.

Tartar is not furnished in equal quantity by all wines; the red wines yield a larger proportion of it than the white: those of the deepest colour and thickest consistence generally yield the most.

Its colour likewise varies very much; and it is distinguished into white and red tartar, according to the colour of the wines from which it has been deposited.

This salt has little solubility in cold water, but considerably more in boiling water. It scarcely dissolves at all in the mouth, and it resists the pressure of the teeth.

It is deprived of its colouring principle by a simple process, and it is then termed cream of tartar. For this purpose it is dissolved in boiling water, and as soon as the solutiou is saturated, it is put into earthen pans to cool. In cooling, it deposits a layer of crystals, which are already very nearly deprived of their colour. These crystals are again dissolved in boiling water, and the solution mixed, in the proportion of four or five parts to a hundred, with a sandy argillaceous earth, which is dug at Murveil, near Montpellier. This mixture is evaporated till a pellicle forms upon it,; in cooling it deposits white crystals, which, after being exposed for some days to the air, upon canvas, acquire that whiteness by which cream of tartar is distinguished. The original water is preserved in order to be employed in new solutions.

Tartar is purified also by calcination. By this operation its acid is decomposed and destroyed, so that nothing remains besides the alkali and the carbon. The alkali is dissolved in water; and by filtrating and evaporating the solution, we obtain the salt well known in pharmacy by the name of salt of tartar, or carbonat of potass.

Tartar furnishes not more than about a fourth part of its weight of alkali.

4. *The extractive principle*. The extractive principle abounds in must, where it appears to be dissolved by the aid of the sugar: but when the saccharine principle is decomposed by means of fermentation, the quantity of extractive matter sensibly diminishes; a part of it deposits itself in a fibrous form; and this deposit, which principally constitutes the lees, is the more considerable in proportion as the fermentation is more gentle, and the alcohol more abundant. This deposit is always mixed with a considerable quantity of tartar.

There always exists in wine a proportion of extractive matter in a state of dissolution, which may be separated from it by means of evaporation. It abounds more in new wines than in old ones; and the older the wine grows, the more completely is it freed from the extractive principle.

The lees, after being well pressed, are dried in the sand, or in stoves, and then burnt, in order to extract that species of alkali known in commerce by the name of pearl-ashes. The residuum, after the combustion, is a porous mass, of a greenish-grey colour, and forms about a thirtieth part of the whole quantity of lees that have been burnt.

5. *The aroma*. All natural wines have an odour more or less agreeable to the smell. Some of them owe their reputation in a great measure to the perfume which they exhale. This is the case with Burgundy. This perfume is lost by too violent a fermentation, and becomes stronger by age. It seldom exists in very spirituous wines, either because it is concealed by the strong smell of the alcohol, or because it has been destroyed or dissipated by the violent fermentation that was requisite to develope the spirit.

This aroma does not appear to be capable of being extracted and communicated at pleasure to other substances. Even heat seems to destroy it; for, excepting the first liquid that passes over in distillation, which still retains something of the odour peculiar to the wine, the brandy which follows after has only those properties that essentially belong to it.

6. *The colouring principle*. The colouring principle of wine belongs to the skin of the grape; for when the must is suffered to ferment without it, the wine is white. This colouring principle does not dissolve till the alcohol is developed; it is only then that the wine acquires its colour, which is deeper in proportion to the violence of the fermentation.

A portion of the colouring principle deposits itself in the cask, together with the tartar and the lees; and, as the wine grows old, it is not unfrequent to see it entirely lose its colour: the colouring principle then deposits itself in pellicles on the sides or bottom of the cask, and is seen floating in the liquid in the form of films, which injure its transparency.

If we expose bottles filled with wine to the rays of the sun, a few days are sufficient to precipitate the colouring principle in large pellicles; the wine losing neither its perfume nor its strength.

By adding a large quantity of lime-water to wines, we precipitate their colouring principle. In this case the lime combines with the malic acid, and forms a salt which appears in light flakes in the liquid. These flakes gradually sink to the bottom, carrying with them the whole of the colouring principle. The deposit is black or white, according to the colour of the wine on which we operate. It frequently happens, that a wine is still susceptible of a new precipitation, although it had been completely discoloured by the first deposit, which proves that the colouring principle has a very strong affinity with the malate of lime. This coloured precipitate is not soluble either in cold or in hot water. Alcohol has scarcely any effect upon it, excepting that it acquires a slight brownish tinge. The nitric acid dissolves the colouring principle of this precipitate.

When wine is reduced to the state of extract, alcohol poured upon it acquires a deep tinge, in the same manner as water does, though not in an equal degree. But, besides the colouring principle which then dissolves itself, there is also a saccharine extractive principle present, which facilitates the solution.

The colouring principle, therefore, does not appear to be of a resinous nature; it exhibits all the characters that belong to a very numerous class of vegetable products, which approach to the nature of the lees of wine, though without possessing all its properties. The greater number of colouring principles are of this kind: they are soluble by the acid of extractive matter, and, upon disengaging them from this agent, they fix themselves in a solid form.

Wine-spirit, a term used by our distillers, and which may seem to mean the same thing with the phrase of spirit of wine; but they are taken in very different senses in the trade.

Spirit of wine is tbe name given to the common malt spirit, when reduced to an alcohol, or totally inflammable state; but the phrase wine-spirit is used to express a very clean and fine spirit, of the ordinary proof strength, and made in England from wines of foreign growth.

The way of producing it is by simple distillation, and it is never rectified any higher than common bubble-proof. The several wines of different natures yield very different proportions of spirit; but, in general, the strongest yield one-fourth, the weakest in spirits one-eighth part of proof-spirit; that is, they contain from a sixteenth to an eighth part of their quantity of pure alcohol.

WINNOWING-MACHINES. Machines of this sort are in pretty general use, where thrashing-mills, to which they may be attached, are not erected: they are made on different principles according to particular circumstances. Those contrived by Mr. Cor, of Leicester, on Mr. Winlow's plan, are good implements, and will dress grain with much dispatch. And there are others which are employed in the northern districts, which are made by Rodgers, that are also upon good and convenient principles; as well as many more in different places which have great merit in their construction, and do their work well and expeditiously. They are made of different prices, from three to five or six pounds, and will last many years when the materials of which they are formed are of a proper kind.

WINTERA, a genus of plants of the class polyandria, and order pentagynia; and in the natural system arranged under the 12th order, holoraceæ. The calyx is three-lobed; there are six or twelve petals; there is no style; the fruit is a berry, which is club-shaped as well as the germen. There are three species, the aromatica, granadensis, and axillaris.

Wintera aromatica, is one of the largest forest-trees upon Terra del Fuego: it often rises to the height of 50 feet. Its outward bark is on the trunk grey and very little wrinkled, on the branches quite smooth and green. The branches do not spread horizontally, but are bent upwards, and form an elegant head of an oval shape. The leaves come out without order, of an oval elliptic shape, quite entire, obtuse, flat, smooth, shining, of a thick leathery substance, evergreen, on the upper side of a lively deep-green colour, and of a pale bluish colour underneath, without any nerves, and their veins scarcely visible; they are somewhat narrower near the footstalks, and there their margins are bent downwards. In general, the leaves are from three to four inches long, and between one and two broad; they have very short footstalks, seldom half an inch long, which are smooth, concave on the upper side, and convex underneath. From the scars of the old footstalks the branches are often tuberculated.

WIRE, a piece of metal drawn through the hole of an iron into a thread of a fineness answerable to the hole it passed through.

Wires are frequently drawn so fine as to be wrought along with other threads of silk, wool, flax, &c.

The metals most commonly drawn into wire, are gold, silver, copper, and iron.

Gold wire is made of cylindrical ingots of silver, covered over with a skin of gold, and thus drawn successively through a vast number of holes, each smaller and smaller; till at last it is brought to a fineness exceeding that of a hair. That admirable ductility which makes one of the distinguishing characters of gold, is no where more conspicuous than in this gilt wire. A cylinder of 48 ounces of silver, covered with a coat of gold, only weighing one ounce, as Dr. Halley informs us, is usually drawn into a wire, two yards of which weigh no more than one grain: whence 98 yards of the wire weigh no more than 49 grains, and one single grain of gold covers the 98 yards; so that the ten-thousandth part of a grain is above one-eighth of an inch long.

Silver wire is the same with gold wire, except that the latter is gilt, or covered with gold, and the other is not.

There are also counterfeit gold and silver wires; the first made of a cylinder of copper, silvered over, and then covered with gold: and the second of a like cylinder of copper, silvered over, and drawn through the iron, after the same manner as gold and silver wire.

Brass wire is drawn after the same manner as the former. Of this there are divers sizes, suited to the different kinds of works. The finest is used for the strings of musical instruments, as harpsichords, &c.

The pin-makers likewise use vast quantities of brass wire, to make their pins of.

Iron wire is drawn of various sizes, from half an inch to one-tenth of an inch diameter, and even smaller.

The first iron that runs from the stone when melting, being the softest and toughest, is preserved to make wire of. Iron wire is made from bars of iron, called esleom-iron, which are first drawn out to a greater length, and to about the thickness of the little finger, at a furnace, with a hammer gently moved by water. These thinner pieces are bored round, and put into a furnace to anneal for 12 hours. A pretty strong fire is used for this operation. After this they are laid under water for three or four months, the longer the better; then they are delivered to the workmen, called rippers, who draw them into wire through two or three holes. After this they anneal them again for six hours, and water them a second time for about a week, and they are then delivered again to the rippers, who draw them into wire of the thickness of a large packthread. They are then annealed a third time, and then watered for a week longer, and delivered to the small wire-drawers, called overhouse-men.

In the mill where this work is performed, there are several barrels hooped with iron, which have two hooks on their upper sides, on each of which hang two links, which stand across, and are fastened to the two ends of the tongs which catch hold of the wire, and draw it through the hole. The axis on which the barrel moves does not run through the centre, but is placed on one side, which is that on which the hooks are placed; and underneath there is fastened to the barrel a spoke of wood, which they call a swingle, which is drawn back a good way by the cogs in the axis of the wheel, and draws back the barrel, which falls to again by its own weight. The tongs hanging on the hooks of the barrel, are by the workmen fastened to the end of the wire, and by the force of the wheel, the hooks being pulled back, draw the wire through the holes. The plate in which the holes are, is iron on the outside, and steel on the inside; and the wire is anointed with train-oil, to make it run the easier.

Wire *of Lapland*. The inhabitants of Lapland have a sort of shining slender substance in use among them on several occasions, which is much of the thickness and appearance of our silver wire, and is therefore called, by those who do not examine its structure or substance, Lapland wire. It is made of the sinews of the rein-deer, which being carefully separated in the eating, are, by the women, after soaking it in water, and beating, spun into a sort of thread, of admirable fineness and strength, when wrought to the smallest filaments; but when larger, is very strong, and fit for the purposes of strength and force. Their wire, as it is called, is made of the finest of these threads, covered with tin. The women do this business; and the way they take is to melt a piece of tin, and placing at the edge of it a horn with a hole through it, they draw these sinewy threads, covered with the tin, through the hole, which prevents their coming out too thick covered. This drawing is performed with their teeth; and there is a small piece of bone placed at the top of the hole, where the wire is made flat, so that we always find it rounded on all sides but one, where it is flat.

This wire they use in embroidering their clothes, as we do gold and silver; they often sell it to strangers, under the notion of its having certain magical virtues.

WITCHCRAFT. By 9 G. II. c. 5, no prosecution shall be commenced or carried on against any person for witchcraft, sorcery, enchantment, or conjuration, or for charging another with any such offence.

But if any person shall pretend to exercise or use any kind of witchcraft, sorcery, enchantment, or conjuration, or undertake to tell fortunes; or pretend from his skill or knowledge in any occult or crafty science, to discover where, and in what manner, any goods supposed to have been stolen or lost, may be found; he shall be imprisoned for a year, and once in every quarter of that year stand openly on the pillory for an hour; and further shall be bound to good behaviour as the court shall award.

WITENA-MOT, or Witena-gemot, among our Saxon ancestors, was a term which literally signified the assembly of the wise men, and was applied to the great council of the nation, of latter days called the parliament.

WITHERINGIA, a genus of plants of the class and order tetrandria monogynia. The corolla is sub-campanulate; calyx very small, four-toothed; perianthium two-celled. There is one species, a herb of South America.

WITZENIA, a genus of plants of the class and order triandria monogynia. The corolla is one-petalled; stigma emarginate; capsule superior. There is one species, a herb of the Cape.

WITHERNAM, in law, a writ that lies where a distress is driven out of the county, and the sheriff cannot make deliverance to the party distrained; in that case this writ is directed to the sheriff, commanding him to take as many of the beasts, or goods, of the party into his keeping, till he make deliverance of the first distress.

WITNESS, one who is sworn to give evidence in a cause.

If a man is subpœnaed as a witness upon a trial, he must appear in court on pain of 100*l.* to be forfeited to the king, and 10*l.* together with damages equivalent to the loss sustained by the want of his evidence to the party aggrieved. 3 Black. Com. 369.

But witnesses ought to have a reasonable time, that their attendance upon the court may be of as little prejudice to themselves as possible; and the court of king's-bench held, that notice at two in the afternoon to attend the sitting that evening at Westminster was too short a time. Str. 510.

