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THE

UNIVERSAL PRECEPTOR;

BEING A

GENERAL GRAMMAR

OF

ARTS, SCIENCES,

AND

USEFUL KNOWLEDGE.

BY THE REV. DAVID BLAIR;
Author of the Class-Book, English Grammar, Models of Juvenile Letters, Reading Exercises, and Grammar of Natural and Experimental Philosophy.

FIRST AMERICAN FROM THE EIGHTH LONDON EDITION;
WITH ADDITIONS AND IMPROVEMENTS.

PHILADELPHIA:
PUBLISHED BY EDWARD & RICHARD PARKER,
NO. 173, MARKET STREET.

1817.

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District of Pennsylvania, to wit:

BE IT REMEMBERED, that on the 19th day of March, in the forty-second year of the independence of the United States of America, A. D. 1817, Edward & Richard Parker, of the said district, hath deposited in this office the title of a book, the right whereof they claim as proprietors, in the words following, to wit:

"The Universal Preceptor; being a general Grammar of Arts, Sciences, and Useful Knowledge. By the Rev. David Blair; author of the Class-Book, English Grammar, Models of Juvenile Letters, Reading Exercises, and Grammar of Natural and Experimental Philosophy. First American from the eighth London edition; with additions and improvements."

In conformity to the act of congress of the United States, entitled "An Act for the encouragement of learning, by securing the copies of maps, charts, and books, to the authors and proprietors of such copies, during the times therein mentioned;" and also an act entitled, "An Act supplementary to an act entitled, 'An Act for the encouragement of learning, by securing the copies of maps, charts, and books, to the authors and proprietors of such copies, during the times therein mentioned,' and extending the benefits thereof to the arts of designing, engraving and etching historical and other prints."

D. CALDWELL,
Clerk of the District of Pennsylvania.

PREFACE

TO THE

FIRST AMERICAN EDITION.

The Publishers of the first American edition of this valuable work of the Rev. D. Blair, and which is taken from the eighth and last British edition, feel gratified in believing that they are rendering to the American public a service of no inconsiderable value. From the prosperous state of science in the United States, its growing energies and the increasing number of seminaries for the education of youth, both of a private and public nature, it is obvious, that nothing can be more important and useful than an able and well-digested system, embracing in a clear, correct, and comprehensive form the first rudiments of the various sciences. This desirable object appears to be at length fully effected in the work now offered to the public. The number of editions through which it has passed in England, is a proof of the estimation in which it is there held: and the Publishers must be allowed to state, that in this edition, not only the errors incident to all works of so comprehensive a nature have been diligently corrected, but that several gentlemen of science, impressed with the utility of the work, have bestowed much pains not only in the corrections, but in contributing additional matter and entirely new-modelling many of the heads and sections, and thus rendering the whole work decidedly superior to all the foreign editions.

PREFACE.

THE author of this work has been many years anxious to achieve his present undertaking. His experience, reason, and feelings, prove to him, that, in the progress of education, young persons ought to be enabled to acquire correct general views on all subjects, which may serve as food for the mind in after-life, and as the bases of further studies in such branches of knowledge, as, at a future period, may gratify their tastes, or accord with their interests.

Early education cannot make adepts in any branch of science; at least, without sacrificing every other subject to one: it ought, therefore, to embrace the elements of general knowledge, as the true means of enlarging and exercising the understanding, and qualifying it to engage with advantage in any peculiar pursuit.

To fill the storehouse of the memory, is the rational business of education; and, at a season of life, when the powers of reason have not acquired a useful degree of action. Nor will such general instruction interfere with particular studies, if the tutor be provided with a Text-Book, embracing the foundations of human learning: such, it is presumed, will be found in the following pages.

When the author compiled his CLASS-BOOK, he was actuated by similar principles; and he believes it is generally felt, that great advantages have accrued to young persons, from the perusal of that work.—Every tutor must be sensible, however, that the Class-Book, as a means of enlarging the sphere of knowledge, is rather to be considered as a commentary, than as a key to the temple of Science itself. The CLASS-BOOK has its superior uses; but, through its medium, the building can only be viewed at a distance; the object, then, in the present work, is to lead the young student up the steps of the portico, open the doors to him, and usher him into that superstructure, which raises man above his fellows, and places him in contact with the good and the illustrious of his species!

Without interfering with particular branches of education, all the parts of this work may be rendered familiar within two years: one paragraph may be committed to memory every day. When this task has been finished, what an accession of varied knowledge will have fallen to the lot of the pupil! How stored, will be his mind, with interesting ideas for contemplation and conversation! and how comparatively blank must be the minds of others, who have not enjoyed the same advantages!—Yet, particular studies, at the same time, need not be neglected! This book may, indeed, be collateral in labour; although it will prove primary in effect!—But the author may be said to be sanguine; he, therefore, forbears to say all that his hopes prompt him to; and leaves his book to speak for itself, and prove its worth, by its actual effects on the rising generation.

D. B.

THE

UNIVERSAL PRECEPTOR;

OR,

GRAMMAR

OF

GENERAL KNOWLEDGE.

I. *Introductory Particulars.*

1. KNOWLEDGE is either necessary and useful, or ornamental and luxurious.

It distinguishes civilized from savage life. Its cultivation in youth promotes virtue, by creating habits of mental discipline; and by inculcating a sense of moral obligation.

Knowledge is, therefore, the best foundation of happiness.

2. *Necessary* KNOWLEDGE is that which simply provides man with food; and with the means of sustaining life.

3. *Useful* KNOWLEDGE is that which teaches the arts of agriculture, clothing, building, restoring health, preserving social order, maintaining national independence, and rendering the produce of all climates subservient to the wants of our own.

4. *Ornamental* KNOWLEDGE relates to subjects of taste; as drawing, painting, poetry, grammar, geometry, eloquence, history, music, dancing, dramatic representation, and the living languages.

5. *Luxurious* KNOWLEDGE includes abstract enquiries; as physics, metaphysics, many branches of experimental philosophy, heraldry, antiquities, and the dead languages.*

6. Man is an animal endowed with powers of communication, memory, association, imitation, reflection, and reasoning;—talents given him by his Maker; for the good use of which, he is accountable in a future state.

7. In his unimproved and uncivilized condition, man is naked, without habitation, without means of defence or offence, and possessed of no means of subsistence, besides the wild fruits and spontaneous produce of the earth.

8. To this day, many nations live naked in caverns under ground, perform no labour, and depend for their subsistence on the spontaneous products of the earth, and on the flesh of animals, which they destroy by simple stratagems.

Observation.—Such, are many of the nations of Africa; the inhabitants of New Holland; of many of the South Sea Islands; the Greenlanders; the natives of Hudson's Bay; and some of the Siberian nations; of whom, very curious particulars will be found in books of voyages and travels, and in Goldsmith's popular system of Geography.†

9. Till the Romans invaded England, the Britons lived naked, chiefly under ground, painting their bodies of various colours, bestowing no cultivation on the soil, and depending for sub-

* This division of knowledge is unavoidably imperfect; and is little respected in the details of this work.

† The observations are not to be committed to memory; but to be read by the pupil to the tutor, or by the pupil alone.

sistence on acorns, berries, and roots, and upon their skill and success in hunting and fishing.

Obs.—The people of England are indebted to the wild ambition of Julius Cæsar, for the introduction into these islands, of those arts of civilization, which had travelled from the Ganges into Persia, thence into Egypt, from Egypt to Greece, and from Greece into Italy: whence, by the lust of conquest, they were spread over Europe. In like manner, at this day, the English are the instruments, from the same causes, of reflecting back the arts of civilization, amended by a true religion, to the banks of the Ganges; and of dissiminating the same blessings, to the Africans; the Americans; and the insulated people of the South Sea Islands.

10. The Romans introduced among the Britons, all the arts and knowledge which they had themselves received from the Greeks; and laid the foundation of that social state, in which we find ourselves in England, after the lapse of nearly two thousand years.

Obs.—To take a view of knowledge, as it has extended itself from the most barbarous and uncultivated ages, down to this age of literature, science, and philosophy; and to render the whole, plain and familiar to young minds, and to the meanest capacities, are the objects of the present work.

II. *Of the Simple Arts of Savage Life.*

11. The arts of savage life were those which were possessed by the ancient Britons; and which are witnessed at this day, among all barbarous people. They include the arts of swimming, hunting, taking aim with missile weapons, and procuring fire.

12. The art of swimming, depends first, in

keeping the arms and hands under the water; in protruding only the face and part of the head out of the water; and then using such action, as will direct the body in any particular course.

Obs.—All animals swim without instruction; because they are unable to lift their fore-legs over their heads. The secret of this art depends, then, on keeping down the hands and arms, and acting under the water with them. The parts of any body which rise out of the water, sink the parts that are immersed within it.

13. Hunting is performed by most savage nations on foot, and with many of them the principal weapon is the club.—Therefore the swiftest and strongest usually become chiefs.

Obs.—Hence, Hercules, the hero of antiquity, is drawn with no other weapon than a club; with which, alone, he is said to have performed all his wonderful exploits. Some nations, nothing removed above savages, are, however, found to have acquired the use of bows and arrows.

14. In taking aim, with missle weapons, the precision which savage nations have attained, is wonderful. In throwing a stone, they seldom miss the smallest mark; they transfix fish in the water; knock down birds on the wing; and strike every enemy with unerring exactness.

Obs.—Every one is acquainted with the success of the shepherd David, in killing Goliah. Even such is the precision of the South Sea islanders at the present day.

15. The greatest attainment of savage life, is the procuring of artificial fire; but this was an art not known to all barbarous people. The inhabitants of the Ladrones considered fire as an invisible monster, when the Spaniards first introduced it among them.

16. The Persians, and other eastern nations,

after they had once acquired, or discovered fire, made its preservation a religious duty; and fire was continued in their temples, without being once extinguished, for many hundred years. Hence, they became, or were considered, fire worshippers.

17. Among savages, the usual mode of producing fire, is, by the rapid friction of two pieces of wood till they produce flames. Having no metals, they do not possess the simple method of communicating a spark to tinder, by the violent collision of flint and steel.

18. The cloathing of savage nations has reference solely to the inclemency of the weather: and consists generally of the skins of animals, or of the natural products of vegetables, prepared by the most ingenious processes.

19. A precarious mode of subsistence is so unfavourable to the human species; that it is found, that savage tribes, in a series of ages, do not increase their numbers; and that they often become altogether extinct.

20. In the back settlements of North America, the souls in the various half-starved savage tribes, do not exceed twenty thousand; while, on an equal space of country in China, two or three hundred millions, aided by the arts of civilization, are much better fed and provided for.

21. The wretched Indians who reside in the districts that surround Hudson's Bay, often pass a week together without food; and frequently die of want, during the chase of an animal, which they have pursued on foot for many days together.

Obs.—Hence, the origin of hospitality and social meetings kept up in civilized life, for purposes of pleasure; but originating in ages, when to divide with friends and neighbours the produce of the chase, was the first and the kindest of duties.

22. If there are some privations to be borne in society; if the successful emulation of industry and talents, creates great inequalities of enjoyment; and if the laws are abused, and sometimes bear oppressively on weak individuals, the worst condition of social and civilized man, is better than the best condition of the untutored savage.

Obs.—Such is man, in his native and original state, in all countries; and such, are the boundaries of knowledge, among all aboriginal people: let us now consider him, in a better, happier, and more respectable condition.

III. *Of Farming, or Agriculture.*

23. The first step, from savage towards civilized life, is the acquirement, protection, and recognition of property. In early ages this consisted only, of what was essential to the immediate wants of man.

24. The first property consisted of sheep, goats, and oxen; and the first husbandmen were shepherds, who tended their flocks, and drove them without restriction from pasture to pasture.

Obs.—We have a beautiful picture of the pastoral life in the Book of Genesis: Abraham, Isaac, Jacob, and their families, were shepherds or husbandmen of the earliest ages. It will be seen, that their wealth consisted in their flocks and live stock; and that they roamed over the country to find pasture.

25. In the pastoral ages of husbandry, there

was no property in land: all the country, was open and common to any occupier; and no one assumed to himself a property in the soil, or considered as his own, the produce of any particular spot.

26. In Africa, among the native Americans, and in most parts of Asia, there exists to this day, no property in the land; hence, in those countries, there is little cultivation; and subsistence is precarious; notwithstanding the fertility of the soil, and the genial character of the climates.

27. The recognition and protection of property in the soil, is the basis of industry, plenty, and social improvement; and is, therefore, one of the most important steps in the progress of man, from the savage, to the civilized state.

28. As soon as any man could call a spot of ground his own, and could secure to his family the produce of it; he would carefully cultivate, sow, and plant it; knowing that he should reap the reward of his labour in the season of harvest.

29. Countries, however, in general, lie open; with nothing but banks and ditches to divide the land of every husbandman: but in all civilized countries, each separate farm is divided from others, by hedges and fences; and the farms themselves, are sub-divided into small enclosures.

30. In France, Germany, Italy, Spain, and most other nations, the lands still remain unenclosed, in large open fields; and those countries in consequence, present a dreary appearance.

31. Enclosures greatly improve the climate of a country, by protecting it from inclement winds; they pleasantly sub-divide the labours of the far-

mer; and, by restraining the exercise of cattle, they occasion them to get fat much sooner.

32. Farmers are called *arable farmers*, when they are chiefly employed in raising corn and grain; and *pasture* or *grass-farmers*, when they are engaged in rearing and fattening sheep, and other live stock.

33. Farms vary in size, from fifty to one thousand acres. Arable farms are generally smaller than those employed in pasture, or grazing. Those, from one to two hundred acres, are the most beneficial to the occupiers and the public.

34. Soils are divided into clayey, loamy, chalky, sandy, gravelly, peaty, and moory. The clayey and loamy are called stiff or strong soils; and the sandy and gravelly, light soils.

35. Soils are barren, when they consist of too much of one kind of material, do not hold moisture, or are too shallow. They are fertile, when they contain a due mixture of several primitive earths with vegetable and animal matter.

36. To render a barren soil fertile, it requires to be frequently turned up to the air, and to have manures mixed with it: which manures consist of animal dungs, decayed vegetables, lime, marl, sweepings of streets, &c.

37. In turning over the soil, the chief implements of the gardener are the spade, the hoe, and the mattock; and of the farmer, the plough, the harrow, the roller, the scythe, and the sickle.

38. As a succession of the same crops tends to impoverish the soil, a rotation of different crops

is necessary. Potatoes, grain, and white crops, are exhausting; but, after them, the soil is ameliorated by tares, vetches, turnips, and green or covering crops.

39. On stiff soils, clover, beans, wheat, cabbages, and oats, may be cultivated in succession; and on light soils, potatoes, turnips, pease, or barley, may succeed each other. The general rule, is one crop for man, and one for beast.

Obs.—This plan of varying the crops, is a new discovery. Formerly, land lay long in fallow; that is to say, was not worked every third or fourth year; but now, it is usual, by varying the crops, to get two or three crops in a year from the same soil, without its being exhausted; and fallowing is, consequently, found to be unnecessary.—*See Young's Farmer's Kalendar.*

40. *Wheat* is sown in September or October; but the spring-wheat is sown in March. It ripens in July and August, when it is reaped, housed, and threshed. After being ground at the mill and sifted, wheat forms flour: the flour mixed with water and yeast, and baked in an oven, becomes *Bread.*

41. *Barley* is sown in April and May: it is made into malt, by being heated to a state of germination, and then broken in a mill. If the malt be infused in hot water, the infusion, with the addition of hops, may be fermented into beer, ale, and porter.

42. *Oats* are sown in February or March; when ground, they form *oat-meal*, and mixed with water the meal becomes oat-bread; but unground, they are the favourite food of horses.

43. There are other species of grain cultivated, as rye, pease, and beans. The former makes dark

but wholesome bread; and the latter are well known as delicious and wholesome food. Rice, a very nutritive grain, is much cultivated in warm climates; and preferred to other kinds of grain for the food of man.

44. Modern husbandry has sub-divided grass into nearly a hundred several kinds; of which, there are two principal divisions; natural grasses, and artificial grasses. The several sorts are sown and cultivated together, or separately; according to the nature of the soil, or the object of the cultivator.

45. The natural grasses are very numerous; and are preferred for lands intended to be kept in grass. The artificial grasses are ray grass, red clover, trefoil, sainfoin, lucern, orchard grass, timothy, &c.

46. On many farms, cows are kept for the milk they yield; and for the purpose of making butter or cheese. Butter is made from cream by agitating it in a churn; and is the oily part of the cream. Cheese is made from milk by curdling it with runnet; and the curd is then pressed, shaped, and dried.

Obs.—The runnet is the inside of the stomach of a calf; and is kept in pickle for the purpose of setting the curd. The cheese would be white, if the milk were not previously coloured with Spanish arnotta. The largest cheese-farms in England, are in Cheshire and Denbighshire; and on some of these, 500 milch cows are kept. In the United States, the largest dairies are in New England and New York.

47. Of late years, selections have been made of breeds of cattle, sheep, &c., from among those

which fatten the quickest, which have the best-flavoured flesh, best wool, &c.

48. Among oxen, the kinds that have been preferred in England, are the middle-horned, or Devonshire, for working; and the short-horned, the spotted, and the Alderney, for milking.

The long-horned, the Welch, the Kyeloe, and the Fifeshire, have also their separate purposes and recommendations.

49. Among the improved breeds of sheep, the favourite is the South Down; but the Tees-water, Dartmoor, and Romney-marsh-breeds, are the largest; the new Leicester and Lincoln are the next. The fleece of the Lincoln weighs 11 lbs.

50. Those sheep which produce the finest wool, are the Merino, the Ryeland, and the Shetland; but their fleeces weigh only from 2 to 3 lbs.

A male sheep is called a *tup* or *ram;* and a female, a *ewe.* They are usually shorn in May or June; and are called one-shear, two-shear, or three-shear sheep, according to their ages.

51. Horses are divided into blood-horses or racers; hackney or riding-horses; coach-horses; Cleaveland-bays; Suffolk-punches; Clydesdales; and heavy-blacks: each of them adapted to distinct purposes of use or pleasure.

52. Hogs are severally of Berkshire, Hampshire, Shropshire, Gloucestershire, Chinese, white, and swing-tailed breeds; all different in their shapes and character.

53. Numerous other productive animals are also objects of the farmer's care; as poultry for eggs; geese, ducks, turkeys, Guinea-fowls, and pigeons; bees for honey; and fish stocked in

ponds. Farmers likewise extract cyder from apples; perry from pears; and delicious wines from various fruits.

54. Every farm-house is provided with its kitchen-garden, for the cultivation of vegetables and fruits. The Art of Gardening forms also one of the most useful and delightful branches of rural employment. Besides kitchen-gardens for raising vegetables, there are fruit-gardens, or orchards, flower-gardens, and pleasure-gardens.

55. By the art of Gardening, the fruits of one part of the world, are propagated and cultivated in other climates, to which, at first, they seemed to be ill-adapted.*

Thus, in England, the only native fruits were the acorn, the blackberry, the alder-berry, hips, and haws; but it now enjoys gooseberries, currants, apples, pears, plumbs, apricots, peaches, nectarines, and grapes—all exotics, and first cultivated in England, about three hundred years since.

56. Within a few years, the bread-fruit tree has been transplanted from the islands of the South Seas to the West Indies; and all the rare spices, natives of the East Indies, are now cultivated in the West Indies.

57. The Potatoe, so considerable and wholesome a portion of our food, was unknown in Europe, about two centuries ago; and was brought from America by sir Walter Raleigh. The period is on record (500 years before Christ,) when the

* In the present edition, the long paragraphs have been purposely broken, for the ease of junior students; but the numbers remain the same.

first wheat was brought into Europe, from Asia Minor. Peas, beans, and all other grain, are exotics in England.

58. Such, also, is the art of man, that he improves whatever he cultivates. By grafting buds of superior fruits on ordinary stocks, he amends, and even alters, the natural produce of the tree; and by managing and selecting his seeds, he improves and enlarges every vegetable production.

59. By the art of Gardening, two, three, or four persons may derive ample subsistence, from every acre of ground in cultivation; but there is, in no country, without cultivation, above one human inhabitant to two square miles; and even on that space, subsistence is obtained with difficulty: such are the triumphs of art over nature!

60. In England and Wales there are *ten* millions of inhabitants; and *forty-seven* millions of acres of ground; of which, nearly *forty millions* are cultivated, or are employed in grazing cattle; the other eight are waste.

There are, consequently, four acres of cultivated ground to every person; and nearly another acre, of that which is uncultivated.

Obs.—It having been ascertained, that an acre of land employed as a garden, will produce regular subsistence for four persons; it follows, that if the ground in England was thus cultivated, it would support a population of 160 millions; and with various allowances, at least 100 millions, or ten times its present number. The ground still uncultivated, might, perhaps, be made to maintain the present number of inhabitants in plenty.

61. Each of the people consume in every year, one quarter of wheat, (eighteen bushels) being the produce of half an acre; three bushels of barley

in beer, being the growth of the eighth of an acre; one sheep, one-eighth of an ox, one-third of a lamb, calf, and pig, being the produce of two acres; and in vegetables and fruits, the produce of the eighth of an acre.

Obs.—Hence, every human inhabitant uses the produce of three acres; and the remainder of his share is consumed by horses; or engaged for buildings, roads, hedge-rows, and pleasure-grounds, or occupied in water.

62. Of the *forty millions* of cultivated land, *twelve millions* are employed in arable farming; *twenty millions*, in grazing cattle; *two millions*, in woods and hedge-rows; *two millions*, in roads, water, and buildings; and *one million*, in hop, garden, and pleasure-grounds; and the remainder lie in fallow.

Obs.—The eight millions of waste consist chiefly of commons or heaths; and it is computed, that five millions of them are equal to any purpose of cultivation; the other three, are in mountains; or have no depth of vegetable soil.

63. The number of bullocks killed, annually, in England and Wales, are at least a million; of sheep, nine millions; and of lambs, calves, and pigs, nine millions; besides thirty millions, of poultry and game; and innumerable small birds and fishes.

The number of horses are nearly two millions; of which a million and a half are employed in agriculture and commerce.

Obs.—It is calculated, that horses consume one-fifth of the entire produce of the land *i.e.* the produce of four acres per horse on the whole of the land, or two acres each, of that 12 millions employed in raising corn.

64. On an average, each man, woman, and child, consumes *ten ounces* per day, of animal

food, or 220 lbs. in the year; which, in animal food, is the annual produce of two acres of land.

It is found, however, that the same two acres, cultivated in potatoes, would yield, on an average, upwards of ten tons per acre, or forty-four thousand pounds weight; and, consequently, afford *one hundred and twenty pounds* of potatoes, per day, the year round!

65. If cultivated in wheat, the produce of the same two acres (which produce but 220 pounds of animal food,) would produce 4000 pounds weight of grain; or afford ten pounds of wheat, per day, leaving sufficient for seed.

Peas and beans yield in the same proportion. Turnips and carrots are as productive as potatoes! but parsnips actually double the weight of potatoes! C

Obs.—Mr. Middleton well observes, "that every acre would support its man well, on *vegetable food*; but," says he, "only let him change his diet to one meal per day of animal food; and he will require the produce of four acres!" The same author observes also, "that the starch or nourishment of a potatoe, is one-fourth of its entire weight; and that the quantity of starch or nutriment, on an acre of potatoes, is four times greater than in an acre of wheat!" Those, who seek further information on agricultural subjects, should consult *Young's Farmer's Kalender;* a work which ought to be found in every farm-housé.

IV. *Metallurgy.*

66. Before man could till the ground, dig it, hoe it, or plough it, he required the aid of something harder than the ground itself; that is to say, he wanted iron or metals. Without iron, he

could have no very useful, sharp instrument;— such as the spade, hoe, plough, scythe, or sickle.

67. Hence, men were found to depend for food, on the spontaneous productions of the earth, and on the flesh of animals; till they had discovered the means of obtaining and working iron. Holy writ tells us that Tubal-cain (or Vulcan,) before the flood, was the instructor of all those who worked in brass and iron.

68. Viewing the metals in ordinary use, we consider them common productions; but no art is so curious, as that of extracting metals from the earth, or ore in which they are buried or concealed; and no discovery or invention was ever more wonderful.

69. It is very seldom that metals are found in a pure state; but perhaps the first discoverer, having found some metal in a detached or pure state, was led to make experiments on those lumps of shapeless, and coarse, but heavy earth; which consist of a mixture of earth and metal, and are called *ores*.

70. Gold-dust is frequently found in the sand of rivers; into which it is washed by the rains from the mountains. This itself might lead to the discovery of metals. Much of the gold used in England, is collected out of the rivers in *Guinea*, on the coast of Africa.

71. Workers of metals imitate nature when they *beat* and *wash* their ores; and having cleared them, in that way, of much of the earth, they then *burn* them in various ways; and, at length, get the metal by itself in a pure state.

72. No one, on looking at most of the metallic

ores, would suspect them to contain metal: they are, apparently, the roughest, coarsest, and least desirable stones or earths; but, on being broken, repeatedly washed, and burnt (or, *roasted*, as it is called,) they yield Gold, Silver, Copper, Iron, and other metals.

73. These ores are found in the veins of mountains, or in the strata, or divisions of rocks; generally beneath the surface of the ground; and the pits or wells, dug in search of the ore, are called *mines*. The well itself, is called the *shaft* of the mine. Pits, from which stone only is extracted, are called *stone-quarries*.

74. The deepest mines are in Hungary; and are about three-quarters of a mile below the surface. Many mines are like towns under ground; and many miners pass their whole lives in them. The want of fresh air, and the influx of water, prevent mines from sinking deeper.

75. All the substances which form the ground and earth, are called minerals. Clay is a mineral; all stones are minerals; coal is a mineral; chalk; and, in short, whatever is not animal or vegetable, is called Mineral.

76. The study of minerals has been methodized, and called the science of mineralogy. In this, as in many other branches of science, little more, however, has been effected, than to attain a systematic classification and nomenclature.

77. All minerals, *i. e.* all earths, soils, stones, and metals, are scientifically divided into four classes.

I. *Earthy* Minerals—being all such, as are void of taste and smell, light and brittle; as mill-stone, flint or silex, clay, sand, crystals, spar, gypsum, alabaster, chalk, stones, cornelians, jasper, topazes, sapphires, rubies, emeralds, and diamonds.

II. *Saline* Minerals—being such, as have a pungent taste, and are heavier, softer, and partly transparent; as salt, alum, nitre or salt-petre, borax, and alkali or potash.

III. *Inflammable* Minerals—being lighter, brittle, opaque, and never feeling cold; as coals, sulphur, black-lead, and amber.

IV. *Metallic* Minerals—being heavier, opaque, cold, *ductile* (capable of making wire,) and *malleable* (capable of being worked into shape,) consisting of gold, silver, &c.

78. Many metals exposed to air become rusty; that is to say, they imbibe a part of the air called *oxygen*, and the rust is called an *oxide*. If melted and burnt on a fire for a considerable time, they also imbibe *oxygen* from the atmosphere; and turn into earthy substances called *oxides*: the process is called *oxidation*.

79. If 10 lbs. of lead be melted and burnt in this manner, it will be converted into an *oxide* called red lead; and the red lead so produced, will be found to weigh 11 lbs., the additional pound arising from the imbibed oxygen.

80. *Oxides* may be converted into metals again, by depriving them of their oxygen. In the example of red lead, if it be burnt again with powdered charcoal, the charcoal will detach the oxygen from the oxide, and the lead will be obtained again in its pure state; this process is called *reduction*.

81. Modern chemists consider the whole earth as metallic; and all the different earths to be nothing more than various oxides, or rusts of metals, produced by the continued action of the air and water on them; and capable, by suitable means, of being re-converted into metals!

82. *Platina* is the heaviest of all metals, being 23 times heavier than water; but it is a modern discovery. The colour is light grey, and it cannot be melted in ordinary fires.

83. *Gold* is 19 times heavier than water; and the most brilliant of all the metals. It is so malleable, that an ounce of it will gild a silver wire, 1300 miles in length; and it may be beaten into leaves; 300,000 of which, are only the thickness of an inch.

84. *Silver* is 11 times heavier than water; and next to gold in beauty; such is its ductility, that it may be drawn out in wire finer than a hair.

85. *Mercury*, or Quicksilver, is 14 times heavier than water; and is remakable for being liquid like water; and for not becoming solid, except in cold greater than that which renders water solid.

86. *Copper* is 9 times heavier than water; and is found in great abundance in the mines in Sweden. It unites well with other metals; and forms a variety of useful compounds.

87. *Iron* is 8 times heavier than water; and is the most useful; and the most abundant, of all the metals. It mixes with the animal, vegetable, and mineral kingdoms. It is melted with more difficulty than gold, silver, or copper; and it usefully strikes fire with flint.

Obs.—The loadstone, which possesses the singular and unaccountable property of always pointing to the north, is an ore of iron.

88. *Tin* is an English or Cornish metal, 7 times heavier than water. It is very malleable; and is highly useful as a coating to iron and copper; requiring only, to have iron dipt into it, and copper to be rubbed with it, to become perfectly coated.

89. *Lead* is 11 times heavier than water; easily melted, and highly useful for various purposes.

90. *Nickel* is a Chinese metal of a light grey; 9 times heavier than water, and melted with difficulty.

91. *Zinc* is 7 times heavier than water, of a bluish white colour, and used in various compounds.

92. The other metallic substances are Antimony, Bismuth, Cobalt, Arsenic, Manganese, Palladium, Rhodium, Potassum, &c., to the number of thirty; although the ancients knew of only seven metals.

93. Iron is formed into *steel*, by being heated with charcoal. *Brass* is a compound of zinc and copper. *Bell-metal* is brass with a little silver. *Pewter* is a mixture of tin, lead, and brass. *Bronze* is a mixture of copper and tin.

94. Coals are minerals dug out of the ground in immense mines; and they are the best fuel yet discovered by man. The British islands are celebrated for their coal-mines; many countries being obliged to depend on wood; which is often scarce and dear.

95. Half the civilized employments of man, consist in working the metals and minerals. In England, the large towns of Birmingham and Sheffield are wholly engaged in the useful and ornamental manufactures of various metals.

96. Civilization depends so much on the discovery of the useful metals, that little progress can be made from a savage state, without the useful trade of a blacksmith.

He makes all the implements of gardening and agriculture; all domestic utensils; knives to cut with; and spears and swords to defend the soil and its produce, against invaders.

97. To avoid the inconvenience of exchanging or bartering, men, in early ages, fixed on metals; as on gold, silver, copper, or iron, for a medium of value: so that, if one man had too much corn and wanted wine, he was not obliged to give corn for the wine, but he might sell his corn for so much metal, and buy the wine with the metal, at his convenience.

Obs.—Hence, the origin of money; and as it was found inconvenient to weigh metal in every transaction, (as Abraham did when he bought the burying-place of Sarah;) stamps were put on pieces of metal, to indicate that they might be safely received for a settled weight or value. Hence, there are pieces of stamped gold of known value; as guineas, half guineas, eagles, half eagles, &c.: pieces of stamped silver, as crowns, dollars, half dollars, &c.: and pieces of stamped copper; as cents and half cents:—all of universal worth.

V. *Of Building.*

98. Man, like other animals, would seek places in which he might shelter himself, from the inclemency of the weather. Beasts of prey retire to thickets and caves; beavers build mud houses; and rabbits make burrows under ground. Man, in his most savage state, imitates their practices; and then improves on them, by the aid of his reason.

99. Among the savage tribes in Siberia and the most northern parts of America, their habitations are constructed in the rudest manner, principally with earth intermixed with leaves, twigs, and the stems of weeds, &c. and the bottoms of their huts are frequently partly under the ground or the snow, and are thus more effectually closed during the long continuance of their winter season. In warmer regions, the American Indians build wigwams of stakes, leaves, turf, and straw in the shape of a soldier's tent.

In Africa, the materials of the kraals are the same as the wigwams; but the shape is circular, with a hole at the top to let out the smoke; and the entrance is so low, in order to keep out beasts of prey, that the inhabitants crawl in and out.

100. A number of these habitations in one place; or a collection of wigwams or kraals, forms a Siberian, American, or African tribe. In many islands of the South Seas, the natives, when first discovered, had learnt to elevate the roofs on poles, and to fill in the sides of their houses with boughs or rushes, mud, or sods.

Obs.—The cottages of many of the poor, are still built in this manner in England: and few need travel a mile from their own residence, to see the original style of architecture.

101. Those nations which first raised the roofs of their houses on poles, were discoverers in this art. Those which first used stone, however rude, and mud or clay to fill up the interstices between the stones, and cement them together, made considerable improvements.

After the discovery of iron and metals, when the axe, the hammer, the saw, and the plane, became the tools of builders, it may be supposed, houses would soon be raised to two stories, and increased in size and convenience.

102. Burning clay into *bricks*, was a further invention of great importance; because, it afforded a universal material for building, as durable as stone, without carriage, and often with less labour than was required to dig and fashion the stone.

The best bricks are made of clay, and are nine inches long, four and a half broad, and two inches and a half thick.

Obs.—Hence, in laying bricks two in breadth, with the interstices for mortar, are equal to one in length, and the requisite crosses and ties may then be made without inequalities in the wall.

103. The first cement for walls, was either mud or clay; but experiment led, in due time, to the preference of a mixture of lime, water, and sand; to which, for plastering, hair is now added. Trees presented the next building material, for beams, and boards for floors. With these materials, the

dwellings of the whole civilized world are now made.

Obs.—Cast iron for many purposes, to which timber was usually applied, has lately been used to great advantage.

104. Simple as is the contrivance of chimnies to carry off smoke, yet, they are a recent invention; and were unknown in building, till within the last five hundred years: down to that period, the smoke escaped through a hole in the roof of the house.

105. The means of letting in the light, and keeping out the cold, is also a recent invention. Anciently, holes for light were made with wooden shutters, to open by day, and close at night.

Various were the contrivances to let in light; and, at the same time, keep out cold. Bladders, horn, and membranous substances of animals and fish, were used for this purpose, in the houses of the great: but all these gave way, to the fine invention of glass.

106. That useful material was discovered by accident: some Phenician carriers of soda, a few years before Christ, happening to light their fire between some of their lumps of this mineral; it melted, and mixing with the sand, produced glass. Soda and sand, or flints, melted together, continue to be the materials of which glass is made to this day.

Obs. 1.—The manufactory of glass was long confined to Pœnicia; but so little improvement was made in it, that Nero give 60,000*l.* for two glass-cups that had handles. It was first applied to windows about the year 300; but did not get into general use till about 1000.

2.—A glass-manufactory is a proper object to gratify the curiosity of young persons. Flint, or purified stony sand, called silex, is mixed with pure soda, and exposed to a moderate heat, producing what is called the *frit*; this is then put into moderate sized vessels, and exposed to a violent heat, till melted; and on cooling a little, it becomes a kind of hot paste, which may be worked and moulded to any shape:—the ingenuity and expertness of the workmen, in so moulding and shaping it into various vessels, is highly amusing.

107. Tiles for the roofs of houses are made of clay in the manner of bricks. Slates dug from quarries are also used for the same purpose. In country-places, where the earliest practices are still continued, roofs are thatched with straw; these will keep out the wet and cold, but generate a musty smell.

Paints, consisting of the oxides of metals, and of certain coloured earths, or natural oxides, mixed with oil, at once serves to preserve wood; and to purify and beautify the inside of houses.

VI. *Of Architecture.*

108. After the art of building had attained what was useful and necessary; luxury would aim at ornament:—an ingenious carpenter would become a carver; and an ingenious stone-mason, a sculptor.

The pillars which supported the work, would not be allowed to be quite plain; but would be cut or carved in ornaments, at the head and base; and other parts of the room, or structure, would be made to correspond. Hence, arose what are called the five orders of Architecture.

109. The five orders of architecture were successively invented in ancient Greece and Italy; and are called the TUSCAN, the DORIC, the IONIC, the CORINTHIAN, and the COMPOSITE: they are to be found in all the principal buildings of the Christian world.

110. The Saxons, also, had a simple style of architecture; distinguished by semi-circular arches aud massive plain columns: these still are found in many of our oldest buildings.

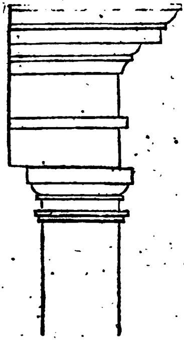
The Normans, too, invented a beautiful style of architecture, called the Gothic; distinguished by its lightness and profuse ornaments; by its pointed arches; and by its pillars, carved to imitate several conjoined.

The Gothic architecture is found in all our old cathedrals; and is often elegantly adopted in private dwellings.

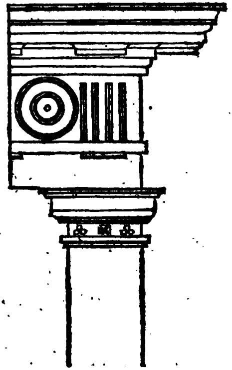
Obs. 1.—As a more effectual means, than any verbal descriptions, of conveying a knowledge of the several species of architecture, the characters of each are here given; and to fix them in his recollection, the pupil should trace or copy them.

2.—The Hindoos, Egyptians, Chinese, and Moors, have likewise their own separate styles of ornamental building; and nothing can be more grand, harmonious, and more picturesque, than each of these, in the splendid specimens, which are to be seen in their several countries. In England, the Pagoda, in Kew Gardens, is a pleasing specimen of Chinese architecture; but we seem, in general, to prefer the five orders; or the Gothic.

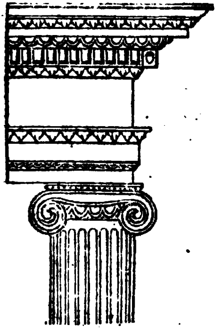
1. The TUSCAN order.



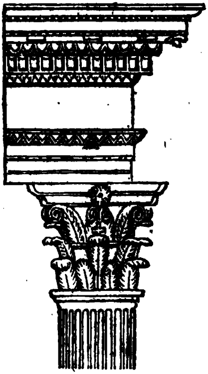
2. The DORIC order.



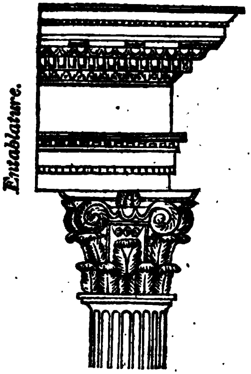
3. The IONIC order.



4. The CORINTHIAN order.



THE COMPOSITE ORDER.



VII. *The Art of Clothing.*

111. Most animals are provided with a coat of hair or wool for covering; but man seems to have been left naked, and in many respects destitute; apparently, to serve as a stimulus to his industry and invention.

Man seems, as to his own wants and powers, to have been formed, to equalize climates, and conquer the elements. His superb edifices, his control of fire and water, his application of light in the night, and his various clothing, distinguish his superior intellects.

112. In all climates, clothing is not alike necessary; between the tropics it is little required, except for ornament: but in the temperate and

frigid zones, man could scarcely subsist without some covering.

Holy writ tells us, that the first clothing of Adam and Eve were the leaves of fig-trees, sewn, perhaps, together; and even at this day, our manufactures of clothing are derived, chiefly, from the fibres of the vegetable kingdom.

113. The skins of animals were doubtless the first substantial clothing. The shepherd would dress himself in his sheep or goat's skin; and the hunter, as a trophy, in the skin of a wild beast.

The Tartars clothe themselves in horse-hides to this day; the Americans, in the skins of buffaloes; and even in some parts of Europe, a sheep's skin, with the woolly side inward or outward, makes a winter or a summer-garment.

114. Some natives of the South Sea islands clothe themselves in mats made of reeds or vegetable fibres; others render pliable the common bark of trees; but none of these will wash, or are durable.

Civilized man, however, adapts the means of nature to his purposes, by a process of his own; he separates the fibres themselves, then twists them into thread, and by interweaving this thread, he obtains a pliable and durable material.

115. The most useful plant, for this purpose, is *flax*. It is cultivated like wheat; and as soon as its seeds are ripe, it is pulled up by the hand; the seed-vessels are taken off, and the stems are put into pits of water, till the mucilageous or gummy matter, which holds the fibres of the stalk together, are dissolved.

116. After the stalks have been taken out of

the pits, they are dried, beaten, and combed, till they are fine, loose, and shining: the flax is then spun, or twisted by a distaff, and wound on a reel or spindle. This thread is either adapted for needle-work; or is given to the weaver to be woven into linen cloth by his loom.

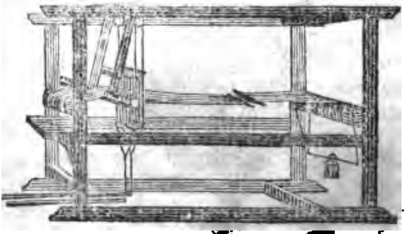
117. The process of weaving is simple:—the threads in their length are called the *warp;* and are drawn tight by weights at one end; at the other, they are divided into two sets, each set composed of alternate threads:—on moving a treadle, one set, or every other thread, is thrown up, and the other set is brought down; and at this instant, a cross thread or woof is thrown between them by means of a shuttle.

The lower set of ends are then raised; and the other brought down and the woof is again thrown between. The operation is thus continued, till the whole length of the warp has been interwoven with cross threads.

Obs. 1.—A figure of a simple loom is here given; in which, the parts referred to above may easily be traced. The forms of looms are, however, various, and often very intricate. There are stocking-looms, or frames, silk-looms, cloth-looms, cotton-looms, linen-looms, cambric-looms, carpet-looms, lace-looms, &c.

Warp.

Treadle.



2.—As the loom is one of the most important of social machines, its principle of action ought to be well understood. Look at a piece of linen with the eye, or with any simple magnifier, and it will be seen, that the loom has simply crossed the threads, and thereby matted the whole together. The four fingers present themselves, as the most simple illustration of its action: but the student may fasten six or eight pieces of string to a wall, to represent the warp; and then by raising every other one, and depressing the others, he will be able to pass the woof by any contrivance, which will represent the shuttle. He may thus make a piece of packthread-cloth; and so, completely illustrate the principle of weaving.

118. After the piece has been woven, it requires to be bleached by the air and sun, or by exposure to some acid. It is afterwards, if desired, printed to any pattern, by means of blocks of wood, cut out to the pattern; and is then pressed and glazed before it is used.

Much skill and experience are required in fixing colours, so that they will not wash out; but in printing, dyeing, and similar arts, the Hindoos and Chinese excel all nations.

119. *Hemp* is another fibrous stalk, much cultivated for the manufacture of ropes and sail-cloth. But the fibrous substance now the most used for every purpose of clothing and furniture, is the product of the *cotton-tree*, or plant.

The cotton wool is found in a state nearly fit for the manufacturer, in the seed-pod of the plants; and in the West Indies, they yield two crops in the year.

120. Hundreds of ships arrive in England every year, laden with this material. The chief

manufactories of cotton are in Lancashire; and they are wonders of human invention.

The articles used in cloathing, produced from this substance, are muslins of every degree of fineness, corduroys, sheeting, calicoes, quilting, bed-furniture, hangings, &c.; all of which have been the means of extending the commerce of England to every part of the world.

Obs.—Manufactories of Cotton are now scattered all over the United Kingdom; and employ a million of men, women, and children.

121. The wonderful operations of a COTTON-MILL, have been so correctly described by Darwin; that they will be much better remembered in that form, than in prose:

First, with nice eye, emerging maidens cull
From leathery pods, the vegetable wool;
With wiry teeth *revolving cards* release
The tangled knots, and smooth the revell'd fleece;
Next, moves the *iron hand* with fingers fine,
Combs the *wide card*, and forms the eternal line;
Slow, with soft lips, the *whirling can* acquires
The tender *skains*, and wraps in rising spires;
With quicken'd pace *successive rollers* move,
And these retain, and those extend, the *rove*;
Then fly the *spoles*; the rapid *axles* glow;
While slowly circumvolves the lab'ring *wheel* below.

122. Civilized man does not disdain to convert the covering of animals to his purpose; but he changes their appearance, and prepares them, so as at once to preserve and clear them from offensive odours.

One of the most common articles of external clothing is derived from the wool of the sheep;

and this forms the most admired and useful, of the native manufactures of Great Britain.

123. The *fleece*, as it comes from the animal, is first picked and sorted; and then cleansed from stains, dirt, and grease. The wool-comber afterwards prepares it for the spinner; who twists it into woollen-thread called *worsted*, or *yarn*. Of late years, the twisting has been performed by worsted-mills, on the plan of cotton-mills.

124. This yarn or worsted, is then wove in a loom into cloths, flannels, or stockings, of various degrees of fineness, according to the nature of the fleece: the weaver delivers the cloths to the fuller; who, by means of *fuller's* earth, deprives it of all remaining grease.

It is, afterwards, dyed any required colour; is pressed, and then sold, under the name of broad and narrow cloth; to the draper, taylor, or merchant.

Obs.—England and Wales feed 36 millions of sheep; each of which, yields a fleece of four pounds weight; or 144 millions of pounds at 1*s*. per pound, value 7,200,000*l*. These manufactured, produce 20 million of pounds sterling; leaving a profit of upwards of 12 millions per annum, to the manufacturers.

125. Carpets are another production of wool; and in making them, the warp is worked perpendicularly instead of horizontally. The fine shawls of the East, are made from the fine wool of the sheep, which range the mountains of Thibet.

Obs.—Cable-ropes, of superior strength and durability, have lately been made from the long wool, which is useless for cloths.

126. Man's golden clothing, however, is derived from the web of a crawling insect, or caterpillar, called the silk-worm. All the countries of the south and east preserve and propagate this insect; and the produce of its labours, forms a considerable article of commerce with China, India, Persia, Turkey, Italy, and the South of France.

127. The worm is hatched by the heat of the sun, from eggs laid by a moth, in the preceding year. Its food are the leaves of the mulberry; in which tree it lives in warm climates. After it attains its full growth, it winds itself in its silky web, attached to one of the leaves; and in this cone of silk, it is converted into a lifeless chrysalis.

128. In a few days, the chrysalis produces a lively and delicate moth, which eats its way out of the cone of silk; flutters its wings for a few days, lays eggs for future supplies of silk-worms, —and then dies! Such is the curious and wonderful economy of this insect, which supplies man with the material of silk. See the cut after paragraph 498.

129. The cones of raw silk are about the size of a pidgeon's egg; and each of them, when wound off, contains, in length, a quarter of a mile! These webs, after slight preparations, are spun into thread, by machinery in silk-mills, and then called *organized* or *thrown* silk. The weaver converts the thread into the various elegant fabrics made of silk; and the dyer and presser finish them for consumption.

Obs.—Attempts have been made to render the web of the spider useful; and stockings have actually been made of this material! In short, whatever man can spin into thread, he contrives to weave into garments; and in this respect there is no bound to his materials, but in nature.

130. Hats are made of the fine hair of animals, felted, or beat; and then gummed together, till they are tenacious and firm. Shoes and gloves are made of the hides of animals, first prepared by the tanner and currier by expelling the fatty and unctuous matter of the animal, and infusing into its place, an astringent made of oak bark.

Skins are many weeks in the tan-pits or bark infusions, undergoing this conversion; and they are then shaved and coloured by the currier, for their various uses.

VIII. *Of Government and Laws.*

131. The heads and fathers of families were anciently their governors; and this kind of government, was called Patriarchal. The histories of Abraham, Isaac, and Jacob, are beautiful illustrations of this state of human society.

132. When the family grew too large, the branches sometimes separated, as we observe in the instance of Abraham and Lot; and of Jacob and Esau; but when they resided together, some one would be regarded as the head: in due time, a title would be given to this ruler; and he would be called a chief, captain, judge, dictator, king, sultan, or emperor.

133. Such was the origin of all governments; and they would prove of various tendencies, ac-

cording to the character of the first rulers. Any quarrel between two tribes, would give to both of them a military character.

He who got the better, would be in danger of being inspired with a love of conquest; hence, much misery would arise. In time, many tribes or families would unite into one; as well for offence as defence: such, doubtless, was the origin of nations.

134. The land of Canaan, when invaded by the Israelites, was sub-divided, in this way, into petty tribes; so was Britain, when it was invaded by Cæsar; Italy, also, was divided in the same way, before the ambition and military character of certain Romans led them to make war with their neighbours.

Such, too, is the state of nameless tribes in North and South America; in Africa, Tartary, and Siberia, at this day.

135. Every man in a society, or nation, is bound to respect its welfare; to do nothing injurious to its members; and to conform himself to the rules or laws by which it is held together, maintained, and protected. By obeying the laws himself, he sets an example to others; and he also partakes of the common benefit and protection afforded by them.

136. A constitution is that plan of government and system of laws, under which a people live together in the same society. In England, for example, we have a chief magistrate, or king, to execute the laws and conduct the business of the government; and we have two houses of parliament, to concur with the king in making

laws, and levying money: this arrangement is called the constitution of England.

137. The two houses of parliament consist of about 400 peers or nobles in the House of Lords; and of 658 members, elected by and representing the people, to the House of Commons.

No law can be enacted without the joint consent of the king, lords, and commons; and nothing can be done contrary to the laws so made; or to the established and known customs, or Common Law, of the country.

138. No tax can be levied on the people, unless it originates in the House of Commons; and is first approved of by that assembly. The creation of peers and transactions with foreign nations, belong to the office of king; as does the direction and appointment of the Army and Navy, and the management of Wars.

139. The laws of England consist of the *Common* Law, the *Statute* Law, and the *Civil* Law.

The *Common Law* is the ancient law of England, supposed to be derived from the Saxon laws, and founded on principles of reason and justice, on the revealed laws of God, and on the customs and rights of the people.

The *Statute Laws* are particular laws to declare, enforce, and modify, the common law; and are made by the two Houses of Parliament, and assented to by the king.

The *Civil law* is the law of our spiritual courts and universities; and is derived from the ancient laws of the Romans, as condensed into a code by the emperor Justinian.

140. The laws are administered in the king's name, in the courts of King's Bench, Exchequer, and Common Pleas, and also at assizes in county towns by judges; of whom, there are twelve. There is also a court of Equity, called the Court of Chancery: in which, in particular cases, in which the principle of the law does not apply, the letter of it is moderated so as to do real justice.

141. There are also courts of quarter-sessions held by justices of the peace, for trying petty offenders; and by corporate bodies, who act under the king's charter. Courts of request, or of conscience, are instituted for the recovery of debts under five pounds.

142. No man in England can be put on his trial, for any offence, unless twelve of a Grand Jury have declared, in a bill of indictment, that there is cause for trying him; and he cannot be convicted or punished, except a verdict has been given against him by another Jury, composed of twelve honest and unexceptionable men.

143. By our laws, wilful murder, forgery, house-breaking, house-burning, horse and sheep-stealing, rape, highway-robbery, cutting and maiming, piracy, coining, and treason against the king, are punishable with death.

144. Numerous other offences are also punishable with death; but the sentence is generally changed into transportation for life: smaller offences involve transportation for fourteen or seven years; and petty ones are punished by imprisonment, whipping, pillory, burning in the hand, and by fines.

145. A man who has committed a crime, is charged with it before a *justice of the peace;* who issues his *warrant* to the *constable* for his apprehension.

The justice commits him to the custody of the sheriff in the *county goal,* on the *oath* of the accuser; who, at the *assizes,* must repeat his charge before *the grand jury.*

If they find *a true bill,* he is then tried before the *petit jury;* and on being found *guilty,* receives from *the judge,* the *sentence* of the *law.*

146. Death is inflicted by hanging: transportation is made to Botany Bay in New Holland; but many such culprits are employed in England on board of hulks, or old ships: small offenders are sent to houses of correction and kept to hard labour.

As the king is the executor of the laws, and as all prosecutions are carried on in his name, he has the power of pardoning criminals.

147. The constitution of England secures the liberty, as well as the good government, of the people,—

Because no law can be made, without the consent of their representatives in the House of commons.

Because no tax can be imposed, without it originates and first passes in that house. And

Because no man can be punished, in any way, without the consent of twenty-four of his peers, or equals; i.e. by twelve of a grand, and twelve of a petit jury.

148. The public rights of Englishmen are also secured by Magna Charta, by the Habeas Corpus

Act, by the Bill of Rights, and by innumerable acts or statutes of parliament passed chiefly in the reign of Edward the First, and William the Third.

Obs.—The two most enlightened countries in Europe, having published the general principles of government, the one in a document, called the BILL OF RIGHTS, 1689; and the other in a DECLARATION OF RIGHTS, in 1789, both are subjoined as the completest and least objectionable summaries that were ever compiled on these subjects.

The lords spiritual and temporal, and commons of England, being assembled in a full and free representation of the nation, did (as their ancestors in like case had usually done) for vindicating and asserting their ancient rights and liberties, declare,

1. That the pretended power of suspending of laws, or for the execution of laws, by legal authority, without consent of parliament, is illegal:

2. That the pretended power of dispensing with laws, or the execution of laws by legal authority, as it hath been assumed and exercised of late, is illegal:

3. That the commission for erecting the late court of commissioners for ecclesiastical causes, and all other commissions and courts of like nature, are illegal and pernicious:

4. That levying money for, or to the use of the crown, by pretence of prerogative, without grant of parliament, for longer time, or in any other manner than the same is or shall be granted, is illegal:

5. That it is the right of the subjects to petition the king; and all commitments and prosecutions for such petitioning are illegal:

6. That the raising or keeping a standing army within the kingdom in time of peace, unless it be with consent of parliament is against law:

7. That the subjects which are protestants may have arms for their defence, suitable to their conditions, and as allowed by law:

8. That election of members of parliament ought to be free:

9. That the freedom of speech, and debates or proceedings in parliament, ought not to be impeached or questioned in any court or place out of parliament:

10. That excessive bail ought not to be required, nor excessive fines imposed, nor cruel and unusual punishments inflicted:

11. That jurors ought to be duly impannelled and returned; and jurors which pass upon men in trials for high-treason ought to be freeholders:

12. That all grants and promises of fines and forfeitures of particular persons before conviction, are illegal and void:

13. And that for redress of all grievances, and for the amending, strengthening, and preserving of the laws, parliaments ought to be held frequently,

And they do claim, demand, and insist upon all and singular the premises, as their undoubted rights and liberties; and that no declarations, judgments, doings, or proceedings, to the prejudice of the people in any of the said premises, ought in any wise to be drawn hereafter into consequence or example.

Again, in 1789, the National Assembly of France recognized and declared, in the presence of the Supreme Being, and in the hope of his blessing and favour, the following sacred rights of men and citizens.

1. Men are born, and always continue free and equal in respect of their rights. Civil distinctions, therefore, can be founded only on public utility.

2. The end of all political associations, is, the preservation of the natural and imprescriptible rights of man; and these rights are liberty, property, security, and resistance of oppression.

3. The nation is essentially the source of all sovereignty, nor can any individual, or any body of men, be entitled to any authority which is not expressly derived from it.

4. Political Liberty consisting in the power of doing whatever does not injure another; the exercise of the natural rights of every man, has no other limits than those which are necessary to secure to every other man the free exercise of the same rights; and these limits are determinable only by the laws.

5. The law ought to prohibit only actions hurtful to society. What is not prohibited by the law, should not be hindered; nor should any one be compelled to do that which the law does not require.

6. The law is an expression of the will of the community; all the people have a right to concur, either personally, or by their representatives, in its formation. It should be the same to all, whether it protects or punishes; and all being equal in its sight, are equally eligible to all honours, places, and employments, according to their different abilities; without any other distinction than that created by their virtues and talents.

7. No man should be accused, arrested, or held in confinement, except in cases determined by the law; and according to the forms which it has prescribed. All who promote, solicit, execute, or cause to be executed, arbitrary orders ought to be punished; and every person called upon, or apprehended by virtue of the law, ought immediately to obey, and he renders himself culpable by resistance.

8. The law ought to impose no other penalties than such as are absolutely and evidently necessary; and no one ought to be punished, but in virtue of a law promulgated before the offence, and legally applied.

9. Every man being presumed innocent, till he has been convicted, whenever his detention becomes indispensible, all rigour to him more than is necessary to secure his person, ought to be provided against by the law.

10. No man ought to be molested on account of his opinions, not even on account of his religious opinions; provided his avowal of them does not disturb the public order established by the law.

11. The unrestrained communication of thoughts and

opinions, being one of the most precious rights of man; every person may speak, write, and publish freely, provided he is responsible for any abuse of this liberty, in modes determined by the law.

12. A public force being necessary to give security to the rights of all the people, that force is instituted for the benefit of the community, and not for the particular benefit of persons with whom it is entrusted.

13. A common contribution being necessary for the support of the public force, and for defraying the other expenses of government, it ought to be divided equally among the members of the community, according to their ability to pay.

14. Every person has a right, either by himself, or his representative, to a free voice in determining the necessity of public contributions; the appropriation of them and their amount; their mode of assessment, and their duration.

15. Every community has a right to demand of all its agents, an account of their conduct.

16. Every community in which a security of rights is not provided for, by a separation of powers, wants a Constitution.

17. The right of property being inviolable and sacred, no one ought to be deprived of it, except in cases of evident public necessity, legally ascertained, and on condition of a previous just indemnity.

*** *Students who desire to become more intimately acquainted with these subjects, should consult Blackstone's Commentaries on the Laws of England; Delolme on the Constitution; Miller on the Constitution; or, Goldsmith's British Geography. On other public subjects, Smith on the Wealth of Nations, and Ganihl on Political Economy, are valuable works.*

149. The enjoyment of private property, which is the stimulus of industry, and the foundation of social order, is secured by the common law of the land, and by the intervention of a jury; who

decide in cases of private right, as well as in cases of public injury, or crime.

150. Property is divided into real and personal; real property consists of lands and their appendages, and of houses and other buildings; personal property signifies moveables, goods, cattle, and every thing, in which the holder has but a temporary interest.

151. Real property is held *in fee simple*. i. e. by the party and his heirs for ever; or it is held *by entail*, i. e. by him, and his own children, or by him, and afterwards to go to some particular person. Estates may also be occupied *for life*; or by *lease* on certain conditions, for a term of years; or *at will*, for an annual rent.

152. The house of peers consists of the *Princes* of the blood royal; of *Dukes, Marquises, Earls, Viscounts, and Barons*. The public sign of their rank, and that which they bear on their carriages and seals, are their respective Coronets, here given.

The other ranks are *Baronets*, distinguished by a bloody hand, quartered in the arms; and *Knights*, distinguished by their helmet; *Esquires* are so by creation, or office; and *Gentlemen*, having 300*l.* in real property per annum.

THE KING, OR REGAL CORONET.

THE DUKE.

THE MARQUESS.

THE EARL.

THE VISCOUNT.

THE BARON.

153. The heads of the church represent that establishment in the house of peers; and consist of the *Archbishops* of Canterbury and York, and of *twenty-four* English, and *four* Irish bishops.

Other dignities of the church are *Deans*, or assistants of the bishops.

Arch-Deacons, or subordinate bishops.

Rural Deans, who preside over part of the diocese.

Rectors or *Vicars* of parishes, according as they receive the great or small tythes.

And *Curates*, who receive a salary for doing the clerical duty.

154. The twelve Judges sit occasionally in the house of lords, but they do not vote. In the law, there are also *Recorders*, or judges of corporations; *Sergeants at law*; *Barristers*, or *counsel*; and *Solicitors* or *Attornies*.

The *Attorney* and *Solicitor-general* are barristers, who plead on the legal business of the crown.

155. *Sheriffs* are officers, who are the executive deputies of the king in their county; they serve all writs and process; keep the prisons; name and summon juries; execute sentences of the law.

Coroners are officers appointed to enquire into the causes of sudden deaths.

Justices of the peace hear complaints; commit offenders for trial, to the sheriffs' public prison; and redress many grievances.

Headboroughs are constables of hundreds: and petty *constables* execute the warrants of justices.

GOVERNMENT AND LAWS OF THE UNITED STATES.

156. The government of the United States, is a representative democracy. All power resides

ultimately in the people; but they exercise it by means of their representatives, or persons chosen by them for that purpose. The constitution is a written one; and to its provisions all the departments of the government are bound to conform; and the act of any one of them, even an act of congress, if contrary thereto, is void.

157. The executive power is vested in "THE PRESIDENT OF THE UNITED STATES." He is chosen every fourth year by electors appointed by the several states.—He is the commander in chief of the army and navy; and by and with the advice and consent of the Senate, makes treaties, appoints judges, foreign ministers and other officers.—He is liable to be impeached and removed from office for misbehaviour.—He is re-eligible as often as the people please to re-elect him.

158. The legislative power resides in a CONGRESS, consisting of a *Senate* and *House* of *Representatives*. The Senate consists of two members from each state in the union, chosen by the legislature thereof, and remain in office six years. The members of the House of Representatives are chosen by the people of each state for two years. The Senate has the power to try all impeachments—the house of representatives prefers them.

159. Every law must be passed by both the Senate and House of Representatives, and also receive the approbation of the President; or if he dissent, two thirds of each house must after his dissent, concur in passing it.

160. The judicial power is vested in a Supreme Court, established by the constitution, and in such inferior courts as congress may think fit to esta-

blish. Besides the ordinary exercise of its power of deciding controversies, it is incident to the judicial power of the United States to pass upon the acts of congress and decide upon their constitutionality; a power essential to the maintenance of the rights of the people, but not known in any of the governments of Europe. In England the power of parliament is said "by a figure rather too bold" to be omnipotent; and the people are bound by its acts however arbitrary. In the United States, the legislative power is wisely limited.

161. Besides the general government, whose powers for many purposes extends over the whole union, each state has a separate local government, whose jurisdiction is confined to the regulation of its own concerns. These separate governments are all republican, and consist generally of a governor, and two legislative branches; though the powers of the different departments are variously modelled in the several states.

162. The rights of personal security, personal liberty, and private property are equally protected in this country as in England, and by much the same means. The Magna Charta, the bulwark of English liberty, is acknowledged in most, probably in every one of the states. The privilege of the Habeas Corpus, the right of trial by jury, to be heard in criminal cases by himself and counsel, to meet the witnesses face to face, to be protected from giving testimony against ones-self, and the other great and essential principles of liberty are firmly established.

163. There are no titles, no orders of nobility, nor privileged orders of any kind in the United States. Merit alone it is considered ought to distinguish men. Nor is there any established religion here: every man is allowed to worship Almighty God according to the dictates of his own conscience. Well may the exclaimation of the Mantuan poet be applied to these people: "*O fortunatos nimium, sua si bona norint.*"

IX. *Of the Mechanical Powers.*

164. Without the aid of art, man could not raise massy stones to the tops of churches and palaces; he could not apply immense beams of timber to his purposes; in short, he would still have been a builder of huts and cottages. He however, soon discovered the use of a *lever*; and the principle of that power he soon applied, in various shapes. . .

Obs.—A lever is the foundation of all the mechanical powers. It is nothing more than a straight stick or bar of wood or iron; and any common lever may be applied in an instant to any object by way of experiment:—a *poker*, a *fire-shovel*, or *strong walking-stick*, for the purpose of illustration, is as good a *lever*, as any that could be made. Lay a shovel across a fender, and put a large coal into it, then balance the coal with the hand at the other end of the shovel; in this situation, the shovel is a *lever*, the fender is the *fulcrum*, the coal is the *weight* or *resistance*, and the hand is the *power* to raise and overcome it.

165. The *force* with which any body moves is called its *momentum*. If a boy walk at the rate

of *two* miles an hour, and go against a wall, he will strike it with a sensible *force* or *momentum*; if he walk at the rate of *four* miles an hour, and go against it, he will strike it with *double* the force; or if he run at the rate of *six* miles an hour, he will strike it with *three times* the *momentum*.

Obs.—Every child that throws a ball, or shoots a marble, is sensible that its *force* or *momentum* is in proportion to its velocity; the same marble will hit twice as hard, he will tell you, if it move twice as fast, or ten times as hard, if it move ten times as fast. Let him substitute the word *momentum* for hard, and *velocity* for fast, and he will at once understand the principle of the mechanical powers.

166. If a man, *twice* the weight of the boy, go with the same degree of swiftness, or with the same velocity as the boy, he will go against the wall with twice the momentum of the boy in every instance. Hence, it is a general rule, which must not be forgotten, that the *momemtum* is always in proportion to the combined or united size and velocity of the forces employed.

Obs.—A marble, twice the size of another, thrown with *equal* velocity, will strike with twice the force, and this is all that need be understood. Any one who has learnt the multiplication-table, may easily calculate forces or momenta: a ball of two pounds weight, moving with a velocity of six miles an hour, will strike with a momentum which may be represented by *two* multiplied by *six*, producing *twelve*; and a ball weighing six pounds, and moving at the rate of eight miles an hour, will have a momentum equal to *six* multiplied by *eight*, producing 48: hence, those two balls move with separate momenta equal to 12 and to 48; or, in simpler terms, one moves with four times the force of the other.

167. If a stone weighing 500 pounds, is to be raised one foot by a man, who can lift only 100

pounds, he cannot raise it, unless he can *contrive* to make his arm move five feet, while the stone moves only one foot; because 100 multiplied by *five*, is equal to 500 multiplied by *one*.

168. This increase of motion in the arm is effected by the *lever;* because the motion of one end is in the same proportion to the motion of the other, as the distance of the two ends are from the fulcrum.

If a lever, six yards in length, be laid on a fulcrum, at one yard from one end, and the above-named stone be fixed to that end; the hand which pulls at the long, or five yards' end, moves over five times the space that the other end does; consequently, though pulling but 100 pounds, it will be equal to 500 pounds at the short end of the lever.

169. The grand principle then of mechanics is this,—that *we gain in power, what we lose in motion;* and hence, the strength of one man could move the earth, if he could bring his strength to act upon it with such a velocity, as there is difference betwixt his power and the weight of the earth.

Obs.—The property of the simple lever is exemplified in the steelyard used by butchers for weighing meat; and in the iron crow.

170. Single *pulleys* merely improve the purchase; but *compound pulleys* enable the hands of those who pull them, to move over *twice* the space according to the number of pulleys; hence, two acting pulleys increase the power four times, and three increase it six times.

171. A force applied to the circumference of a large wheel, as water, wind, and the feet, or

strength of men and horses, gains power in the proportion of the diameter of the wheel to the axle.

If a water-wheel be 12 feet in diameter, and turn an axle of one foot, the powers acting at the circumference of the large wheel, moves over twelve times the space which the circumference of the axle moves; hence 12 cwt. may be raised with the power of *one* cwt.

Obs.—All windlasses, cranes, mills, windmills, and watermills, are formed on this principle. The power, whatever it be, is applied to the circumference of a large wheel, whose circumference moves in consequence, perhaps, ten miles an hour, while its axle, one tenth of the diameter, moves but one mile an hour; consequently, the strength of one man at the circumference, will be equal to that of ten men at the axle.

172. Inclined planes, or sides of hills, wedges, screws, jacks, &c., are all used in mechanics on the same principle: their power depends on the proportion between the *height* actually attained, and the *length* of the plane moved over.

A screw is an inclined plane; and if a lever be added to it as in presses, the power gained is so great, that a man can multiply his own strength many thouand times.