Where a witness cannot be present at a trial, he may, by consent of the plaintiff and defendant, or by rule of court, be examined upon interrogatories at the judge's chambers.

No witness is bound to appear to give evidence in a cause unless his reasonable expence is tendered him, and if he appears till such charge is actually paid him, except he both resides and is summoned to give evidence within the bills of mortality.

WOAD, in botany. See Isatis, and Indigo.

WOLF. See Canis.

WOLF-HOLES, in the defence of places, are round holes, generally about two or three feet in diameter at the top, one at bottom, and two and a half deep, dug in the front of any work. Sometimes a sharp-pointed stake or two are fixed at the bottom, and covered with very thin planks, and green sods; consequently the enemy, on advancing, fall in, and are put into confusion.

WOLFRAM, an ore of tungsten, is found in different parts of Germany, in Sweden, Britain, France, and Spain; and almost constantly accompanied by ores of tin. It occurs both massive and crystallized. The primitive form of its crystals, according to the observations of Mr. Hauy, is a rectangular parellelopiped, whose length is 8.66, whose breadth is five, and thickness 4.33. It is not common, however, to find crystals of this perfect form in many cases: the angles, and sometimes the edges, of the crystal are wanting; owing, as Mr. Hauy has shewn, to the superposition of plates, whose edges or angles decrease according to a certain law.

Colour brown or brownish black. Streak reddish brown. Powder stains paper with the same colour. Texture foliated. Easily separated into plates by percussion. Specific gravity from 7. to 7.3. Moderately electric by communication. Not magnetic. Infusible by the blowpipe. Forms with borax a greenish globule, and with microcosmic salt a transparent globule of a deep red.

The specimen of this ore, examined by Messrs. d'Elhuyarts, was composed of

65	oxide of tungsten
22	oxide of manganese
13	oxide of iron
100.	

Another specimen from Puy-les-Mines in France, analysed by Vauquelin and Hecht, contained

67.00	oxide of tungsten
18.00	black oxide of iron
6.25	black oxide of manganese
1.50	silica
7.25	oxide of the iron and manganese
100.00	

WOMEN. By the 26 G. II. c. 33, no suit shall be had in any ecclesiastical court, to compel a celebration of marriage in facie ecclesiæ, by reason of any contract of matrimony whatsoever, whether per verba de præsenti, or per verba de futuro: and the marriage of any person under the age of twenty-one, without the consent of parents or guardians, shall be null and void.

By 20 H. VI. c. 9 peeresses shall be tried as peers for treason or felony.

And by stat. 3 W. c. 9, a woman being convicted of an offence, for which a man may have his clergy, shall suffer the same punishment that a man should suffer, who has the benefit of his clergy allowed; that is, shall be burnt in the hand, and further kept in prison as the court shall think fit, not exceeding one year.

But she shall be only once intitled to the benefit of the said statute.

WOOD, a solid substance, whereof the trunks and branches of trees consist. See the articles Tree, Trunk, Branch, Underwood, Plants, *physiology of*, Timber, &c.

The wood lies immediately under the bark, and forms by far the greatest part of the trunk and large branches of trees. It consists of concentric layers, the number of which increases with the age of the part. Each of these layers, as Mr. Duhamel ascertained, may be separated into several thinner layers, and these are composed chiefly of longitudinal fibres. Hence the reason that wood may be much more easily split asunder than cut across.

The wood, when we inspect it with attention, is not, through its whole exent, the same; the part of it next the bark is much softer and whiter, and more juicy than the rest, and has for that reason obtained a particular name; it has been called the alburnum or aubier. The perfect wood is browner, and harder, and denser, than the alburnum, and the layers increase in density the nearer they are to the centre. Sir John Hill gave to the innermost layer of wood the name of corona; or rather he gave this name to a thin zone which, according to him, lies between the wood and the pith.

Mortimer observes that all kinds of wood are to be preserved from insects and from many other occasions of decay, by oily substances, particularly the essential oils of vegetables. Oil of spike is excellent; and oil of juniper, turpentine, or any other of this kind, will serve the purpose; these will preserve tables, instruments, &c. from being eaten to pieces by these vermin; and linseed-oil will serve, in many cases, to the same purpose; probably nut-oil will do also, and this is a sweeter oil, and a better varnish for wood.

Some of the West Indian trees afford a sort of timber which, if it would answer in point of size, would have great advantages over any of the European wood in ship-building for the merchant-service, no worm ever touching this timber. The acajou, or tree which produces the cashew-nut, is of this kind; and there is a tree of Jamaica, known by the name of the white wood, which has exactly the same property; and so have many other of their trees.

To season wood expeditiously for sea-service, Mr. Boyle observes, that it has been usual to bake it in ovens.

The art of moulding wood is mentioned by Mr. Boyle as a desideratum in the art of carving. He says, he had been credibly informed of its having been practised at the Hague; and suspects that it might have been performed by some menstruum that softens the wood, and afterwards allows it to harden again, in the manner that tortoise-shell is moulded: or perhaps by reducing the wood into a powder, and then uniting it into a mass with strong but thin glue. And he adds, that, having mixed saw-dust with a fine glue made of isinglass, slightly straining out what was superfluous through a piece of linen, the remainder, formed into a ball, and dried, became so hard as to rebound when thrown against the floor.

The people who work much in wood, and about small works, find a very surprising difference in it, according to the different seasons at which the tree was cut down; and thts not regularly the same in regard to all species, but different in regard to each. The button-mould makers find that the wood of the pear-tree, cut in summer, works toughest; holly, on the contrary, works toughest when cut in winter; box is mellowest when it has been cut in summer, but hardest when cut about Easter; hawthorn works mellow when cut about October, and the service is always tough if cut in summer.

Wood Staining.

To stain wood yellow. Take any white wood, and brush it over several times with the tincture of turmeric root, made by putting an ounce of turmeric, ground to powder, to a pint of spirit, and after they have stood for some days, straining off the tincture. If the yellow colour is desired to have a reddish cast, a little dragon's blood must be added.

A cheaper, but less strong and bright yellow is, by the tincture of French berries made boiling-hot.

Wood may also be stained yellow by means of aqua fortis, which will sometimes produce a very beautiful yellow colour, but at other times a browner. Care must be taken, however, that the aqua fortis is not too strong; otherwise a blackish colour will be the result.

To stain wood red. For a bright red stain for wood, make a strong infusion of Brazil wood in stale urine, or water impregnated with pearl-ashes, in the proportion of an ounce to a gallon; to a gallon of either of which, the proportion of Brazil wood must be a pound, which being put to them, they must stand together for two or three days, often stirring the mixture. With this infusion strained, and made boiling-hot, brush over the wood to be stained till it appears strongly coloured; then, while yet wet, brush it over with alum-water made in the proportion of two ounces of alum to a quart of water.

For a less bright red dissolve an ounce of dragon's blood in a pint of spirit of wine, and brush over the wood with the tincture till the stain appears to be as strong as is desired; but this is, in fact, rather lacquering than staining.

For a pink or rose red, add to a gallon of the above infusion of Brazil wood two additional ounces of the pearl-ashes, and use it as was before directed: but it is necessary, in this case, to brush the wood over with alum-water. By increasing the proportion of pearl-ashes, the red may be rendered yet paler: but it is proper, when more than this quantity is added, to make the alum-water stronger.

To stain wood blue. Wood may be stained blue by means either of copper or indigo.

The method of staining blue with copper is as follows: Make a solution of copper in aqua fortis, and brush it while hot several times over the wood; then make a solution of pearl-ashes in the proportion of two ounces to a pint of water, and brush it hot over the wood stained with the solution of copper, till it is of a perfectly blue colour.

To stain wood green. Dissolve verdigrise in vinegar, or crystals of verdigrise in water, and with the hot solution brush over the wood till it is duly stained.

To stain wood purple. Brush the wood to be stained several times with a strong decoction of logwood and Brazil, made in the proportion of one pound of the logwood, and a quarter of a pound of the Brazil, to a gallon of water, and boiled for an hour or more. When the wood has been brushed over till there is a sufficient body of colour, let it dry, and then be slightly passed over by a solution of one drachm of pearl-ashes in a quart of water. This solution must be carefully used, as it will gradually change the colour from a brown red, which it will be originally found to be, to a dark blue purple, and therefore its effect must be restrained to the due point for producing the colour desired.

To stain wood a mahogany colour. The substances used for staining mahogany colour are madder, Brazil wood, and logwood: each of which produces reddish brown stains, and they must be mixed together in such proportions as will produce the tint required.

To stain wood black. Brush the wood several times over with a hot decoction of logwood. Then having prepared an infusion of galls by putting a quarter of a pound of powdered galls to two quarts of water, and setting them in the sunshine, or any other gentle heat, for three or four days, brush the wood over three or four times with it, and it will be of a beautiful black. It may be polished with a hard brush and shoemakers' black wax.

Wood, *fossile:* whole trees, or parts of them, are very frequently found buried in the earth, and that in different strata; sometimes in stone, but more usually in earth, but sometimes in small pieces loose among gravel. See Petrifaction.

WOODCOCK. See the article Scolopax.

Woodcock-shell, in natural history, the variegated yellowish purpura, with tubercles, and a long beak; and the thorny woodcock-shell is the yellow long-beaked purpura, with long and crooked spines.

WOODLOUSE. See Oniscus.

WOODPECKER. See Picus.

WOOF, among manufacturers, the threads which the weavers shoot across with an instrument called the shuttle. The woof is of different matter, according to the piece to be wrought. In taffety, both woof and warp are silk. In mohairs, the woof is usually wool, and the warp silk. In satins, the warp is frequently flax, and the woof silk.

WOOL, a kind of long, soft, curly hair (see the article Hair), which covers the skin of several of the ruminating animals, but which is particularly cut or shorn from that of the sheep, is in such universal use, that we should think it must be one of those animal substances most accurately known; it is, however, within a few years, that chemists have occupied themselves with examining it. Formerly, they contented themselves with considering it as diffusing a disagreeable smell when it was burned, and as yielding much oil and carbonat of ammonia, by distillation. It had been remarked in common life, that it did not inflame without great difficulty, and that it exhaled a very fetid thick smoke, instead of taking a bright flame. Finally, it was known, that the caustic alkalies easily corroded it, and that it quickly received, and forcibly retained, the colouring matters that were imprinted upon it, so that it deserved the first rank amongst the substances to be dyed. The extremely numerous uses, to which it has been appropriated in a number of arts from time immemorial, had brought all its useful properties to light; but chemistry had considered it only under its most general relation with all the animal matters, without ascertaining any thing specific in it. Berthollet began to occupy himself particularly with it in 1784 and 1785. He has shewn that the caustic alkaline leys dissolve it entirely, and that the acids precipitate it from this solution; in this combination, he has sought the mode of action which the alkalies exert upon animal substances, and he has particularly availed himself of it, for explaining the very remarkable energy which exists between these two matters. In this manner he has especially accounted for the action of the lapis causticus, upon the bodies of animals. He has, moreover, shown that the coal of wool was difficult to be burned, like that of all the animal compounds; that wool, treated by the nitric acid, afforded azotic gas, and oxalic acid, with a fatty matter. Chaptal, applying this solution of wool in the alkalies, to the processes of the manufacture of cloth, has represented it as a soap of great utility for these manufactures, and very well adapted for being substituted instead of that which is fabricated with vegetable oil. Wool has, moreover, been considered as a very bad conductor of caloric; and upon this principle it has been explained, how, by retaining that which exhales from our bodies, it forms the warmest clothing, the best adapted for moderating the severity of the winters. See Hair.

The facts contained in the article to which we refer, will explain all the phenomena, and all the properties which wool presents, in the frequent and advantageous uses to which it is constantly applied. The warmth which it affords as clothing or covering, its impenetrability by water, its fine colouration, the durability and solidity of its dyes, its destruction by the alkalies, the facility with which grease and oils penetrate it, the extension of the spots which are formed upon it, even the use which it has, and the functions which it performs upon the bodies of those animals which are covered with it, and from which we take it in order to clothe ourselves; the adherent and fetid oil; the exudation with which it is impregnated upon the bodies of sheep; the manner in which it defends them against the rain and the water, which are so hurtful to them; its slow combustion; the yellowness and loss of tenacity that are produced in it by long exposure to the air: in a word, all that appertains to its characters, its formation, its use, its so various properties, its destruction, becomes clear and easily conceivable by the distinct determination of its nature, and of its composition.

Wool, either in a raw or manufactured state, has always been the principal of the staple articles of this country. The price of wool was in very early times much higher in proportion to the wages of labour, the rent of land, and the price of butcher's meat, than at present. It was before the time of Edward III. always exported raw, the art of working it into cloth and dyeing being so imperfectly known, that no persons above the degree of working people could go dressed in cloth of English manufacture.

The first steps taken to encourage the manufacture of woollen cloths was by Edward the Third, who procured some good workmen from the Netherlands by means of protection and encouragement. The value of wool was considered as so essentially solid, that taxes were voted in that commodity, reckoning by the number of sacks; and in proportion to the price of the necessaries of life and value of silver, wool was at least three times dearer then than it is now. The manufacturing of cloth being once introduced into the country, the policy of preventing the exportation of the raw material was soon evident; and the first act, was that of H. IV. c. 2., by which the exportation of sheep, lambs, or rams, is forbidden under very heavy penalties.