Obs.—If I wish to roll a cask weighing six hundred weight, on an elevation equal to ten feet, and my own force is but two hundred weight, it is obvious, on the above principle, that an inclined plane must be three times ten feet, or 30 feet long. If a mail-coach weighs two tons, and is drawn on level ground, by a force equal to eight hundred weight, and is to be drawn to the top of a hill which rises twenty yards in a hundred, the horses will have to pull with an additional force equal to one-fifth of the weight of the carriage, *i. e.* one fifth of 40 cwt., or double that with which they could draw on level ground.

173. A body put in motion, would move for ever, if it were not for the friction of the parts, and the resistance of the air, which alone stop it. A fourth of all power is lost in machinery, from Friction and Resistance: hence, the use of oil to soften the parts; the necessity of smooth roads for wheel-carriages; and hence, various contrivances called friction-wheels for diminishing friction.

Obs. 1.—The principle of bodies continuing in motion after being put into it, is felt by those who are in a carriage which suddenly stops. They are thrown forwards, owing to their not parting with the motion they have acquired. From this cause, when a ship in full sail strikes on a rock, every one on board is thrown down, and generally the masts snap in two; so when an open chaise stops from a horse falling, those in it are thrown forward; not from the position of the chaise, but owing to the motion which has been communicated to their bodies.

2.—Hence also, rollers are very useful assistants in moving heavy stones or bodies, from the little friction they create.

174. The principle of all the mechanical powers, however they are combined, is the same; that is to say, *to create all the difference possible between the velocity of the power, and the velocity of that body which is to be acted upon, so as to increase the momentum of the power.*

One of the most common combinations is effected by *cogged-wheels*; which, when turned by some power, move greater or smaller wheels, or give new directions to the force.

175. A small wheel, with *eight* cogs or teeth, moving another which has *forty cogs*, diminishes the motion of the axle of the larger wheel a *fifth*, and increases the power *five* times, and this is the common windlass.

Some wheels are destined to effect certain objects without increase of power, as in clocks or watches. Sometimes, a greater power is applied to produce increased motion, as in the roasting jack, and in many mills.

Obs.—On duly considering the vast increase of power by some of these combinations, it cannot be matter of further wonder that first-rate men of war, and other such vast objects, are easily constructed. In some instances, one man is enabled to lift as much as 1000, and powers may be applied equal to the strength of a hundred thousand men.

176. Clocks and watches are nothing more than a simple arrangement of wheels of different diameters and numbers of teeth, so as to indicate seconds, minutes, hours, days, and even months.

Clocks are set in motion by a weight which turns a cylinder, which cylinder sets the whole in motion.

Watches are kept in motion by a coiled spring, which, in seeking to uncoil itself, exerts a power that gives motion to one wheel, which turns all the others.

Obs.—A lecture of ten minutes at a watch-maker's, with the wheels and other parts under the eye, will explain more than could be done by verbal description in a volume.

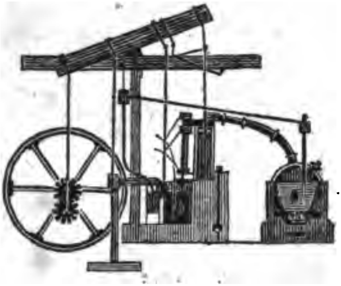
177. The triumph of mechanics is the steam-engine. The inventor observed the excessive force of steam in lifting up the stiff lid of a kettle as he sat at breakfast, and he and others have since applied this resistless power to produce a motion applicable to all kinds of machinery.

178. In constructing these engines, steam from a copper is thrown into a hollow iron cy-

linder, with a close lid or stopper, which rises as the steam rushes into the cylinder, and falls, when the steam is condensed by cold water thrown in for the purpose.

An upright iron rod is fixed to that lid, and to one end of a large beam; which, in consequence, has an action communicated to it similar to that of a see-saw, and is lifted up and pulled down, with wonderful precision and force.

THE STEAM ENGINE.

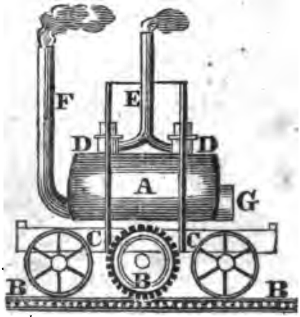


Obs. 1.—A regular and powerful motion being thus produced, the mechanic seizes upon it, and applies it with ease to all kinds of machinery. The apparatus itself has been slightly varied by different persons, and for different objects; but the principle remains the same, and it is, perhaps, the greatest discovery that ever was made in mechanics.

2.—Mr. Watt, of Birmingham, has made many improvements in the steam-engine; and, among others, he fastens the top of the cylinder, working the rod through it, and injects steam above as well as below, so that the motion downward is produced by steam, as well as that upward; he also condenses the steam in an adjoining vessel. One horse can, by common machinery, raise 25,000 pounds one foot high in a minute; but some steam machines perform the labour of 60 or 80 horses! A small one of a ten-horse power, with the steam produced by a *single bushel of coals*, will raise 30,000,000 of pounds one foot high; or it will grind and dress three sacks of wheat, slit and draw into nails five cwt. of iron, and drive at the same time 1000 cotton spindles. Steam-engines have lately been applied with success, to impel boats and ships.

3.—Mr. Blenkinsop, of Leeds, has lately applied steam to move coal waggons on a rail-way, instead of drawing them with the power of horses, with great success. Here is represented his machine, to which any carriage may be annexed.

BLENKINSOP'S MACHINE.



A. Boiler.
B. B. B. Patent Road Rack and Wheel.
C. C. Crank Rods.
D. D. Steam Cylinder.
E. Discharging Pipe.
F. Smoke Chimney.
G. Fire Door.
Scale one-eighth of an inch to a foot.

179. The Pump for raising water is a very useful machine; and its principle should be understood. It can raise water, if required, to the height of thirty-three feet, by the pressure of the air on the water; and is founded on the principle of the elasticity or pressure of air.

Obs.—If a long glass tube closed at one end, were deprived of air, and its open end immersed in quicksilver, the quicksilver will rise in it about 29 inches; or if placed in water, 33 feet of water will rise in it, the weight of 33 feet of water, being equal to 29 inches of quicksilver. The rise of those fluids in such a tube, is caused by the pressure of the air on the surface of the external mercury or water: hence, it is inferred, and with reason, that the elasticity of the air which we breathe, is in all places equal in force to the weight of about 29 inches of mercury, or 33 feet of water.

180. To raise water 33 feet high, nothing more then is requisite than to put one end of a pipe in it, and to draw the air out of that pipe, when the water will instantly ascend in the pipe.

Such is the purpose and effect of a pump; and all that is to be done is by proper contrivances to draw out the air above, and keep up a supply of the water below.

181. A pump consists of a wooden or copper pipe, with a long iron rod to work up and down within it, by means of a handle.

At the lower end of the iron rod is fixed a metallic hoop, provided with leather to fit the pipe: in the centre of the hoop is a *little trap-door* or *valve*, which opens only upwards, and when down, shuts very close.

At the bottom of the pipe, near the water, another such valve also opening upwards, is *fixed* tight within the pipe itself.

182. The handle of the pump being raised, the iron rod (called the *piston*,) with its valve at the bottom of it, is forced down the pipe.

As the valve opens upwards, the air in the pipe passes up through the valve.

On pulling down the handle, the piston is *raised*, and with it the valve, leaving a vacuum or vacuity between it and the lower fixed valve.

To fill up the vacuum, the water rushes up through the lower valve.

On again raising the handle, the piston again *descends*; and the water now rushes through its valve, and on pulling down the handle again, the piston and its closed valve *rise*, bringing up the water.

Its ascent creates a new vacuum, and other water rushes through the lower valve; the upper valve is made to descend again, to rise again closed, and bring up water.

183. *Fire-engines*, and other *forcing-engines*, have no valve or flap fixed to the piston; but a solid plate is moved up and down by it, and the rising water is thus violently driven into an adjoining air-tight vessel.

Through the top of that vessel, the playing pipe is so inserted, that its mouth may lie below the water, leaving the upper part of the vessel filled with air.

Then the elastic power of that portion of air, forces the driven water up the playing pipe.

The energy of the stream, will of course depend on the power applied to force down the piston, and drive the water into the air-vessel.

Obs.—An inspection of a pump or fire-engine, will teach more in ten miuutes, than mere description in as many hours.

X. *Trade and Commerce.*

184. The barter of commodities is necessarily coeval with the first formation of society. One man might have too much corn; and another too much wool; and each would be willing to give what he had to spare of his own superfluity, for what he might want of the superfluity of the other.

185. In time, such barter would become a system; otherwise, every family would have to grow every commodity it wanted; and to manufacture every article it consumed. The taylor would make clothes for the farmer, and take provisions for his labour. The carpenter would build on the same principle of reward; and hence, all the distinct trades would arise, which we now see exercised.

186. One farmer too would cultivate wheat; and another make cheese and butter, according to the nature of their respective soils.

They would either exchange on the spot, or each would carry his peculiar produce to a common market, and exchange it for gold or silver, articles of universal currency, which he could exchange at any time, for whatever else he wanted.

187. The application of labour to particular or individual objects, has also tended greatly to improve every manufacture.

A man who is nothing but a taylor, is far more expert at making clothes, than if he were also, a shoemaker, carpenter, and blacksmith; and still more so, if instead of making all kinds of clothes, he work at particular parts of garments.

This is called *division of labour.*

188. The utility of dividing labour is exemplified in making pins.

Were a piece of metal given to a man to make one pin, he could scarcely do it in a day.

In pin-manufactories, however, each pin passes through twenty-five hands: one draws out the wire, another straightens it, another cuts it, another points it, three or four prepare the head, two or three puts it on, and others finish them, and put them on a paper.

Twenty-five persons, thus, make one hundred and twenty-five thousand pins in a day; or five thousand to each person!

189. Labour likewise sub-divides itself numerously in every branch of the elegant and useful arts.

Thus, in building, there are, the brickmaker, the stone-mason, the architect, the surveyer, the bricklayer, the sawyer, the carpenter, the joiner, the slater, the plasterer, the plumber, the glazier, the ironmonger, and the painter; *all* necessary in their several departments.

190. In villages and remote countries, where every separate branch could not meet with sufficient employment, the same person often pur-

sues two or three branches; for example, the stone-mason, bricklayer, slater, and plasterer, are often united in one workman; so the carpenter and joiner; also the plumber, glazier, and painter; and probably, the carpenter or bricklayer takes it on himself, to act also as architect and surveyor. *See the Book of Trades.*

191. In the arts connected with the furnishing of the house, there are the smith, the ironmonger, the cabinet-maker, the looking-glass maker, the frame-maker, the carpet-maker, the bedstead-maker, the feather-merchant, the blanket manufacturer, the oil-cloth-maker, the copper-smith, the venitian blind-maker, the tinman, the print-seller, the bookseller, and the painter; all necessary for the house of a man of taste and fortune.

192. In branches of trade connected with the clothing of a man, we have the wool-man, the comber, the spinner, the weaver, the fuller, the dyer, the presser, the packer, and the woollen-draper.

For *linens*, we have the flax-dresser, the spinner, the weaver, the bleacher, the presser, the packer, and the linen-draper.

For *cottons*, there are the planter, the merchant, the cotton-spinner, the weaver, the bleacher, the dyer, the presser, the packer, the warehouseman, and the draper.

193. In the *silk trade*, there are the importer, the silk-throwster or spinner, the weaver, the dyer, presser, and mercer.

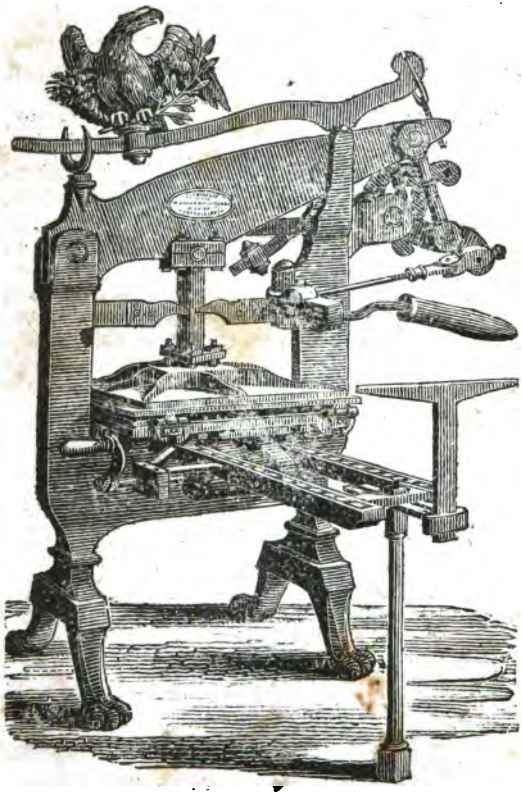
In the *iron* and *metallic trades*, called the *hardware-manufacture*, there are the miner, the smelter, the iron-master, the founder, the scythe-smith, the button-maker, the gun-smith, the sword blade manufacturer, the cutler, the polisher, the plater, the finisher, the sorter, the packer, the factor, and the hardware-man.

194. In connection with books and literature, there are the author, the designer, the publisher, the rag-merchant, the paper-maker, the stationer, the type-founder, the press-maker, the ink-maker, the pelt-maker, the chase-maker, the compositor, the pressman, the gatherer, the folder, the stitcher, the leather-seller, the binder, the copper-smith, the engraver, the wood-cutter, the copper-plate printer, and the bookseller; in all 23 trades, to produce the Universal Preceptor.

Obs.—The author requires, too, his quill-merchant and his ink-maker; the designer, various branches of trade; as the pencil-maker, colour grinder, &c. &c.; the rags require sorters; the paper-maker has his vatmen, his dryers, pickers, sorters, pressers, &c. &c.; and so on in each department, extending the 23 even to 100.

COLUMBIAN PRESS.

***Invented by George Clymer, Anno Domini,* 1813.**



195. A pack of *wool* weighing 240 pounds, employs 200 persons, before it is ready for sale, in the form of stuffs, cloths, &c.; to be made into stockings, it will occupy 184 persons for a week; as 10 combers, 100 spinners, winders, &c.; 60 weavers or stocking-makers, besides dyers, pressers, &c.

A sword made of *steel*, the original metal of which was not worth a shilling, is sometimes sold for 300 guineas; and a watch-chain has produced 50 guineas; the metal of which before it was wrought, was not worth three-pence.

In like manner, a yard of Mechlin-*lace* will fetch 20 guineas; the flax in which was originally not worth three-pence.

So likewise, a *painting*, not two yards square, has been valued at 25,000*l.*; and a shawl, which contains but a few ounces of wool, sells for 60 or 80 guineas.

196. As it is with individuals, so it is with distant nations: what one nation possesses in superfluity, it is desirous to exchange for some article it wants, with any other nation which possesses a superfluity of that article. Anciently, England had tin, wool, and coals, which it exchanged for wines and manufactures.

Obs.—A people, who have no superfluities desirable among other nations, can have no trade, nor can they enjoy any foreign commodities; but if they have such superfluities, they can exchange them, and trade. Gold or silver are superfluities which command trade, and pay the balance of trade, when the goods received exceed the goods delivered. Hence, arises the wealth in gold and silver, of all fruitful and industrious countries.

197. Such was the origin, and such is the principle of foreign commerce. At this day, England manufactures for a large portion of the world, and gives its manufactures in exchange for raw materials; and in some cases for manufactured produce, which is consumed at home, or re-exported.

198. The Phœnicians or Philistines were the first people on record who employed ships to carry the produce and manufactures of one nation to another.

They were followed by the Carthaginians; and these, by the Venetians, Genoese, and Hans Towns.

During the two last centuries, the Portuguese and Dutch divided the trade of the world with the English.

199. The English are not only the greatest manufacturers, but the greatest carriers of produce; and they have had as many merchant-vessels on the seas, as all other nations put together.

200. Besides trading with the remotest nations, the English have established considerable settlements or colonies in Asia, Africa, and America; by means of which, they enjoy the profits of cultivation, in addition to those of monopoly.

201. In Asia, the colonies of the English are Bengal, all the countries on the Ganges, the coasts of Coromandel and Malabar, and the large islands of Ceylon and Sumatra.

From these and neighbouring countries, they bring to Europe spices, silk, rice, tea, muslins, coffee, drugs, perfumes, and precious stones.

202. In Africa, the colonies of England are

the Cape of Good Hope, Goree, Sierra Leone, and forts on the coast of Guinea.

From these, they bring to Europe gold dust, ivory, gums, and drugs.

203. In America, the English provinces of Upper and Lower Canada and Nova Scotia, produce furs, corn, and fish. In the West Indies, England occupies Jamaica, Barbadoes, and many other islands. And in South America, Demarara, Berbice, Guiana, &c.; all which supply sugar, rum, cotton, coffee, spices, drugs, mahogany, sweet-meats, &c.

204. These luxuries serve at once to gratify ourselves; and as desirable mediums of exchange for the produce and manufactures of all other countries.

We give them to Russia, for hemp, tar, and tallow:

To Sweden, for copper:

To Norway, for timber:

To Germany, for linen rags and smalts for paper:

To France, for wine and brandy:

To Portugal, for wine:

To Spain, for gold and silver, and fruit:

To Italy, for silk, rags, oil, and fruit:

And to Turkey, for silk, drugs, oil, and coffee.

205. This amazing intercourse, in time of peace, was carried on in about 24,000 vessels of all sizes, carrying three millions of tons burthen, and employing 200,000 seamen.

The trade and manufactures employ, besides, from four to five millions of the inhabitants of

Great Britain and Ireland; and serve also, to enrich all its inhabitants.

206. Several branches of the foreign trade of England is carried on by subscription-companies; who divide the profits in half-yearly or yearly dividends.

These are the East India Company; which enjoys a monopoly of the trade to Asia:

The Bank of England; for bullion and precious stones:

And the Hudson's Bay Company; which monopolizes the trade in furs from those countries.

There are also the nearly extinct Turkey, Russia, African, and South Sea-Companies.

207. The inland or domestic trade of Great Britain and Ireland, is carried on by means of many thousand waggons and stage-coaches; by canals and rivers, which intersect every part of the two islands; and by many hundred coasting-vessels, which carry the produce and manufactures of one place to another.

208. The chief ports are London (equal in trade to all the others,) Liverpool, Bristol, Glasgow, Hull, Falmouth, Dartmouth, Plymouth, Portsmouth, Yarmouth, Lynn, Shields, Leith, Aberdeen, Whitehaven, Swansea, Dublin, Cork, and Waterford.

209. The chief manufacturing towns are Birmingham, Wolverhampton, and Sheffield, for cutlery, and metallic wares.

Manchester, Stockport, Bolton, and Paisley, for calicoes and muslins.

Leeds and Norwich, for woollen cloths.

Nottingham and Leicester, for hosiery.
Belfast and Londonderry, for linens.
Wilton and Kidderminster, for carpets.
Newcastle and Worcester, for china, porcelain, and glass.

210. The United States of America, under the advantages of a long peace, the possession of raw materials of every kind, numerous fine ports, and a free government, are rapidly advancing in the manufacturing system; have numerous ships at sea, and are carrying on an extensive trade with all parts of the world.

211. The trade of most other nations has been ruined by unwise governments, or by political revolutions. That of China, by its immense canals, is the greatest and most advantageous that is carried on in any country in Asia; but, the Chinese have no general foreign trade, except with Japan.

212. The exports and imports of Great Britain have been nearly fifty millions each per annum. The worth of the various merchandize and manufactures in hand, is estimated at 60 millions; and the value of the shipping employed, at about 25 millions.

213. The employments to which so vast a trade gives rise, are, as far as regards the ship, those of the ship-owner, the ship-builder, the copper-smith, the rope-maker, the biscuit-baker, the provision-merchant, the ship-carpenter, the anchor-smith, the mathematical instrument-maker, and the slop-seller.

214. In regard to the cargo of ships, there are

the merchant, the ship-broker, the factor, the manufacturer, the packer, and the lighterman.

Among merchants, there are *Spanish* merchants, *Turkey* merchants, *Italian* merchants, *Russia* merchants, *Hamburgh* merchants, *West India* merchants, *American* merchants, *Brazil* merchants, and *African* merchants.

XI. *The Art of Navigation.*

215. That must be allowed to be a most useful as well as an extraordinary art, which enables men to conduct great ships with precision, across vast seas many thousand miles wide, in which they often sail for months together without seeing any land to guide them in their course.

216. Anciently, and indeed till within the last 400 years, ships seldom ventured out of sight of land; and if they did, it was by mere accident that they ever regained the shore: such were the disadvantages of the Egyptian, Phœnician, Carthaginian, Roman, and Grecian commerce.

217. About the beginning however of the 14th century, a new æra was produced in this most noble and useful of all the arts, by the discovery, or perhaps more properly, the application of the properties of the Load Stone. This substance is a species of iron ore, or ferruginated stone, which is foound, generally in iron mines, and of various forms, sizes and colours, and has not only the property of attracting Iron and Steel, but the more extraordinary one of pointing always towards the

north pole of the earth, and in that state, it is called a natural magnet. It has also the property of imparting its virtue to a bar of Iron or Steel, which is then called the artificial magnet or magnetic needle, and which being properly balanced and fitted up, forms the mariners compass. With this instrument, the navigator can now always shape his course with correctness and safety, over all the oceans of the earth.

Obs.—Considerable controversy and uncertainty has subsisted in relation to the discovery of the Load Stone and mariners compass, and various nations have contended for the honour of it. Some learned writers assert, that it was known to the Chinese above a thousand years before the Christian æra. It is certain that the Load Stone was known to the ancients before the time of Plato and Aristotle, as its properties are referred to in their works. But it appears, that they were only acquainted with its capacity of attracting and repelling iron, and not at all with its polarity or always pointing towards the pole of the earth. Among the moderns, this discovery has been claimed by the Neapolitans, the Venitians, and the French. It has been generally ascribed to the first of these, the (Neapolitans) but however, this may be, it was not until about the 14th century, that the mariners compass as it is now constructed was adopted into general use, and which has since been greatly improved under the denomination of the Azimuth Compass.

218. As the compass enabled him to keep an account of the *course* of his voyage out, so it was not difficult to retrace the same course back by referring to his journal. If a man in the dark, go 50 steps to the right, 20 strait on, and 30 to the left; he will easily return to the place whence he set out, if he take 30 steps to the right, 20 strait on, and 50 to the left.

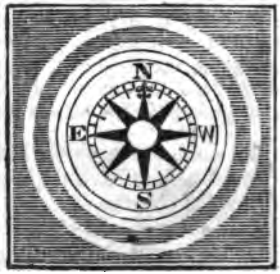
219. In the wide and pathless ocean, therefore this instrument proves a certain guide to the mariner and enables him, if he has recorded his past course correctly, to ascertain his exact position at all times on the sea, and to shape his future course accordingly.

220. In the construction of the compass, the magnetic needle is usually placed in a frame, and covered by a glass. Beneath it, in the frame, are marked the 32 points of the compass; that is to say, the whole circle of the horizon is thus divided into 32 parts.

The principal of these are, the four *cardinal* points, the north, south, east, and west; and these are subdivided into north-east, north-west, south-east, and south-west, &c. &c.

Obs.—Annexed is the representation of this division; the *boxing* or *repeating* of which is, among young sailors, deemed a conisderable achievement.

THE MARINER'S COMPASS.



221. The practice of navigation led, however, to various other discoveries; which now render the mariner's compass not the only guide to the navigator, except, during a series of cloudy weather.

Every child can always tell where he is, by looking at objects out of himself: *i. e.* at the houses, trees, and places, to which he is accustomed.

So it is with sailors: there are certain fixed objects out of the earth, as the sun, moon, planets, and stars; and by the position of these, a skilful sailor with the aid of his instruments can always ascertain his true situation.

222. If it appear by the nautical almanac, that the sun is, on the 5th of June, at London, 61 degrees high at 12 o'clock, and a sailor, by his quadrant, finds it at that time to be 70 degrees high, he concludes that he is nine degrees, or 625 miles, nearer to the vertical place of the sun, or more to the *south* than London.

223. If it appear by the almanac, that at ten o'clock on the evening of June 5, that the moon comes to a conjunction with the planet Mars, at London, and a sailor find that the conjunction takes place at nine o'clock where he is, he concludes that he is one hour, or 15 degrees, or 1045 miles *west* of London.

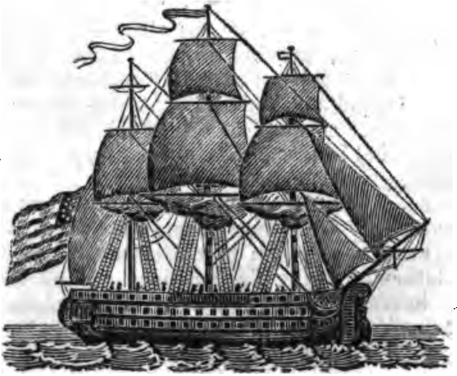
224. The nautical almanac is a work published annually by the British government expressly for the use of navigation. It consists of tables and calculations, shewing the positions and motions of the heavenly bodies and their various relations to each other, by means of which, the navigator with

his quadrant, or sextant, and a good watch or time piece, can now ascertain his position in any part of the ocean within a few miles. Several American editions of this most useful work, have been published with important *additions* and *improvements*, for the facility of navigation.

225. So expert are navigators become in our days, that a ship has sailed from Portsmouth to Calcutta in 55 days, and from Batavia to Philadelphia in 78 days, voyages which formerly employed six months; from Portsmouth to Malta in 11 days, formerly two months; to New York in 21 days, formerly two months; and to the West Indies in 21 days, formerly two months.

Drake and Anson were three years in sailing round the world; and this is now frequently performed by merchantmen, in nine or ten months.

A SHIP.



Obs.—Of all the arts and professions which at any time attract notice, none appear more astonishing and marvellous, than that of navigation, in the state in which it exists at present. This cannot be made more evident, than by taking a retrospective view of the small craft to which navigation owes its origin; and comparing them to a majestic first-rate ship of war, containing 1000 men, with their provisions, drink, furniture, apparel, and other necessaries for many months, besides 100 pieces of heavy ordnance, and bearing all this vast apparatus, safely to the most distant shores. A man in health consumes, in the space of twenty-four hours, about eight pounds of victuals and drink: consequently, 8,000lb. of provisions are required daily, in such a ship. Let us then suppose her to be fitted out for three months, and we shall find, that she must be laden with 720,000lb. of provisions. A large forty-two-pounder weighs about 6,100lb., if made of brass, and about 5,500lb., of iron; and generally, there are twenty-eight or thirty of these, on board a ship of 100 guns; the weight of which, exclusive of that of their carriages, amounts to 183,000lb. On the second deck, thirty twenty-four-pounders; each of which weighs about 5,100lb., and therefore altogether, 153,000lb.; and the weight of the twenty-six or twenty-eight twelve-pounders on the lower deck, amounts to about 75,400lb.; that of the fourteen six-pounders on the upper deck, to about 26,000lb.; and beside that, on the round-tops, there are even three-pounders and swivels. If to this we add, that the complete charge of a forty-two-pounder weighs about 64lbs., and that at least upwards of 100 charges are required for each gun, we shall find this to amount nearly to the same weight as the guns themselves. In addition also, to this, we must reflect, that every ship must have, by way of providing against exigencies, at least another set of sails, cables, cordage, and tacklings, which altogether amount to a considerable weight: the stores, likewise, consisting of planks, pitch, and tow; the chests belonging to the officers and sailors; the surgeon's stores, and various other articles requisite on a long voyage; with the small-arms, bayonets, swords, and pistols, make no inconsiderable load; to which we must finally add, the weight of the crew; so that one of these large ships carries, at least, 2,162 tons burden, or 4,324,000lb.; and, at the same time, is steered and governed with as much ease as the smallest boat.

226. There does not exist a more prodigious and wonderful combination of human industry, than is visible on board a first-rate man of war. It appears incredible that a vessel as large as the largest parish church, should be moved and directed in the water with nearly the same rapidity and precision as a small boat; and it is wonderful that human hands could have fabricated and put together such gigantic materials.

227. The immense ropes and cables consist of hemp spun together; the aggregation of timbers lately grew separately in the forests; the iron-work was melted and prepared from the ore: the cannon were cast in the foundery; in short, the whole fabric has been assembled together by man from the raw productions of the earth!

XII. *Geography and Astronomy.*

228. Geography describes the surface of the earth; the shape and size of the land and seas; the boundaries of empires and states, and their climate and natural productions.

It also teaches the character of the inhabitants; their government, religion, manufactures, and mode of living; and it ought to enable us to avoid their errors, and profit by their experience.

Obs.—As there are numerous works adapted for schools on this subject, and the details are very extensive and prolix; it would be trifling with the pages of this work, to dwell tediously on geography.

229. The earth, on which we live, is a round ball or globe, about 8,000 miles in diameter, and 25,000 miles round. Its surface is covered with one part of *land*, and three parts of *water*, which are inhabited and filled with innumerable living creatures.

230. Of the internal parts of this immense globe little is known to us. From the surface to the centre is 4,000 miles, yet no mine is a mile deep.

As far as man has penetrated, he has found successive layers or coats of different earths; lying over each other, like the coats of an onion, or the leaves of a book.

Obs.—In digging wells, various thicknesses of different soils are found in different places; and what is remarkable, every layer is nearly the same thickness as far as it extends, and generally parallel with the surface of the earth.—*See my Grammar of Philosophy.*

231. The highest mountains subtract no more from the roundness of the earth than the inequalities on the rind of an orange subtract from its general rotundity. Chimboraço, one of the Andes, rears its lofty head four miles high, yet this is but the two thousandth part of the earth's diameter.

Obs.—The Peak of Teneriffe is but two miles and a half high; and Mount Etna and Mount Blanc not two miles. Our Snowdon is not three quarters of a mile; and but a grain of sand compared to the whole earth.

232. The mines, valleys, and mountains, therefore, may be compared to the inequalities in the rind of an orange; yet, vast as is the earth, the

sun, which lights and warms it, is one million times greater; or, in other words, one million earths united in one mass, would only be the size of the sun.

233. The land consists of two *continents;* the old one consisting of Europe, Asia, and Africa; and the other, the newly discovered continent of America.

There are also many thousand *islands* surrounded by the sea; many of them, as Great Britain, anciently united to the continent, and others, the tops of mountains peeping out of the sea, the bases of which are at the bottom of the ocean.

234. When a point of land juts out into the sea, it is called a *Cape* or *Promontory;* as the Cape of Good Hope.

When two masses of land are joined together by a narrow slip, it is called an *Isthmus;* as the Isthmus of Sues, and the Isthmus of Panama.

A *Peninsula* is the smaller portion of the two; as the *peninsula* of Spain, in regard to Europe.

235. The waters are usually divided into four *Oceans:* the Great Ocean, ten thousand miles across; the Atlantic Ocean, three thousand miles across; the Indian and Southern Ocean; and the Northern Ocean.

Seas are detached pieces of water; as the Mediterranean and the Baltic.

Gulfs and *Bays* are parts of the sea that indent into the land.

And *Straits* are narrow passes joining one sea or ocean to another.

236. The vast SUN, to which we are under such sensible obligations, for light, heat, and ve-

getation; and without whose genial influence all the Earth would become a dark, solid mass of ice, is 900,000 miles in diameter; and the earth is 95 millions of miles distant from it.

237. The Sun is the centre of a vast system of planets, or globes like the earth; all of which move round his body at immense distances, in periods which include the various seasons to each, and are therefore a year to each.

Obs.—They are all pressed to each other's centre; but the action of their fluid parts against their solid parts, gives them a tendency to go forward in a straight line; and those two forces so balance each other, that they neutralize one another, and, in consequence, the planets are moved round the sun in an orbit which is nearly circular. *See* 267.

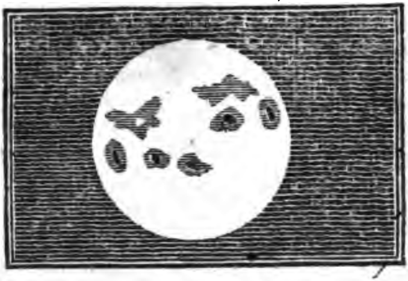
238. The Sun has been commonly considered a globe of pure fire. But this has been doubted by modern astronomers, particularly the celebrated Herschel, by whom that great planet is considered an inhabitable globe somewhat like our own; and that its luminous properties which affect our globe, are derived from its atmosphere. A number of maculæ, or dark spots, by means of a telescope, may, however, be seen on his surface, but without any regular periodical returns.

These consist of a nucleus, which is much darker than the rest, and surrounded by a mist or smoke; and they are so changeable as frequently to vary during the time of observation.

Some of the largest of them exceed the bulk of the whole earth, and are often seen for three months together.

They are supposed to be cavities in the body of the sun; the nucleus being the bottom of the excavation; and the shady zone surrounding it, the shelving sides of the cavity.

THE SUN AND SOME OF HIS SPOTS.



Great source of day! best image here below
Of thy Creator, ever pouring wide,
From world to world, the vital ocean round;
On Nature, write with every beam, His praise.
Soul of surrounding worlds !———
'Tis by thy secret, strong *attractive* force,
(As with a chain indissolubly bound,)
Thy system rolls entire; from the far bourne
Of utmost "*Herschel*," wheeling wide his round
Of "*eighty*" years; to Mercury whose disk
Can scarce be caught by philosophic eye,
Lost in the near effulgence of thy blaze.—THOMSON.

239. As the Sun is one million times larger than the earth, it is evident that the balance of their mutual pressure would not be destroyed, if one million of earths moved round the Sun; but at present, we know only of SEVEN such bodies, some nearer and some farther off than the earth, and some greater, and some less; called Mercu-

ry, Venus, Earth, Mars, Jupiter, Saturn, and Herschel.

The *Sun* revolving on his axis turns,
And with creative fire intensely burns;
First *Mercury* completes his transient year,
Glowing, refulgent, with reflected glare;
Bright *Venus* occupies a wider way,
The early harbinger of night and day;
More distant still our *globe terraqueous* turns,
Nor chills intense, nor fiercely heated burns;
Around he rolls the *lunar orb* of light,
Trailing her silver glories through the night.
Beyond our globe, the sanguine *Mars* displays
A strong reflection of primeval rays;
Next belted *Jupiter* far distant gleams,
Scarcely enlightened with the solar beams;
With four unfix'd receptacles of light,
He towers majestic thro' the spacious height:
But farther yet, the tardy *Saturn* lags,
And six attendant luminaries drags;
Investing with a double ring his pace,
He circles through immensity of space.

CHATTERTON.

240. These several globes, so revolving to receive light and heat from the sun, serve, some of them, as centres to other minor globes called *moons*. These satellites accompany the planet in his tour round the Sun; serving to balance its motions, and to reflect the Sun's light on the planet by night for the use of the inhabitants.

241. The Earth has *one* moon, about 2,000 miles in diameter, and a quarter of a million of miles distant from the Earth.

Jupiter, another planet, has *four* moons.

Saturn *seven* moons; and he is also surrounded by a *large double ring*, 30,000 miles distant from his body.

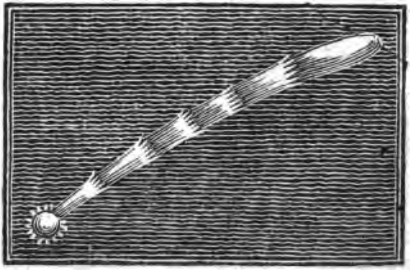
And Herschel has *six* moons.

242. But if the matter of all these planets and moons were put together, they are not equal to a ten thousandth part of the Sun; or rather, it would require ten thousand such masses to make up the bulk of the Sun.

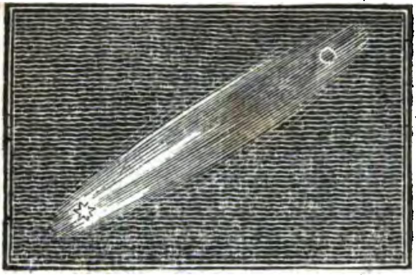
243. Besides the *seven* planets, and their *eighteen* moons, there are *four* very small bodies called *Asteroids*, which move round the Sun between the orbits of Mars and Jupiter, called Ceres, Pallas, Juno, and Vesta, all of them late discoveries.

244. There are also a multitude of bodies, some as large as the earth, called *Comets*, which exhibit very peculiar phenomena of the Sun. The Planets move round him in orbits nearly circular, but comets almost touch the Sun in one part of their orbit, and then stretch out into space thousands of millions of miles.

THE COMET OF 1680.



THE COMET OF 1811.



Hast thou ne'er seen the comet's flaming light?
Th' illustrious stranger passing, terror sheds
On gazing nations, from his fiery train
Of length enormous; takes his ample round
Through depths of ether; coasts unnumber'd worlds
Of more than solar glory; doubles wide
Heav'ns mighty cape; and then revisits earth,
From the long travel of a thousand years. YOUNG.

245. The twinkling stars, of which we see so many every clear evening, do not belong to our solar system; but are themselves so many *Suns* to other systems like ours.

Each Star is supposed to be the centre of its own system; and to have planets, moons, and comets moving round it at immense distances, like those of our solar system!

Bright legions swarm unseen, and sing, unheard
By mortal ear, the glorious Architect,
In this his universal temple, hung
With lustres, with innumerable lights,
That shed religion on the soul; at once,—
The temple and the preacher! O how loud,
It calls Devotion! genuine growth of night!

—Devotion! daughter of Astronomy!
An undevout astronomer is mad. YOUNG.

246. They are called *fixed stars*, because they never appear to move; aud are so distant, that although the orbit of the earth is twice 96 millions, or 192 millions of miles across; and we are consequently 192 millions of miles nearer to some stars at one time than we are at another, yet the stars always appear in the same places.

Oh Nature! all-sufficient! over all!
Enrich me with the knowledge of thy works!
Snatch me to heaven; and show thy wonders there;—
World beyond world, in infinite extent,
Profusely scatter'd o'er the blue immense. THOMSON.

247. The distance of the nearest of the fixed stars from the earth, is estimated to be not less than many thousand millions of miles, and they are all of them probably as far distant from each other. They appear to fill infinite space in vast clusters or systems, and our sun is supposed to be one of that amazing cluster of stars, whose myriads form that bright cloud or path in the heavens, called the Milky Way.

How distant, some of the nocturnal suns!
So distant, says the sage, 'twere not absurd
To doubt, if beams, set out at Nature's birth,
Are yet arrived at this so foreign world;
Though nothing half so rapid as their flight.
An eye of awe and wonder let me roll,
And roll for ever. Who can satiate sight
In such a scene, in such an ocean wide
Of deep astonishment? Where depth, height, breadth,
Are lost in their extremes; and where, to count
The thick-sown glories in this field of fire,
Perhaps a seraph's computation fails. YOUNG.

248. The stars as seen through modern Telescopes of improved constructions, appear to be infinite in number. By ancient observations, the whole number contained in the different constellations amounted to about 3,000, but of these not above one-third can be perceived by the naked eye in the clearest night. This depends however, somewhat upon *climate*, and the clearness of the sky. By the improvement however in modern Telescopes and their increased powers, and particularly the great Telescope of Herschel, not less than one hundred and sixteen thousand stars have passed through the field of his instrument, in 15 minutes.

249. The ancients, in order to find and describe the stars, classed them into figures of men and beasts, called Constellations, and there were fifty of these. The moderns have added thirty others; so that the celestial globe, in which the stars are accurately laid down as in the heavens, is covered with the figures of these imaginary constellations, and now amount to eighty.

250. In the Zodiac, or part of the heavens where the sun appears to move, there were twelve of these constellations: as,

Aries, the Ram .... ♈
Taurus, the Bull .... ♉
Gemini, the Twins .... ♊
Cancer, the Crab .... ♋
Leo, the Lion .... ♌
Virgo, the Virgin .... ♍
Libra, the Balance .... ♎
Scorpio, the Scorpion .... ♏
Sagittarius, the Archer....... ♐

Capricornus, the Goat .... ♑
Aquarius, the Water Bearer .. ♒
Pisces, the Fishes .... ♓

On the *earth's orbit*, see the various *signs*:—
Mark where the Sun, our year completing, shines;
First the bright *Ram* his languid ray improves:
Next glaring wat'ry thro' the *Bull* he moves;
The am'rous *Twins* admit his genial ray;
Now burning, thro' the *Crab*, he takes his way;
The *Lion*, flaming, bears the solar power;
The *Virgin* faints beneath the sultry shower.
Now the *just Balance* weighs his equal force;
The slimy *Serpent* swelters in his course;
The sabled *Archer* clouds his languid face;
The *Goat* with tempests urges on his race;
Now in the *Water* his faint beams appear;
And the cold *Fishes* end the circling year.

CHATTERTON.

Obs. 1.—These constellations were of Egyptian contrivance; and the characters (which it is needful to learn) are Egyptian hieroglyphics, or rude paintings of the things represented, or some known emblem of the things.

2.—The signs of the Zodiac, in which the earth and planets move, may also be recollected by means of the following lines:—

The *ram*, the *bull*, the *heav'nly twins*,
And next the *crab*, the *lion* shines,
The *virgin* and the *scales*:
The *scorpion*, *archer*, and *sea-goat*,
The man that holds the *water-pot*,
And *fish* with glittering tails.

251. The most showy of the constellations is Orion, distinguished by his belt of * * * in a row; beneath these is Sirius, the brightest of the stars; and above, to the right, are the red star of the

Bull, and the Pleiades or Seven Stars; and to the left, two bright stars, Castor and Pollux.

These bright constellations are always visible, on a winter's evening.

Obs.—The student of Nature, who takes *an evening's walk* to admire the magnificence and the glory of the starry heavens, and desires to profit by his observations, should learn to class the heavens into particular divisions; and fix on certain points, as a sort of landmarks, to direct his attention.

By knowing the part of the heavens in which the Sun rises, he is able to determine the *eastern* side; by attending to its situation at *noon*, he ascertains the *south*; and by noticing the place of its setting, he determines the *western side* of the horizon. He need not be told that the *north* is opposite to the *south*.

The moment, then, in which he casts his eyes on the sparkling expanse of heaven, he is supposed to be sensible of the bearings of the cardinal points, *north*, *south*, *east*, and *west*.

The next principle to be recognized is, that he sees above his horizon,* one-half of the whole heavens; that is to say, one-half of the heavens are always visible, or above the horizon, and the other half is below the horizon. He must not expect, therefore, to see all the constellations and planets at once; but only that half which, at the time of observation, is above the horizon.

For the sake of precision and accurate reference, astronomers have supposed the 360 degrees, into which geographers divide the surface of the earth, to be extended to the heavens: so that the whole round of the horizon of the heavens is supposed to be 360 degrees, or proportional parts; half is 180 degrees, and a quarter is 90 degrees. And as we see one-half of the heavens above the horizon, it is of course 180 degrees from one side of the horizon, in a line passing *over our heads*,

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* The *horizon* is the part all around where the sky and the earth seem to meet. The *zenith* is the point directly over head, 90 degrees from the *horizon*.

to the directly opposite side; and of course from the point over our heads, called the *zenith*, it is 90 degrees to the horizon on every side.

Remember, then, that the whole heavens are 360 degrees, or proportional parts round, and that it is always 90 of these degrees from the point directly over head down to the horizon.

An observer of the heavens will discover the progression of the whole, from east to west, by a quarter of an hour's attention. Let him bring a star, in any part between the zenith and the southern part of the horizon, into apparent contact with the end of a house, steeple, or other fixed object, and he will in a few minutes perceive the motion of that star, and of the whole heavens, from east to west.

It may be proper for the student now to consider, that this general motion of the whole heavens is merely apparent; and is occasioned by the rotation of the earth on is axis in a contrary direction. Of course, if the spectator is moving on the earth from west to east, the distant stars will appear to move from east to west.

The rising and setting of all the distant heavenly bodies will, hence, be easily understood. The earth turns completely round every twenty-four hours: every inhabitant of it will, therefore, be carried round towards all the bodies out of it; and distant from it, every twenty-four hours. Hence, the rising and setting of the Sun; the succession of day and night; and all the dependent phenomena.

This progression of the whole heavens from east to west; the rising of some stars in the east, and the setting of others in the west; are objects which, viewed in this manner, will leave impressions much stronger than the mimic representation of the same phenomena on the celestial globe. The immensity of the great vault of heaven; the still, solemn, uniform motion; the accompanying association of the immeasurable distances, the apparent perpetuity, and the countless numbers of the stars, will fill the mind with reverence and devotion towards the omnipotent, infinite, and eternal Author of the whole!

Having thus obtained ocular demonstration of the motion of the stars from east to west, or rather of the motion of earth in the contrary direction, it will then be necessary to attend to another circumstance which is a consequence of that motion.

A slight consideration will evince, that the stars immediately above the axis on which the earth may be supposed to turn, will appear to remain stationary over those places, at both ends of the axis. In turning a wheel on a fixed axis, all the parts of the circumference will successively present themselves to different objects; but the axis will continue to point to the same place. If the wheel be supposed to be a globe revolving on an axis, the effect will be the same; the point of the axis, called the pole of the globe, will point to the same spot, while all the parts will perform smaller or larger circuits, in proportion as they are removed in a greater or less degree from the poles.

It is important, then, to be able to determine the points in the heavens which are opposite to the poles of the earth; these always appear to stand still, while the other stars appear to make a daily circuit round them. As, however, *we can only see 90 degrees in the heavens from the point over our own heads,* the inhabitants of no part of the earth can see both poles, except those who live at the equator, from which both poles are distant ninety degrees. The poles of the heavens may therefore be seen at the equator, exactly in the horizon, in the north and the south; but if you travel or sail one degree to the north of the equator, so as to be within 89 degrees of the north pole, you will, of course, see one degree beyond the north pole, and not so far as the south pole by one degree; because, as before stated, you can always see 90 degree in the heavens, from your zenith, or place over your head. In England, which lies between 50 and 60 degrees from the equator, or within 40 or 50 degrees of the north pole, we always see 50 or 60 degrees beyond or below the north pole; or, in other words, the north pole in the heavens, or the stars immediately over the north pole of the earth, will be 50 or 60 degrees high.

Rather above mid-way between the horizon and the zenith, in this northern part of the heavens, we are in England, to look for the north pole of the heavens, or the part which never appears to move. It happens that there is a star so near the north pole, that for all ordinary purposes it may be taken for the north pole itself; and this star may always be found very easily, by means of two other stars which point to it in a right line. During the winter months, these stars, which are in the constellation of the Great Bear, are to be found with the other stars of that remarkable constellation on the eastern side of the pole. They are about *six* degrees asunder, and the nearest is five times that space, or *thirty* degrees from the polar star, at which they seem to point, and are, thence, called the *Pointers*.

The north pole star being thus found, it will be a pleasing employment to observe, that all the stars appear to move round it, according to their several distances, while it constantly stands still. An hour's contemplation of this star, and of the motions of the rest of the heavens, while it remains an immoveable centre, will teach more to the uninformed in astronomy, than a thousand lessons or lectures in the closet.

On a winter's evening, the other remarkable objects in view, will be the *Pleiades*, or *seven stars*, in the south-east; and below them, a little to the east, the grand constellation of *Orion*: and still lower, the dog-star *Sirius*, the brightest of all the fixed stars. The three bright stars together in a line, called the Belt of Orion, are at about equal distance from the Pleiades and Sirius; that is, about *twenty-five* degrees from each. Besides remembering this distance, and that of the *Pointers*, before-mentioned, for the sake of occasional comparisons, it will be useful to recollect, that the most northern of the three stars in the Belt of Orion, is exactly over the equator; so that from that star to the north pole star is exactly ninety degrees.

The *Pleiades* are in the Zodiac, on the south side; and so is the red star *Aldeberan*, near them; and the two bright stars about *forty* degrees to the left, called *Castor* and *Pollux*, or the Twins, are also in the Zodiac, and about *five* degrees north of the Sun's place, on the 12th of July.

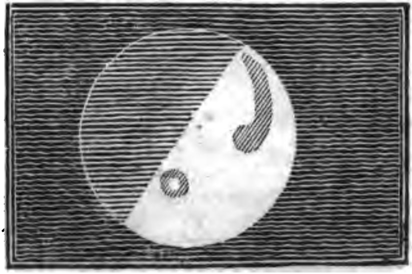
On such an evening, the Milky-Way will be seen in the west, as a light cloud; supposed by some to be formed of a mass or cluster of stars, almost infinite in number, but indistinct from their distance; though others suppose it to consist of a luminous space, and not of stars.

A celestial globe, rectified to the day and hour, will point to other objects: an ephemeris will indicate the names or places of the planets which may then be above the horizon; and any telescope will render visible many other interesting and wonderful phenomena.

Should the Moon be visible, the motion in her orbit may be nightly traced by her approximating to, or receding from certain stars; and the same may be observed in the motion of the planets in their orbits.

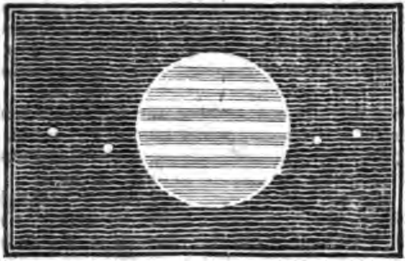
The morning and evening-stars are the bright planets, Venus and Jupiter, so called from their rising or setting with the Sun. Mars is red; Saturn of a pale colour; Herschel is so distant, and Mercury is so near the Sun, that they can seldom be seen but with a telescope.

VENUS, AS SEEN THROUGH A TELESCOPE.

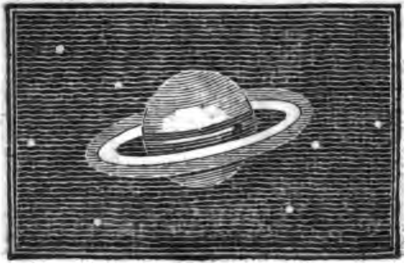


Very small telescopes will shew most of the celestial phenomena; Jupiter's moons, Saturn's ring, the moon-like phases of Venus, the Pleiades, the luminous space in the sword of Orion, the spots in the Sun, and the mountains in the Moon, may all be seen with such telescopes as are bought for ten or fifteen shillings. Galileo made his great discoveries with a telescope eight or ten inches long, and which magnified only ten or twelve times.

JUPITER, HIS MOONS AND BELTS.



SATURN, HIS MOONS AND RING.



252. The stars, according to their distances, are of seven sizes, called *first* magnitude, *second* magnitude, &c. down to the *seventh* magnitude, which can only be seen with a telescope. The stars may be distinguished from the planets by their twinkling; whereas the planets have a steady light.

Obs.—Having now acquired some knowledge of the wonderful things out of the EARTH, we will return again to it, observing, that these fixed stars and other celestial objects are constantly made use of to determine the relative situation of places; and that they are unerring guides both in regard to time and space.

253. Besides their motion round the Sun in their respective years, the earth and the planets also turn round on their own axes, and by turning to and from the Sun, produce to their inhabitants, alternate light and darkness, or day and night; so that their seasons and years are produced by the grand revolution round the Sun; and their days and nights by turning on their own axes.

Obs.—If a boy throw a ball out of his hand, besides going forwards, it turns round on its axis, and this is the precise motion of the earth and planets.

254. The distances of the seven primary planets from the Sun, in round millions, are—Mercury ☿ 36, Venus ♀ 68, Earth ⊕ 93, Mars ♂ 142, Jupiter ♃ 486, Saturn ♄ 892, and Herschel ♅ 1800 millions of miles from the Sun.

Their diameters are respectively 3, 8, 8, 4, 89, 79, and 35 thousand miles.

And their periods of revolution are 3, 7, 12, 22, 144, 340, and 1000 months.

255. In their grand orbits, the planets do not move exactly in the same level or plane; but

each moves regularly in its own level. Nor are their axes exactly perpendicular to the plane of their orbits, but variously inclined; and this inclination produce the difference of their seasons, and the different lengths of day and night.

256. The whole earth is calculated to be 4½ times heavier than water? the Sun, Jupiter, and Herschel about the weight of water; Mercury nine times, and Venus six times heavier. In this way, taking matter for matter, it is found, that it would take a million of our earths, to make a body equal to the Sun.

257. Next to the Sun, the Moon is that of the heavenly bodies, which the most interests our curiosity. She is but 240,000 miles distant from the earth, only 2346 miles in diameter, and near 7000 miles in circumference. She accompanies the Earth in its annual orbit; and, during that period, goes herself nearly thirteen times round the earth in an orbit of her own.

258. The moon goes round her orbit in 27 days 8 hours; but, as the Earth moves forward during the time, it is 29 days 12 hours before she returns again to a conjunction with the Sun. The Earth is sixty times larger than the Moon; or it would require sixty moons to make up the bulk of the Earth.

259. The mountains in the Moon are, however, higher than those on the Earth. For example, Mount Leibnitz, in the Moon, is five miles high, which is a mile higher than Chimboraço, in Peru. The surface of the Moon is, besides, covered with deep pits or vallies, some of them four miles deep.

THE MOON, AS SEEN THROUGH A TELESCOPE.

260. The Moon always keeps the same side towards the Earth, so that she turns once on her axis as she moves round the Earth; and her day and night are, consequently, as long as the period from new moon to full moon. But the Earth acts also as a moon to her, being at the same time far more luminous; so when it is new moon to the Earth, it is a full earth to the Moon, and the contrary.

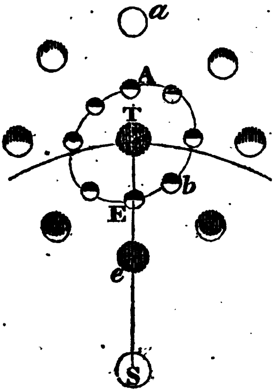
261. As the Moon shines with no light besides that which she reflects from the Sun; it is evident, that her shape must depend on her position in regard to the Sun and Earth.

When the Earth is exactly in the middle, the whole illumined side of the Moon will be towards the Earth, and it will be a full moon.

When the Moon is in the middle, her dark side will be presented to the Earth; and it will be new or no moon.

As she proceeds from new to full, more and more of her light side will appear, or it will increase; and on going from full to new, it will, of course, decrease.

THE MOON'S PHASES.



EXPLANATION.

S is the Sun; T the Earth; the inner circle represents the Moon in its orbit receiving its light from the Sun. The outer circle is the portrait of the Moon in each adjoining part of her orbit as seen at the Earth. Thus at *A* it is full moon, or all light, as at *a*; and at *E* it is new, or all dark, as at *e*. At E it is in a position to produce an eclipse of the Sun, or overshadow the Earth; and at A to be eclipsed itself, or receive the Earth's shadow.

262. As both Earth and Moon cast long shadows, it is evident, if they be moved on the same level, that every time the Earth passes between the Sun and Moon, the Earth's shadow would fall on it, and darken or eclipse the Moon; and

that every time the Moon passes between the Sun and Earth, the Moon's shadow would eclipse the Sun.

263. The Moon, however, ascends and descends 5 degrees in every revolution, so that in general the shadows pass under or over; but when the new or full moon take place at the very time she is passing the plane of the Earth's orbit, in ascending or descending, then the striking phenomena of an eclipse take place.

264. The shadow of the Earth, as seen on the Moon, demonstrates its rotundity; and the shadow of the Moon on the Earth, proves that it is nearer than the Sun; so the passing of the Moon over planets and stars, called Occultations, proves that they are more distant than the Moon.

265. Occasionally, Venus and Mercury, the two planets nearer to the Sun than the Earth, pass over the surface of the Sun like black spots, called *transits* of Venus and Mercury.

This proves that those planets are nearer to the Earth than the Sun; and, by observing the progress of the transit at different parts of the Earth, we can obtain the measure of an angle, by which we can determine the exact distance of the Earth from the Sun.

266. Having ascertained, by means of the observation of a transit, the distance of the Earth from the Sun, the distances of all the other planets are determined by that law of nature, which exactly proportions *the cubes of the distances of the planets, to the squares of their respective periodical revolutions.* That law, was discovered

by the celebrated Kepler, in the beginning of the seventeenth century.

267. Besides affording us light, the Moon affects the waters, and causes high tides; which obey her influence, as the seas pass beneath her. But as she moves forward in her orbit 12 or 13 degrees every day, and consequently passes over every sea 50 minutes later one day than the day before, so the time of high water is always 50 minutes later each following day.

Obs. 1.—There are two tides in every twenty-four hours; and one is evidently but a returning vibration, stroke, or effect of the preceding tide. If the Moon were to be destroyed, and not to re-produce the effect on the following day, the vibration of the waters would probably continue for many days, till it gradually ceased, like the motion of a pendulum. Many mathematicians have puzzled themselves in calculating the relative forces acting on the near surface, centre, and remote surface of the earth, but to little purpose, as the effect is so much better accounted for by the vibratory property of fluid bodies.

2.—Sir Richard Phillips, in a late Essay in the Monthly Magazine for September and October, 1811, successfully combated the prevailing notion of an occult or invisible influence called *attraction*, acting between the planetary bodies by means of supposed effluvia. He proves, on the contrary, that all the phenomena of the planetary motions are produced by the universal pressure of an elastic medium, on all masses of matter; the interception of which pressure, by the different masses in regard to one another, produces their mutual gravitation towards one another. Their circular and rotary motions, he ascribes to the action of their fluid parts; and thence, he explains the courses and uses of the tides of the sea.

268. The Sun and moon concur in raising the tides; and hence, we have high or spring tides,

when their actions concur at the new and full moon; and low or neap tides, when the forces act in opposite directions, as at the quarters; or when the Moon is half way between the conjunction and opposition.

Obs.—On small seas not readily communicating with others, and on which the rotary forces act generally, there are no tides.

269. All the terrestrial phenomena, and all the problems on the globes and maps, may be reduced to one general principle; that the Sun always illuminates *one half* the earth, and that the *other half* is in darkness; and that, from every part of the earth, we always see *one half* the heavens, the *other half* being invisible.

270. The circumference of the earth, the heavens, and of all circles of the earth and heavens, is supposed to be 360 parts or degrees; consequently, half a circle, or half the heavens, is 180 degrees, and a fourth 90 degrees. On the surface of the Earth, each degree is 69½ miles; but the actual size of a degree, as carried out to the heavens, is indefinite.

271. Hence, if the Sun illumines half the Earth, he illumines 180 degrees of the Earth; or 90 degrees every way, from the place over which he is vertical. Hence also, it is 180 degrees from the north to the south pole; and 90 degrees from each pole, is the middle of the Earth called *the Equator.*

272. Hence, as half the heavens are always visible, 180 degrees are visible, and from the point over head, it will be 90 degrees to that line, where the earth and the heavens appear to the eye to

meet called *the Horizon*. Hence also, an inhabitant of the equator can see the stars as far as each pole; *i. e.* he can see 90 degrees each way.

273. The inhabitants of the poles can see the stars as far as the equator and no further; *i. e.* they can see 90 degrees. When the Sun is vertical over the equator, he shines as far as each pole; because he shines 90 degrees from the place where he is vertical, or over-head.

274. Also, when the Sun is vertical 10 degrees north of the equator, he shines 10 degrees beyond the north pole, and his rays do not reach the south pole by 10 degrees; and when he becomes vertical 23½ degrees north of the equator, he shines 23½ degrees beyond the north pole, and 23½ degrees short of the south pole.

275. In its annual orbit, the Earth ascends 23½ degrees above the level of the equator, and descends 23½ degrees below. Hence, when it is at the highest point above, the Sun will be vertical over that part of the globe which is 23½ below the equator, and when below, the contrary.

*Obs.*1.—The terms above and below, up and down, relate merely to the feelings and sensations of human beings. In nature, there is no up or down, or above or below;—the earth is round, and all bodies tend towards its centre; because the universal pressure of the universal medium is taken off or interrupted in that direction. See Obs. 2, paragraph 267. All men and every thing called upright or perpendicular, stand in a straight line towards the centre of the earth; with the earth beneath their feet, and the heavens, which surround the earth, over their heads. We usually place the south pole downward, but the inhabitant of the south pole, like him at the north pole, stands with his feet towards the centre of the earth, each having the heavens over-head. The inhabitants of New South Wales are the Antipodes to us in Great Britain, standing with their feet towards ours, and their heads in opposite directions, each of them wondering how the other stands; but the earth is the centre or loadstone of all its inhabitants; and in nature up and down are mere relative terms.

2.—It is usual for authors to talk about the inclination of the axis to the orbit, its parellelism, &c. &c.; but as I consider the ascent and descent in the plane as more simple, and more accordant with the phenomena, although it is a mere change of terms, I prefer my own explication to that generally adopted, particularly in aid of the tutor, if he should amuse his pupils by passing a globe round a candle, to shew the change of the seasons. The idea of an inclination of the axis I consider a vulgar error. The moon ascends and descends in its orbit about 5¼ degrees; but no one ever talked of the inclination of the moon's axis to the plane of its orbit!

3.—The obliquity or angle of the orbit diminishes at the rate of a minute in 110 years, and a degree in 6600 years. Observations were made in China 2900 years ago, by which it appears, that the obliquity was 23° 54′; but it is now only 23° 28′—a wonderful coincidence, and a proof at once, of the diminution and the observation.

276. It must be evident, that during all the time the Sun is vertical north of the equator, he will shine as many degrees beyond the north pole as he is vertical north of the equator; and that, during all the time he is vertical to the south of the equator, he will constantly illumine as many degrees beyond the south pole.

Obs.—As it is ninety degrees from the equator to each pole, and as the Sun shines ninety degrees from the part where he is vertical, he must of course shine as many degrees beyond either pole as he is degrees advanced towards it from the equator. If I can read an inscription ninety yards off, and I advance 23½ yards nearer to it, it is evident I could read if it were now placed 23½ yards further. The undersanding of this single proposition, is all that is needful to comprehend the phenomena of the seasons, and the various lengths of day and night.

277. The earth, in its diurnal rotation, carries every place round in a circle which is equi-distant from the equator; and all places which are exactly the same distance from the equator, are carried round in the same circle.

Distance to the north or south of the equator is called *latitude;* and of course, if the Sun shines vertically at 10 degrees north of the equator, all places having 10 degrees of north latitude will pass exactly under the Sun on that day.

278. As the Sun, when vertical 10 degrees north of the equator, shines 10 degrees beyond the north pole, and 10 degrees short of the south pole, it is evident that during that rotation of the earth, no place within 10 degrees of the north pole can turn out of the sun-shine, so that to them it will be all day; and that no place within 10 degrees of the south pole, can turn into the sun-shine, so that to them it will be all night.

279. When the sun is vertical over the equator, he will then of course, shine exactly as far as each pole, and the boundary of day and night will cut all the circles made by the diurnal rotation of every place, into two equal parts; so that the day-part of the circle being equal to the night-part, the days and nights will then be equal all over the world.

280. The Sun is vertical over the equator on the 21st of March; and the Earth descends in its annual orbit for 91 days, till the 21st of June, when the Sun is vertical over all places 23½ de-

grees north of the equator; so that, during the 91 days, the Sun gradually gains the 23½ degrees, and has been successively vertical over all countries within that distance of the equator.

281. During the same time, he has successively shone, by similar gradual advances, as many degrees beyond the north pole, and afforded to those countries perpetual day; and, of course, an increased length of day, to all places in the northern hemisphere, in proportion to their proximity to the pole, in consequence of his shining over the larger part of their diurnal circles.

282. The opposite phenomena will, necessarily, take place in the southern hemisphere of the Earth. The Sun's rays will fall short of the south pole as many degrees as he advances above the equator, and the country round that pole will be involved in darkness; and the nights will increase in length, in the same proportion as the days increase in the northern hemisphere.

Obs.—All this will be made evident, by hanging any round body somewhat below the level of a fire or candle. It will be seen, that the light shines over one pole, and does not reach the other. If, then, the ball be turned round, it will be observed, that the circles performed by any parts of the surface are unequally divided by the light; that it will be constant day near the north pole, and that all the phenomena will be reversed in the other, or lower hemisphere.

283. When the earth has so ascended in its orbit, as to render the sun vertical 23½ degrees north of the equator, it then begins to descend again after the same rate; and in 91 days, viz. the 21st of September, the Sun becomes vertical again over the equator.

meter, he appears just above the horizon, when, in reality, his upper edge is just touching it.

So it is at his setting; and with his appearance and disappearance in the polar regions; and also, with the Moon, and all the heavenly bodies.

289. The denominations of various parts of the earth are derived from the phenomena produced by the Sun in the Earth's descent and ascent in its orbit. All these are given beneath, and they should not be forgotten.

North Pole, 90 degrees from the Equator.

Earth's Axis.

Frozen *Zone.*

—Arctic Circle, 66½ degrees.

Temperate *Zone.*

—Tropic of Cancer, 23½ degrees.

Torrid *Zone.*

—EQUATOR, OR MIDDLE.

Torrid *Zone.*

—Tropic of Capricorn, 23½ degrees.

Temperate *Zone.*

—Ant-arctic Circle, 66½ degrees.

Frozen *Zone.*

South Pole, 90 degrees from the Equator.

290. The space between the tropics, twice 23½ degrees wide, is called the Torrid Zone, from its extreme heat; the spaces within 23½ degrees of each pole are called the Frozen Zones, from the length and frigid nature of their winters; and the two spaces between the hot and cold zones, are called the Temperate Zones.

uator.

291. Such are the divisions of the earth, arising from the phenomena and effects of the Sun, the source of Light, Heat, and Life. They give rise to all the varieties of climates, productions, colour, and habits of man; and are, therefore, the key to a further and more correct knowledge of his habitation, the Globe of the Earth.

GEOGRAPHY.

292. The natural divisions into lands and waters have already been noticed. The other great divisions, founded on local views only, are called Europe, Asia, Africa, and America; each quarter is divided into kingdoms; and each kingdom into provinces, principalities, or counties.

293. This last division gives national denominations to men; but the climates or zones fix their colour or character. These divide man into at least six varieties, produced by habit, and the effects of heat and cold during a series of ages.

I. *The dwarfish inhabitants of the polar regions;*

II. *The flat-nosed, olive-coloured tawny race;*

III. *The blacks of Asia, with European features;*

IV. *The woolly-haired negroes of Africa;*

V. *The copper-coloured native Americans, with black hair and high cheek-bones.*

VI. *The white European nations.*

294. Man is at the head of the animated creation; and unites all the advantages of strength, beauty, and structure, which are but partially possessed by other animals. His Creator has also

endowed him with the faculty of reasoning, and with the power and will to adapt all the contrivances of other animals, to his own wants and luxuries.

295. Man supports his body erect; and his face turned towards the heavens, displays the dignity of his nature. His soul is painted in his visage; and his majestic and resolute step announces the nobleness of his rank. His arms and hands were not given him for support, but to second the intentions of his will, and to adapt to his purposes all the gifts of nature.

296. What animals effect by natural instinct, man effects by reason, invention, and by combined power. Birds build their nests; bees their cells; and beavers their habitations; with unvarying uniformity; but the works of man possess every possible variety; and afford evidence of his possessing a mind and soul distinct from the body.

Obs.—Man, however, disgraces his intellectual character by engaging in frequent wars of aggression, malice, and ambition. Nor are such wars confined to the savage tribes of his species; but are often wantonly and lightly engaged in, by nations which boast the highest civilization.