By stat. 28. Geo. III. all former statutes respecting the exportation of wool and sheep are repealed, and numerous restrictions are consolidated in that statute.

By this act, if any person shall send or receive any sheep on board any vessel, to be carried out of the kingdom, such vessel shall be forfeited, and the person so offending shall forfeit 3*l.* for every sheep, and suffer solitary imprisonment for three months. But wether sheep, by a licence from the collector of the customs, may be taken on board for the use of the ship's company; and every person who shall export any wool, or woollen articles slightly made up, so as easily to be reduced again to wool, or any fuller's earth or tobacco-pipe clay, and every carrier, ship-owner, commander, mariner, or other person, who shall knowingly assist in exporting, or attempting to export, these articles, shall forfeit three shillings for every pound weight, or the sum of 50*l.* in the whole, at the election of the prosecutor, and shall also suffer solitary imprisonment for three months. But wool may be carried coastwise upon being duly entered, and security being given according to the directions of the statute, to the officer of the port whence the same shall be conveyed; and the owners of sheep within five miles of the sea, and ten miles in Kent and Sussex, cannot remove the wool, without giving notice to the officer of the nearest port, as directed by the statute.

Woollen Cloth, *interment in.* By 30 G. II. c. 3. (an act which is required to be given in charge at the assizes and sessions, and to be read four times publicly each year in the church by every parson), no corpse of any person (except of those who die of the plague) shall be buried in any shirt, shift, sheet, or shroud, or any thing made or mingled with flax, hemp, silk, hair, gold, or silver, or in any stuff or thing not made of sheep's wool only; or be put into any coffin lined or faced with any sort of clothier-stuff, or any other thing, made of any other material than sheep's wool only, under penalty of *5l.* to be recovered by distress and sale of the goods and chattels of the party deceased.

Wool-combers. By 35 G. III. c. 124, all those who have served an apprenticeship to the trade of a wool-comber, or who are by law entitled to exercise the same, and also their wives and children, may set up and exercise such trade, or any other trade or business they are apt and able for, in any town or place within this kingdom, without any molestation; nor shall they be removeable from such place by the poor laws.

WORD, in a military sense, signifies signal, token, order; as watch-word, &c.

The Word, / *Watch* Word, is a peculiar word that serves for a token and mark of distinction, given out in the orders of the day in times of peace, but in war every evening in the field, by the general who commands, and in garrison by the governor, or other officer commanding in chief, to prevent surprise, and hinder an enemy, or any treacherous person, from passing backwards and forwards. This watch-word is generally called the parole, and to it is added the countersign. The first is known to all officers and non-commissioned officers, the latter only to the sentinels. The officers that go the rounds, or patroles, exchange the word with the officers on duty; nor must the sentinels let any one pass who has not got the countersign.

Words *of command*, certain terms which have been adopted for the exercise and movement of military bodies, according to the nature of each particular service. Words of command are classed under two principal heads, and consist of those which are given by the chief or commander of a brigade, battalion, or division, and of those which are uttered by the subordinate leaders of troops, &c.

WORD, in language, an articulate sound, representing some idea or conception of the mind. The copiousness of the English language is proved by the following enumeration of the words in Johnson's Dictionary:

Articles			3
Nouns substantive			20409
Adjectives			9053
Pronouns			41
Verbs	active	5445	7880
	neuter	2425	
	passive	1	
	defective (or imperfect)	5	
	auxiliary	1	
	impersonal	3	
Verbal noun			1
Participles			38
Participial	adjectives		125
	nouns		3
Adverbs		496	2592
—— in *ly*		2096	
Prepositions			69
Conjunctions			19
Interjections			68
Total			40301

It must be remarked, however, that in this list many of the compound words are not reckoned; that the participles are those only having no verbs to which they may be referred, as *beloved*; that though so few verbal and participial nouns are stated by Johnson, yet every active verb may supply one of the former description, and every verb one of the latter; and that both these (verbal and participial nouns) seem to be merely different applications of a true gerund.

WORDS, which may be taken or interpreted by law in a general or common sense, ought not to receive a strained or unusual construction: and ambiguous words are to be construed so as to make them stand with law and equity, and not to be wrested to do wrong. 2 Lill. 711. See 16 Vin. Abr.

Words, Defamatory, are in some cases indictable, as calling a justice of the peace a rogue; and in others actionable, as to say such an attorney is a rogue.

WORKING IN HARVEST. A person may go abroad to work in harvest, carrying with him a certificate from the minister, and one churchwarden or overseer, that he has a dwelling-house or place, in which he inhabits, and has left wife and children, or some of them, there (or otherwise as his condition shall require), and declaring him an inhabitant there. A person carrying such certificate with him, shall not be apprehended under the stat. 17 G. II. c. 5. commonly called the vagrant act.

WORMS. See Vermes, and Medicine.

WORMWOOD. See Artemisia.

WOUND. See Surgery.

WRECK, such goods as after a shipwreck are cast upon the land by the sea, and left there within some county, for they are not wrecks so long as they remain at sea, being within the jurisdiction of the admiralty.

Various statutes have been made relative to wreck, which was formerly a perquisite belonging to the king, or by special grant to the lord of the manor; it is now, however, held, that if proof can be made of the property of any of the goods or lading which come to shore, they shall not be forfeited as wreck.

By the 3 Ed. c. 4, the sheriff of the county shall be bound to keep the goods a year and a day; that if any man can prove a property in them, either in his own right, or by right of representation, they shall be restored to him without delay.

By stat. 26. G. II. c. 19, plundering any vessel either in distress or wreck, and whether any living creature is on board or not, or preventing the escape of any person that endeavours to save his life, or putting out false lights to bring any vessel into danger, are all declared to be capital felonies; and by this statute, pilfering any goods cast ashore is declared to be petty larceny.

WREN. See Motacilla.

WRIST. See Anatomy.

WRIT, is the king's precept, by which any thing is commanded touching a suit or action; as the defendant or tenant to be summoned, a distress to be taken, a disseisin to be redressed, &c. And these writs are diversly divided; some in respect of their order, or manner of granting, are termed original, and some judicial.

Original writs, are those that are sent out for the summoning of the defendant in a personal, or the tenant in a real action, before the suit begins, or rather to begin the suit.

The judicial writs are those which are sent out by order of the court where the cause depends, upon occasion after the suit is begun.

Original writs are issued out in the court of chancery, for the summoning a defendant to appear, and are granted before the suit is begun, to begin the same: and judicial writs issue out of the court where the original is returned, after the suit began. The original bear date in the name of the king; but the judicial writs bear teste in the name of the chief justice.

Writ of Assistance, issues out of the exchequer, to authorize any person to take a constable, or other public officer, to seize goods or merchandize prohibited and uncustomed.

It is also a writ issuing out of the chancery to give a possession.

Writ of Inquiry of Damages, a judicial writ that issues out to the sheriff, upon a judgment by default, in action of the case, covenant, trespass, trover, &c. commanding him to summon a jury to inquire what damages the plaintiff has sustained occasione præmissiorum; and when this is returned with the inquisition, the rule for judgment is given upon it: and if nothing is said to the contrary, judgment is thereupon entered. 2 Lill. Abr. 721.

A writ of inquiry of damages, is a mere inquest of office, to inform the conscience of the court; who, if they please, may themselves assess the damages. And it is accordingly the practice, in actions upon promissory notes and bills of exchange, instead of executing a writ of inquiry, to apply to the court for a rule to shew cause, why it should not be referred to the master to see what is due, &c. which rule is made absolute unless good cause is shewn to the contrary.

WRITER *of the tallies,* an officer of the exchequer, being clerk to the auditor of the receipt, who writes upon the tallies, the whole letters of the teller's bill.

WULFERRIA, a genus of plants of the class and order diandria monogynia. The corolla is tubular, ringent, with the upper lip short: calyx five-parted; capsules two-celled, four-valved. There is one species, a herb of Carinthia.

WURMBEA, a genus of plants of the class and order hexandria trigynia. The corolla is six-parted, with an hexangular tube; filaments inserted into the throat. There are three species, herbs of the Cape.

X.

X, or x, the twenty-second letter of our alphabet. In numerals it expresses 10, whence in old Roman manuscripts it is used for denarius; and as such seems to be made of two V's placed one over the other. When a dash is added over it, thus $\bar{X}$, it signifies ten thousand.

XANTHE, a genus of plants of the class and order dioecia syngenesia. The flowers are dioecious; the calyx five-parted; corolla 5-6 petalled. There are two species, shrubs of Guiana.

XANTHIUM, a genus of plants of the class monœcia, order pentandria, and arranged in the natural classification under the 49th order, compositæ. The male flowers are composite, common calyx imbricated; corollulæ monopetalous, tubular, quinquefid. Female: calyx involucrum of two leaves, containing two flowers; corolla 0; drupa dry, prickly; nucleus bilocular. There are five species, only one of which is a native of Britain, the strumarium or less burdock. The stem of this plant is a foot and a half high, thick, often spotted; leaves heart-shaped, lobed, on long footstalks. Flowers, male and female, many together, in the alæ of the leaves. The leaves are bitter and astringent. A decoction of the whole plant affords a showy yellow colour, but it is better if only the flowers are used. Horses and goats eat it: cows, sheep, and swine, refuse it.

XANTHIORZA, a genus of plants of the class and order pentandria polygamia. There is no calyx; the petals five; nectarines five, pedicelled; capsules five, one-seeded. There is one species, a shrub of North America.

XANTHOXYLUM, the tooth-ache tree, a genus of plants of the class and order diœcia pentandria. The calyx is five-parted; no corolla; fem. pist. five; capsules five, one-seeded. There is one species, a tree of Jamaica.

XERANTHEMUM, a genus of the syngenesia polygamia superflua class of plants; the compound flower of which is unequal, and consists of many tubulous hermaphrodite floscules placed on the disc, and also a few female tubulated ones on the verge; the seeds are oblong, coronated, and contained in the cup. There are twenty-seven species.

XIMENIA, a genus of plants of the class and order pentandria monogynia. The calyx is a perianthium, composed of three small, cordated, and deciduous leaves; the corolla is formed of four petals, of a campanulated figure, divided at the edge into three erect, oblong, obtuse segments; the germen is small, and of a suboval figure; the fruit is an oval drupe, containing one cell; the seed is oval, unilocular, and smooth. There are three species, trees of the West Indies.

XIPHIAS, in zoology, the sword-fish, a genus of fishes belonging to the order of apodes. The upper jaw terminates in a long sword-shaped rostrum, from which it is called the sword-fish: there are no teeth in the mouth; the gill membrane has eight rays; and the body is somewhat cylindrical. There is but one species, viz. the gladius, found in the European ocean. This fish sometimes frequents our coasts, but is much more common in the Mediterranean sea, especially in the part that separates Italy from Sicily, which has been long celebrated for it: the promontory Pelorus, now Capo di Faro, was a place noted for the resort of the xiphias, and possibly the station of the speculatores, or the persons who watched and gave notice of the approach of the fish.

The antient method of taking them is particularly described by Strabo, and agrees exactly with that practised by the moderns. A man ascends one of the cliffs that overhang the sea: as soon as he spies the fish, he gives notice, either by his voice or by signs, of the course it takes. Another, that is stationed in a boat, climbs up the mast, and on seeing the sword-fish, directs the rowers towards it. As soon as he thinks they are got within reach, he descends, and taking a spear in his hand, strikes it into the fish; which, after wearying itself with its agitation, is seized and drawn into the boat. It is much esteemed by the Sicilians, who buy it up eagerly, and at its first coming into season, give about six-pence English per pound. The season lasts from May till August. The antients used to cut this fish into pieces and salt it; whence it was called Tomus Thurianus, from Thurii, a town in the bay of Tarentum, where it was taken and cured.

The sword-fish is said to be very voracious, and that it is a great enemy to the tunny, who (according to Belon) are as much terrified at it as sheep are at the sight of a wolf. It is a great enemy to the whales, and frequently destroys them.

XIPHIDIUM, a genus of plants of the class and order triandria monogynia. The corolla is six-petalled, equal; capsules superior, three-celled, many-seeded. There is one species, a herb of the West Indies.

XYLO-ALOES, or Aloe-wood, in pharmacy. See Excoecaria.

XYLOCARPUS, a genus of plants of the class and order octandria monogynia. The calyx is four-toothed; the corolla four-petalled; nectarium eight-cleft; filaments inserted in nect.; drupe four or five-grooved; nuts eight or ten. There is one species, a tree of the East Indies.

XYLOMELUM, a genus of plants of the class and order tetrandria monogynia. The ament. is with a simple scale; petals four, staminiferous; stigma club-shaped, obtuse. There is one species, of no note.

XYLOPHYLLA, a genus of plants of the class and order pentandria trigynia. The calyx is five-parted, coloured; corolla none; one stigma, jagged; capsule three-celled; seeds two. There are seven species, shrubs of the West Indies.

XYLOPIA, a genus of plants of the class and order polyandria polygynia. The calyx is three-leaved; petals six; capsule one or two seeded, four-cornered, two-valved; seeds arilled. There are three species, trees of the West Indies.

XYLOSMA, a genus of plants of the class and order diœcia polyandria. The calyx is four or five parted; corolla none; male stamina twenty to fifty; female style scarcely any; stigma trifid; berry dry; seeds two, three-sided. There are two species.