297. Men are to be found, however, in every stage of improvement throughout Europe generally. In India, China, and some other Asiatic nations, and in the cultivated parts of North and South America, man appears to have advanced towards the summit of his powers. But in Africa, Siberia, and among the Aborigines of America, the inhabitants are still in a state below that in which the Romans found the Britons two thousand years ago.

298. Man, in point of natural intellect, is nearly equal in all countries; notwithstanding the differences of colour and gradations of civilization. Those differences are the effects of climate, habit, and education; and there is little doubt, but the whole human race sprung from one stock, as recorded in the Scriptures.

299. Considering man, as we find him, scattered over the earth, the Laplanders, the Esquimaux, the Samoides, the Greenlanders, the Nova Zemblanians, and the Kamschatkadales, appear to be of one family, inhabiting the northern frigid zone.

Vast regions, dreary, bleak, and bare!
There, on an icy mountain's height,
Seen only by the moon's pale light,
Stern Winter rears his giant-form,
His robe a mist, his voice a storm;
His frown, the shivering nations fly,
And, hid for half the year, in smoky caverns, lie.

SCOTT.

ICE-MOUNTAINS, &C. OF THE FRIGID ZONE.

300. No inhabited land has yet been discovered in the southern frigid zone; but the climate and habits of living, the effect of climate, render all the inhabitants of the northern frigid zone of a deep brown colour approaching to blackness. Their statures are shrunk by cold to a diminutive size; and their countenances are as ferocious, as their manners are savage.

301. Their usual height is four feet, and the tallest are not above five feet; their voices are thin and squeaking; their heads large; their cheek-bones high; their eye-lids drawn aside; their mouths large; and their lips thick, and turned outward.

Obs.—Yet, they account themselves the handsomest and most civilized people in the world; and the Greenlanders, when they compliment a stranger, say, he is almost as well-bred as a Greenlander.

The following is Dryden's description of the Polar regions:—

The sun from far peeps with a sickly face,
Too weak, the clouds and mighty fogs to chase;
Swift rivers are with sudden ice constrained;
And studded wheels are on their back sustain'd—
The brazen caldrons with the frost are flaw'd;
The garment stiff with ice at hearths is thaw'd.
With axes first they cleave the wine; and thence
By weight, the solid potions they dispense.
From locks uncomb'd, and from the frozen beard,
Long icicles depend, and crackling sounds are heard.
Meantime, perpetual sleet and driving snow,
Obscure the skies, and hang on herds below.
The starving cattle perish in their stalls,
Huge oxen stand inclos'd in wint'ry walls
Of snow conceal'd; whole herds are buried there;—
Of mighty stags, and scarce their horns appear.
The dextrous huntsman wounds not these afar

With shafts or darts, or makes a distant war
With dogs, or pitches toils to stop their flight;
But close engages in unequal fight;
And while they strive in vain, to make their way
Through hills of snow, and pitifully bray;
Assaults with dint of sword, or pointed spears,
And homeward, on his back, the burthen bears.
The men to subterranean caves retire,
Secure from cold, and crowd the chearful fire;
With trunks of elms and oaks the hearth they load,
Nor tempt th' inclemency of heav'n abroad.
Their jovial nights in frolic and in play
They pass, to drive the tedious hours away.

302. Their food consists of dried fish, and the flesh of bears, rein-deer, and other wild animals. Their drink is water, or train-oil as a luxury, when they can get it.

Obs.—Two inhabitants of Nova Zembla were brought to Copenhagen a few years ago; and they pined for want, till they met with some train-oil, which they drank with the same relish as we would drink chocolate or wine; and they danced in ecstacy, when they found they were to be sent back to their own country.

303. The next variety of the human species are the Tartars, the Chinese, and the Japanese, who inhabit all that vast space of Asia from the great ocean to the Caspian Sea. They have broad foreheads and narrow chins, small sunk eyes, high cheek-bones, short and flat noses, large and separated teeth, short set statures, and olive complexions.

304. The Tartars have no settled habitation; but wander from place to place, and live with their horses and herds under tents covered with hides. The Chinese are the most numerous peo-

ple in the world, inhabit one of the finest climates of the earth, and cultivate with success, most of the arts and sciences.

The Japanese inhabit certain large islands, and are not inferior to the Chinese in industry and ingenuity; but wisely allow little or no intercourse with meddling foreigners.

305. Another distinct family of the human race, are the black and swarthy inhabitants of India, and of the islands of the Indian Ocean. They have European features, long black straight hair, and slender shapes. Their manners are effeminate; but their dresses and houses are very elegant.

Many millions of them, called Gentoos, never eat flesh, or any thing that has lived; but subsist chiefly on rice and fruits, and enjoy health, strength, and long life.

306. The peaceable habits of the Hindoos have, in all ages, rendered them a prey to foreign invaders. The Tartars have frequently invaded and plundered them.

Latterly, the European nations, particularly the English, have established themselves among them; but though they have sometimes committed excesses, yet they are happily introducing among the natives, the arts, philosophy, and the religion of Europe.

307. The fourth variety of the human species, and the most remarkable of the whole, are the Negroes of Africa. Their black colour, their woolly heads, their flat noses, and thick lips, are well known among us.

For many ages an infamous and most shocking traffic was carried on in these poor people, who were torn from their country to work in the sugar-plantations of the West Indies; but, happily, the slave-trade is now nearly abolished.

308. These simple people inhabit all the coasts and interior of Africa between the tropics, and have been retained in a barbarous state by the effects of the slave-trade; which induced their tribes and nations to make war on each other, for the purpose of stealing the people, and selling them for slaves to Europeans.

AFRICANS.

HOTTENTOTS.

309. The next distinct family of men, are the native American Indians, spread in small tribes over the whole of that vast continent. They are of a dark copper-colour, have black hair, and small black eyes, high cheek-bones, and frequently flat noses.

As the Europeans advance, the natives retire, and form the inhabitants of what are called—the Back Settlements.

NATIVE AMERICANS.

310. The sixth variety of the European race, are the English, the French, the Germans, Italians, Spaniards, and other modern nations. These had their origin partly from the Scandinavians, (Swedes and Goths,) characterized by light hair and blue eyes; and from the Celts, distinguished by black eyes and black hair.

The Swedes, English, Irish, Scotch, and Germans, are very fair; but the Italians, French, Spaniards, and other nations occupying the south of Europe, are of brown complexions.

ENGLISH.

SPANISH.

311. The clear complexion of the Europeans is best adapted to express the passions of the soul and the health of the body; while the energy of their understandings, and the vigour of their corporeal frames, qualify them to carry all the arts to perfection: and to raise man to that scale of eminence, to which he seems to have been fitted and destined by his Creator.

312. Such are the natures and the varieties of men, as scattered over the face of the earth. Their numbers united are supposed to be nearly eight hundred millions: of whom, in Europe, every square mile contains 34, in Asia 36, in Africa 6, and in America 3 individuals.

The whole number of human beings being renewed every 32 years, on the average, 25 millons must die and be born every year, *i. e.* 3000 every hour, or 50 every minute.

Like leaves on trees, the race of man is found;
Now green in youth, now withering on the ground.
Another race the following spring supplies,
They fall successive, and successive rise;

So generations in their course decay,
So flourish these, when those are past away.—POPE.

313. As men have divided by chance or design, into separate governments, they have assumed the names of Nations, Republics, Kingdoms, or Empires; and the knowledge of these constitutes a leading feature of geographical study.

The most populous nations are, the Chinese of 300 millions, the Hindoos of 40 millions, the French of 40 millions, and the Russians of 36 millions. The most extensive are the Russian, Chinese, Turkish, and French empires.

314. From north to south, Europe is divided into Russia, Sweden, Denmark, Prussia, Poland, Saxony, Westphalia, France, Wurtemburg, Bavaria, Switzerland, Austria, Turkey, Italy, Naples, Spain, Portugal, and Great Britain and Ireland.

Obs.—It will be highly proper that tutors point out all these countries to the pupil on the map of the world, and render him expert in pointing to them himself. He ought also to be directed to write out the boundaries and latitude and longitude of each from the map. Nothing can be so ridiculous, as to compel children to commit verbal descriptions of the boundaries of countries to memory. The only guide is a good map; and *that* they ought to trace or copy, till they can answer any question that is put to them. No one need blush for ignorance of geography, after he has twice or thrice traced or copied the annexed map. The scale of mountains should also be copied in like manner, and the lines of comparative sizes deserve some consideration. The best exercises in geography, however, are in the Geographical Copy-Books and the Royal School-Atlas.

315. The following is an enumeration of the names, capitals, and population of the countries of Europe:

Nations.	*Chief Cities.*	*Population.*
Sweden	Stockholm	3 millions
Russia in Europe	Petersburgh	30 do.
Denmark	Copenhagen	3 do.
Prussia	Berlin	8 do.
Poland	Warsaw	6 do.
Batavia (now French)	Amsterdam	3 do.
Germanic States	Dresden	18 do.
Austria	Vienna	28 do.
Turkey in Europe	Constantinople	8 do.
France (proper)	Paris	32 do.
Switzerland	Berne	2 do.
Italy	Milan	4 do.
Etruria	Florence	2 do.
Pope's States	Rome	2 do.
Naples	Naples	6 do.
Portugal	Lisbon	4 do.
Spain	Madrid	11 do.
G. Britain and Ireland	London	17 do.

316. Europe has three inland seas: the Mediterranean, the Baltic, and the White Sea; and its shores are washed by the Atlantic, the Bay of Biscay, the English Channel, the Northern Ocean, St. George's Channel, and the German ocean.

317. The great European rivers are, the Danube, the Rhine, the Elbe, the Weser, the Maine, and the Oder, in Germany; the Wolga and the Nieper, in Russia; the Rhone, the Garonne, and the Seine, in France; the Thames, the Severn, and the Humber, in England; the Clyde, in Scotland; and the Shannon, in Ireland.

Obs.—The rivers of South Britain are thus described:—

——————From his oozy bed,
Old father *Thames* advanc'd his rev'rend head:
Around his throne the sea-born brothers stood,
Who swell with tributary urns his flood.
First, the fam'd authors of his ancient name,
The winding *Isis* and the fruitful *Tame*!

The *Kennet* swift, for silver-eels renown'd:
The *Loddon* slow, with verdant alders crown'd:
Cole, whose dark streams his flow'ry islands lave:
And chalky *Wey* that rolls a milky wave:
The blue transparent *Vandalis* appears:
The gulphy *Lee* his sedgy tresses rears:
And sullen *Mole* that hides his diving flood:
And silent *Darent* stain'd with Danish blood.—Pope.

318. The mountains of Europe are, the Alps, of Switzerland; the Pyrenees, between France and Spain; the Dofrafelds, in Norway; the Welsh, in Wales; and Ben Nivis and Ben Lomond, in Scotland. It has also three volcanoes, or burning mountains; viz. Etna, in Sicily; Vesuvius, near Naples; and Heckla, in Iceland.

319. The British empire is composed of two large islands, Great Britain, and Ireland, and several small ones, as the Isle of Man, Isle of Wight, the Hebrides, the Orkneys, Jersey and Guernsey, and the Scilly-islands. Great Britain is 700 miles long, and 250 broad; and Ireland 300 long, and 200 broad. Great Britain includes Scotland on the north, Wales north-west, and England on the south, east, and west.

320. England is subdivided into 40 counties as follow:

Counties.	*Chief Towns.*	*Counties.*	*Chief Towns.*
Northumberland	Newcastle	Lincolnshire	Lincoln
Durham	Durham	Rutland	Oakham
Cumberland	Carlisle	Leicestershire	Leicester
Westmoreland	Appleby	Staffordshire	Stafford
Yorkshire	York	Warwickshire	Warwick
Lancashire	Lancaster	Worcestershire	Worcester
Cheshire	Chester	Herefordshire	Hereford
Shropshire	Shrewsbury	Monmouthshire	Monmouth
Derbyshire	Derby	Gloucestershire	Gloucester
Nottinghamsh.	Nottingham	Oxfordshire	Oxford

Counties.	Chief Towns.	Counties.	Chief Towns.
Northamptns.	Northampton	Kent	Canterbury
Buckinghamsh.	Aylesbury	Surry	Guildford
Bedfordshire	Bedford	Sussex	Chichester
Huntingdonsh.	Huntingdon	Berkshire	Reading
Cambridgesh.	Cambridge	Hampshire	Winchester
Norfolk	Norwich	Wiltshire	Salisbury
Suffolk	Bury	Dorsetshire	Dorset
Essex	Chelmsford	Somersetshire	Wells
Hertfordshire	Hertford	Devonshire	Exeter
Middlesex	London	Cornwall	Launceston

321. Wales is divided into 12 counties, as beneath.

Counties.	Chief Towns.	Counties.	Chief Towns.
Flintshire	Flint	Radnorshire	Radnor
Denbighshire	Denbigh	Brecknocksh.	Brecknock
Montgomerys.	Montgomery	Glamorganshire	Cardiff
Anglesea	Beaumaris	Pembrokeshire	Pembroke
Caernarvonsh.	Caernarvon	Cardiganshire	Cardigan
Merionethshire	Harlech	Carmarthensh.	Carmarthen

322. Scotland is divided into 33 counties, as follow:

Shires.	Chief Towns.	Shires.	Chief Towns.
Edinburgh	Edinburgh	Argyle	Inverary
Haddington	Dunbar	Perth	Perth
Merse	Dunse	Cincardin	Bervie
Roxburgh	Jedburgh	Aberdeen	Aberdeen
Selkirk	Selkirk	Inverness	Inverness
Peebles	Peebles	Nairne and Cromartie	Nairne and Cromartie
Lanerk	Glasgow		
Dumfries	Dumfries	Fife	St. Andrew's
Wigtown	Wigtown	Forfar	Montrose
Kirkcudbright	Kirkcudbri.	Bamff	Bamff
Ayr	Ayr	Sutherland	Strathy Darnoc
Dumbarton	Dumbarton	Clacmannan	Clacmannan
Bute & Caithness	Rothsay.	Kinross	Kinross
Renfrew	Renfrew	Ross	Taine
Stirling	Stirling	Elgin	Elgin
Linlithgow	Linlithgow	Orkney	Kirkwall

323. Ireland is divided into four provinces; Ulster to the north, Leinster to the east, Munster to the south, and Connaught to the west; and these are subdivided into 32 counties.

Counties.	*Chief Towns.*	*Counties.*	*Chief Towns.*
Dublin	Dublin	Antrim	Carrickfergus
Louth	Drogheda	Londonderry	Derry
Wicklow	Wicklow	Tyrone	Omagh
Wexford	Wexford	Fermanagh	Inniskilling
Longford	Longford	Donegal	Lifford
East Meath	Trim	Leitrim	Ballinrobe
West Meath	Mullingar	Roscommon	Roscommon
King's County	Philipstown	Mayo	Carrick on Shannon
Queen's Co.	Maryborough	Sligo	Sligo
Kilkenny	Kilkenny	Galway	Galway
Kildare	Naas and Athy	Clare	Ennis
Carlow	Carlow	Cork	Cork
Down	Downpatrick	Kerry	Tralee
Armagh	Armagh	Limerick	Limerick
Monaghan	Monaghan	Tipperary	Clonmell
Cavan	Cavan	Waterford	Waterford

Obs.—For the particulars of the British Empire, see Goldsmith's British Geography.

324. Asia includes countries the most populous and fertile of any on the globe. It was, besides, the first peopled, was the residence of our first parents, the scene of scripture-history, and in Canaan, Jesus Christ worked his miracles, and promulgated the doctrines of revelation and a future state.

325. Modern Asia contains, Siberia, Tartary, China, Birmania, Malacca, Hindostan, Thibet, Persia, Arabia, Syria, Turkey in Asia, besides the vast islands of Japan, Borneo, Sumatra, Ceylon, New Holland, the Phillipines, Formosa, &c.

326. The internal seas of Asia are the Red Sea, the Persian Gulph, the Caspian Sea, the Japanese Sea, and the Yellow Sea. Its coasts are

washed besides, by the Great Ocean, the Indian Ocean, the Chinese Sea, the Northern Ocean; the Bay of Bengal, and the Arabian Sea.

327. Its great rivers are, the Ganges, the Euphrates, the Indus, the Amur, the Kian Ku, and the Koan Ho; and the mountains where these rise are, the Uralian, the Gauts, those of Caucasus, Taurus, and Thibet.

328. British India, or countries governed by Great Britain in India, are those immense and fertile districts watered by the Ganges, of which Calcutta is one of the capital towns; nearly the whole of the coasts of the peninsula of India; and the island of Ceylon.

Where sacred Ganges pours along the plain,
And Indus rolls to swell the eastern main,
What awful scenes the curious mind delight;
What wonders burst upon the dazzled sight!
There giant-palms lift high their tufted heads;
The plantain wide his graceful foliage spreads;
Wild in the woods the active monkey springs;
The chattering parrot claps her painted wings;
'Mid tall bamboos lies hid the deadly snake;
The tiger couches in the tangled brake;
The spotted axis bounds in fear away;
The leopard darts on his defenceless prey.
'Mid reedy pools and ancient forests rude,
Cool, peaceful haunts of awful solitude!
The huge rhinoceros rends the crashing boughs;
And stately elephants untroubled browse.
Two tyrant-seasons rule the wide domain,
Scorch with dry heat, or drench with floods of rain;
Now feverish herds rush madding o'er the plains
And cool in shady streams their throbbing veins:
The birds drop lifeless from the silent spray,
And nature faints beneath the fiery day:
Then bursts the deluge on the sinking shore,
And teeming Plenty empties all her store.

329. China is one of the most ancient, most extensive, most populous, and well regulated empires in the world. In it are more than 300 millions of people; and its laws and government have subsisted, with very slight changes, for upwards of 3000 years.

330. It is covered with canals, and almost every acre of its soil is cultivated. To secure it from invasion, it is separated from Tartary by a wall 1500 miles long, and so thick, that five horsemen may every where ride abreast on it; yet the Tartars conquered China about 150 years ago, and still retain its government.

331. The chief cities of China are, Pekin, Nankin, and Canton, each of which contains more inhabitants than London, and they are rather more extensive. Canton is the only port where foreigners are allowed to trade; and from hence, the English bring the teas and other Chinese commodities for the supply of Europe.

CHINESE.

332. The Birman empire, of which the capitals are Ava and Pegu, separates China from India. Persia, celebrated in ancient history, has for many years been torn in pieces by civil wars. Arabia is famous for the exploits of Mahomet; and for the wandering character of its inhabitants.

O'er Arabia's desert sands
  The patient camel walks:
'Mid lonely caves and rocky lands
  The fell hyena stalks.
On her cool and shady hills,
  Coffee-shrubs and tam'rinds grow:
Headlong, fall the welcome rills
  Down the fruitful dells below.
The fragrant myrrh and healing balm
  Perfume the passing gale:
Thick hung with dates the spreading palm
  O'er-tow'rs the peopl'd vale.
Locusts oft, a living cloud,
  Hover in the darken'd air;
Like a torrent dashing loud,
  Bringing famine and despair:
And often o'er the level waste
  The stifling hot winds fly;
Down falls the swain with trembling haste;
  The gasping cattle die.
Shepherd-people on the plain
  Pitch their tents and wander free;
Wealthy cities they disdain;
  Poor—yet blest with liberty.

333. The land of Canaan, now called Syria, has been for four centuries in the hands of the Turks; and, like other parts of their empire, has become almost a desert. Jerusalem, Bethlehem, and the places recorded in the Old and New Testaments, are now supported chiefly by pilgrims

from Catholic countries, and there are still chapels for their reception.

334. The following is a summary of the great divisions of Asia:—

Nations.	*Chief Cities.*	*Population.*
Turkey . .	Aleppo . . .	12 millions.
Russia . . .	Astracan . . .	10 do.
China . . .	Pekin and Nankin	300 do.
Japan . . .	Jeddo . . .	30 do.
Birman Empire .	Ava . . .	17 do.
Siam . . .	Siam . . .	5 do.
Hindostan . .	Calcutta. . .	60 do.
Persia . . .	Ispahan . .	10 do.
Tartary . .	Samarcand . .	12 do.
Arabia . . .	Mecca and Medina	10 do.

335. AFRICA is that quarter of the world which lies, for the chief part, within the torrid zone; and its soil is therefore much parched and dried up by the extreme heat of the sun. It abounds with deserts and extensive barren sands, and also with various species of ferocious and poisonous animals. It is therefore unhealthy; and in every respect unfavourable to the civilization of man.

336. It was in Africa, however on the shores of the Mediterranean that the famous city of Carthage was situated. This city was in ancient times the rival of Rome, and for ages the mistress of the commerce of the world; and through all history, Egypt has been famous as the Nursery of the Sciences, and the Emporium of Commerce. At present, Carthage lies in ruins; and Egypt is a prey to civil anarchy.

337. The northern coasts are inhabited by the Moors, at whose head is the despotic Emperor

of Morocco. The piratical states of Algiers, Tunis, and Tripoli, are also on these coasts. At present, the Cape of Good Hope, the southern promontory, and an English settlement, is the only part of Africa adapted to the enjoyment of man.

338. From the northern coasts, to the Cape of Good Hope, the whole of this great continent is inhabited by innumerable tribes of Blacks; many of them in a state of absolute barbarism, and few possessing any considerable degree of civilization.

339. The rivers of Africa are,—the Nile, the Niger, and the Senegal. The mountains are those of Atlas and the Moon. The islands are—Madagascar, the Cape Verd, and the delightful Canaries, in one of which is the lofty Peak of Teneriffe.

340. The following is a survey of those parts of Africa which are perfectly formed:—

Nations.	*Chief Cities.*	*Population.*
Abyssinia	Gondar	2 millions.
Egypt	Cairo	3 do.
Morocco	Morocco	2 do.
States of Barbary		3 do.
Savage Tribes		50 do.

341. Till the discovery of the powers of the magnetic needle, navigators dared not to venture out of sight of land; but, about 200 years after that discovery, Columbus, a Genoese, aware that the earth was round, conceived, that if he sailed from Europe westward, he should in time arrive at the East Indies, without having to sail around Africa.

342. He sailed accordingly from Cadiz, in the autumn of the year 1492, across the Atlantic;

and, on the morning of the 12th of October, one of his anxious and mutinous crew spied land; which proved to be the Island of San Salvador, and which is sometimes called Cat Island, one of the Bahamas, and part of a new world, till then unknown to the other three-quarters.

343. In fact Columbus could not reach the Indies in this direction; because the continent of America intervened from the North Pole almost to the South. America, and all its islands, were found, at this time, to be peopled by the race described in Art. 309; and among them were established the two extensive and populous empires of Mexico and Peru.

344. Unhappily these empires, and many other parts of this new world, abounded in gold and silver; and, as the inhabitants knew not the use of gunpowder, and the rapacity of the Spaniards had no bounds, they destroyed nearly thirty millions of the natives, in a few years, to get possession of their riches.

345. The bloody success of the Spaniards, however, led other European nations to embark in the same enterprize; and, within a century, the Portuguese established themselves in the Brazils, the English in Virginia, and the French in Canada.

Soon after, the fine islands called the West Indies, were successively colonized by different powers, for the sake of their produce in sugar, rum, and other tropical luxuries.

346. At length, in 1776, the populous English colonies in North America declared themselves independent; and, after a contest of seven years,

they were recognized as a new empire, under the title of the United States of America, then thirteen, but now *nineteen* in number, as follows, viz.

		Counties.	*Population.*
New Hampshire, subdivided into		6	214,460
Massachusetts, including Dis. of Maine,	do.	22	700,745
Vermont,	do.	13	217,895
Rhode Island,	do.	5	76,931
Connecticut,	do.	8	261,942
New York,	do.	47	959,049
New Jersey,	do.	13	245,562
Pennsylvania,	do.	50	810,091
Delaware,	do.	3	72,674
Maryland,	do.	19	380,564
Virginia,	do.	97	974,622
North Carolina,	do.	62	555,500
South Carolina,	do.	36	415,115
Georgia,	do.	40	252,433
Kentucky,	do.	57	406,511
Tennessee,	do.	38	261,727
Ohio,	do.	43	230,760
Louisianna,	do.	00	76,556
Indianna,	do.	10	24,520
Also the Territories of	Mississippi,		40,352
	Illionois,		12,282
	Michigan,		4,762
	North-West,		
	Missouri		20,845
And the District of Columbia,			24,023
			7,239,903

N. B. The above population is according to the Census of 1810, including 1,121,564 Slaves.

347. These States, under a free, prudent, and wise government, form now the happiest and most flourishing countries in the world; and are

the refuge of people driven from the various nations of Europe, by ruinous wars and political revolutions. Their head is called a President; he is chosen for four years, and governs acccording to laws made by two houses of legislature.

348. Among the chief towns are Washington, Philadelphia, New York, Boston, Baltimore, and Charlestown. The chief rivers, are the Delaware, the Chesapeake, the Hudson, the Mississippi, the Ohio, and the Missouri.

349. North and westward of the United States, lie Upper and Lower Canada, still subject to the British empire; the capitals of which are Quebec and York, both situated on the great river St. Lawrence.

Obs.—This great river joins five lakes of fresh water, the largest in the world; and between two of them are the grand falls of Niagara.

350. Southward of the United States, lies the Gulf of Mexico; and the islands called the West Indies—as Cuba, St. Domingo, Jamaica, Porto Rico, Barbadoes, Martinico, Guadaloupe, Tobago, St. Kitts, &c.

351. By turning to the Map, it will be seen that North America is joined to South America by a long slip of land called the Isthmus of Darien, occupied or governed by the Spaniards, as well as the greater part of South America itself, ever since the discoveries of Columbus.

352. In this great continent, the three Spanish viceroys of Mexico, Peru, and Buenos-Ayres, have for three centuries governed countries each more extensive than all Europe, and abounding in gold and silver, and various valuable productions.

353. South America is watered by the largest rivers in the world, as the Amazons, La Plata, and Oronooka. In the Andes, it possesses the highest chain of mountains, some of them four miles high; and among them are the most productive gold and silver-mines in the world.

354. South of Peru is Chili; and south of Chili the inhospitable and frozen regions of Patagonia; Terra del Fuego, or the Land of Fogs, is the most southerly region of America, and Cape Horn is its extreme point.

355. The following is an enumeration of the organized districts and countries of America:—

NORTH AMERICA.

Nations.	*Capitals.*	*Population.*
United States, .	Washington, about .	7 millions.
Spanish Dominions,	Salvador, . .	6 ditto.
British Possessions,	Quebec, . . .	1 ditto.
Native Tribes,	. . . .	2 ditto.

SOUTH AMERICA.

Spanish Dominions,	Lima, . .	9 ditto.
Portuguese Dominions,	Rio Janeiro, . .	2 ditto.
Native Tribes,	. . . . . .	4 ditto.
South Sea Islands,	. . . . . .	2 ditto.

356. The Great or Pacific Ocean contains numerous clusters of islands, called the Society Islands, the Friendly Islands, the Sandwich Islands, Phillips's Island, &c. all discovered by the English within the last fifty years. The inhabitants live in a savage state; and the history and anecdotes of their simple manners form the charm of the voyages of Wallis, Cook, and others.

357. Maps are exact delineations of the surface of the earth, viewed as from an eminence, or laid down according to a *scale*, in which every part retains its exact proportion.

The top of a map is generally the *north*, the bottom the *south*, the right-hand is the *east*, and the left-hand the *west*: except when these points are indicated by a compass engraved on the map, when the north is indicated by a *fleur-de-luce*.

Obs. 1.—It would be well to convey the idea of the principle of maps to children, by shewing them a plan of the place where they live, or a map of their county or district, laying it in the position of the places.

2.—Young persons should be taught the use of maps, by means of the Problems in Goldsmith's Royal Atlas.

358. The figures running from north to south, or south to north, at the side of a map, indicate the *latitude* or distance in degrees or minutes from the equator. The lines across are mere guides to the eye, to connect the figures on each side, and are called the *parallels of latitude*. If the figures increase upward, it is north latitude; if downward, it is south latitude.

359. An imaginary line, which passes over every place on the earth, from the north pole to the south pole, is called the Meridian; and the distance between these meridians, measured at the equator, is called the *longitude*.

The figures at the bottom and top of the map indicate such distances between meridians, and the lines which join them are called parallels of *longitude*. The longitude is *east* when the distance increase from left to right; or *west*, when the figures increase from right to left.

Obs.—See the opposite map of the whole world; and examine, study, and copy it.

360. A globe is an exact resemblance of the earth or heavens. For the facility of working problems, it is provided with a universal *brass*

meridian; with a universal *wooden horizon;* with an *hour circle* to reduce its motion into time; with *a compass* to set it due north and south; and with *a quadrant* to measure distances and altitudes.

361. As the earth, which is 360 degrees round, turns opposite to the Sun in every 24 hours, of course, 15 degrees turn to and from the Sun in every hour, and one degree in every four minutes.

The hour of the day, therefore, at different places, depends on their difference in longitude; calculated in the above proportion; all places to the east moving under the Sun, or having their noon sooner than those to the west, because the earth turns from west to east.

Obs.—Bristol is nearly 120 miles, or two degrees west of London; it therefore passes under the Sun eight minutes later than London arrives at the Sun; and of course, when it is twelve o'clock at London, it wants eight minutes of twelve in Bristol; or when it is twelve in Bristol, it is eight minutes after twelve in London. In working such problems, it is simply necessary to bear in mind, that the whole earth of 360 degrees turns round in twenty-four hours; and of course, that the clocks every where vary in proportion to the distances of their meridians, or the difference of their longitudes.

XIV. *Of Morals and Religion.*

362. Man will not be well adapted to a social state, unless his conduct be restrained by a respect for others beyond what is imposed by Laws; that is, without he be actuated by an habitual sense of what is *right*, and by feelings of remorse for having done what is *wrong*.

363. In due time he will find, that his happiness consists in restraining his own passions and sensual propensities; in doing good to others; and in rendering *his existence useful*, by creating a reliance in others upon his labour, skill, and kindness.

364. The perception which every man feels of what is right and wrong, is called *the Moral Sense;* and it appears to arise from a consciousness of doing, or not doing to others what we would have them do to us, were our situations reversed. *Doing to others*, therefore, as *we would that others should do to us*, is the golden rule of social virtue.

Obs.—Another rule as universal, and not less important to the cause of virtue, is *never to do an act which you would be ashamed to have known.*

365. The practice of virtue implies restraint on our own wishes, and on our respecting the rights and happiness of others; restraint is the result of habit, and habit is produced by education. Hence, the necessity of education, for restraining vicious propensities, and for producing virtuous *habits*, on which depend all our happiness and prosperity.

Obs.—The golden rule of *virtue* is also the golden rule of *manners;* true politeness consisting in deference to others, and conceding our own wants and wishes to the pleasure and enjoyment of others.

366. There are no general rules so unerring as those, that virtue ought always to be practised for its own sake, as productive of happiness; and that future misery is an inevitable consequence of vicious habits.

367. Such were the results of men's own ex-

perience in the pagan world; but at length it pleased Almighty God to send his only Son Jesus Christ among his chosen people, the Jews, to recall them, and all mankind, from their idolatries; and to convey to them a just knowledge of ONE GOD, the maker of all things, and of the immortality of the soul of man after this life of probation.

368. The history of this divine Personage is met with in the writings of the four Evangelists; in which, his precious doctrines are recorded for the instruction of mankind.

As everlasting foundations of virtue, these writings, those of the Apostles, and the whole Bible, should be consulted by young and old, for that wisdom which surpasses finite enquiry, and the delusive knowledge of man.

369. By the information of the holy scriptures, and the inferences of our reason, deduced from the perfection of his wonderful works, we learn that there is ONE GOD; that he is a Supreme Being; First Cause; the Creator of the universe; Omnipotent, or all-powerful; Omniscient, or all-wise; Infinite, or present every where; and Eternal, or without beginning and without end.

In the Vast and the Minute, we see
The unambiguous footsteps of the God
Who gives its lustre to an insect's wing,
And wheels his throne upon the rolling worlds.

COWPER.

370. We learn, and we perceive, that God is always present with us; that all our thoughts and actions are known to him; and that we are accountable for them in a future state of immortality, which will follow this transient and ephe-

meral existence. Hence, we have a far more powerful stimulus to virtuous conduct, than mere temporal happiness.

I read his aweful name, emblazon'd high
With golden letters on th' illumin'd sky;
Nor less, the mystic characters I see
Wrought in each flower; inscrib'd on ev'ry tree;
In ev'ry leaf that trembles on the breeze,
I hear the voice of GOD among the trees. BARBAULD.

371. Some virtues, from their great worth, are called Cardinal Virtues: these are Sincerity, Charity, Temperance, Justice, Prudence, and Fortitude.

a. Sincerity is that desirable virtue which deal plainly and honestly without disguise, falsehood, or hypocrisy.

b. Charity is that amiable virtue which leads us to relieve the distresses, tolerate the imperfections, pity the sufferings, and ameliorate the condition of all sensitive beings; and it opposes itself to persecution, cruelty, selfishness, and all barbarous practices towards men, animals, or insects.

c. Temperance sets bounds to our desires, ambition, and passions; opposes our self-love, vanity, and sensual gratifications; and leads to contentment, health, and long life.

d. Justice is that virtue which leads us to do to men and animals that which we would they should do to us, were we in their situation and they in ours; and it is the opposite of tyranny, and of practices towards others, founded on our own supposed impunity.

Obs.—Tenderness to animals, and to all who cannot help themselves, or resist our power, is the primary duty of all men.

e. Prudence is that useful virtue which results from experience, of what is fit or unfit for our condition; and being possessed by the aged and by parents, their precepts ought to have full weight on the minds of children.

f. Fortitude is that necessary virtue, which enables us to bear with the adversities and accidents of social life; and which keeps us steady in the practice of virtue.

372. In early ages, the Christian world became divided into two great bodies, called the Greek church and the Romish church.