XYRIS, a genus of the triandria monogynia class of plants, the flower of which consists of three plain, patent, large, crenated petals, with narrow ungues, of the length of the cup. The fruit is a roundish, trilocular, trivalvular capsule, within the cup, with a great number of very small seeds. There are three species.

Y.

Y, the twenty-third letter of our alphabet. Y is a numeral, signifying 150, or according to Baronius, 159; and with a dash at top, as $\bar{Y}$, it signified 150,000.

YACHT. This word is taken from the Dutch. It is a small ship with one deck, carrying four, eight, or twelve guns, and thirty or forty men. Yachts, in general, are from thirty to 160 tons; contrived and adorned both withinside and without, for carrying state passengers. They answer the purposes of business as well as pleasure, being remarkably good sailers.

YARD. See Measure.

Yards *of a ship*, are those long pieces of timber which are made a little tapering at each end, and are fitted each athwart its proper mast, with the sails made fast to them, so as to be hoisted up, or lowered down, as occasion serves. They have their names from the masts to which they belong. As for the length of the main-yard, it is usually five-sixths of the length of the keel, or six-sevenths of the length of the main-mast. Their thickness is commonly three quarters of an inch for every yard in length. The length of the main-top-yard is two-fifths of the main-yard; and the fore-yard four-fifths of it. The sprit-sail-yard, and cross-jack-yard, are half the mizen-yard; and the thickness of the mizen-yard and spritsail-yard is half an inch for every yard in length. All small yards are half the great yards from cleat to cleat. When a yard is down a portlast, it gives the length of all top-sail-sheets, lifts, ties, and bunt-lines, as also of the leech-lines and halliards, measuring from the hounds to the deck: and when it is hoisted, it gives the length of clew-lines, clew-garnets, braces, tackles, sheets, and bow-lines.

There are several sea-terms relating to the management of the yards; as, square the yards; that is, see that they hang right across the ship, and no yard-arm traversed more than another: top the yards, that is, make them stand even. To top the main and fore-yards, the clew-lines are the most proper;

but when the top-sails are stowed, then the top-sail-sheets will top them.

Yard-arm is that half of the yard that is on either side of the mast, when it lies athwart the ship.

YARN, wool or flax spun into thread, of which they weave cloth.

Yarn is ordered after the following manner: After it has been spun upon spindles, spools, or the like, they reel it upon reels, which are hardly two feet in length, and have but two contrary cross-bars, being the best, and the least liable to ravelling. In reeling of fine yarn, the better to keep it from ravelling, you must, as it is reeled, with a tye-band of big twist, divide the slipping or skain into several leys, allowing to every ley eighty threads, and twenty leys to every slipping, if the yarn is very fine; otherwise less of both kinds. The yarn being spun, reeled, and in the slippings, the next thing is to scour it. In order to fetch out the spots, it should be laid in lukewarm water for three or four days, each day shifting it once, wringing it out, and laying it in another water of the same nature: then carry it to a well or brook, and rinse it till nothing comes from it but pure clean water: that done, take a bucking-tub, and cover the bottom with very fine ashen ashes; and then having opened and spread the slippings, lay them on those ashes, and put more ashes above, and lay in more slippings, covering them with ashes as before; and thus lay one upon another, till all the yarn is put in: afterwards cover up the uppermost yarn with a bucking cloth, and, in proportion to the size of the tub, lay in it a peck or two more of ashes: this done, pour upon the uppermost cloth a great deal of warm water, till the tub can receive no more, and let it stand so all night. Next morning you are to set a kettle of clean water on the fire; and when it is warm, pull out the spiggot of the bucking tub, to let the water run out of it, into another clean vessel; as the bucking tub wastes, fill it up again with the warm water on the fire: and as the water on the fire wastes, so likewise fill that up with the lye that comes from the bucking-tub; ever observing to make the lye hotter and hotter, till it boils: then you must, as before, ply it with the boiling lye at least four hours together, which is called the driving of a buck of yarn.

All this being done, for the whitening of it, you must take off the bucking cloth; then putting the yarn with the lye-ashes into large tubs, with your hands labour the yarn, ashes, and lye, pretty well together; afterwards carry it to a well, or river, and rinse it clean; then hang it upon poles in the air all day, and in the evening take the slippings down, and lay them in water all night; the next day hang them up again, and throw water upon them as they dry, observing to turn that side outermost which whitens slowest. After having done this for a week together, put all the yarn again into a bucking-tub, without ashes, covering it as before with a bucking cloth; lay thereon good store of fresh ashes, and drive that buck, as before, with very strong boiling lye, for half a day, or more; then take it out, and rinse it, hanging it up, as before, in the day-time, to dry, and laying it in water at night, another week: lastly, wash it over in fair water, and so dry it up. Your yarn being thus scoured and whitened, wind it up into round balls of a moderate size.

YEAR, in the full extent of the word, is a system or cycle of several months, usually 12. Others define year, in the general, a period or space of time, measured out by the revolution of some celestial body in its orbit. Thus, the time in which the fixed stars make a revolution, is called the great year; and the times in which Jupiter, Saturn, the Sun, Moon, &c. complete their courses, and return to the same point of the zodiac, are respectively called the years of Jupiter and Saturn, and the solar and lunar years, &c.

As year denoted originally a revolution, and was not limited to that of the Sun; accordingly we find by the oldest accounts, that people have, at different times, expressed other revolutions by it, particularly that of the Moon; and consequently that the years of some accounts, are to be reckoned only months, and sometimes periods of 2, or 3, or 4 months. This will help us greatly in understanding the accounts that certain nations give of their own antiquity, and perhaps of the age of men. We read expressly, in several of the old Greek writers, that the Egyptian year, at one period, was only a month; and we are farther told that at other periods it was three months, or four months; and it is probable that the children of Israel followed the Eglptian account of their years. The Egyptians talked, almost 2000 years ago, of having accounts of events 48,000 years distance. A great deal must be allowed to fallacy, on the above account; but beside this, the Egyptians had, in the time of the Greeks, the same ambition which the Chinese have at present; and wanted to pass themselves upon that people, as these do upon us, for the oldest inhabitants of the earth. They had recourse also to the same means; and both the present and the early impostors have pretended to antient observations of the heavenly bodies, and recounted eclipses in particular, to vouch for the truth of their accounts. Since the time in which the solar year, or period of the earth's revolution round the sun, has been received, we may account with certainty; but for those remote ages, in which we do not know with certainty what is meant by the term year, it is impossible to form any conjecture of the duration of time in the accounts. The Babylonians pretend to an antiquity of the same romantic kind; they talk of 47,000 years in which they had kept observations; but we may judge of these as of the others, and of the observations as of the years. The Egyptians speak of the stars having four times altered their courses in that period which they claim for their history, and that the Sun set twice in the east. They were not such perfect astronomers, but, after a roundabout voyage, they might perhaps mistake the east for the west when they came in.

Year, or *solar year*, properly, and by way of eminence so called, is the space of time in which the sun moves through the twelve signs of the ecliptic. This, by the observations of the best modern astronomers, contains 365 days, 5 hours, 48 minutes, 48 seconds; the quantity assumed by the authors of the Gregorian calendar is 365 days, 5 hours, 49 minutes. But in the civil or popular account, this year contains only 365 days; except every fourth year, which contains 366.

The vicissitude of seasons seems to have given occasion to the first institution of the year. Man, naturally curious to know the cause of that diversity, soon found it was the proximity and distance of the sun; and therefore gave the name year to the space of time in which that luminary performed his whole course, by returning to the same point of his orbit. According to the accuracy in their observations, the year of some nations was more perfect than that of others, but none of them quite exact, nor whose parts did not shift with regard to the parts of the sun's course.

According to Herodotus, it was the Egyptians who first formed the year, making it to contain 360 days, which they subdivided into 12 months, of 30 days each. Mercury Trismegistus added five days more to the account. And on this footing it is said that Thales instituted the year among the Greeks; though that form of the year did not hold throughout all Greece. Also, the Jewish, Syrian, Roman, Persian, Ethiopic, Arabic, &c. years, were all different. In fact, considering the imperfect state of astronomy in those ages, it is no wonder that different people should disagree in the calculation of the sun's course. We are even assured, that the Egyptian year itself was at first very different from that now represented.

The solar year is either astronomical or civil.

The astronomical solar year, is that which is determined precisely by astronomical observations; and is of two kinds, tropical, and sidereal or astral.

Tropical, or natural year, is the time the sun takes in passing through the zodiac; which, as before observed, is 365 days, 5 hours, 48 minutes, 48 seconds; or 365 days, 5 hours, 49 minutes. This is the only proper or natural year, because it always keeps the same seasons to the same months.

Sidereal or astral year, is the space of time the sun takes in passing from any fixed star, till his return to it again. This consists of 365 days, 6 hours, 9 minutes, 17 seconds; being 20 minutes, 29 seconds, longer than the true solar year.

Lunar year, is the space of twelve lunar months. Hence, from the two kinds of synodical lunar months, there arise two kinds of lunar years; the one astronomical, the other civil.

Lunar astronomical year, consists of twelve lunar synodical months; and therefore contains 354 days, 8 hours, 28 minutes, 38 seconds, and is therefore 10 days, 21 hours, 0 minutes, 10 seconds, shorter than the solar year; a difference which is the foundation of the epact.

Lunar civil year, is either common or embolismic.

The common lunar year consists of twelve lunar civil months, and therefore contains 354 days. And

The embolismic or intercalary lunar year, consists of 13 lunar civil months, and therefore contains 384 days.

Thus far we have considered years and months, with regard to astronomical principles, upon which the division is founded. By this, the various forms of civil years that have formerly obtained, or that do still obtain, in different nations, are to be examined.

Civil year, is that form of year which every nation has contrived or adopted, for computing their time by. Or the civil is the tropical year, considered as only consisting of a certain number of whole days; the odd hours and minutes being set aside, to render the computation of time, in the common occasions of life, more easy. As the tropical year is 365 days, 5 hours, 49 minutes, or almost 365 days, 6 hours, which is 365 days and a quarter; therefore if the civil year is made 365 days, every fourth year it must be 366 days, to keep nearly to the course of the sun. And hence the civil year is either common or bissextile. The

Common civil year, is that consisting of 365 days; having seven months of thirty-one days each, four of thirty days, and one of twenty-eight days; as indicated by the following well-known memorial verses:

Thirty days hath September,
April, June, and November;
February twenty-eight alone,
And all the rest have thirty-one.

Bissextile or leap-year, consists of 366 days, having one day extraordinary, called the intercalary, or bissextile day, which takes place every fourth year. This additional day to every fourth year, was first introduced by Julius Cæsar; who, to make the civil years keep pace with the tropical ones, contrived that the six hours which the latter exceeded the former, should make one day in four years, and be added between the 24th and 23d of February, which was their sixth of the calends of March; and as they then counted this day twice over, or had bis sexto calendas, hence the year itself came to be called bis sextus, and bissextile.

Among us, however, the intercalary day is not introduced by counting the 23d of February twice over, but by adding a day at the end of that month, which therefore in that year contains 29 days.

The civil or legal year, in England, formerly commenced on the day of the annunciation, or 25th of March; though the historical year began on the day of the Circumcision, or 1st of January; on which day the German and Italian year also begins. The part of the year between these two terms was usually expressed both ways; as 1745-6, or $174\frac{5}{6}$. But by the act for altering the style, the civil year now commences with the 1st of January.

Antient Roman year. This was the lunar year, which, as first settled by Romulus, contained only ten months, of unequal numbers of days, in the following order: viz.

March 31, April 30, May 31, June 30, Quintilis 31, Sextilis 30, September 30, October 31, November 30, December 30, in all 304 days; which came short of the true lunar year by 50 days, and of the solar by 61 days. Hence the beginning of Romulus's year was vague, and unfixed to any precise season; to remove which inconvenience, that prince ordered so many days to be added yearly as would make the state of the heavens correspond to the first month, without calling them by the name of any month.

Numa Pompilius corrected this irregular constitution of the year, composing two new months, January and February, of the days that were used to be added to the former year. Thus Numa's year consisted of twelve months, of different days, as follow; viz.

January	29;	February	28;	March	31;
April	29;	May	31;	June	29;
Quintilis	31;	Sextilis	29;	September	29;
October	31;	November	29;	December	29;

in all 355 days; therefore exceeding the quantity of a lunar civil year by one day; that of a lunar astronomical year by 15 hours, 11 minutes, 22 seconds; but falling short of the common solar year by 10 days; so that its beginning was still vague and unfixed.

Numa, however, desiring to have it begin at the winter solstice, ordered 22 days to be intercalated in February every 2d year, 23 every 4th, 22 every 6th, and 23 every 8th year.

But this rule failing to keep matters even, recourse was had to a new way of intercalating; and instead of 23 days every 8th year, only 15 were to be added. The care of the whole was committed to the pontifex maximus; who, however, neglecting the trust, let things run to great confusion. And thus the Roman year stood till Julius Cæsar reformed it.

Julian Year. This is in effect a solar year, commonly containing 365 days; though every 4th year, called bissextile, it contains 366. The months of the Julian year, with the number of their days, stood thus:

January	31;	February	28;	March	31;
April	30;	May	31;	June	30;
July	31;	August	31;	September	30;
October	31;	November	30;	December	31.

But every bissextile year had a day added in February, making it then to contain 29 days.

The mean quantity therefore of the Julian year is $365\frac{1}{4}$ days, or 365 days, 6 hours; exceeding the true solar year by somewhat more than 11 minutes; an excess which amounts to a whole day in almost 131 years. Hence the times of the equinoxes go backward, and fall earlier by one day in about 130 or 131 years. And thus the Roman year stood, till it was farther corrected by pope Gregory.

For settling this year, Julius Cæsar brought over from Egypt, Sosigenes, a celebrated mathematician; who, to supply the defect of 67 days, which had been lost through the neglect of the priests, and to bring the beginning of the year to the winter solstice, made one year to consist of 15 months, or 445 days; on which account, that year used to be called annus confusionis, or the year of confusion.

Gregorian Year. This is the Julian year corrected by this rule, viz. that instead of every secular or 100th year being a bissextile, as it would be in the former way, in the new way three of them are common years, and only the 4th is bissextile.

The error of 11 minutes in the Julian year, by continual repetition, had accumulated to an error of 13 days from the time when Cæsar made his correction; by which means the equinoxes were greatly disturbed. In the year 1582, the equinoxes were fallen back 10 days, and the full moons four days, more backward than they were in the time of the Nicene council, which was in the year 325; viz. the former from the 20th of March to the 10th, and the latter from the 5th to the 1st of April. To remedy this increasing irregularity, pope Gregory the 13th, in the year 1582, called together the chief astronomers of his time, and concerted this correction, throwing out the 10 days abovementioned. He exchanged the lunar cycle for that of the epacts, and made the 4th of October of that year to be the 15th; by that means restoring the vernal equinox to the 21st of March. It was also provided, by the omission of three intercalary days in 400 years, to make the civil year keep pace nearly with the solar year, for the time to come.

In the year 1700, the error of 10 days was grown to 11; upon which, the protestant states of Germany, to prevent farther confusion, adopted the Gregorian correction. And the same was accepted also in England in the year 1752, when 11 days were thrown out after the 2d of September that year, by accounting the 3d to be the 14th day of the month; calling this the new style, and the former the old style. And the Gregorian, or new style, is now in like manner used in most countries of Europe.

Yet this last correction is still not quite perfect; for as it has been shewn that in four centuries, the Julian year gains 3 days, 2 hours, 40 minutes; and as it is only the three days that are kept out of the Gregorian year, there is still an excess of 2 hours 40 minutes in four centuries, which amounts to a whole day in 36 centuries, or in 3600 years. See Calendar, &c.

Egyptian Year, called also the year of Nabonassar, on account of the epoch of Nabonassar, is the solar year of 365 days, divided into 12 months, of 30 days each, beside 5 intercalary days, added at the end. The order and names of these months are as follow:

1. Thoth;	2. Paophi;	3. Athyr;
4. Chojac;	5. Tybi;	6. Mecheir;
7. Phamenoth;	8. Pharmuthi;	9. Pachon;
10. Pauni;	11. Epiphi;	12. Mesori.

As the Egyptian year, by neglecting the 6 hours, in every 4 years loses a whole day of the Julian year, its beginning runs through every part of the Julian year in the space of 1460 years; after which, they meet again; for which reason it is called the erratic year. And because this return to the same day of the Julian year, is performed in the space of 1460 Julian years, this circle is called the Sothic period.

This year was applied by the Egyptians to civil uses, till Anthony and Cleopatra were defeated; but the mathematicians and astronomers used it till the time of Ptolomy, who made use of it in his Almagest; so that the knowledge of it is of great use in astronomy, for comparing the antient observations with the modern.

The antient Egyptians, we are told by Diodorus Siculus, measured their years by the course of the moon. At first they were only one month, then 3, then 4, like that of the Arcadians; and then 6, like that of the people of Acarnania. Those authors add, that it is on this account that they reckon such a vast number of years from the beginning of the world; and that in the history of their kings, we meet with some who lived 1000 or 1200 years. By such means many account for the great ages of the antient patriarchs; expounding the gradual decrease in their ages, by the successive increase of the number of months in their years.

Upon the Egyptians being subdued by the Romans, they received the Julian year, though with some alteration; for they still retained their antient months, with the five additional days; and every fourth year they intercalated another day, for the 6 hours, at the end of the year, or between the 28th and 29th of August. Also, the beginning of their year, or the first day of the month Thoth, answered to the 29th of August of the Julian year, or to the 30th if it happened to be leap-year.

The antient Greek year, was a lunar year, consisting of 12 months, which at first had each 30 days, then alternately 29 and 30 days, computed from the first appearance of the new moon; with the addition of an embolismic month of 30 days, every 3d, 5th, 8th, 11th, 14th, 16th, and 19th year of a cycle of 19 years; in order to keep the new and full moons to the same terms or seasons of the year.

Their year commenced with that new moon which was nearest to the summer solstice. And the order of the months, with the number of their days, were as follow: 1. Εκατομβαιων, of 29 days; 2. Μηταγειτνιω 30; 3. Βοηδρομιων 29; 4. Μαιμακτηριων 30; 5. Πυανεψιων 29; 6 Ποσειδεων 30; 7. Γαμηλιων 29; 8. Ανθεστηριων 30; 9. Ελαφηβολιων 29; 10. Μουνυχιων 30: 11. Θαργηλιων; 12. Σκιροφοριων 30. But many of the Greek nations had other names for their months.

The ancient Jewish year is a lunar year, usually consisting of 11 months, containing alternately 30 and 29 days. And it was made to agree with the solar year, by adding 11, and sometimes 12 days, at the end of the year, or by an embolismic month. The order and quantities of the months were as follow; 1. Nisan or Abib, 30 days; 2. Jiar or Zius, 29; 3. Siban or Sievan 30; 4. Thamuz or Tamuz 29; 5. Ab 30; 6. Elul 29; 7. Tisri or Ethanim 30; 8. Marchesvam or Bul 29; 9. Cisleu 30; 10. Tebeth 29; 11. Sabat or Schebeth 30; 12. Adar 30, in the embolismic year, but 29 in the common year. Note, in the defective year, Cisleu was only 29 days; and in the redundant year, Marchesvam was 30.

The modern Jewish year is likewise lunar, consisting of 12 months in common years, but of 13 in embolismic years; which, in a cycle of 19 years, are the 3d, 6th, 8th, 11th, 14th, 17th, and 19th. Its beginning is fixed to the new moon next after the autumnal equinox. The names and order of the months, with the number of the days, are as follow: 1. Tisri 30 days; 2. Marchesvam 29; 3. Cisleu 30; 4. Tebeth 29; 5. Schebeth 30; 6. Adar 29; 7. Veadar, in the embolismic year, 30; 8. Nisan 30; 9. Ilar 29; 10. Sivan 30; 11. Thamuz 29; 12. Ab, 30; 13. Elul 29.

The Syrian year, is a solar one, having its beginning fixed to the beginning of October in the Julian year; from which it only differs in the names of the months, the quantities being the same, as follow: 1. Tishrin, answering to our October, and containing 31 days; 2. Latter Tishrin, containing, like November, 30 days; 3. Canun 31: 4. Latter Canun 31; 5. Shabat 28, or 29 in a leap year; 6. Adar 31; 7. Nisan 30; 8. Aiyar 31; 9. Haziram 30; 10. Thamuz 31; 11. Ab 31; 12. Elul 30.

The Persian year, is a solar one, of 365 days, consisting of 12 months of 30 days each, with 5 intercalary days added at the end. The months are as follow: 1. Asrudia meh; 2. Ardihascht meh; 3. Cardi meh; 4. Thir meh; 5. Merded meh; 6. Schabarir meh; 7. Mehar meh; 8. Aben meh; 9. Adar meh; 10. Di meh; 11. Behen meh; 12. Assirer meh. This year is the same as the Egyptian Nabonassarean, and is called the Yesdegerdic year, to distinguish it from the fixed solar year, called the Gelalean year, which the Persians began to use in the year 1079, and which was formed by an intercalation, made six or seven times in four years, and then once every 5th year.

The Arabic, Mahometan, and Turkish year, called also the year of the Hegira, is a lunar year, equal to 354 days, 8 hours, 48 minutes, and consists of 12 months, containing alternately 30 and 29 days: although sometimes it contains 13 months; the names &c. being as follow: 1. Muharram of 30 days; 2. Saphar 29; 3. Rabia 30; 4. Latter Rabia 29; 5. Jomada 30; 6. Latter Jomada 29; 7. Rajab 30; 8. Shaaban 29; 9. Ramadan 30; 10. Shawal 29; 11. Dulkaadah 30; 12. Dulheggia 29, but in the embolismic year 30. An intercalary day is added every 2d, 5th, 7th, 10th, 13th, 15th, 18th, 21st, 24th, 26th, 29th, in a cycle of 29 years. The months commence with the first appearance of the new moons after the conjunctions.

Ethiopic year, is a solar year perfectly agreeing with the Actiac, except in the names of the months, which are: 1. Mascaram; 2. Tykympt; 3. Hydar; 4. Tyshas; 5. Tyr; 6. Jacatil; 7. Magabit; 8. Mijazia; 9. Ginbat; 10. Syne; 11. Hamel; 12. Hahase. Intercalary days 5. It commences with the Egyptian year, on the 29th of August of the Julian year.

YESDEGERDIC Year. See Persian Year.

Year and day, is a time that determines a right in many cases; and in some works an usurpation, and in others a prescription; as in case of an estray, if the owner, proclamation being made, challenges it not within the time, it is forfeited.

So is the year and day given in case of appeal; in case of descent after entry or claim, if no claim upon a fine or writ of right at the common law: so of a villain remaining in ancient demesne; of a man sore bruised or wounded; of protections; essoins in respect of the king's service; of a wreck; and divers other cases. Co. 6. Rep. Fol. 107.

Year books, reports in a regular series, from Ed. II. inclusive, to the time of Henry VIII., which were taken by the prothonotaries of the court, at the expence of the crown, and published annually.

Year day and waste, is a part of the king's prerogative whereby he challenges the profits of their lands and tenements for a year and a day, that are attainted of petty treason or felony; whoever is lord of the manor where the lands or tenements belong; and not only so, but in the end may waste the tenements, destroy the houses, root up the woods, garden, and pasture, and plough up the meadows, except the lord of the fee agrees with him for redemption of such waste, afterward restoring it to the lord of the fee. Staundf. Prærog. c. 16.

YEARS, *estate for*. Tenant for term of years, is where a man lets lands or tenements to another, for a certain term of years agreed upon between the lessor and lessee; and when the lessee enters by force of the lease, then he is tenant for term of years. Litt. Sect. 58.

If tenements are let to a man for the term of half a year, or for a quarter of a year, or any less time; this lessee is respected as tenant for years, and is styled so in some legal proceedings; a year being the shortest term, which the law in this case takes notice of. Litt. Sect. 67.

Generally, every estate which must expire at a period certain and prefixed, by whatever words created, is an estate for years; and therefore this estate is frequently called a term; because its duration or continuance, is bounded, limited, and determined. 2 Black. 143.

For every such estate must have a certain beginning, and certain end. If no day of commencement is named in the creation of this estate, it begins from the making, or delivery of the lease. A lease for so many years as such an one shall live, is void from the beginning; for it is neither certain, nor can it ever be reduced to a certainty, during the continuance of the lease. Id.

And the same doctrine holds, if a person makes a lease of his glebe for so many years as he shall continue parson of such a church, for this is still more uncertain. But a lease for twenty or more years, if the parson shall so long live, or if he shall so long continue parson, is good; for there is a certain period fixed, beyond which it cannot last, though it may determine sooner, on the parson's death, or his ceasing to be parson there. 2 Black. 143.

An estate for years, though ever so many, is inferior to an estate for life. For an estate for life, though it should be only for the life of another person, is a freehold; but an estate, though for a thousand years, is only a chattel, and reckoned part of the personal estate. Id.

Hence it follows, that a lease for years may be made to commence in futuro, though a lease for life cannot. As if I grant lands to one from Michaelmas next for twenty years, this is good; but to hold from Michaelmas next for the term of his natural life, is void. Id.

For no estate of freehold can commence in futuro, because it cannot be created at common law without livery of seisin, or corporal possession of the land; and corporal possession cannot be given of an estate now, which is not to commence now, but hereafter. And because no livery of seisin is necessary for a lease for years, such a lessee is not said to be seized, or to have true legal seisin of the lands. Nor indeed does the bare lease, vest any estate in the lessee, but only gives him a right of entry on the tenement, which right is called his interest in the term; but when he has actually so entered, and thereby accepted the grant, the estate is then and not before vested in him; and he is possessed, not properly of the land, but of the term of years, the possession or seisin of the land remaining still in him who has the freehold. 2 Black.

YELLOW. See Dyeing.

Yellow-hammer. See Emberiza.

YEOMAN, is defined to be one that has fee land of 40*s.* a-year; who was thereby heretofore qualified to serve on juries, and can yet vote for knights of the shire, and do any other act where the law requires one that is probus et legalis homo. Below yeomen are ranked tradesmen, artificers, and labourers. 2 Inst. 668.