The *Greek* church was, and is still, established in Russia, Turkey, Asia, and Greece.

The *Romish* church spread its influence over the west of Europe into Germany, France, Spain, Sweden, Britain, &c.

373. Soon after the invention of printing, the abuses and palpable errors of the Romish church led to the efforts of Luther, Calvin, Cranmer, and others.

A reformed religion was, in consequence, established in Great Britain, Germany, Sweden, Holland, and some other countries, called *Protestant*, from the early reformers *protesting* against the proceedings of a Romish council.

374. The Protestants have subdivided themselves into.

Lutherans, or followers of Luther.

Calvinists, or those who prefer the doctrines of Calvin.

Arminians, who follow those of Arminius.

Socinians, those of Socinus.

Anglican, who prefer the national church of England, and its rights and liturgy.

Presbyterians, who deny the authority of bishops.

Independents, who acknowledge no church-government.

Baptists, who disapprove of infant baptism.

Quakers, who have no external religious ceremonies.

Unitarians, who deny the doctrine of the Trinity.

Swedenborgians, who believe in the divine mission of Emanuel Swedenborg.

And *Methodists*, who use the church-liturgy but preach extemporaneously.

375. The *Jews* still exist as a distinct people in all parts of the world; over which they are dispersed, according to ancient prophecy, preserving every where their religion and original language.

376. In Turkey, and in most parts of Asia and Africa, the religion of Mahomet, an Arabian impostor of the 7th century, still prevails; and descendants of Mahomet still occupy several Asiatic and African thrones, as sultans, emperors, &c.

377. In China, the national religion is founded on the pure belief of ONE God; and on the moral writings of Confucius, a Chinese philosopher.

In India, many superstitions and much idolatry prevail; but the effect tends to maintain subordination and industry; while it teaches peace among men, and charity even to animals and insects.

378. In other nations, Christianity is silently working its way among the people; and civilization and Christianity appear happily to go hand-

in-hand in Africa, in America, and among the South-Sea islanders, the majority of whom entertain the grossest superstition and idolatries.

XV. *Grammar.*

379. The power of communicating ideas by speech is peculiar to man; but it is a power on which depends his improvement in all the arts; because the gradation and accumulation of improvments depend on co-operation and continuation.

Neither could exist, if the power were not attained of describing improvements to the living, and of transmitting them to posterity.

380. The language of savage nations is, however, very limited: they are able to call a few hundred things by their names; to express some qualities; and name a few modes of action; but they express more by gesture than by sound: few of them can count above ten; and when desired to express a higher number, they shew the hair of their heads.

381. The most ancient languages consisted of two or three hundred monosylables, expressing general ideas:—as air, sea, tree, man, God, house, good, bad, &c.: and all other words, by a systematic combination, were formed out of these;—such were the Welsh, Chinese, and some other languages.

382. The first sounds used by savages, may be supposed to have been cries of pleasure and pain; as *Oh! Ah!* and other such words, called INTERJECTIONS.

They probably next named visible objects; as *river*, *tree*, *grass*, &c.; thereby introducing a new class of words, called NOUNS.

They would then derive from nouns, a class of words to express corresponding actions; as *walk*, *talk*, *eat*, *drink*, &c. called VERBS.

383. The next class of words describe and may be supposed to have been the qualities of *nouns* and *verbs*; as *tall*, *swift*, *short*, *fast*, &c. called *ad*-NOUNS and *ad*-VERBS.

Words, to describe the position of nouns in regard to each other; as *to*, *from*, *above*, *below*, &c., were also among those necessary to a language, and these were called *pre*-POSITIONS.

384. The seventh class was a mere refinement of speech, and consisted of words used in place of nouns; as *he*, *she*, *it*, *they*, &c., called *pro*-NOUNS.

The eighth class was intended to give precision to the noun; as *a* man, or *the* man, and called ARTICLES.

And the ninth class consisted solely of words intended to *join* others together in a discourse; as *and*, *because*, *but*, *yet*, &c.; and are called CONJUNC-*tions*.

385. Such were the origin and progress of speech; and such, without variation, is the general composition of language. The English language, and all others, contain *nine* kinds of words, or parts of speech named as above; and the science of grammar merely supplies general rules for their arrangement and government.

386. The classification of *all* words into *nine kinds*, enables grammarians to simplify the rules

which direct the construction of language. Instead of a rule for every word, a few rules only are necessary to regulate forty thousand words.

Obs.—For the details of grammar, I must refer the student to my own *Practical grammar*; or to any other modern grammar which is not too long and complex.

387. All names of things, are called *nouns*; all qualities of thing are called *ad-nouns*, or *adjectives*.

All actions are expressed by *verbs*.

All words, which modify actions or qualities, are called *ad-verbs*.

All words, which describe the position of persons and things, are called *pre-positions*.

All words, which are used instead of nouns, or for nouns, are called *pro-nouns*.

All words, which are used to join sentences or parts of sentences, are called *conjunctions*.

The words *a* or *an*, and *the*, are called *articles*.

The exclamatory words, which express earnestness or surprise, are called *interjections*.

388. The first written signs of words were probably hieroglyphics, or characters, which represented the object named by the character; and, of course, there were nearly as many characters as ideas. The characters now used for the signs of the Zodiac and the Planets are specimens of this kind of character; and so is a *circle* or *snake*, when used to signify eternity.

389. The invention of letters, by combining which all sounds could be represented, is ascribed to some wise man in the reign of Cadmus, king of Thebes. This simple contrivance facilitated

the propagation and preservation of knowledge, by enabling us to express a million of words, if we desire it, by the various combination of only twenty-four or five characters.

Obs. 1.—In the Greek Language there are twenty-four letters; of which seven are vowels, and seventeen consonants:—

Α α	Alpha	Ἄλφα	a
Β β ϐ	Beta	Βῆτα	b
Γ γ ʃ	Gemma	Γάμμα	g
Δ δ	Delta	Δέλτα	d
Ε ε	Epsilon	Ἐψιλὸν	e short
Ζ ζ ξ	Zeta	Ζῆτα	z
Η η	Eta	Ἦτα	e long
Θ ϑ θ	Theta	Θῆτα	th
Ι ι	Iota	Ἰῶτα	i
Κ κ	Kappa	Κάππα	k c
Λ λ	Lambda	Λάμβδα	l
Μ μ	Mu	Μῦ	m
Ν ν	Nu	Νῦ	n
Ξ ξ	Xi	Ξῖ	x
Ο ο	Omicron	Ὀμικρὸν	o small
Π π ϖ	Pi	Πῖ	p
Ρ ρ ϱ	Rho	Ῥῶ	r
Σ ϛ σ ς	Sigma	Σῖγμα	s
Τ τ ͳ	Tau	Ταυ	t
Υ υ	Upsilon	Ὕψιλὸν	u
Φ φ	Phi	Φῖ	ph
Χ χ	Chi	Χῖ	ch
Ψ ψ	Psi	Ψῖ	ps
Ω ω	Omega	Ὠμέγα	o great

The vowels are α, ε, η, ι, ο, υ, ω.

2.—The following is the ancient HEBREW ALPHABET of twenty-two letters, of which five are vowels, and the rest are consonants:—

Name.	*Form.*	*English Sound.*
Aleph - - -	א	a broad, as in *war.*
Beth - - -	ב	b
Gimel - -	ג	g hard, as in *give*, *get*.
Daleth - -	ד	d
He - - -	ה	e, as in *where.*
Vau - - -	ו	u, as *oo*, w before a vowel.
Zain - - -	ז	z
Heth or Cheth	ח	h hard aspirate.
Teth - - -	ט	th
Yod - - -	י	i like *ee*.
Caph - - -	כ	k or c hard, as *come.*
Lamed - -	ל	l
Mem - - -	מ	m
Nun - - -	נ	n
Samech - -	ס	sh
Oin - - -	ע	o long, as *whole.*
Pe - - - -	צ	p
Jaddi - - -	פ	j soft, as s in *treasure*.
Koph - - -	ק	q or qu
Resch - - -	ר	r
Shin or Sin -	ש	s
Tau - - -	ת	t

The vowels are א ה ו י ע

390. The English language consists of about 40,000 words; and is derived from the Celtic, Gothic, and Latin; successively incorporated by the Welsh, Romans, Saxons, Danes, and Normans; and by the terms used in the sciences, de-

rived from the Greek, French, Italian, and German languages.

391. Grammar, in a limited sense, is the art which teaches the construction of phrases and sentences; but, in an extended sense, it embraces the whole science of language.

The study of language is properly divided into the seven following branches:—Orthoëpy, Orthography, Accidence, Syntax, Prosody, Rhetoric, and Composition

392. *Orthoëpy* consists of rules for pronouncing letters and syllables according to the established usage.

Orthography is the art of writing words with the proper and necessary letters.

The *Accidence* treats of the modification of the different kinds of words, called parts of speech.

Syntax furnishes the rules for the proper construction and just disposition of words in a sentence.

393. *Prosody* teaches the right accentuation of syllables; and the different measures of verses.

Rhetoric enables us to affect or convince those whom we address in speaking or in writing.

Composition is the art of arranging our thoughts with precision and elegance; and is, consequently, the object and end of the study of language.

394. The nine kinds of words, or *nine parts of speech,* compose all languages; and there are in the English language about 20,500 nouns, 40 pronouns, 9,200 adnouns, or adjectives, 8,000 verbs, 2,600 adverbs, 69 prepositions, 19 conjunctions, 68 interjections, and 2 articles;—in all about forty thousand words.

395. After having acquired a stock of words by reading and copying the best authors, and mixing in good company, we should learn to arrange and combine them in a sentence with elegance; and in such manner, as exactly to express the sense we intend to convey, and no other than that sense;—a power of writing which is called *perspicuity*.

396. The great rule for the attainment of the art of composition, is to conceive, ourselves, that sentiment, which we purpose to convey to others, by previously reflecting upon it; as it is impossible to express clearly, to others, what we do not well understand ourselves.

397. We should never desire to express too many ideas in one sentence; but dispatch them one after another in their proper order; and confine ourselves to simple and short sentences till we have acquired facility in the management of them.

Obs.—The best exercise in writing and speaking is to read a short story; and then write or speak it, in our own phraseology. Such an exercise continued every day for two years, one day writing, and the other speaking, would teach the arts of spelling, writing, and speaking, at the same instant.

398. We should avoid all quaint phrases, cant words, vulgar proverbs, and foreign idioms; and make our choice from the phraseology of the Old or New Testaments, or the works of Addison or Shakspeare; and avoid the latinized phraseology of Johnson, and the Gallic phraseology of some other modern writers.

Obs.—Happily, the translation of the Scriptures has served to preserve our language; or it would have been lost amidst the barbarous affectations of Johnson and his followers. We have no where such variety of beautiful and affecting language, as in the Old and New Testaments. These will, I hope, preserve our language from the corruptions and innovations daily making in it, by those who prefer sound to sense.

399. To speak or write our ideas in an able and persuasive manner, we ought to possess ourselves of various knowledge; to read the best books on all subjects; to suffer no hour to pass, without making some improvement; and think, talk, and write ourselves on subjects, on which we have perused the opinion of others.

400. We should commit to memory the terms and leading facts of the various Arts and Sciences; and frequently reduce to writing, striking facts or important sentiments which we meet with in reading. We should compare one author with another on the same subject; and frequently converse with others, on any points in which authors do not satisfy our curiosity.

Obs.—Dr. Irving's Elements of Composition is a library for young persons; and the study of it should follow that of every grammar. Adair's Questions render it practical for schools.

XVI. *Logic.*

401. Logic, (which notwithstanding its importance, is too much neglected,) is the science of *correct thinking*. Logicians give five general rules, by which to assist their views in thinking, writing, and speaking on all subjects.

As these rules are of great and constant use, I have copied them from my own English Grammar:—

a. Conceive of things *clearly and distinctly*, in their own natures.

Obs.—That is, we should acquire a clear and distinct conception of things as they are in their own nature;

and not be content with obscure and confused ideas, when clearer are to be obtained.

b. Conceive of things *completely*, in all their parts.

Obs.—There is a metaphysical, or ideal whole, a mathematical, or integral whole, and a physical, or essential whole.

c. Conceive of things *comprehensively*, in all their properties and relations.

Obs.—That is, we must consider them in all their modes, attributes, properties, and relations; in order to attain a comprehensive view of their essential modes or attributes, and of their various occasional properties, accidental modes, and relations.

d. Conceive of things *extensively*, in all their kinds.

Obs.—That is, we must search out the various species, or special natures, which are contained under the subject as a genus or general nature: as, if we would know the nature of an animal perfectly, we must take cognizance of beasts, birds, fishes, and insects, as well as men; all which are contained under the general nature and name of animal.

e. Conceive of things *in order*, or in a proper method.

Obs.—That is, we should rank and place our ideas in a proper method and just order. We must not conceive of things in a confused heap; but dispose of our ideas in some method, which may be easy and useful for the understanding and memory.

402. Method is analytical or synthetical. *Analytical method* resolves the compound into its principles, and the whole into its parts. *Synthetical* begins with the parts and leads to a whole, or it puts together the principles and forms a compound.

403. *Arguments* are either metaphysical, physical, political, moral, mechanical, or theological,

according to the science or subject from which they are drawn. The following deserve notice:

a. The Argumentum ad judicium, is an appeal to the common sense of mankind.

b. The Argumentum ad fidem, is an appeal to the faith.

c. The Argumentum ad hominem, is an appeal to the practices, or professed principles of the adversary.

d. The Argumentum ad populum, is an appeal to the people.

e. The Argumentum ex concesso, is when something is proved by means of some proposition previously conceded.

f. The Argumentum ad passiones, is an appeal to the passions.

g. The Argumentum a fortiori, proves the conclusion, by proving a less probable proposition on which the conclusion depends.

h. The Argumentum ad ignorantiam, is founded upon insufficient principles, which the opponent has not skill to refute.

i. Argumentum ad verecundiam, is drawn from authority we are ashamed to dispute.

k. A *direct argument*, is that which immediately proves the proposition in question.

l. An *indirect argument*, proves the conclusion; by proving or disproving some proposition upon which the conclusion depends.

404. *Certainty or Truth* is of several kinds: there is a *mathematical certainty*, which admits of demonstration; a *moral certainty*, which is derived from testimony; a *physical certainty*, derived from the evidence of the senses and the course of nature; and a *theological certainty*, founded on the doctrines of the Scriptures.

405. *Evidence* is of different kinds; as the *evidence of sense*, founded on the perceptions of our senses.

The evidence of intuition, founded on self-evident axioms; as that the whole is greater than a part, or, every effect is produced by some cause.

The evidence of reason, founded on clear and indubitable deductions from well-founded premises and doctrines.

And *the evidence of faith,* deduced from the testimony of others.

406. *Demonstrations* are a succession of connected Propositions, beginning with self-evident truths and advancing to remoter ones.

A Demonstration á priori, is when the effect is proved by referring to the cause.

A Demonstration á posteriori, is when the cause is inferred from the effects.

Obs.—Corollaries are self-evident inferences from established propositions.

407. *Sophistry* is false reasoning, founded on false premises, or on ambiguity of terms.

Obs.—As most of the evils which exist in society grow out of sophistry, no art is more important than that which enables us to detect or expose it. The crimes of courts and wicked ministers usually escape punishment, from the effect of sophistry; and there would be few or no wars, if sophistry did not triumph in the statements of the parties.

A Sophism of composition, is when we infer that of any thing in an aggregate or compounded sense, which is true only in a divided sense.

A Sophism of division, is when we infer any thing in a divided sense, which is true only in a compounded sense.

A Sophism of equivocation, is when we use words of an ambiguous or double sense, and draw inferences in one sense, of which the proposition is capable only in the other.

408. *A petitio principii,* or begging the

question, is the supposition of what is not granted, or a supposed proof, by stating the question in other words.

The reductio ad absurdum, is when the truth of a proposition is proved by shewing the absurdity of a contrary supposition.

409. *Induction* consists in distributing a general idea into its species, and ascribing to the whole the property found in the species.

A false induction is when general deductions are made from too limited a number of experiments or facts.

The fallacia accidentis, is when we draw inferences in regard to the nature of a thing, from circumstances only temporary or accidental.

The ignorantia elenchi, is a mistake of the question, or when one thing is proved instead of another.

Analogy is an argument in which, from corresponding causes, are deduced corresponding effects.

Obs.—The sources of *errors* are, (1.) The want of diligence in investigation. (2.) Judging of things by their external appearances only. (3.) Not separating the good and bad qualities that pervade the same thing, but forming a hasty judgment. (4.) Comparing things with our own situation in life; or as they happen to affect us. (5.) Associating an idea with something disagreeable, or the contrary. (6.) Prejudices formed in our infancy. (7.) Giving credit to the assertions or misrepresentations of others, without enquiring into their motives, as in news-writers and reviewers; and (8.) Submitting to the force and influence of custom and fashion.

410. *A Syllogism* is a sentence made up of three propositions, so disposed, as that the last is necessarily inferred from those that precede it.

Every *syllogism* contains two premises and a conclusion; or a major and minor proposition and a consequence.

Example of a Syllogism:

Major. - - Our Creator ought to be worshipped.
Minor. - - God is our creator;
Consequence. Therefore God ought to be worshipped.

411. An *Argument* is a series of syllogisms; and, although arguments do not retain their syllogistic form in ordinary discourse, yet all arguments may be reduced to syllogisms; and errors or sophisms may thus be detected.

412. Formerly, Logic, or the art of reasoning, was almost the sole business of a university-education; but it is now in some degree superseded, by the practice of reasoning in the study of mathematics, by the various branches of philosophy, and by the perusal of the classic authors.

Obs.—The great master of philosophy, ARISTOTLE, divided all science into THEOREMS formed of SYLLOGISMS, which Syllogisms were composed of PROPOSITIONS, which Propositions were formed of TERMS; which Terms were WORDS or SIGNS of our IDEAS of THINGS. He then considered all THINGS with reference to their TEN CATEGORIES, or *Predicaments;* as *Substance, Quality, Quantity, Relation, Action, Passiveness, When, Where, Position,* and *Habit.*

XVII. *Rhetoric.*

413. Rhetoric teaches us to affect the passions by suitable illustrations and imagery; and to arrange our arguments to the best advantage, so as to make the deepest impression on the feelings and judgment of those we address.

414. The following are the chief figures of speech.

a. Simile, or comparison, is that figure by which we compare one thing with another for the sake of illustration.

b. *Metaphor*, is a comparison expressed without the signs of comparison; as, when we say of a minister, that *he is the pillar of the state*, we speak in metaphor; and when we say, that *Charles the twelfth was the lion of the north*, we speak metaphorically.

c. *Allegory*, is a continuation of several metaphors, so connected as to form a kind of parable or fable; as, in describing the people of Israel under the image of a vine.

d. *Irony*, is a figure in which we urge one thing, and mean the contrary, in order to give effect to our meaning; as, in describing a notorious cheat, we say, ironically, *A mighty honest man, truly!*

e. *Hyperbolè*, gives us the highest idea of an object, and magnifies it beyond its natural dimensions; as, *Achilles was swifter than a stag*.

f. *Antithesis*, is the contrast or opposition of two objects in a sentence; as, *If you seek to make a man rich, study not so much to increase his stores, as to diminish his desires*.

g. *Climax*, or Gradation, is a figure by which we rise from one circumstance to another, till our idea is raised to the highest.

h. *Personification*, is a figure by which we attribute life and the use of reason to inanimate objects and irrational creatures.

i. *Apostrophe*, is a figure by which we address absent persons, or inanimate objects which we personify.

k. *Interrogation*, is a figure which, by asking a question, gives ardour and energy to our discourse.

l. Exclamation, is a figure that expresses some strong emotion of the mind, and is generally followed by a note of admiration.

415. Rhetorical disposition or arrangement is the *placing* of the *arguments*, or the parts of a discourse, oration, or composition, in the most suitable and impressive order.

The parts of a discourse are sometimes five, and sometimes six; viz. the Exordium, the Narration, the Proposition, the Confirmation, the Refutation, and the Peroration.

a. In the *Exordium*, or beginning of a discourse, the writer or speaker gives some intimation of his subject, and solicits favour and attention.

b. The *Narration* is a brief recital of the facts connected with the case from the beginning to the end.

c. In the *Proposition*, is given the true state of the question; specifying the points maintained, and those in which the writer or speaker differs from the adversary.

d. The *Confirmation* assembles all the proofs and arguments which can be adduced.

e. In the *Refutation*, the writer or speaker answers the arguments and objections of his opponent.

f. In the *Peroration*, he sums up the strong and principal arguments, and endeavours to excite the passions in his favour.

416. A distinct and audible *delivery* is essential to a good orator.

The *first* rule is, to open the mouth sufficiently, and not to mumble or mutter the words.

The *second* is, to pronounce distinctly every letter and syllable without hurry.

And the *third* is, to fill the room with the voice, so that the most distant part of the auditory may hear.

417. In regard to *gesture*, that which is natural is the best, provided it is not awkward and offensive.

The head should be held up, and the speaker should look those he is addressing in the face.

His action should be easy, and should keep pace with his voice and the nature of his discourse.

He should also avoid contortions and vulgar grimaces; ease in delivery, being the chief grace of oratory.

XVIII. *Of Vegetable Nature.*

418. Every substance known to man is divisible into three kingdoms, the Mineral, Vegetable, and Animal. Linnæus thus distinguishes these kingdoms: "Stones *grow*;—vegetables grow and *live*;—and animals grow, live, and *feel*."

Obs.—For the *Mineral* Kingdom, see chapter XX.

419. The existence of all vegetables may be regarded as mechanical, or as similar to that of an animal when asleep, during which time his functions proceed without consciousness. The mechanism of plants is, however, most wonderful; and bespeaks the contrivance of an all-wise and all-powerful Creator.

420. A seed, which is thrown into the earth by the husbandman, is similar in its construction to

the egg of an animal. The earth acts upon it, by means as inexplicable to man, as that by which the sitting of an hen on an egg converts it into a chicken.

421. In a few days, the seed opens, and there issues a green plant, with a number of fibrous threads.

Whatever was the position of the seed, the green sprout struggles through the soil *upward* into the air; and the fibrous shoots strike *downward* into the ground; and there imbibe, transmit, or pump up, the moisture, as nourishment to the plant.

422. Nothing is more wonderful than the means of nature for the preservation of seeds; and the contrivances by which they are distributed.

Some seeds are provided with downy wings, as the dandelion, and are impelled by the winds; others are swallowed by animals, and voided again in distant places, being preserved by their coverings, till excited into germination, by the heat of the sun's rays in the following spring.

423. Linnæus divided all plants into 24 *classes*, and 121 *orders;* and these into *genera*, and *species*, with *varieties* of the species without number.

Each has its peculiar habitation; and each adapts the nutriment derived from the same earth, so differently, that, by an unknown agency, are produced all the degrees of flavour, odour, poison, and nutriment, which we find in various plants.

Each tree, each plant, from all its branching roots,
Amid the glebe small hollow fibres shoots;
Which drink with thirsty mouths the vital juice,

And to the limbs and leaves their food diffuse;
Peculiar pores peculiar juice receive;
To this, deny, to that, admittance give.—BLACKMORE.

Obs. 1.—Of the different distinctions of *leaves* only, according to their position and form, above one hundred are enumerated. In all of them, one of the offices, is, to subtilize the abundance of nourishing sap, and to convey it to the little buds. There are two orders of veins and nerves in leaves, one belonging to each surface; and it has been generally observed, that the lower lamina, or under side of the leaf, has the ramifications larger, and is capable of admitting a liquid to pass through them, which those of the upper surface will not. The lower lamina is supposed to be intended for the receiving, preparing, and conveying the moisture imbibed from the rising vapours of the earth, by which trees and plants are greatly nourished; so that one principal use of leaves is to perform, in some measure, the same office for the support of vegetable life, as the lungs of animals do for the subsistence of animal life.

2.—Another of the great functions for which the leaves of trees and plants are designed, is that of their foot-stalks nourishing and preparing the buds of the future shoots, which are always formed at the base of these foot-stalks. Leaves, moreover, are designed to shade the buds for future shoots from the sun; which would otherwise exhale and dry up all their moisture. Air evidently passes in at the leaves, and goes through the whole plant, and out again at the roots. If the leaves have no air, the whole plant will die. This has been proved by experiments with the air-pump. And plants not only draw through their leaves some part of their nourishment from the air, but the leaves also perform the necessary work of altering the water received in at the roots into the nature and juices of the plant; and hence it is, that the life of the plant depends so immediately on their leaves.

424. Every plant consists of a root, buds, a trunk or stem, of leaves, of props or arms, of the inflorescence; and of the parts of fructification.

425. In regard to their bulk, plants are divided into *trees, shrubs, under-shrubs, and herbs.*

According to their respective durations, they are *annual*, lasting one year, and reproduced from their seed; or *biennial*, when they are produced in one year and flower the next; *perennial*, when they last many years.

426. Plants, in regard to the *roots*, are *bulbous*, as in onions or tulips; *tuberose*, as in turnips or potatoes; and *fibrous*, as in grasses.

They are *deciduous*, when their leaves fall in autumn; and *ever-green*, when they are constantly renewed, as in all resinous trees.

They are said to *sleep*, when they change the appearance of their leaves or flowers at night.

They are *indigenous*, or native; and *exotic* or foreign.

427. The parts of *fructification* consist of the *calyx*, or cup, which is usually the outer green covering of a flower.

The *corolla* are the delicate leaves or petals of the flower generally coloured, and are the parts which constitute its beauty.

The *nectary*, or nectarium, is a part in some flowers, supposed to secrete honey, but not easily defined.

428. The calyx and corolla are fine expansions of the outer and inner bark or rind of the plant; and their evident purpose is, to protect certain delicate extensions of the pith and wood, which grow within the corolla, and are called the *pistil* and the *stamen*, by the peculiar organization of which the seed is produced.

429. The *pistil* is provided at its head with a gummy matter, and the *stamen* with a fine dust,

called pollen; and when the dust falls on the head of the pistil, it is there absorbed and carried down the *style* of the pistil to the *germen* or seed-vessel in the centre of the flower; where the *seed* is, in consequence, produced within a *pericarp*, afterwards called fruit.

430. Fruits, which afford us so many luxuries, are, in fact, nothing more than the covering, which protects the seed of plants, and called by botanists *Pericarps.*

Some pericarps are *pulpy*, as apples, pears, nectarines, &c.; some are *hard*, as nuts: and some *scaly*, as the cones of fir-trees

Your contemplation further yet, pursue;
The wondrous world of vegetables view!
See various trees, their various fruits, produce,
Some for delightful taste, and some for use.
See sprouting plants enrich the plain and wood,
For physic some, and some designed for food.
See fragrant flowers, with different colours dy'd,
On smiling meads unfold their gaudy pride.

BLACKMORE.

431. It must not then be forgotten, that the design of the beautiful flowers which cover the earth is to create the seed of future trees; that the leaves or corolla of the flowers are merely protections of the delicate pistil, stamen, and germen; that in this last are produced the seeds; and that for their protection is provided the pericarp, which we call the fruit.

Go, mark the matchless workings of the Power,
That shuts within the seed the future flower;
Bids these, in elegance of form excel,
In colour these, and those delight the smell;
Sends Nature forth, the daughter of the Skies,
To dance on earth, and charm all human eyes.

COWPER.

432. Linnæus seized on the variations in the number of the stamens, as a means of *classing* the vegetable kingdom into *twenty-four* denominations.

Those flowers having but one stamen, he called *mon-andria;* those of two stamens he called *di-andria;* three, *tri-andria;* so on up to twenty stamens, and above twenty, *poly-andria.*

When he found stamens, in one flower, and pistils in another, on the same plant, he called them *monœcia;* and on different plants, *diœcia,* When altogether invisible, *cryptogamia.*

433. Nothing can be more easy than to remember the names of these 24 classes; they are,

1. *Monandria,* one stamen.
2. *Diandria,* two stamens.
3. *Triandria,* three stamens.
4. *Tetrandria,* four stamens, equal in length.
5. *Pentandria,* five stamens.
6. *Hexandria,* six stamens, all of equal length,
7. *Heptandria,* seven stamens.
8. *Octandria,* eight stamens.
9. *Enneandria,* nine stamens.
10. *Decandria,* ten stamens, filaments separate.
11. *Dodecandria,* twelve stamens to nineteen, inserted on the receptacle.
12. *Icosandria,* twenty or more stamens, inserted upon the calyx or corolla.
13. *Polyandria,* many stamens, inserted on the receptacle.
14. *Didynamia,* four stamens, two long, two short.
15. *Tetradynamia,* six stamens, four long, two short.
16. *Monadelphia,* filaments united at bottom, but separate at top.

17. *Diadelphia*, filaments united in two sets.

18. *Polyadelphia*, filaments united in three or more sets.

19. *Syngenesia*, five stamens united above in the form of a cylinder.

20. *Gynandria*, stamens inserted on the pistil, or on a pillar elevating the pistil.

21. *Monœcia*, stamens and pistils in separate corollas, upon the same plant.

22. *Diœcia*, stamens and pistils in distinct corollas, upon different plants.

23. *Polygamia*, various situations; stamens only, or pistils only on one plant, and stamens and pistils on another plant.

24. *Cryptogamia*, stamens and pistils inconspicuous.

Obs.—I have introduced beneath, a representation of the pistils and stamens of a few of the first classes; and the pupil will, doubtless, be led to observe them within any flowers which may fall in his way.

1. 2. 3. 4. 5.

434. The class Triandria contains chiefly the natural tribe of *grasses;* Hexandria the *lillies*.

The Icosandria contains the *edible fruit;* Polyandria, has many *poisonous plants*.

The Tetradynamia contains the natural tribe of *flowers*, which are antiscorbutic.

The Monadelphia is composed chiefly of the *mallow tribe*.

Diadelphia consists of the pea-*tribe*, which produce edible seeds.

Syngenesia possesses the *compound flowers*.

And the Cryptogamia contains the natural tribes of *ferns*, *mosses*, *sea-weeds*, and *mushrooms*.

Obs.—The first order of the fourteenth class, denominated "Didynamia Gymnospermia" are all innocent or wholesome: those of the other order, are fœtid, narcotic, and dangerous; being allied to a large part of the Pentandria Monogynia, known to be poisonous, as containing henbane, night-shade, and tobacco. The whole class Tetradynamia is wholesome. Whenever the stamens are found to grow out of the calyx, they indicate the pulpy fruits of such plants to be wholesome. The papilionaceous plants are wholesome, except the seeds of the laburnum; which, if eaten unripe, are violently emetic and dangerous. Milky plants are generally to be suspected. Umbelliferous plants, which grow in dry or elevated situations, are aromatic, safe, and often wholesome; while those that inhabit low and watery places, are among the most deadly poisons.

435. Other distinctions in each class produce a division of the classes, called *Orders*. A further division of the orders, founded on distinctions in the flower and fruit, lead to the *Genera*.

Other divisions of the genera, in regard to the root, trunk, leaves, &c. lead to *Species:* and casual differences in species are called *Varieties*.

436. The useful substances found in vegetables are, *sugar* in the sugar-cane, beet, carrots, &c.; *gum*, or mucilage, which oozes from many trees; *jelly*, procured from many fruits; *bitters*, from hops and quassia; and the *narcotic* principle from the milk of *poppies*, *lettuce*, &c.

437. The vegetables of the greatest value to man, are those which produce *gluten* and *starch;* as wheat, potatoes, barley, beans, &c. *Oils* are

produced by pressing the seeds or kernels of vegetables; as olives, almonds, linseed, &c. *Volatile oils* are distilled from peppermint, lavender, &c. *Wax* is collected from all flowers by bees.

438. *Resins* exude like gum from furs and other trees; and are known as balsams, varnishes, turpentine, tar, pitch, &c. Of this class, too, is *Indian rubber*; which exudes from certain trees in South America.

Iron mixes with the substance of most vegetables; and is the cause of the beautiful colours of flowers. *Pot-ash* is obtained from the ashes of burnt vegetables.

Obs.—The classes Monœcia and Diœcia, containing the pistil and stamens in different flowers, have the pistil fructified by the bees and other insects, which enter the corolla to extract the honey from the nectarium. The pollen in those flowers which have stamens only, falls on their bodies, and is carried by them to the flowers which have pistils only. And here the wisdom of the Divine Architect of nature is conspicuous, that when the pistil is shorter than the stamens, the flowers grow upright, that the pollen may fall from the anthers of the stamens on the stigma of the pistils; but when the pistil is longer than the stamen, the flower hangs downward, that the pollen, in falling, may be received by the stigma of the pistil.

Four remarkable Exotics.

THE TEA-TREE.

THE COFFEE-TREE.

THE TOBACCO-TREE.

THE SUGAR-CANE.

439. The chemical or elementary principles of vegetables, are *carbon*, *water*, and *air*; or hydrogen (15,) and oxygen (85,) for the constituent parts of (100) *water*; and azote or nitrogen (72,) and oxygen (28,) as the constituent parts of (100) atmospheric *air*; and *carbon*.

Obs. 1.—Wood burnt in a close vessel till it has neither smell nor taste, will produce the basis of all vegetable matter called charcoal; or, when purified, called *carbon*, which is the hardest and most indestructible substance in nature.

2.—It is found, that water is nothing but a mixture of two airs or gases, one the inflammable or light gas called *hydrogen*, and the other the vital gas called *oxygen*; and water may be made by combining these; or, it may also be separated into these: one hundred parts of water are combined of *fifteen* of hydrogen, and *eighty-five* of oxygen.

3.—In like manner, the air or fluid in which we live, is found to be composed of 28 parts of oxygen, or pure vital air; and 72 parts of nitrogen, or air in which animals will not live; but the due mixture of both, forms the salutary fluid or atmospheric air in which we breathe.

4.—I have explained the meaning of these easy terms in this place, in order to illustrate the beautiful provisions of vegetables which follow. There is no mystery in them; and they may be understood now as well as when I treat of Chemistry.

440. Vegetables generate, or give out oxygen or vital air, in the light or sunshine, by a natural process of their own.

Air, which has been breathed by animals, is deprived of its 28 parts of oxygen, and will no longer sustain life.

In like manner, a body, while burning, deprives air of its 28 parts of oxygen, and the flame will go out.

An animal would die, or a flame go out, when put into air so deprived of its oxygen; but a vegetable will then thrive in it, and will restore it to its original power of sustaining animal life.

Obs.—Hence, the oxygen of the whole atmosphere would, in due time, be consumed by the breathing of animals and by flame, but for this provision of nature. The leaves of vegetables create oxygen in the day-time, and keep up the due proportion which is necessary to the support of animal life; the leaves of aquatic and herbaceous plants produce it, however, in the greatest quantity.

441. The saccharine and oily productions of vegetables are parts of their sap or juices; but the turpentine, the bitter, and the acid principles, are considered as the effect of preparation or secretion.

The green colour of vegetables arises from the oil they contain; the rays of the sun extracting the oxygen from the outer surface, and leaving the carbon and hydrogen, which are known to be the constituent parts of oil.

442. Healthy vegetables perspire water by the under part of their leaves, equal to one-third of their weight every twenty-four hours; by which part they also give out oxygen.

443. Nor do they derive their substance in a principal degree from the matter of the soil in which they grow; but they are created by a vital principle of their own, out of air and water, and of the imperceptible matters combined with air and water, from which all their distinctions of smell, taste, and substance, are derived!

Hail, Source of Being! Universal Soul
Of heaven and earth! Essential Presence, hail!
By THEE, the various vegetative tribes,
Wrapt in a filmy net, and clad with leaves,
Draw the live ether, and imbibe the dew:
By THEE, disposed into congenial soils,

Stands each attractive plant, and sucks and swells
The juicy tide, a twining mass of tubes:
At THY command, the vernal sun awakes
The torpid sap, detruded to the root
By wintry winds; that now in fluent dance,
And lively fermentation, mounting, spreads
All this innumerous-colour'd scene of things.

THOMSON.

444. Some plants exhibit signs of great sensibility, besides the effects in nearly all arising from the presence or absence of the rays of the sun: these are the sensitive plant, whose leaves drop on being touched by the hand; and Venus's fly-trap, which closes on any insect that goes into it, and stings it to death.

Obs.—Throughout universal nature, a gradation of beings may be traced; and yet their particular differences elude the observation, like the various colours of the rainbow, blending and mixing with each other. Where vegetation ceases, or seems to cease, perception begins; and we trace some of the first rudiments, or sparks of it, in the actinia, or sea-anemone, the oyster, and the snail. The polypus ranks as the first of plants, and the last of animals; if its propagation, as some naturalists affirm, can be effected by cuttings, similar to the multiplication of plants by slips and suckers. Then, it ascends through various gradations of beings; distinguished by more enlarged and active faculties, more perfect and more numerous organs, to those creatures which approach to the nature of man. We behold the distant resemblance of his sagacity in the elephant; of his social attachments in the bee and the beaver; and the rude traces of his form in the ourang-outang.

XIX. *Of Animated Nature.*

445. Animals are a class of beings organized differently from vegetables; because they have different destinations, different habits, and the

power of moving from place to place, called the faculty of loco-motion.

> See, thro' this air, this ocean, and this earth,
> All matter quick, and bursting into birth.
> Above, how high progressive, life may go!
> Around, how wide! how deep, extend below!
> Vast chain of being! which from GOD began,
> Natures ethereal, human, angel, man,
> Beast, bird, fish, insect, what no eye can see,
> No glass can reach; from Infinite to thee,
> From thee to nothing. POPE.

Obs.—The principal object of the study of natural history, is to teach us the characteristics, or distinctive marks of each individual natural object called *classification.* To distinguish a *species* from all others that exist in nature, it is necessary to express in its characters almost the whole of its properties. A number of species brought together, constitutes a *genus* or tribe. Those properties which are common to all *genera,* compose a character that distinguishes this assemblage or group from all other groups. Such an assemblage is called an *order*. By bringing together such orders as are more nearly allied, we form a more general assemblage, called a *class;* and by the union of several classes, we obtain a higher division, to which naturalists have given the name of *kingdom.*

446. When the all-wise Creator determined on making beings which should be able to move from place to place, he contrived for them an organization different from that of beings which were fixed.

As moveable beings could not have their roots in the ground, he provided them with the cavity of the stomach, in which they were to carry about what should be equivalent to the soil for plants; and the suckers of their nutriment centering into that cavity, were destined to act like the roots of plants in the soil.

447. Hence, in all animals, exists the necessity of eating frequently, to fill the cavity of the stomach; hence the folly and mischief of filling it with heterogeneous and unnatural substances; it being the object of nature simply to extract from the matter in the stomach a homogenious milky substance called *chyle;* no other juice but chyle being admitted into the animal system, the rest being rejected and expelled.

448. As animals were intended to move about, the perfect are therefore provided with *eyes*, to see objects which might endanger their safety, with *ears* to hear, for a similar reason; with a *voice* to warn others, or to obtain assistance in danger.

Hence, also, they were provided with senses of *smelling* and *tasting*, to discriminate the food which was proper for the stomach; and with the sense of *feeling*, to secure their identities, and excite them to action.

> And though things sensible be numberless,
> But only five the senses' organs be;
> And in those five, all things their forms express,
> Which we can touch, taste, smell, or hear, or see.

449. The organs of sense and the powers of volition proceed from the head and *brain*, by the nerves, which direct the muscles and tendons; but the functions of animal life are sustained by a simple, yet wonderful arrangement, in the stomach and cavities of the body.

The *heart* is the centre of a thousand tubes, called *arteries;* and by its never-ceasing contractions, it carries the blood through them, to all parts of the frame, diffusing every where warmth and life.

450. The blood of a man, thus driven by the contraction of the heart (a force like that by which water is driven out of a syringe or bladder,) weighs 30 pounds; and, as this is the stock of the precious fluid possessed by each of us, and our lives depend on its constant circulation, it is not allowed to remain at the extremity of the arteries, but is there taken up by another set of tubes called *veins*, and by them brought back again to the heart.

451. Thus, there is a constant circulation, outward and inward, of this same blood, at the rate of an ounce to each contraction, from the heart through the *arteries*, and back to the *heart* by the *veins*. To warm, revive, nourish it, and keep up its quantity, there are various other wonderful, but very simple contrivances.

Were once the energy of air deny'd,
The heart would cease to pour its purple tide;
The purple tide forget its wonted play,
Nor back again pursue its curious way.

452. The heart consists of four cavities, from one of which, called the *left ventricle*, the blood is driven into the arteries through the body; by another, called the *right auricle*, it is received back again by the veins: it then passes into the *right ventricle*, whence it is forced into the lungs. Having there been revivified by coming into contact with the air, it is carried back by a set of veins into the *left auricle*, and, from thence, into the *left ventricle*, where it began its course: it is then again forced into the arteries, brought back by the veins, &c., till the end of life.

453. The *lungs* are a large spongy substance, filling nearly the whole cavity of the chest, which

rises as they fill, and falls as they empty, in respiring air through the mouth and nostrils.

The act of respiration is performed about 20 times in a minute; and about 40 cubic inches of air are respired every time; of which 2 inches of oxygen are absorbed by the blood in the lungs, producing, at the same instant, 98 degrees of vital heat, and restoring to the veinous blood its bright red colour.

Obs.—The *Lights* as they are called, are the lungs of sheep or oxen, and are exactly similar to the lungs of man. On inspection, they will be found to be wonderfully adapted to their design of bringing the air into contact with the blood. Any rupture in their tender fabric, or defect in their action, leads to that fatal disease, called Consumption.

454. Four thousand times in every hour, each cavity of the heart is called into action; and all the blood in the body passes through the heart 14 times during that space.

The arteries, into which it is forced, branch in every direction through the body, like the roots, branches, and leaves of a tree, running through the substance of the bones, and every part of the animal substance, till they are lost in such fine tubes as to be wholly invisible.

455. In this manner, they distribute nourishment; supply perspiration; and renew all the waste of the system; and, by passing through glands in every part of the body, all the various animal secretions are elaborated.

In the parts where the arteries are lost to the sight, the veins take their rise, and in their commencement are also imperceptible. The blood is then of a dark colour; and, as it returns to the heart with a less impetus, there is always more blood in the veins than in the arteries.

456. As the blood, in this discoloured state, has lost some of its vital power, it is driven through the lungs, and its colour is restored; but on its passage back to the heart, it also receives a supply of a new fluid extracted from the food of the animal in the stomach and intestines.

The loss of weight in a human body by perspiration in 24 hours is about four pounds; and what is gained by the inspiration of air into the lungs, is lost by the expulsion of moisture, and of gas generated in the lungs.

457. The motion of the lungs is preserved by that of the chest containing them; that of the heart, may be felt on the left breast; and the circulation of the blood, from the action of the pulse in various parts of the body, and particularly at the wrist.

In children, the pulse gives 120 strokes in a minute; at 20 years, about 75; at 30, about 70; and in old age, 60 or 65.

458. For the purpose of renewing and nourishing the blood, food is taken in at the mouth, macerated by the teeth, and mixed with the saliva: it is then carried into the stomach, a bag like a highland bag-pipe; where it is dissolved into a soft pap by a powerful liquid called the gastric juice.

459. This pap is then forced from the stomach into the intestines; where it is separated into a white milky liquid called *chyle*, and into the *excrement*.

The chyle is taken up, or absorbed, by myriads of fine tubes called the *lacteals*, which carry it to a main-pipe called the thoracic duct. This pipe ascends to the throat, where it empties the chyle into a large vein, and being mixed with the blood, is conveyed to the heart.

460. Of such subtle and wonderful contrivance is the organization of man! Similar, also, is the construction of the whole of animated nature, from the greatest to the smallest.

Within the package of the skin, and essential to life and comfort, are numerous bones for strength; hundreds of muscles and tendons for action; nerves spread every where for sensation: hundreds of arteries, to carry out the blood; hundreds of veins to bring it back again; and hundreds of glands performing all kinds of secretions; besides an infinite number of tubes called lacteals and lymphatics, to absorb and convey nutriment to the blood.

461. Such being the complex construction of animal bodies, is it not rather wonderful that we last 70 or 80 years, than that we endure no longer! When it is considered also, that a muscle or a bone out of place, a vein or an artery stopt in its circulation, or a nerve unduly acted upon, creates disease, pain, and misery; is it not wonderful, that we enjoy so large a portion of health and pleasure?

Should not such considerations teach us the value of prudence and temperance?

Thick, in yon stream of light, a thousand ways,
Upward, and downward, thwarting and convolv'd,
The quivering nations sport; till, tempest-wing'd,
Fierce Winter sweeps them from the face of day;
Ev'n so, luxurious men, unheeding pass
An idle summer-life in fortune's shine—
A season's glitter! Thus they flutter on
From toy to toy, from vanity to vice :—

Till, blown away by death, oblivion comes
Behind, and strikes them from the book of life.
THOMSON.

262. The *nerves* are soft white chords which rise from the *brain*, the focus of sensation, and disperse themselves in branches through all parts of the body. Impressions are received by the brain from the adjacent organs of sense; and the brain exercises its commands over the muscles and limbs by means of the nerves.

Thus, the body is enabled to avoid what is hurtful, to flee from danger, and to pursue every thing useful and agreeable.

Obs.—The proper object of vegetable-organization, appears to be to supply food to animated nature; and the wisdom of Providence is in nothing more evident than in the variety, wholesomeness, and abundance of vegetable provisions.

463. The *ear* is placed in the most convenient part of his body near the brain, the common seat of all the senses, to give more speedy information.

In man it is of a form proper for the erect posture of his body; in birds, of a form proper for flight, and not protuberant; in quadrupeds, its form is, in some, large, erect, and open; in others, covered; in subterraneous quadrupeds, the ears are short and lodged deep.

464. The structure of the ear is admirably contrived to collect the undulations of sound, and to convey them to the sensory in the brain. The first part is the auricle, or external ear, formed to stop and collect the sonorous undulations, and convey them to the concha, or large capacious round cell, at the entrance of the ear. Persons, whose ears are cut off, have a confused hearing,

and are obliged to form a cavity round the ear with their hand.

In the interior is the auditory passage, curiously tunnelled and turned, to give sounds an easy passage, and prevent their too furiously assaulting the more tender internal parts.

465. To prevent the entrance of noxious insects, this passage is secured with a bitter nauseous substance, called ear-wax. The next principal part is the membrana tympani, or drum of the ear, with its inner membrane, the four little appendant bones, and the three inner museles to move them, and adjust the whole system to hear loud or soft sounds.

The passage behind the drum of the ear, is called the vestibulum, being the entrance to two other cavities, called the labyrinth, and the second cochlea, from its resemblance to a snail-shell.

466. The principal organs of the sense of *smelling* are the nostrils and olfactory nerves; the ramifications of which are distributed throughout the nostrils.

Smelling is affected by the odourous effluvia in the air, being drawn into the nostrils by inspiration, and struck with such force against the olfactory nerves, as to shake them, and occasion ideas of sweet, fœtid, sour, and aromatic.

467. The *taste* is that sensation which all things give to the tongue; but some consider the palate, the upper part of the roof of the mouth to be the instrument of taste.

The Creator seems to have established a very intimate union between the eye, the nose, and the palate, by directing branches of the same nerves to each of these parts, by which means there exists all the necessary guards against pernicious food; since, before it is admitted into the stomach, it undergoes the trial of two of the senses and the scrutiny of the eye.

468. *Feeling* is the sense by which we acquire ideas of solid, hard, hot, cold, &c.

Some consider the four other senses merely as modifications of *feeling*.

The immediate organs of feeling are the pyramidal papillæ under the skin, which are little, soft, medullary, nervous prominences, lodged every where under the outermost skin.

Feeling is the most universal of our senses; spiders, flies, and ants, have this sense in greater perfection than man. In blind persons, the defect of sight has been supplied by their exquisite touch or sense of feeling.

469. From these five senses, flow all our sensitive perceptions, the result of experience; and all the various habits, qualities, passions, and powers of animals.

Certain practices called *instincts*, not the apparent result of experience, *appear* to us to belong to some animals, contrived by some unknown means of that all-powerful Creator, whose wondrous and incomprehensible works inspire with rapture and devotion the being whom he has qualified to examine and estimate them.

Obs.—To follow this wonderful scheme of creation into all its ramifications and variations, and to trace all its analogies, would fill hundreds of volumes, and occupy ages of observation; having, therefore, given the above general idea of animated existence in its relation to vegetables, I shall proceed to a brief enumeration of the Linnæan classes; referring my young students to

Bingley's Animal Biography, to Buffon's Natural History, and Mavor's Abridgment.

470. As a prop-work, or substantial frame to the body, the *bones* are formed.

That the bones might not interfere with motion, they are provided with hinges or *ligaments.*

That the ligaments might work smoothly into one another, the joints are separated by gristles or *cartilages,* and provided with a gland for the secretion of oil or *mucus,* which is constantly exuding into the joints.

471. There are 248 separate bones in the human body, classed under those of the head, the trunk, and the extremities.

The skull, or cranium, consists of eight pieces, and serves as a vault and protection to the brain. There are also the cheek-bones, the jaws, and 32 teeth imbedded in them.

The head is joined to the trunk by the vertebræ, consisting of several short bones, to the upper part of which it is fastened by an hinge-joint, and turned in the socket of the next lower one to the right or left by suitable muscles.

472. In the front and centre of the trunk is the breast bone, extending from the neck to the *abdomen;* and opposite to it, in the *back,* is the *spine* or back-bone, which extends from the skull to the bottom of the loins, and is a long chain of separate short bones, called vertebræ.

These serve as the support of seven hoops or *ribs,* which are inserted in them, and form the chest or *thorax,* in which are the *heart, lungs,* &c.

Beneath them, inserted in the spine only, and extending but half way round the body, are five false ribs. The hip-bones supporting the abdomen are called the pelvis.

473. From the neck to the top of each arm, a bone extends on each side, called the collar-bone, and the blade-bones are independent supporters of it. The bone extending from the shoulder to the elbow is called the humerus.

From the elbow to the wrists are two bones, the outer of which is the *radius*

The thigh-bone is called the *os femur;* the knee, the *patella;* and the leg has two bones like the arm, the inner called the *tibia*, and the outer the *fibula.*

474. The Animal Frame is constantly exhausted and renewed; so that every particle of the human body is changed in the compass of a year!

Nor is it less surprising that so many different substances as compose every animal body, should also be secreted by the glands from the same blood, than that that blood may, in every instance, be traced to grass for its origin.

Obs. 1.—Those functions by which aliment is assimilated for the nourishment of the body, are *digestion, absorption, circulation, respiration*, and *secretion;* and the effect of such assimilation is called *nutrition.*

2.—The food received into the stomach after mastication by the teeth, and being mixed with *saliva*, is converted into *chyme* by the gastric juice; the chyme passes into the intestines, where it is converted into *chyle* and *excrementitious matter;* which last, being separated by means of *bile*, is evacuated from the body; whilst the *chyle* is absorbed by the *lacteals* and conveyed into the *blood-vessels.*

3.—The absorbent system consists of the lacteals, lymphatics, the thoracic duct, and the glands called conglobate throughout the body.

4.—*Glands* are organic bodies consisting of blood-vessels, nerves, and absorbents, intended for the secretion or alteration of particular fluids. They are divided into four classes, simple, compound, conglobate, and conglomerate; and the orifices of glands are said to be peculiarly irritable.

5.—*Secretion* is the process by which various fluids are separated from the blood by means of the glands. The secretions are divided into the saline, as sweat and urine; the oleaginous, as the fat, cerumen of the ear, &c.; the saponaceous, as bile and milk; the mucous, as on the surface of membranes, &c.

6.—*Sensibility* is the faculty of perception by the contact of an extraneous body; and this principle is generally diffused in our corporeal organs, but in different degrees. That modification of animal matter, in which sensation appears peculiar to exist, is termed *nervous*.

7.—*Motion* is effected by the muscular fibre contracting by volition; but the will can only exercise this power, through the *medium* of the nerves. *Irritability* is the power of contraction, inherent in our bodily organs, but not liable to be influenced by the will.

475. All the senses of animals, and all their varied powers of action are exactly adapted to their different modes of existence. What is food to one, is poison to another; and every one finds provision according to its natural habits.

Every thing, also, is in exact proportion; and every provision of nature harmonizes with the corresponding desires and wants of animals.

Nature's unnumbered family, combine
In one beneficent, one vast design;
E'en from inanimates to breathing man,
An Heaven-conceived, Heaven-executed plan;
Onward, from those, who soar or lowly creep,
The wholesome equipoise through all to keep;
As faithful agents in earth, sea, and air,
The Lower World to watch with constant care:
Her due proportion wisely to conserve;—
A wondrous trust, from which they never swerve.

PRATT's Lower World.

476. Linnæus divides Animated Nature into,

1. QUADRUPEDS (Mammalia,) of which there are already known to man about 230 species.

2. BIRDS, of which there are about 1000 species.

3. AMPHIBIOUS ANIMALS of which there are about 100 species.

4. FISHES, of which there are about 500 species.

5. INSECTS, of which there are 2000 species.

And 6. WORMS, of which there are 800 species.

477. The first class of animated beings, called *mam-malia,* comprehends all those that suckle their young; and have warm red blood flowing in their arteries.

Their bodies, for the most part, are covered with hair, in quantity proportioned to the climate they inhabit. Beneath this covering, is a skin of various thicknesses, inclosing a frame or skeleton of bones, acted upon by a system of muscles and tendons, which are put in motion by nerves communicating with the organ of sense and will of the animal.

They have *Blood,* for Life; *Bones,* for Strength; *Muscles,* for Motion; and *Nerves,* for Sensation.

478. Linnæus divides mammalious animals, or *those which suckle their young,* into seven orders; which are chiefly regulated by the number and situation of the teeth.

a. Primates, or animals having two canine and four-cutting teeth, and furnished with two pectoral teats. To this class belong man, the ape, the maucauco, and the bat.

b. *Bruta*, or animals which have no cutting teeth in either jaw; as the elephant, the sloth, the ant-eater, &c.

c. *Feræ*, or animals whose cutting teeth vary from ten to two. This order includes most of the formidable rapacious quadrupeds; as the lion, the tiger, the bear, &c.

d. *Glires*, or animals which have only two cutting and no canine teeth; as the hare-kind, the mouse, the squirrel, &c.

e. *Pecora*, or animals which are hoofed, and have no cutting teeth in the upper jaw, including the camel, the deer, the sheep, the ox-kind, &c.

f. *Belluæ*, or quadrupeds with cutting teeth in each jaw, as the horse, the boar, &c.

g. *Cetæ*, or animals whose teeth greatly vary in different genera. This order comprehends all the whale-tribes; which from certain similarities of structure, are arranged under the class of quadrupeds.

479. Birds, the *second* class, constituting those covered with feathers, have two wings to fly with, a tail to direct their flight, and a hard horny bill. Their bones are hollow and light; and they are, in every respect, made for making their way through the air with the least resistance. Many tribes migrate, at certain seasons, from one country to another, and no less than nineteen tribes arrive in England in the spring, and leave there in the autumn; and ten other arrive in autumn and leave there in the spring.

It wins my admiration
To view the structure of that little work—
A bird's nest. Mark it well within, without;
No tool had he that wrought; no knife to cut;
No nail to fix; no bodkin to insert;

No glue to join; his little beak was all;—
And yet how neatly finished! What nice hand,
With every implement and means of art,
And twenty years' apprenticeship to boot,
Cou'd make me such another? Fondly, then,
We boast of excellence, whose noblest skill
Instinctive genius foils. HURDIS.

480. There are six orders of birds:

1. The *Accipitres*, or rapacious kinds; as condors, vultures, eagles, and hawks.

2. *Picæ*, or the pye-kind; as parrots, ravens, crows, &c.

3. *Censores*, or the duck-kind; as the swan, goose, &c.

4. *Grallæ*, or the crane-kind; as storks, flamingoes, &c.

5. *Gallinæ*, or the poultry kind; as peacocks, turkeys, partridges, &c.

And 6. *Passeres*, or the sparrow-kind; as pigeons, larks, blackbirds, nightingales, swallows, &c.

But who the various nations can declare
That plough with busy wing the peopled air?
These, cleave the crumbling bark for insect-food;
Those, dip the crooked beak in kindred blood;
Some, haunt the rushy moor, the lonely woods;
Some, bathe their silver-plumage in the floods;
Some, fly to man, his household-gods implore,
And gather round his hospitable door,
Wait the known call, and find protection there
From all the lesser tyrants of the air.
The tawny eagle seats his callow brood
High on the cliff, and feasts his young with blood.
BARBAULD.

481. The *third* class is constituted of *Amphibia*. These have a naked or scaly body, pointed teeth and no fins.

There are four orders:

1. *Reptiles;* as the crocodile, tortoise, lizard, frog, &c.

2. *Serpents;* as the rattle-snake, boa constrictor, viper, &c., some of which are harmless.

3. *Meantes;* as the siren.

4. *Nantes;* as torpedoes, sharks, &c.

482. The *fourth* class of animated beings, are fishes; the inhabitants of a different element from man, but not less wonderful in their organization, nor less various in their forms and habits than the other classes.

Many hundred species of fishes that reside in the unfathomable depths of the ocean, are doubtless unknown to man; and he knows little of the real habits and economy even of those the most familiar to him.

Obs.—The eye can reach but a very short way into the depth of the sea; and that only when its surface is glassy and serene. In many seas, it perceives nothing but a bright sandy plain at bottom, extending for several hundred miles, without an intervening object. But, in others, particularly the Red Sea, it is very different; the whole body of this extensive bed of water is, literally speaking, a forest of submarine plants, and corals formed by insects for their habitation, sometimes branching out to a great extent. Here, are seen the madrepores, the sponges, mosses, sea-mushrooms, and other marine productions, covering every part of the bottom. The bed of many parts of the sea near America, presents a very different, though a very beautiful appearance, being covered with vegetables, which make it look as green as a meadow; and, beneath, are seen thousands of turtles, and other sea-animals, feeding.

2.—"Were it not (says Hawkins,) for the moving of the sea, by the force of winds, tides, and currents, it would corrupt into life! An experiment of this I saw, when lying with a fleet about the islands of Azores, almost six months; the greater part of which time we were becalmed. Upon which, all the sea became so replenished with various sorts of jellies, and forms of serpents, adders, and snakes, as seemed wonderful; some green, some black, some yellow, some white, some of divers colours, and many of them had life; and some there were a yard and a half, and two yards long; which, had I not seen, I could hardly have believed. And hereof were witnesses, all the companies of the ships which were then present; so that a man could hardly draw a bucket of water clear of some corruption." Mr. Boyle was also assured by one of his acquaintance, who had been becalmed for about fourteen days, in the Indian ocean, that the water for want of motion, began to stink with life; and that, had the calm continued much longer, the stench would probably have poisoned him. These assertions may be supported by our knowledge that animal food left to corrupt, will engender life.

483. Fishes are divided into four orders:—

1. *Apodes;* such as have no ventrical Fins, as eels, congers, &c.

2. *Jugulares;* such as have the ventral fins placed before the pectoral, as cod, &c.

3. *Thoracici;* those that inspire by the gills only, as the perch, &c.

And 4. *Abdominales;* those having ventral fins behind the pectoral in the abdomen, as pike, salmon, &c.

484. Insects, the *fifth* class of animated beings, are, in many respects, the most entitled to our wonder and attention, on account of the amazing variety of their forms and habits.

Those *animalculæ*, of which a thousand might dance on the point of a needle, are as curiously, as beautifully, and as perfectly formed, as the largest animals in nature.

Myriads of creatures (each too nicely small
Bare sense to reach,) for thy inspection, call.

In animalcules, germs, seeds, and flow'rs,
Live in their perfect shapes, the little pow'rs,
Vast trees lie pictured in their slend'rest grains;
Armies one wat'ry globule contains.
Some, so minute, that, to their fine extreme,
The mite a vast leviathan will seem—
That yet, of organs, functions, sense partake,
Equal with animals of largest make;
In curious limbs and clothing they surpass,
By far, the comliest of the bulky mass.—THOMSON.

Obs.—Insects are small in our eyes, but not so to the Creator, who views *infinity* itself at a glance; and, compared with infinity, an emmet is as large as the solar system. Largeness and smallness are terms as relative, as up or down.

485. Insects, viewed through a microscope, would teach children to respect their lives and happiness, and never, in wantonness, to destroy the most apparently insigificant. The child, who treads upon a worm, or destroys a fly in sport, gives indication of a wicked, cruel, or thoughtless mind.

The poor beetle, that we tread upon,
In corporal suff'rance, feels as great a pang
As when the giant dies. SHAKSPEARE.

Obs.—The influence of kind treatment on the fiercest animals, is beautifully described by PRATT, in his "Lower World:"

Kindness can woo the lion from his den—
(A moral lesson to the sons of men!)
His mighty heart in silken bonds can draw;
And bend his nature to sweet pity's law.
Kindness can lure the eagle from her nest,
Midst sun-beams plac'd, content with man to rest:
Can make the elephant, whose bulk supplies
The warrior-tower, compassionate as wise;
Make the fell tygress (from her chain unbound,
Herself unfed, her craving offspring round,)
Forget the force of hunger and of blood,
Meekly receive from man her long-wish'd food;

Take too, the chastisement, and (if 'tis just)
Submissive take it, crouching to the dust.
Kindness can habits, nay, the nature change,
Of all who swim the deep, or forests range:
And for the mild, *domestic* train, who come,
The dog—the steed—with thee to find a home;
Gladly they serve thee; serve thee better too,
When only happy beings meet their view:
Ah! then, let gentler accents, gentler looks, supply
The thunders of thy voice, the lightnings of thine eye.

486. The class of insects is divided into *seven* orders, viz.

a. Coleoptera, or insects having four wings; the two superior ones being crustaceous, and furnished with a straight suture.

b. Hemiptera; insects smaller than the preceding, with four wings: the two superior semicrustaceous, and the interior edges lying one upon the other.

c. Lepidoptera; insects with four wings, all of them imbricated with scales.

d. Neuroptera; insects having four wings interwoven with the veins, like a piece of net-work, and no sting.

e. Hymenoptera; insects agreeing in their characteristics with the preceding, except that these are armed with a sting.

f. Diptera; insects having two wings, and two elevated alteres (or balances) behind each.

g. Aptera; insects destitute of wings.

487. Every *insect* is furnished with a head, antennæ, or horns, and feet. All insects likewise, have six or more feet. They respire through pores on their sides, called spiracles. Their skin is extremely hard, and serves them instead of bones, of which they have none.

The head also, the trunk, the proboscis, the feelers, the breast, the belly, the limbs, the tail, and the wings, are all objects of notice to the entomologist.

See the proud giant of the beetle race!
What shining arms his polish'd limbs enchase!
Like some stern warrior, formidably bright,
His steelly sides reflect a gleaming light!
On his large forehead, spreading horns he wears;
And high in air, his branching antlers bears;
O'er many an inch, extends his wide domain;
And his rich treasury swells with hoarded grain.

BARBAULD.

488. *Worms* are, according to the Linnæan system, the *sixth* class. Some of them have only two senses; others, no head; and most of them, no feet.

They are divided into five orders:—

1. *Intestinal worms*; as tape-worms, leeches, &c.

2. *Molluscous worms*; chiefly inhabiting the sea.

3. *Testaceous worms*; as muscles, cockles, oysters, snails, &c.

4. *Zoophytes*; between animals and vegetables.

And 5. *Animalcules*; generally invisible to the naked eye.

489. The Indian thread-worm eats into the skin in the West Indies, and its extraction occasions great trouble. The furia does the same in Sweden. The common hair-worm is said to occasion whitlows. Garden or dew-worms, are useful to vegetation, by loosening the soil. The heads and tails of snails if cut off will grow again. The Nereis is the sea glow-worm.

Full Nature swarms with life: one wond'rous mass
Of animals, or atoms organized,
Waiting the vital breath, when Parent-Heaven

Shall bid his Spirit blow. The hoary fen,
In putrid streams, emits the living cloud
Of pestilence. Through subterraneous cells,
Where scorching sunbeams scarce can find a way,
Earth, animated, heaves. The flowery leaf
Wants not its soft inhabitants. Secure,
Within its winding citadel, the stone
Holds multitudes. But chief, the forest-boughs,
That dance unnumbered to the playful breeze,
The downy orchard, and the melting pulp
Of mellow fruit, the nameless nations feed
Of evanescent insects. Where the pool
Stands, mantled o'er with green, invisible,
Amid the floating verdure, millions stray.—THOMSON.

490. Young snails come forth with their shells on their backs; and the shells are enlarged with the animal, by means of a secretion for the purpose, by which also they repair the shells when broken. The shell so effectually preserves them, that they have revived in water after being kept dry in a box for twenty years; and even after being immersed in boiling water.

Corals are shells produced by an insect within them; and they grow in such quantities, and to such heights in some seas, as to create islands inhabited by men. The Friendly Islands, in the Pacific Ocean, were thus raised by corals from the depth of that sea. Ships have often been lost on coral-rocks.

Obs. 1.—The wisdom of BEES, the harmony of their government, their persevering industry, and wonderful economy, have been celebrated in every age. Their combs, or nests, are composed of cells or six-sided figures, so finely finished, that the most expert workman would find himself unqualified to construct a similar habitation. By applying hexagonal cells to each other's sides, no void spaces are left between them; and, though the same end might be accomplished by other figures, yet they would require a greater quantity of wax. A comb consists of two rows of cells applied to each other's ends. This arrangement both saves room in the hive, and gives a double entry into the cells: the bases of the cells in one row of a comb, serving for bases to the opposite row. It is difficult to perceive, even with the assistance of glass-hives, the manner in which bees operate. They are so eager to afford mutual assistance; and, for this purpose, so many of them crowd together, that their individual operations can seldom be observed. It has, however, been discovered, that their two teeth are the instruments they employ in modelling and polishing the wax. The combs are generally arranged in a direction parallel to each other. An interval, or street, between the combs, is always left, that the bees may have a free passage, and an easy communication with the different combs in the hive. These streets are sufficiently wide, to allow two bees to pass one another. Beside these parallel streets, to shorten their journey when working, they leave several round cross-passages, which are always covered. The honey-bees not only labour in common with astonishing assiduity and art, but their whole attention and affections seem to centre in the person of the Queen or sovereign of the hive. When she dies by any accident, the whole community are instantly in disorder—all their labours cease; no new cells are constructed; and neither honey nor wax are collected.

> To their delicious task the fervent bees
> In swarming millions tend; around, athwart
> Through the soft air the busy nations fly,
> Cling to the bud, and with inserted tube
> Suck its pure essence, its ethereal soul;
> And oft, with bolder wing, they soaring dare
> The purple heath, or where the wild thyme grows,
> And yellow load them with the luscious spoil.
>
> THOMSON.

2.—The labours of WASPS, though not beneficial to mankind, are not less ingenious nor less worthy of admiration. Wasps associate in great numbers, and construct a common habitation with much dexterity and skill. The cells of the wasps are formed of a kind of paper, which, with great dexterity, is fabricated by the animals themselves. The hole which leads to a wasp's nest is about an inch in diameter, and is a kind of gallery mined by the wasps; the whole nest is of a roundish form, and sometimes above twelve inches in diameter. This subterraneous city, though small, is extremely populous; in a middle-sized nest, there were at least 10,000 cells. The different stories of combs are always about half an inch high; these intervals are so spacious, in proportion to the bulk of the animals, that they may be compared to great halls, or broad streets. Each of the larger combs is supported by about fifty pillars, which, at the same time, give solidity to the fabric, and greatly ornament the whole nest. Boys, and even men, are guilty of great and undeserved cruelty to these ingenious insects, who never sting, unless they are irritated and attacked.