Yeoman *of the guard*, one belonging to a sort of foot guards, who attend at the palace. The yeomen were uniformly required to be six feet high. They are in number 100 on constant duty, and 70 off duty. The one half carry arquebuses, and the other pertuisans. Their attendance is confined to the sovereign's person, both at home and abroad. They are clad after the manner of king Henry VIII.

The yeomen of the guards were anciently 250 men of the next rank, under gentry. This corps was first instituted by king Henry VII. anno 1466.

YEST, Yeast, or Barm, a head or scum, rising upon beer or ale, while working or fermenting in the vat. See Fermentation.

YEW. See Taxus.

YOKE, in agriculture, a frame of wood, fitted over the necks of oxen, whereby they are coupled together, and harnessed to the plough. See Plough.

It consists of several parts: as the yoke, properly so called, which is a thick piece of wood, lying over the neck; the bow, which compasses the neck about; the stitchings and wreathings, which hold the bow fast in the yoke; and the yoke-ring and ox-chain.

The Romans made the enemies they subdued, pass under the yoke, which they called sub jugum mittere, that is, they made them pass under a sort of furcæ patibulares, or gallows, consisting of a pike or other weapon, laid across two others, planted upright in the ground.

YORK. In the county of York, only one pannel of 48 jurors shall be returned to serve on the grand jury at the assizes; and at the quarter-sessions not above 40, either upon the grand jury or other service there. 7 and 8 W. III. c. 32.

And no person having 150*l.* a year, shall be summoned to the sessions, but only persons less liable to bear the expence of attending at the assizes. 1 Anne, c. 13.

By stat. 4 W. III. c. 2. the inhabitants of the province of York, have power to dispose of their personal estate by will; which before they had not, further than the testator's own proportionable part, called the dead man's or death's part. For if the testator had a wife, and a child, or children, the wife should have one third, the child or children another third, and the remaining third was all that the testator had to dispose of. If he had a wife and no child, then she should have one moiety, and the other moiety remained to him to dispose of by his testament; so if he left a child or children, and no wife. But if he had neither wife or child, he might dispose of the whole. In case of intestacy, the same proportions continue to the wife and children to this day; but the dead man's part shall be distributed according to the stat. 22 and 23 Car. II. c. 10. commonly called the statute of distributions.

YTTRIA. Some time before 1788, Captain Arhenius discovered in the quarry of Ytterby in Sweden, a peculiar mineral different from all those described by mineralogists. Its colour is greenish-black, and its fracture like that of glass. It is magnetic, and generally too hard to be scratched by a knife. It is opaque, except in small pieces, when it transmits some yellow rays. Its specific gravity is 4.237. Professor Gadolin analysed this mineral in 1794, and found it to contain a new earth; but though his analysis was published in the Stockholm Transactions for 1794, and in Crell's Annals for 1796, it was some time before it drew the attention of chemical mineralogists. The conclusions of Gadolin were confirmed by Ekeberg in 1707, who gave to the new earth the name of yttria. They were still farther confirmed and extended by Vauquelin in 1800, and likewise by Klaproth about the same time; and Ekeberg has published a new dissertation on the subject in the Swedish Transactions for 1802. We may therefore consider the peculiar nature of yttria as sufficiently established.

Hitherto yttria has been found only in the black mineral first analysed by Gadolin, and hence called gadolinite, in which it is combined with black oxide of iron and the earth called silica; and in yttrotantalite, which from the description of Ekeberg is a compound of tantalium and yttria. Both these minerals occur only in the quarry of Ytterby. From the first, which is the most common, the earth may be procured by treating the mineral reduced to powder with a mixture of nitric and muriatic acids, till it is completely decomposed; then filtring the solution, previously evaporated nearly to dryness, and then diluting it with water. By this process the silica is left behind. The liquid which passes through the filtre is to be evaporated to dryness, and the residue heated to redness for a considerable time in a close vessel, and then redissolved in water and filtred. What passes through the filtre is colourless; when treated with ammonia, pure yttria falls.

Yttria, thus procured, has the appearance of a fine white powder, and has neither taste nor smell. It is not melted by the application of heat. It has no action on vegetable blues. It is much heavier than any of the other earths; its specific gravity according to Ekeberg, being no less than 4.842.

It is insoluble in water; yet it is capable of retaining a great proportion of that liquid, as is the case with alumina. Klaproth ascertained, that one hundred parts of yttria precipitated from muriatic acid by ammonia, and dried in a low temperature, lose thirty-one parts, or almost a third of their weight, when heated to redness in a crucible. Now this last consists of pure water alone.

It is not soluble in pure alkalies; but it dissolves readily in carbonat of ammonia, and in all the other alkaline carbonats. It combines with acids, and forms with them salts which have a sweet taste, and at the same time a certain degree of austerity. Some of these salts have a red colour. Yttria is the only earthy body known which has the property of forming coloured salts with acids.

Yttria is not altered by light, nor is it likely that it combines with oxygen. From the experiments of Klaproth, it does not appear to combine readily with sulphur; nor is it likely that it unites with any of the other simple combustibles.

We may take it for granted that it is not affected by azote; but it combines with muriatic acid, and forms a salt not capable of crystallizing. Its action on the metals and metallic oxides is unknown.

YTTROTANTALITE, a mineral found in the same place with gadolinite. It is in small kidney-form masses of the size of a hazel-nut. Fracture granular, iron-grey, and of a metallic lustre. Hardness inconsiderable. May be scratched with a knife, and gives a grey-coloured powder. Not magnetic. Specific gravity 5.130. It is composed of the oxides of tantalium and iron united to yttria.

YUCCA, *Adam's needle*, a genus of plants of the class hexandria and order monogynia. The corolla is campanulate and patent, there is no style, the capsule is trilocular. There are four species, none of which are natives of Britain. All of them are exceedingly curious in their growth, and are therefore much cultivated in gardens. The Indians make a kind of bread from the roots of this plant.

YUNX, in zoology, a genus of birds of the order picæ. The bill is short, roundish, and pointed; the nostrils concave and naked; the tongue very long and cylindric; there are two fore and two hind claws. There is only one species, the torquilla, wry-neck, which is a native of Europe, Asia, and Africa, and is often seen in Britain. It is ash-coloured above, with light black and brown strokes; beneath light-brown, with black spots; tail ash-colour, with four black bars; weight 1 oz; irides hazel; length seven inches; migrates.

Z.

Z, the twenty-fourth and last letter of our alphabet.

In abbreviations this letter formerly stood as a mark for several sorts of weights; sometimes it signified an ounce and a half, and very frequently it stood for half an ounce; sometimes for the eighth part of an ounce, or a dram troy weight; and it has in earlier times been used to express the third part of an ounce, or eight scruples. ZZ were used by some of the antient physicians to express myrrh, and at present they are often used to signify zinziber, or ginger.

ZAFFRE, is the oxyde of cobalt, employed for painting pottery-ware and cobalt of a blue colour. See Cobalt.

ZAMIA, a genus of the natural order of palmæ. The ament. is shobile-shaped, scales with pollen underneath; fem. ament. shobile-shaped with scales at each margin; berry solitary. There are five species.

ZANNICHELLIA, horned pond-weed, a genus of the monœcia monandria class of plants, the male flower of which consists only of a single stamen; it has neither calyx nor corolla. In the female flower the calyx is composed of a single leaf; there is no corolla; the germina are about four; the seeds, which are oblong and acuminated on both sides, are as many. There is one species.

ZANONIA, the name of a genus of plants of the order diœcia, and class pentandria. The characters are these: it produces separate male and female flowers; in the male flower the cup is a perianthium, composed of three leaves of an oval figure, expanding every way, and shorter than the flower; the flower is monopetalous, but divided into five segments, and has an open mouth; the segments are jagged, and are equal in size, and bend backwards; the stamina are five filaments of the length of the cup, standing open at their end, and terminated by simple apices; the female flowers grow on separate plants, and have the cup and flower the same as in the male, only that the cup stands upon the germen of the pistil; this germen is oblong, and from it are propagated three reflex conic styles; the stigmata are bifid and curled; the fruit is a long and very large berry, truncated at the end, and very small at the base; it contains three cells, and has a curled suture near the apex; the seeds are two, they are of an oblong figure and flat. There is one species, the indica.

ZEA, *Indian corn*, a genus of plants of the class monœcia, order triandria. The male flowers are placed on distinct spikes; the calyx is a biflorous, beardless glume; the corolla is a beardless glume; the female calyx is a bivalve glume, as is the corolla. There is one filiform, pendulous style; the seeds are solitary and buried in an oblong receptacle. There is only species, the Mays, or maize. The Indians in New England, and many other parts of America, had no other vegetable but maize or Indian corn for making their bread. They call it weachin; and in the United States of America there is much of the bread of the country made of this grain, not of the European corn. In Italy, Germany, Spain and Portugal, maize constitutes a great part of the food of the poor inhabitants.

The ear of the maize yields a much greater quantity of grain than any of our corn-ears. There are commonly about eight rows of grain in the ear, often more, if the ground is good. Each of these rows contains at least thirty grains, and each of these gives much more flour than a grain of any of our corn. The grains are usually either white or yellowish; but sometimes they are red, blueish, greenish, or olive-coloured, and sometimes striped and variegated. This sort of grain, though so essentially necessary to the natives of the place, is yet liable to many accidents. It does not ripen till the end of September; so that the rains often fall heavy upon it while on the stalk, and birds in general peck it when it is soft and unripe. Nature has, to defend it from these accidents, covered it with a thick husk, which keeps off slight rains very well; but the birds, if not frightened away, often eat through it, and devour a great quantity of the grain.

ZEBRA. See Equus.

ZENITH, in astronomy, the vertical point; or a point in the heavens directly over our heads.

ZEOLITE. This stone was first described by Cronstedt in the Stockholm Transactions for 1756. It is sometimes found amorphous and crystallized. The primitive form of its crystal is a rectangular prism, whose bases are squares. The most common variety is a long four-sided prism, terminated by low four-sided pyramids.

Its texture is striated or fibrous. Its lustre is silky. Refracts double. Absorbs water. Specific gravity 2,0833. Colour white, often with a shade of red or yellow. When heated it becomes electric like the tourmaline. Before the blow-pipe it froths, emits a phosphorescent light, and melts into a white semi-transparent enamel, too soft to cut glass, and soluble in acids. In acids it dissolves slowly and partially without effervescence; and at last, unless the quantity of liquid is too great, it is converted into a jelly. A specimen of zeolite, analysed by Vauquelin, contained

53.00	silica
27.00	alumina
9.46	lime
10.00	water
99.46.	

ZEUS, in ichthyology, a genus of fishes of the order of thoracici. The head is compressed and declines, the upper lip being vaulted over by a transverse membrane; the tongue is subulated; there are seven rays in the gill-membrane; and the body is compressed. The species are eight; of which the most remarkable is the faber or doree. It is of a hideous form; its body is oval, and greatly compressed on the sides; the head large; the snout vastly projecting; the mouth very wide; the teeth very small; the eyes great, the irides yellow; the lateral line oddly distorted, sinking at each end, and rising near the back in the middle; beneath it on each side is a round black spot. The tail is round at the end, and consists of fifteen yellow rays. The colour of the sides is olive, varied with light blue and white, and while living is very resplendent, and as if gilt; for which reason it is called the doree. The largest fish we have heard of weighed twelve pounds. See Plate Nat. Hist. fig. 421.

ZIERIA, a genus of plants of the class and order tetrandria monogynia. The cal. is four-parted; petals four; styles simple; caps. four; seeds arilled. There is one species, not deserving notice.

ZINC. The antients were acquainted with a mineral to which they give the name of cadmia, from Cadmus, who first taught the Greeks to use it. They knew that when melted with copper it formed brass; and that when burnt, a white spongy kind of ashes was volatilized, which they used in medicine. This mineral contained a good deal of zinc; and yet there is no proof remaining that the antients were acquainted with that metal. The word zinc first occurs in the writings Paracelsus, who died in 1541. He informs us very gravely, that it is a metal, and not a metal, and that it consists chiefly of the ashes of copper. This metal has also been called spelter.

Zinc has never been found in Europe in a state of purity, and it was long before a method was discovered of extracting it from its ore. Henkel pointed out one in 1721; Von Swab obtained it by distillation in 1742; and Margraf published a process in the Berlin Memoirs in 1746.

Zinc is of a brilliant white colour, with a shade of blue, and is composed of a number of thin plates adhering together. When this metal is rubbed for some time between the fingers, they acquire a peculiar taste, and emit a very perceptible smell. Its hardness is six and a half. When rubbed upon the fingers it tinges them of a black colour. Its specific gravity, after it has been melted, is 6.861; after it has been compressed 7.1908; so that its density is increased 1-20th.

This metal forms in a manner the limit between the brittle and the malleable metals. Its malleability is by no means to be compared with that of some of the metals; yet it is not brittle, like others. When struck with a hammer, it does not break, but yields and becomes somewhat flatter; and by a cautious and equal pressure, it may be reduced to pretty thin plates, which are supple and elastic, but cannot be folded without breaking. This property of zinc was first ascertained by Mr. Sage. When heated to about 400°, it becomes so brittle, that it may be reduced to powder in a mortar.

It is not ductile. Its tenacity has not been ascertained. When heated to the temperature of about 700°, it melts; and if the heat is increased, it evaporates, and may be easily distilled over in close vessels. When allowed to cool slowly, it crystallizes in small bundles of quadrangular prisms, disposed in all directions. If they are exposed to the air while hot, they assume a blue changeable colour.

When exposed to the air, its lustre is soon tarnished, but it scarcely undergoes any other change. When kept under water its surface soon becomes black, the water is slowly decomposed, hydrogen gas is emitted, and the oxygen combines with the metal. If the heat is increased, the decomposition goes on more rapidly; and if the steam of water is made to pass over zinc at a very high temperature, it is decomposed so rapidly, that very violent detonations take place.

When zinc is kept melted in an open vessel, its surface is soon covered with a grey-coloured pellicle, in consequence of its combination with oxygen. When this pellicle is removed, another soon succeeds it; and in this manner may the whole of the zinc be oxidated. When these pellicles are heated and agitated in an open vessel, they soon assume the form of a grey powder, often having a shade of yellow. The powder has been called the grey oxide of zinc. When zinc is raised to a very strong red heat in an open vessel, it takes fire, and burns with a brilliant white flame, and at the same time emits a vast quantity of very light white flakes These are merely an oxide of zinc. This oxide was well known to the antients. Dioscorides describes the method of preparing it. The antients called it pompholyx; the early chemists gave it the name of nibil album, lana philosophica, and flowers of zinc. Dioscorides compares it to wool.

Two different oxides of zinc are at present known.

The peroxide, or white oxide of zinc, is the oxide usually formed in the different processes to which the metal is subjected. We are indebted to Mr. Proust for an exact analysis of this oxide and its combinations. It is composed of eighty parts of zinc and twenty of oxygen. It may be formed not only by burning zinc, but also by dissolving it in diluted sulphuric or nitric acid, and precipitating it by potass. This oxide is used as a paint; but its colour must be perfectly white. When zinc happens to contain a little iron, which is often the case with the zinc of commerce, the oxide obtained has a tinge of yellow, because it is mixed with a little yellow oxide of iron.

The protoxide, or zinc combined with a minimum of oxygen, is obtained by exposing the peroxide to a strong heat in an earthenware retort or covered crucible. From the experiments of Desormes and Clement, it appears that by this process zinc loses a portion of its oxygen, and assumes a yellow colour. According to the analysis of these chemists, the protoxide of zinc is composed of eighty-eight parts of zinc and twelve parts of oxygen. The reduction of the oxides of zinc is an operation of difficulty, in consequence of the strong affinity which exists between zinc and oxygen. It must be mixed with charcoal, and exposed to a strong heat in vessels which screen it from the contact of the external air.

Most of the simple combustibles combine with zinc.

Hydrogen gas dissolves a little of it in certain situations. It is usual to procure hydrogen gas by dissolving zinc in diluted sulphuric acid. The gas thus obtained is as pure as any which can be procured. It carries along with it however a little zinc in solution; but it deposits it again upon the sides of the glass jars, and on the surface of the water over which it stands. This gas, if we believe the French chemists, contains often a little carbureted hydrogen gas; a proof that zinc frequently contains carbon. When this metal is dissolved in sulphuric acid, it deposits a black insoluble powder, which the French chemists found to be carburet of iron. It is uncertain whether it is carburet, or carbon combined with zinc, which gives occasion to the production of the carbureted hydrogen gas.

It is believed at present that sulphur does not combine with zinc in the metallic state; because no attempt to form the combination artificially has succeeded. Sulphur unites with the oxide of zinc when melted along with it in a crucible. This was first discovered by Dehne in 1781. The experiment was afterwards repeated by Morveau. The sulphureted oxide of zinc is of a dark-brown colour, and brittle. It exists native in great abundance, and is known by the name of blende. Mr. Proust, however, has announced it as his opinion, that blende is a sulphuret of zinc, or a compound of sulphur and zinc in the metallic state.

Zinc may be combined with phosphorus, by dropping small bits of phosphorus into it while in a state of fusion. Pelletier, to whom we are indebted for the experiment, added also a little resin, to prevent the oxidation of the zinc. Phosphuret of zinc is of a white colour, and metallic splendour, but resembles lead more than zinc. It is somewhat malleable. When hammered or filed, it emits the odour of phosphorus. When exposed to a strong heat, it burns like zinc.

Phosphorus combines also with the oxide of zinc; a compound which Margraf had obtained during his experiments on phosphorus. When twelve parts of oxide of zinc, twelve parts of phosphoric glass, and two parts of charcoal-powder, are distilled in an earthenware retort, and a strong heat applied, a metallic substance sublimes of a silver-white colour, which when broken has a vitreous appearance. This, according to Pelletier, is phosphureted oxide of zinc. When heated by the blowpipe, the phosphorus burns, and leaves behind a glass, transparent while in fusion, but opaque after cooling.

Phosphureted oxide of zinc is obtained also when two parts of zinc and one part of phosphorus are distilled in an earthen retort. The products are, 1. Zinc; 2. Oxide of zinc; 3. A red sublimate, which is phosphureted oxide of zinc; 4. Needleform crystals of metallic brilliancy, and a blueish colour. These also Pelletier considers as phosphureted oxide of zinc.

Zinc does not combine with azote. Muriatic acid readily converts it into an oxide.

Zinc combines with almost all the metals, and some of its alloys are of great importance.

It may be united to gold in any proportion by fusion. The alloy is the whiter and the more brittle, the greater quantity of zinc it contains. An alloy, consisting of equal parts of these metals, is very hard and white, receives a fine polish, and does not tarnish readily. It has therefore been proposed by Mr. Malouin as very proper for the specula of telescopes. One part of zinc is said to destroy the ductility of 100 parts of gold.

Platinum combines very readily with zinc. The alloy is brittle, pretty hard, very fusible, of a blueish-white colour, and not so clear as that of zinc.

The alloy of silver and zinc is easily produced by fusion. It is brittle, and has not been applied to any use.

Zinc may be combined with mercury, either by triturating the two metals together, or by dropping mercury into melted zinc. This amalgam is solid. It crystallizes when melted, and cooled slowly into lamellated hexagonal figures, with cavities between them. They are composed of one part of zinc and two and a half of mercury. It is used to rub on electrical machines, in order to excite electricity.

Zinc combines readily with copper, and forms one of the most useful of all the metallic alloys. The metals are usually combined together by stratifying plates of copper and a native oxide of zinc combined with carbonic acid, called calamine, and applying heat. When the zinc does not exceed a fourth part of the copper, the alloy is known by the name of brass. It is of a beautiful yellow colour, more fusible than copper, and not so apt to tarnish. It is malleable, and so ductile that it may be drawn out into wire. Its density is greater than the mean. It ought to be by calculation 7.6296, but it actually is 8.3958; so that its density is increased by about 1-10th. When the alloy contains three parts of zinc and four of copper, it assumes a colour nearly the same with gold, but it is not so malleable as brass. It is then called pinchbeck, prince's metal, or prince Rupert's metal. Brass was known, and very much valued, by the antients. They used an ore of zinc to form it, which they called cadmia. Dr. Watson has proved that it was to brass that they gave the name of orichalcum. Their æs was copper, or rather bronze.

It is very difficult to form an alloy of iron and zinc. Wallerius has shewn that iron is capable of combining with a small portion of zinc; and Malouin has shewn that zinc may be used instead of tin to cover iron plates, a proof that there is an affinity between the two metals.

Tin and zinc may be easily combined by fusion. The alloy is much harder than zinc, and scarcely less ductile. This alloy is often the principal ingredient in the compound called pewter.

The alloy of lead and zinc has been examined by Wallerius, Gelert, Muschenbroeck, and Gmelin. This last chemist succeeded in forming the alloy by fusion. He put some suet into the mixture, and covered the crucible in order to prevent the evaporation of the zinc. When the zinc exceeded the lead very much, the alloy was malleable, and much harder than lead. A mixture of two parts of zinc and one of lead formed an alloy more ductile and harder than the last. A mixture of equal parts of zinc and lead, formed an alloy differing little in ductility and colour from lead; but it was harder and more susceptible of polish, and much more sonorous. When the mixture contained a smaller quantity of zinc, it still approached nearer the ductility and colour of lead; but it continued harder, more sonorous, and susceptible of polish, till the proportions approached to 1 of zinc and 16 of lead, when the alloy differed from the last metal only in being somewhat harder.

ZINNIA, a genus of plants of the class syngenesia, order polygamia superflua; and in the natural system arranged under the 49th order, composita. The receptacle is paleaceous, the pappus consists of two erect awns, the calyx is ovato-cylindrical and imbricated; the rays consist of five persisting entire florets. There are 5 species, none of them natives of Britain.

ZIRCON. This stone is brought from Ceylon, and found also in France and Spain, and other parts of Europe. It is commonly crystallized. The primitive form of its crystals is an octahedron, composed of two four-sided pyramids applied base to base, whose sides are isosceles triangles. The inclination of the sides of the same pyramid to each other is 124° 12′; the inclination of the sides of one pyramid to those of another 82° 50′. The solid angle at the apex is 73° 44′. The varieties of the crystalline forms of zircon amount to seven. In some cases there is a four-sided prism interposed between the pyramids of the primitive form; sometimes all the angles of this prism are wanting, and two small triangular faces in place of each; sometimes the crystals are dodecahedrons, composed of a flat four-sided prism with hexagonal faces, terminated by four-sided summits with rhomboidal faces; sometimes the edges of this prism, sometimes the edges where the prism and summit join, and sometimes both together, are wanting, and we find small faces in their place. For an accurate description and figure of these varieties, the reader is referred to Hauy.

The texture of zircon is foliated. Fracture imperfectly conchoidal. Causes a very great double refraction. Specific gravity from 4.615 to 4.383. Colours various, commonly reddish or yellowish; sometimes it is limpid. Before the blowpipe it loses its colour, but not its transparency. With borax it melts into a transparent glass. Infusible with fixed alkali and microcosmic salt.

1. The variety formerly called hyacinth is of a yellowish-red colour, mixed with brown. Its surface is smooth. Its lustre 3. Its transparency 3 to 4.

2. The variety formerly called jargon of Ceylon is either grey, greenish, yellowish brown, reddish brown, or violet. It has little external lustre. It is sometimes nearly opaque.

The first variety, according to the analysis of Vauquelin, is composed of

64.5	zirconia
32.0	silica
2.0	oxide of iron
98.5	

ZIZANIA, a genus of plants of the class monœcia, order hexandria; and in the natural system arranged under the 4th order, gramina. There is no male calyx; the corolla is a bivalved beardless glume, intermixed with the female flowers; there is no female calyx; the corolla is an univalved, cucullated, and aristated glume; the style is bipartite, and there is one seed covered with the plaited corolla. There are 2 species; the aquatica and terrestris, none of which are natives of Britain.

ZODIAC, See ASTRONOMY.

ZODIACAL *light*, a brightness sometimes observed in the zodiac, resembling that of the galaxy, or milky way. It appears at certain seasons, viz. towards the end of winter and in spring after sun-set, or before his rising in autumn and beginning of winter, resembling the form of a pyramid, lying lengthways with its axis along the zodiac, its base being placed obliquely with respect to the horizon. This phenomenon was first described and named by the elder Cassini, in 1683. It was afterwards observed by Fatio, in 1684, 1685, and 1686; also by Kirch and Eimmart, in 1688, 1689, 1691, 1693, and 1694.

ZOEGA, a genus of plants of the class syngenesia, and order polygamia frustranea. The receptacle is bristly; the pappus setaceous; the corollulæ of the radius ligulated; the calyx imbricated. There is one species, the leptaurea.

ZONE, in geography and astronomy, a division of the terraqueous globe, with respect to the different degree of heat found in the different parts.

A zone is the fifth part of the surface of the earth, contained between two parallels.

The zones are denominated torrid, frigid and temperate.

The torrid zone is a band surrounding the terraqueous globe, and terminated by the two tropics. Its breadth is 46° 58′. The equator, running through the middle of it, divides it into two equal parts, each containing 23° 29′. The antients imagined the torrid zone uninhabitable.

The temperate zones are two bands, environing the globe, and contained between the tropics and the polar circles: the breadth of each is 43° 2′.

The frigid zones are segments of the surface of the earth, terminated, one by the antarctic, and the other by the arctic circle. The breadth of each is 46° 58′.

ZONITIS, a genus of insects of the order coleoptera, The generic character is, antennæ testaceous; feelers four, filiform; jaw entire, longer than the feelers; lip emarginate. There are eight species.

ZOOLOGY, is that part of natural history which relates to animals.

In order to abridge the study of zoology, many methods of reducing animals to classes, genera, and species, have been invented: but as that of Linnæus is undoubtedly the best, the most extensive, and the most generally adopted, we shall give a brief account of it.

Linnæus divides the whole animal kingdom into six classes. The characters of these six classes are taken from the internal structure of animals, in the following manner:

Class I. *Mammalia*, includes all animals that suckle their young. The characters of this class are these: The heart has two ventricles and two auricles; the blood is red and warm; and the animals belonging to it are viviparous.

Class II. *Aves*, or birds. The characters are the same with those of class I. excepting that the animals belonging to it are oviparous.

Class III. *Amphibia*, or amphibious animals. The heart has but one ventricle and one auricle; the blood is red and cold; and the animals belonging to this class have the command of their lungs, so that the intervals between inspiration and exspiration are in some measure voluntary.

Class IV. *Pisces*, or fishes. The heart has the same structure, and the blood the same qualities, with those of the amphibia; but the animals belonging to this class are easily distinguished from the amphibia, by having no such voluntary command of their lungs, and by having external branchiæ or gills.

Class V. *Insecta*, or insects. The heart has one ventricle, but no auricle; the blood is cold and white; and the animals are furnished with antennæ or feelers. See INSECT.

Class VI. *Vermes*, or worms. The characters are the same with those of class V. only the animals have no antennæ, and are furnished with tentacula.

The first class, *Mammalia*, is subdivided into seven orders; the characters which are taken from the number, structure, and situation of the teeth.

Order I. The primates have four incisores. or fore teeth, in each jaw, and one dog-tooth, N. B. By one dog-tooth, Linnæus means one on each side of the fore-teeth in both jaws. This order includes four genera, viz. homo, simia, lemur, vespertilio.

Order II. The bruta have no fore-teeth in either jaw. This order includes seven genera, viz. rhinoceros, elephas, trichechus, bradypus, myrmecophaga, manis, dasypus.

Order III. The feræ have, for the most part, six conical fore-teeth in each jaw. This order includes ten genera, viz. phoca, canis, felis, viverra, mustela, ursus, didelphis, talpa, sorex, erinaceus.

Order IV. The glires have two fore-teeth in each jaw, and no dog-teeth. This order includes ten genera, viz. hystrix, lepus, castor, mus, sciurus, myoxus, cavia, arotomys, dypus, hyrox.

Order V. The pecora have no fore-teeth in the upper jaw, but six or eight in the under jaw. This order includes eight genera, viz. camelus, moschus, giraffa, cervus, antilope, capra, ovis, bos.

Order VI. The belluæ have obtuse fore-teeth in each jaw. This order includes four genera, viz. equus, hippopotamus, sus, tapir.

Order VII. The cete, or whale kind, have no uniform character in their teeth, being very different in the different genera; but are sufficiently distinguished from the other orders of mammalia, by living in the ocean, having pectoral fins, and a fistula or spiraculum upon the head. This order includes four genera, viz. monodon, balæna, physeter, delphinus.

The generic characters of the mammalia are, like those of the orders, almost entirely taken from the teeth, excepting the vespertilio, which, besides the character of the order derived from the teeth, has this farther mark, that there is a membrane attached to the feet and sides, by means of which the creature is enabled to fly: the hystrix, whose body is covered with sharp spines: and the whole order of pecora, whose genera, besides the characters taken from the teeth, are distinguished into those which have horns, those which have no horns, and by peculiarities in the horns themselves.

The specific characters are very various, being taken from any part of the body which possesses a peculiar uniform mark of distinction. As examples of these characters are to be found under the proper name of each genus, it is unnecessary to say any thing further concerning them in this place.

The second class, *Aves*, is subdivided into six orders; the characters of which are taken chiefly from the structure of the bill.

Order I. The accipitres have a hooked bill, the superior mandibule, near the base, being extended on each side beyond the inferior; and in some it is armed with teeth. This order includes four species, viz. vultur, falco, strix, lanius.

Order II. The picæ have a convex, compressed bill, resembling a knife. This order contains 23 genera, viz. trochilus, certhia, upupa, glaucopis, buphaga, sitta, oriolus, coracias, gracula, corvus, paradisea, ramphastos, trogon, psittacus, crotophaga, picus, yunx, cuculus, bucco, boceros, alcedo, merops, todus.

Order III. The anseres have a smooth bill, broadest at the point, covered with a smooth skin, and furnished with teeth: the tongue is fleshy; and the toes are palmated or webbed. This order includes 13 genera, viz. anas, mergus, phaeton, plotus, rhyncops, diomedea, aptenodyta, alca, procellaria, pelecanus, larus, sterna, colymbus.

Order IV. The grallæ have a somewhat cylindrical bill: the tail is short, and the thighs are naked. This order contains 20 genera, viz. phœnicopterus, platalea, palamedea, mycteria, tantalus, ardea, corrira, recurvirostra, scolopax, tringa, fulica, parra, rallus, vaginalis, psophia, cancroma, scopus, glareola, hæmatopus, charadrius.

Order V. The gallinæ have a convex bill; the superior mandible is vaulted over the inferior: the nostrils are half covered with a convex cartilaginous membrane: and the feet are divided, but connected, at the inmost joint. This order contains 10 genera, viz. struthio, didus, pavo, meleagris, penelope, crax, phasianus, numida, tetrao.

Order VI. The passeres have a conical sharp pointed bill; and the nostrils are oval, wide, and naked. This order contains 17 genera, viz. loxia, colius, fringilla, phytotoma, emberiza, caprimulgus, hirundo, pipra, turdus, ampelis, tanagra, mucicapa, parus, motacilla, alauda, sturnus, columba.

The generic characters of this class are taken from peculiarities in the bill, the nostrils, the tongue, the feet, the feathers, the face, the figure of the body, &c.

The characters which serve to distinguish the species are very various: for example, the colour of the particular feathers or parts of feathers; crests of feathers on the head, disposed in different manners; the colour of the cere or wax; the colour of the feet; the shape and length of the tail; the number, situation, &c. of the toes; the colour and figure of the bill, &c.

The third class, *Amphibia*, is divided into two orders.

Order I. The reptiles have four feet, and breathe by the mouth. This order contains four genera, viz. testudo, draco, lacerta, rana.

Order II. The serpentes have no legs, and breathe by the mouth. This order contains six genera, viz. crotalus, boa, coluber, anguis, amphisbæna, cæcilia.

The generic characters of this class are taken from the general figure of the body; from their having tails or no tails; being covered with a shell; having teeth or no teeth in the month; being furnished with lungs; having covered or naked bodies; from the number, situation, and figure of the scuta and scales; from the number and situation of the spiracula; from the situation of the mouth, &c.

The specific characters are so very various, that it would be superfluous to enumerate them.

The fourth class, *Pisces*, is subdivided into six orders, the characters of which are taken from the situation of the belly fins.

Order I. The apodes have no belly fins. This order contains eight genera, viz. muræna, gymnotus, trichiurus, anarchichas, ammodytes, ophydium, stromateus, xiphias, sternoptyx, leptocephaius.

Order II. The jugulares have the belly fins placed before the pectoral fins. This order includes five genera, viz. callionymus, uranoscopus, trachinus, gadus, blennius, kurtus.

Order III. The thoracici have the belly fins placed under the pectoral fins. This order comprehends nineteen genera, viz. cepola, echeneis, coryphæna, gobius, cottus, scorphæna, zeus, pleuronectes, chætodon, sparus, scarus, labrus, sciæna, perca, gasterosteus, scomber, centrogaster, mullus, trigla.

Order IV. The abdominales have the belly fins placed behind the pectoral fins. This order contains sixteen genera, viz. cobitis, amia, silurus, teuthis, loricaria, salmo, fistularia, esox, elops, argentina, atherina, mugil, exocætus, polynemus, clupea, cyprinus.

Order V. The branchiostegi have the gills destitute of bony rays. This order contains ten genera, viz. mormyrus, ostracion, tetrodon, diodon, syngnathus, pegasus, centriscus, balistes, cyclopterus, lophius.

Order VI. The chondropterygii have cartilaginous gills. This order contains five genera, viz. accipenser, chimæra, squalus, raia, ptromyzon.

The generic characters of this class are taken from peculiarities in the head, the mouth, the teeth, the nostrils, the rays in the membrane of the gills, the eyes, the general figure of the body, the figure of the tail, the situation of the spiracula, &c.

The specific characters are taken from peculiarities in all the parts above enumerated, and many others.

The fifth class, *Insecta*, is subdivided into seven orders, the characters of which are taken from the wings. See the article INSECT.

Order I. The coleoptera have four wings, the two superior ones being crustaceous, and furnished with a straight suture. This order comprehends forty-seven genera, viz. scarabæus, lucanus, dermestes, melyris, byrrhus, silpha, tritoma, hydrophilus, hister, pausus, bostrichus, anthrenus, nitidula, coccinella, curculio, brentus, attelabus, erodius, staphylinus, scaurus, zygia, meloe, tenebrio, cassida, opatrum, mordella, chrysomela, horia, apalus, manticora, pimelia, gyrinus, cucujus, cryptocephalus, bruchus, ptinus, hispa, buprestis, necydalis, lampyris, cantharis, notoxus, elater, calopus, alurnus, carabus, lytta, serropalpus, cerambyx, leptura, rhinomacer, zonitis, cicindela, dyticus, forficula.

Order II. The hemiptera have four wings, the two superior ones being semicrustaceous and incumbent, *i. e.* the interior edges lie above one another. This order includes fourteen genera, viz. blatta, pneumora, mantis, gryllus, fulgora, cicada, notonecta, nepa, cimex, macrocephalus, aphis, chermes, coccus, thrips.

Order III. The lepidoptera have four wings, all of them imbricated with scales. This order contains three genera, viz. papilio, sphinx, phalæna.

Order IV. The neuroptera have four wings, interwoven with veins, like a piece of network, and no sting in the anus. This order includes seven genera, viz. libella, ephemera, hemerobius, myrmelion, phryganea, panorpa, rophidia.

Order V. The hymenoptera have the same characters with the former, only the anus is armed with a sting. But this mark is peculiar to the females and neuters; for the males have no sting. This order comprehends fifteen genera, viz. cynips, tentredo, sirex, ichneumon, sphex, scolia, thynnus, leucospis, tiphia, chalcis, chrysis, vespa, apis, formica, mutilla.

Order VI. The diptera have two wings, and two clavated halteres or balances behind each wing. This order contains twelve genera, viz. diopsis, tipula, musca, tabanus, empis, conops, oestrus, asilus, stomoxys, culex, bombylius, hippobosca.

Order VII. The aptera have no wings. This order contains fifteen species, viz. lepisma, podura, termes, pediculus, pulex, acarus, hydrachna, aranea, phalangium, scorpio, cancer, monoculus, oniscus, scolopendra, julus.

The sixth class, *Vermes*, is divided into five orders.

Order I. The intestina are the most simple animals, being perfectly naked, and without limbs of any kind. This order contains twenty-one genera, viz. ascaris, trichocephalus, uncinaria, tilaria, scolex, ligula, linguatula, strongylus, echinorhynchus, hæruca, cucullanus, caryophyllæus, fasciola, tænia, furia, myxine, gordius, hirudo, lumbricus, sipunculus, planaria.

Order II. The mollusca are likewise simple naked animals, without any shell; but they are brachiated, or furnished with a kind of limbs. This order comprehends thirty-one genera, viz. actinia, clava, mammaria, pedicellaria, ascidia, salpa, dagysa, pterotrachea, limax, aplysia, doris, tethys, holothuria, terebella, triton, sepia, clio, lobaria, lernæa, scyllæa, glaucus, ahprodita, amphitrite, spio, nereis, nais, physsophora, medusa, lucernaria, asterias, echinus.

Order III. The testacea have the same characters with those of order II. but are covered with a shell. This order includes 36 genera, viz. chiton, lepas, pholas, mya, solen, tellina, cardium, mactra, donax, venus, spondylus, chama, arca, ostrea, anomia, mytilus, pinna, argonauta, nautilus, conus, cypræa, bulla, voluta; buccinum, strombus, murex, trochus, turbo, helix, nerita, haliotis, patella, dentalium, serpula, teredo, sabella.

Order IV. The zoophyta, are compound animals, furnished with a kind of flowers, and having a vegetating root and stem. This order contains 15 genera, viz tubipora, madrepora, millepora, cellepora, isis, antipathos, gorgonia, alcyonium, spongia, flustra, tubularia, corralina, sertularia, pennatula, hydra.

Order V. The infusoria consists of very small simple animals. This order contains 15 genera, viz. brachionus, vorticella, trichoda, cercaria, leucopera, gonium, colpoda, paramecium, cyclidium, bursaria, vibrio, enchelis, bacillaria, volvox, monas.

For more particular information concerning the several branches and subjects of zoology, the reader may consult the various articles above referred to, and he will find most of the genera described in their order in the alphabet.

ZOOPHYTE, in natural history, the 4th order of the class of vermes. See ZOOLOGY.

ZOSTERA, a genus of plants of the class gynandria, order polyandria; and in the natural system arranged under the second order, piperitæ. The spadix is linear, and fertile only on one side; there is no calyx nor corolla; the stamina are alternate; the seeds solitary and alternate. There is one species.

ZWINGERA, a genus of the class and order of plants decandria monogynia. The calyx is five-parted; petals five; capsules five. There is one species, the amasa, resembling quassia, a shrub of Guiana.

ZYGÆNA. See SQUALUS.

ZYGIA, a genus of insects of the order coleoptera. The generic character is, antennæ moniliform: feelers equal, filiform: lip elongated, membranaceous: jaw one-toothed.

ZYGOPHYLLUM, bean-caper, a genus of plants of the class of decandria and order monogynia, and in the natural system arranged under the 14th order, gruinales. The calyx is five-leaved; petals five; nectarium ten-leaved, covering the germ; capsules five-celled. There are 14 species, partly shrubby and partly herbaceous plants, all natives of warm climates, though some of them are hardy enough to endure the open air in this country.

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