3.—The association of ANTS merits no less admiration than those of bees and wasps. The form of their nest, or hill, is somewhat conical; and, of course, the water, when it rains, runs easily off, without penetrating their abode. Under this hill, there are many galleries or passages, which communicate with each other, and resemble the streets of a city. They go to great distances in search of provisions; and their roads, which are often winding and involved, all terminate in the nest.

491. The study of Shells is called *Conchology*. There are more than a thousand species of shells, and they are separated into three divisions:—*multivalves*, *bivalves*, and *univalves*, accordingly as the shells consist of *many* parts, of *two*, or of a *single* part.

Multivalves consist of many plates or shells, connected in some species, like the different parts of a coat of mail.

Bivalves consist of two shells, connected by a hinge; as the muscle, oyster, &c.

And the *Univalves* comprehend those that have a regular spiral, which is a numerous division, including the snail, periwinkle, &c., and those also without a regular spiral.

Obs.—Pearls are found in oysters and muscles. They are calcareous concretions, formed of the liquid of which the inner surface of the shell is composed, and are an effect of accidental injury to the shell. The Chinese increase the number of pearls, by catching muscles, and perforating the shells; and then replace the muscles in the water. After a certain time, on opening them again, they discover pearls attached to the part injured. The substance of the shells of these animals, when chemically examined, is found to be a mild calcareous earth, deposited in a mass of net-work, composed of animal matter. The shining matter, left in the tracks of snails, is this very substance; which, when deposited in strata above one another, hardens and forms a shell.

2.—Many hundreds of unknown species of mineral shells are found in the strata of the earth, the remains of seas and shores now no more.

492. The *polype* is an insect, of a snail, or jelly-like substance. It shrinks into a round green spot, if disturbed; but, in its natural form, is a long tube, and has a head and mouth, from which eight or ten long arms are projected, to seize worms and other insects.

The young issue from its side in a surprising manner; but, it is the wonderful property of this insect, that if cut into any number of pieces, and in any direction, each part will become a perfect polype in itself!

It may even be turned inside out without injury; and the dismembered parts of one polype will unite with those of another, and make one perfect polype!

493. After man has exerted his eyes to view the smallest insects, he will find, on applying a microscope, others so small, that ten thousand of them are not equal in bulk to the smallest which he can view with his naked eye.

Lewenhoeck tells us of insects seen with a microscope, of which 27 millions would only be equal to a mite, and four millions to a single grain of sand.

494. Yet, each of these animalculæ has an organized body, provided with a heart, lungs, muscles, glands, arteries, and veins; and with blood and other fluids passing through them!

Their vigour and powers of action are generally superior even to those of larger animals; their length of life is also great in proportion to their size.

The mite makes 500 steps in a second; animalcules, in a drop of water, swim about with as much freedom as a whale in the sea; and those that feed on the leaves of trees resemble oxen grazing in large pastures.

Wak'd by his warmer ray, the reptile young
Come wing'd abroad; by the light air upborne,
Lighter, and full of soul. From every chink,
And secret corner, where they slept away
The wintry storms; or rising from their tombs,
To higher life; by myriads, forth at once,
Swarming, they pour; of all the vary'd hues,
Their beauty-beaming parent can disclose.
Ten thousand forms, ten thousand different tribes!
People the blaze. To sunny waters, some,
By fatal instinct, fly; where on the pool,

They, sportive, wheel; or, sailing down the stream,
Are snatch'd immediate by the quick-eyed trout,
Or darting salmon. Through the greenwood glade
Some love to stray; there lodg'd, amus'd, and fed,
In the fresh leaf. Luxurious, others make
The meads their choice, and visit every flower,
And every latent herb; for the sweet task,
To propagate their kinds, and where to wrap,
In what soft beds, their young, yet undisclos'd,
Employs their tender care. Some, to the house,
The fold, and dairy, hungry, bend their flight;
Sip round the pail, or taste the curdling cheese:
Oft, inadvertent, from the milky stream
They meet their fate; or, weltering in the bowl,
With powerless wings, around them wrapt, expire.

THOMSON.

495. Animalcules are shaped like fish, reptiles, eels, stars, hexagons, triangles, ovals, and circles; they have horns, proboscis, &c.; and although the eyes of many species are not discernible, yet they move about with inconceivable relative velocity in the fluids they inhabit, without interfering with each other.

496. HUNTER divided all animated nature into single and complicated animals. The single, are those which possess only feeling or the powers of muscular contraction, and the power of absorbing food, as chalk absorbs moisture, and appropriating it to nourishment.

The *hydatid*, found in sheep, consists only of a bag filled with water, and has no appearance of animal powers; but, when excited or pricked *contracts* and shews its *irratibility;* while this vital power is *supported* by the nourishment which it receives through its coat.

497. For such simple animals, we ascend,

through all the degrees, up to the complicated and combined powers of body and mind, in MAN!

The links are kept up, by the addition of muscles for additional motions; by other senses, for hearing, seeing, &c.; and by various degrees of irritability in those senses.

The blood for renovation circulates through the lungs; and for action through the muscles of the heart; secretions take place by the various glands; the contraction of the muscles move the bones; the nerves convey the effect of the mental secretions to the brain; and there produce the inscrutable powers of sensation, will, and judgment.

498. Although animals, in general, are sufficiently distinct from vegetables, yet the gradations of nature are so minute, that many animals are but slightly removed from vegetables, having not more than one or two senses; and, as in some shell-fish, have not even the power of loco-motion.

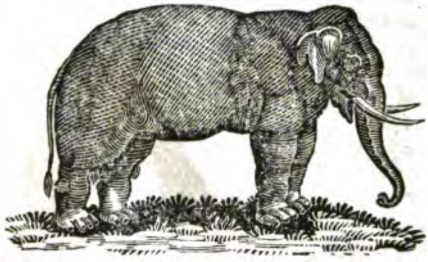
Between these and man, there is a regular succession of that cunning and sagacity, which are necessary to preserve and sustain life; yet, between man and most other animals, there is, in mental capacity, as great a difference, as between some of those and vegetables.

> Far as creation's ample range extends,
> The scale of sensual, mental powers, ascends:
> Mark, how it mounts to man's imperial race,
> From the green myriads in the peopled grass:
> What modes of sight, betwixt each wide extreme,
> The mole's dim curtain, and the lynx's beam:
> Of smell, the headlong lioness between,
> And hound sagacious, on the tainted green:
> Of hearing, from the life that fills the flood,
> To that which warbles thro' the vernal wood!

The spider's touch, how exquisitely fine!
Feels at each thread, and lives along the line:
In the nice bee, what sense so subtly true!
From poisonous herbs extracting healthy dew:
How instinct varies in the groveling swine,
Compar'd, half-reasoning elephant, with thine!
'Twixt that, and Reason, what a nice barrier!
For ever, separate,—yet, for ever, near! POPE.

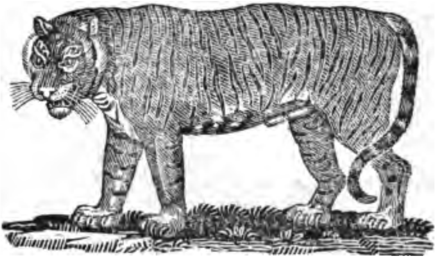
Seven remarkable Specimens of Animated Nature.

AN ELEPHANT.

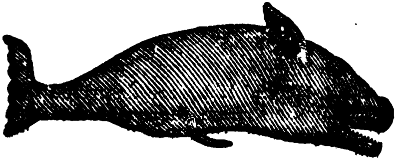


A WHITE BEAR.

A TYGER.

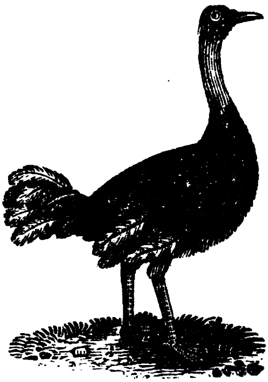


A WHALE.



AN EAGLE.

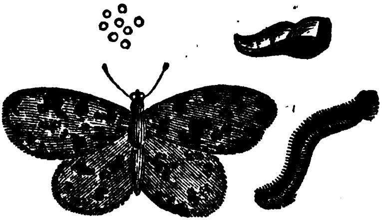
AN OSTRICH.



Obs.—In Art. 127 and 128, were described the transformations of insects, from the *egg* to the *worm;* the *worm* to the *chrysalis* and the *chrysalis* to the *butterfly.*

The following cut represents those four states in the common caterpillar:

THE EGGS, CATERPILLAR, CHRYSALIS, AND BUTTERFLY;



XX. *Chemistry.*

499. The principal object of chemistry is to ascertain the *elementary* or *first principles*, of which bodies are composed.

The ancients conceived that there were but *four* elements, or first principles;—Air, Water, Earth, and Fire: of these, and by their mutual action, they conceived that every kind of matter was composed.

Modern experimental philosophy has, however, analysed three of these elements, or has discovered other *elements* of those *elements*; and until these may have been analysed by further experiments, we must consider them as elementary bodies.

Obs.—Sir Humphrey Davy, in the preliminary observations to *his Elements of Chemistry*, beautifully observes, that "the forms and appearances of the beings and substances of the external world are almost infinitely various, and they are in a state of continued alteration." The whole surface of the earth even undergoes modifications. Acted on by moisture and air, it affords the food of plants; an immense number of vegetable productions arise from apparently the same materials; these become the substance of animals; one species of animal matter is converted into another; the most perfect and beautiful of the forms of organized life, ultimately decay, and are resolved into inorganic aggregates; and the same elementary substances, differently arranged, are contained in the inert soil; or bloom, and emit fragrance in the flower; or become in animals, the active organs of mind and intelligence. In artificial operations, changes of the same order occur; substances having the characters of earth, are converted into metals; clays and sands are united, so as to become porcelain; earths and alkalies are combined into glass; acrid and corrosive matters are formed from tasteless substances; colours are fixed upon stuffs; or changed; or made to disappear; and the productions of the mineral, vegetable, and animal kingdoms, are converted into new forms, and made subservient to the purposes of civilized life. To trace, in detail, these diversified and complicated phenomena, to arrange them, and deduce general laws from their analogies, is the business of Chemistry.

500. It is, now, found, that the AIR which we breathe is composed of a mixture of two distinct elements; one called nitrogen or *Azote;* the other *Oxygen;* and both are kept in their *gazeous* state by Heat, called *Caloric*, and that WATER is a mixture of *Oxygen* with *Hydrogen;*—that EARTH is a mixture of many substances;—and that FIRE is composed of Heat (or *Caloric*,) and *Light*, united to a combustible substance.

Obs.—The forms of matter, are well arranged into four distinct classes, by SIR H. DAVY. The *first* class consists of *solids;* which compose the great, known, part of the globe. Solid bodies, when in small masses, retain whatever mechanical form is given to them; their parts are separated with difficulty, and cannot readily be made to unite after separation; some solid bodies yield to pressure, and do not recover their former figure, when the compressing force is removed, and they are called *non-elastic* solids; others, that regain this form, are called *elastic* bodies. Solids differ in degrees of *hardness;* in *colour;* in degrees of *opacity* or *transparency;* in *density*, or in the weight afforded by equal volumes; and when their forms are *regular* or *crystallized*, in the nature of these forms.

The *second* class consists of *fluids;* of which there are much fewer varieties. Fluids when in small masses, assume the spherical form; their parts possess freedom of motion; they differ in degrees of density and tenacity; in colour and degrees of opacity or transparency. They are usually regarded as incompressible; at least a very great mechanical force is required, to make them occupy a space perceptibly smaller.

Elastic fluids or *gases*, the *third* class, exist free in the atmosphere; but they may be confined by solids, or by solids and fluids, and their properties examined. Their parts are highly moveable; they are compressible and expansible; and their volumes are inversely, as the weights compressing them. All known elastic fluids are transparent, and present only two or three varieties of colour; they differ materially in density.

Besides these forms of matter, which are easily submitted to experiment, and the parts of which may be considered as in a state of apparent rest, there are other forms of matter which are known to us only in their states of motion when acting upon our organs of sense, or upon other matter, and which are not susceptible of being confined. They have been sometimes called *ethereal substances*, which appears a more unexceptionable name than *imponderable substances*. It cannot be doubted that there is matter in motion in the space, between the sun, the stars and our globe; though it is a subject of discussion, whether successions of particles be emitted from these heavenly bodies; or motions communicated by them, to particles in their vicinity, and transmitted by successive impulses to other particles. *Ethereal* matter differs, either in its nature, or in its affections by motion; for it produces different effects;—radient heat, and different kinds of light.

501. Caloric is a mere name of that element or property, which, combined with various bodies, produces the sensation of *heat* while it is passing from one body to another.

According to its quantity in different bodies, it renders them *fluid*; or converts them into *gas*, or air.

Ice is water deprived of its caloric: when the caloric returns, the ice is again converted into water; and a further addition converts the water into steam, or aqueous *gas.*

It has been called *sensible* caloric, when it gives the sensation of heat; and *combined* caloric, when it is supposed to form an insensible part of the substance of bodies.

Obs. 1.—By mixing sulphuric acid with water, caloric is given out or disengaged, and the mixture becomes heated: and by mixing snow and nitre, the combination absorbs caloric from surrounding bodies by which they become evolved.

2.—Different bodies change their states at very different temperatures. Thus mercury, which is a solid at about 40 below Fahrenheit, boils at about 660; sulphur, which becomes fluid at 218°, boils at 570°; either boils at 98°. The temperatures, at which the common metals become gaseous, are generally very high, and most of them incapable of being produced by common means. Iron, manganese, platina, and some other metals, which can scarcely be fused in the best furnaces, are readily melted by electricity; *and by the Voltaic apparatus, a degree of heat is attained, in which platina not only fuses with readiness, but seems even to evaporate.*

3.—When solids are converted into fluids, or fluids into gases, there is always a loss of heat of temperature; and *vice versa:* when gases are converted into fluids, or fluids into solids, there is an increase of heat of temperature; and in this case, it is said, that *latent heat* is absorbed, or is given out.

4.—Sir Richard Phillips has published a new Theory of *Heat* and *Light* in the Monthly Magazine, No. 239. He considers both, as the effect of motion;—*heat,* as the motion or vibration of the parts of *solid* and *non-elastic* bodies,—and *light,* as the effect of the *vibrations* of the *elastic* medium which fills the universe; and the expansion of which same medium, produces also the phenomena of gravitation. The change of the phenomena of Heat, into the phenomena of Light, he ascribes to the action and re-action which take place in the elastic medium, during the decomposition which attends combustion when heat becomes light; or, in other words, when the *motion* of *solids* is transferred to *ethereals*.

502. Oxygen is an element or simple substance diffused generally through nature; and its different combinations (for, like caloric, it does exist by itself;) are essential to animal life and combustion.

Some chemists consider *oxygen* as the basis or substratum of all nature.

Acted upon, or combined with caloric, it becomes oxygen gas; which forms 28 parts of 100 of atmospheric air; and further condensed, it forms 85 of every 100 parts of water.

Obs.—Oxygen gas is distinguished from all other gaseous matter by several important properties. Inflammable substances burn in it under the same circumstances as in common air, but with infinitely greater vividness. If a taper, the flame of which has been extinguished, the wick only remaining ignited, be plunged into a bottle filled with it, the flame will instantly be re-kindled, and will be very brilliant, and accompanied by a crackling noise. If a steel wire, or thin file, having a sharp point, armed with a bit of wood in inflammation, be introduced into a jar filled with the gas, the steel will take fire, and its combustion will continue producing a most brilliant phenomenon. Oxygen gas is respirable; a small animal, confined in a jar filled with this gas, lives four or five times as long as within an equal quantity of common air;—hence, it has been called *vital air*.

503. During the burning of any combustible body, the *oxygen* leaves the atmospheric air and combining with the *calx* or *residuum* of said

body, adds to its weight, and forms what is called *an oxyde.*

This process is called *oxygenation;* and if the *oxygen* be combined with *sulphur, phosphorus, carbon,* or any other substance in various degrees, it will produce *acids* of strength proportioned to the degree of oxygenation; which are distinguished by the terminations *ous* and *ic;* as,

1. Oxide of sulphur;	1. Oxide of phosphorus;
2. Sulphur*ous* acid;	2. Phosphor*ous* acid;.
3. Sulphur*ic* acid.	3. Phosphor*ic* acid.

Combined with metals in various degrees, oxygen produces *oxides* of different colours; as *grey* oxyde of lead, *red* oxyde of lead, &c.

504. *Hydrogen* is one of the most abundant principles in nature; and 15 parts of it combined with 85 of oxygen, form water.

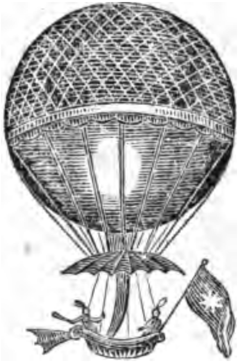
It is only to be met with in the gaseous form; and then it is 12 times lighter than atmospheric air; and is employed to fill *balloons.*

It is also *inflammable,* and is the gas called the *fire-damp,* so often fatal to miners; it is the chief constituent of oils, fats, spirits, ether, &c.

It is always produced from water.

Obs.—The process for filling balloons, is, by mixing five parts of water with one of sulphuric acid; and, by pouring the mixture on iron filings; the light gas, by the decomposition of the water, will rise into the balloon; and the balloon, being 12 times lighter than the atmospheric air, will rise through it.

AIR-BALLOON.



505. *Nitrogen*, or *azote*, is a substance diffused through nature, and particularly in animal bodies.

Nitrogen is not to be found in a solid or liquid state; but combined with caloric, it forms azotic gas, or mephitic air, in which no animal can breathe, or any combustible burn.

Seventy-eight parts combined with 22 of oxygen, form 100 parts of atmospheric air. In a higher degree of oxygenation when an actual combination between it and oxygen is effected, it produces nitr*ous gas*; and in a still higher, nitr*ic acid*.

Obs. 1.—As oxygen is absorbed during burning or breathing, and as soon as the 22 parts, or nearly, of oxygen are absorbed, the remainder is nitrogen, and becomes *mephitic* or deadly, being incapable of sustaining life or flame.

2.—As the constitution of the atmosphere constantly remains the same, it is evident there must be some process in nature, by which a fresh quantity of oxygen is produced equal to that consumed. One principal means of the reproduction of oxygen appears in the process of vegetation; healthy plants exposed in the sun-shine to air, containing small quantities of carbonic acid gas, destroy that elastic fluid, and evolve oxygen gas; so that the two great classes of organized beings are dependent upon each other. Carbonic acid gas, which is formed in many processes of combustion, as well as in respiration, if not removed from air, by its excess, would be deleterious to animals; but it is the healthy food of vegetables; and these vegetables produce oxygen, so necessary to the existence of animals. This part of the œconomy of nature is therefore preserved, by the very functions to which it is subservient; and the order displayed in the arrangement, demonstrates the intelligence by which it was designed.

506. *Oxygen, Nitrogen,* (or *azote,*) *Hydrogen* and perhaps *Caloric* and *Light,* may therefore be considered as the active and universal elements of nature.

They constitute the bulk, basis, or substance of atmospheric air, water, vegetables, and animals; and it is suspected, that gold, other metals, and all other bodies and powers of nature, will, in due time, be proved to arise out of their combinations in various proportions.

We say, for the present, call them *agents* of Nature; and the other simple substances may be called *patients.*

Obs.—*Chlorine,* or Oxymuriatic Gas, which Sir H. Davy assimilates to oxygen, as an elementary substance, is of a yellowish-green colour; and it is this property which suggested its name. Its odour is extremely disagreeable. It is not capable of being respired, and even when mixed in very small quantities with common air, renders the air extremely pernicious to the lungs. When an inflamed taper is introduced into a phial filled with it, the light continues, but of a dull red colour, and a dark carbonaceous smoke arises from the flame.

Many of the metals introduced into it in thin filaments, or leaves, or powder, take fire, and burn spontaneously at common temperatures: such, are copper, tin, arsenic, zinc, antimony, and the alkaline metals.

Phosphorus burns in it spontaneously, with a pale white light, producing a white volatile powder.

Sulphur melted or sublimed in it does not burn; but forms with it a volatile red liquor. Chlorine has never been found pure in nature; but exists in many compounds; particularly in common salt, as it may be produced from that substance.

507. Before we proceed further, we request that it may be remembered.

1. That all fluids are combinations of heat or motion, with some other substances;

2. That combustion arises from the action of heat on the parts of the combustible body; and that the process called burning, is nothing more than the oxygen of the atmosphere uniting with certain parts of the body;

3. That oxygen seems to be the *acid*ifying principle; and that all acids are combinations of oxygen with other substances;

4. And that all compounded *salts* are combinations of an acid with some other substance.

508. *Acids* therefore are formed from *oxygenous* combinations; and *salts* from *acid* combinations. *Weak* acids are indicated by the termination *ous*;

as sulphur*ous*, &c.; and strong ones by *ic*, as sulphur*ic*, &c.

But in forming salts from acids, if those acids ending in *ous* are used, the salt is terminated by *ite*, as sulph*ite*, &c.; but if from the strong acid ending in *ic*, the salt ends with *at*; as sulph*at*, &c.

When there is an *excess of acid*, the preposition *super* is added; and when an *excess of the base*, then *sub* is prefixed.

509. The other substances which have not yet been *decompounded*, and therefore called elementary, are, *Carbon*, *Sulphur*, *Phosphorus*, and two or three others, which, combined with oxygen, form acids.

There are also nine *earthy* substances, as *lime*, *magnesia*, *silex* or flint, *alumine* or clay, and five others, which, combined with acids, form numerous salts.

All pure metals have, hitherto, been deemed simple substances; as platina, gold, silver, iron, &c. They are nearly forty in number.

510. *Carbon*, or diamond, or pure charcoal, is that hard substance which is diffused through all animal and vegetable bodies. It may be obtained by exposing them to a red heat, which drives off all their aqueous and foreign combinations.

Carbon combined with *oxygen*, of course forms an *acid*, called *carbonic acid*, which exists in large quantities in chalk, lime-stone, &c.

Carbonic acid cannot be obtained in a liquid form; but its purest state is that of *gas*.

The carbonic acid gas (*i. e.* a gas raised by applying *heat* to a combination of oxygen and carbon) is the choke damp of mines.

Combined with hydrogen, it forms fixed and volatile oils; and with other bodies, what are called *carbonats* and *carburets*.

511. *Sulphur*, or brimstone, found near volcanoes, in coal-mines, &c., has a great tendency to combination.

United with metals, it forms *pyrites;* as iron or martial pyrites, copper-pyrites, &c.

The modern name of its combinations with earths, metals, &c., is *sulphuret;* as sulphuret of iron, sulphuret of magnesia, &c.

Combined with oxygen, it forms sulphur*ous* and sulphur*ic* acid.

512. *Phosphorous* is a simple substance, found in a state of combination with the bones of animals, from which it is extracted.

Its tendency to unite with *oxygen* is so great, that it always *burns* in the open air; and bursts into *flame*, at a degree of heat a little above that of the human body.

Its combinations with earths and metals are called *phosphurets*.

Obs.—Many amusing experiments may be performed with it; but great care should be taken, and a basin of water kept at hand, for it will kindle into an unextinguishable flame even by friction.

513. Chemists, by separating earths from foreign matters, and from each other, have discovered nine primitive earths, which are not soluble in water or in flame: the principal are,

1. *Lime*, or calcareous earth, is obtained by applying heat to chalk, marble, lime-stone, &c., by which carbonic acid gas and water are expelled, and the lime left as a product.

When used as a cement in building, water is fused to make it plastic; and, in time, it imbibes its carbonic acid again from the atmosphere, and acquires its original hardness.

Lime is also used in tanning; in making sugar and soap; and it forms 80 parts, combined with 20 of phosphoric acid, in 100 parts of animal bones.

514. (2.) *Magnesia*, is a soft white earth, generally found in combination with other minerals. United with sulphuric acid, it forms Epsom-salts. It purifies putrid water, if agitated with it.

3. *Silex*, or flint, is the principal ingredient of stones, crystals, sand, &c., and cannot be melted by itself in any heat; but in contact with alkalies, as soda or potash, it forms that useful production, called glass.

4. *Alumine, argil*, or pure clay, is fusible by a great heat, when, it becomes so hard, as to scratch glass. It readily absorbs water, and also grease; and hence, its use as fuller's earth in scouring cloths, &c.

515. The immense stony masses of which the globe is composed, are found in the earth lying in *strata* one above another; a rock of one kind covering another species of rock; this a third, and so on. The arrangement is not arbitrary; but each species occupies its regular place, from the deepest part yet explored, to the surface.

516. Rocks are divided into five classes or *formations;* and called *primitive, transitive, stratified, alluvial* and *volcanic*.

a. The *primitive* formations of rocks are the lowest; and are supposed to have been chemical precipitations, formed in the chaotic state of the earth; because they have no trace of organized beings or petrifactions. They are chiefly composed of *silicious* and *argillaceous* earths, as granite, slate, &c.

b. Transition-rocks are supposed to have been formed during the transition of the earth into a habitable state; and differ from the primitive, in the variety of their colours, and in containing the remains of marine animals.

c. Stratified rocks are disposed in horizontal *strata;* and contain the remains of animals and vegetables, and consequently were formed after the creation of animals and vegetables.

d. Alluvial formations consist of the constituent parts of previous rocks, separated by the action of water, air, and temperature, and deposited in beds. These are compounded of sand, gravel, loam, clay, turf, &c.; and contain also plants, roots, moss, bones, &c.; likewise petrified wood, and skeletons of quadrupeds;—the remains of destroyed worlds.

e. Volcanic formations are minerals thrown out of the crater of a volcano, consisting of pumicestones, lava, and basalts.

Obs.—It is maintained by a late writer, that we are indebted to the agency of the weight or pressure of masses on masses for many of the varieties of substaces which are found under the surface of the earth. The pressure of one or two hundred thousand tons weight for thousands of years, aided by various chemical and other combinations, it is thought sufficient to account for many geological phenomena.

517. It has been already explained, that *oxygen* communicates the *acid* principle, and is sup-

posed to be the universal cause of *acidity;* the peculiar power of which is to turn all vegetable *blues* into *reds*, and give the flavour called sour.

There is also another property in nature, called *alkaline*, which is distinguished from the *acid* by a burning and urinous taste; and it has the distinct property of converting vegetable *blues* into *greens*.

The only *alkalies* are *potash* and *soda;* and there is a volatile alkali called *ammonia*.

518. *Alkalies* and *acids* have the property, when combined, of simplifying, or neutralizing each other; and hence *acids* (which, it must again be remembered, form one of the constituents of all kinds of salts;) and when combined with alkalies, form what are called *neutral salts*.

Alkalies, mixed with *fats*, make *soap;* and, when melted with *silex*, *glass*.

Potash is chiefly obtained by burning vegetables, and hence called *pot-ashes;* but *Soda*, the other alkali, is obtained from sea-salt, sea-weeds, from natron beds, and even from mines.

519. The principal acids obtained by the union of oxygen with other substances, are oxygen and sulphur, called *sulphuric* acid, or oil of vitriol.

Oxygen and nitrogen, called *nitric* acid, or aqua fortis, which dissolves silver, and thence, the art of plating with silver.

Oxygen, and an unknown base, or radical, forms *muriatic* acid, or acid of sea-salt;—when united to soda, called muri*at* of soda, it is the common salt of the table.

Oxygenated muriatic acid, or chlorine, is used for bleaching, cleaning paper, and taking out ink-spots.

Nitro-muriatic acid, or aqua regia, dissolves gold and platina.

Oxygen, and an unknown radical obtained from Derbyshire-spar, called *fluoric* acid, is employed for etching on glass.

There are fifty other acids known and used in the arts.

520. *Affinity* is the apparent preference which one elementary body has for another; and the various degrees of this preference create most of the chemical phenomena of nature.

Oxygen has a strong *affinity* for all bodies; therefore, to *oxygenate* any body, it is necessary to weaken the affinity between its parts by heat or motion; and, if this be done in the open air, the oxygen of the atmosphere will leave its azote, and combine with the new body, forming, according to its degree, an oxyde or an acid.

Obs.—When olive-oil and water are agitated together, they refuse to act upon each other, and separate according to the order of their densities, the oil swimming above the water. Oil and water will not mix intimately; they will not *combine;* and they are said to have no chemical *attraction* or *affinity* for each other. But if oil and soap-lees, or solution of potassa in water, be mixed, the oil and the solution blend together, and a species of soap will be formed, which may be procured in a soft solid substance by evaporating a part of the water. This is an instance of *combination;* and solution of potassa and oil are said to *attract* each other chemically, or to have an *affinity* for each other.—Davy.

521. The chemical properties of bodies arise, in a great measure, from their varied *affinities*, propensities, or preferences for one another, by

which they leave one, and combine with another; and this *varied* power of *affinity*, leads to most of the combinations of nature, and affords to chemists their powers of analyzing bodies.

In passing from a fluid to a solid state, the substance unites into very curious and regular forms, called *Chrystals.*

When bodies unite, and form a new substance, they are said to be chemically *combined;* and when they are separated again by the action of any *re-agent*, they are said to be *decomposed.*

Obs.—Oil is almost insipid; but the solution of potassa is a caustic substance, which corrodes the skin, and has a strong taste.—The body resulting from their union, differs both from the oil and the alkali in taste, smell, colour, and in all its sensible qualities; and it is a general character of *chemical combination*, that it changes the sensible qualities of bodies. Corrosive and pungent substances often become mild and tasteless by their union; as is the case with sulphuric acid and quicklime, which form gypsum, or sulphat of lime. Bodies possessed of little taste or smell, often gain these qualities in a high degree by combination. Thus sulphur, when inflamed in oxygen or in common air, dissolves and forms an elastic fluid of a most penetrating and disagreeable odour and peculiar flavour. The forms of bodies, or their densities, likewise usually alter; solids become fluids; and solids and fluids, gases; and gases are often converted into fluids or solids. Thus, sugar, or salt, or isinglass, dissolve in water. The consumption of charcoal in our fires, depends upon its uniting with a part of the air, with which it forms an invisible elastic fluid: mercury is rendered solid, by being heated with half its weight of tin; and a substance of this kind is used for silvering mirrors. The gas produced by the combustion of charcoal, is condensed by another gas procured from quicklime and sal ammoniac, when they are mixed over mercury; and the two invisible, elastic fluids form a white saline solid.

522. If salt be mixed in water, it is said to be in *solution*, and the water is called the *menstruum*.

If no more salt will dissolve, the water is said to be *saturated*.

If we would extract the salt, we must *evaporate* the water by *heat*; and if the *vapour* from the *retort* pass through a spiral tube or *worm*, to the *receiver*, we shall have *distilled* water, and the *extract*, or *residuum* of salt will remain in the *still*.

523. All *mineral waters* are formed by the solution, or mixture in them, of *oxygen* and *nitrogen gases*, of acids, alkalies, and neutral salts.

Sulphurous acid is found in some mineral waters; soda, in others; and salts, as sulphats, nitrats, muriats, and carbonats of soda, or lime; and in chalybeate waters, or carbonat of iron.

Obs. 1.—The *test* of the presence of carbonic acid in any mineral water is an infusion of *litmus*, which will be turned red by water containing it; and this acid also gives the briskness of champaign into whatever it enters, and an acidulated flavour to water. Any acid contained in any water may be detected by its turning the infusion of violets, red. Alkalies in water may, in like manner, be detected, by turning the infusion of violets green. The infusion of dry violets, or paper stained with them, answers best. The infusion of turmeric, or paper stained with turmeric, is rendered brown by alkalies; or reddish brown, if the quantity is minute. When the change is temporary, it is volatile alkali. Sulphur and bitumen may be detected, by the smell and taste. Iron, in mineral water, may be detected by Prussian alkali, which will precipitate it, and tinge it blue. The solution of galls also is an exquisite test of the presence of iron. When there is copper in water, it will shew itself on the surface of any piece of bright iron put into it. If arsenic, the residuum will tinge copper *white*.

2.—Chemistry is an unsettled, but interesting science; and new discoveries, and further decompositions of bodies, deemed elementary, are constantly taking place.

XXI. *Electricity and Galvanism.*

524. If a piece of glass, or sealing wax, be rubbed on a piece of dry woollen cloth, or silk, and instantly held over any small pieces of paper, they will be attracted towards it, raised on an end, and otherwise put in motion.

The power thus excited is called *electric*; and if the experiment be made in the dark, the *glass* and the *wax* will exhibit faint signs of *light*; which light is called the electric fire or fluid.

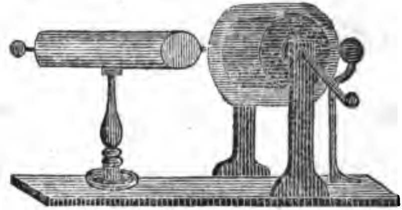
525. If the glass be of larger dimensions, and turned rapidly round by a wince and a wheel, instead of being rubbed backward and forward with the hand; and be provided with a piece of silk to rub against it during its rotation, streams and large sparks of fluid fire will be elicited; which will fly round the glass, attract light bodies, and produce a pungent sensation, if the hand be held to it.

526. This glass, its cushion of silk, wheel, &c. are called an electrical machine. The fluid, or power produced by it, is one of the most wonderful in nature.

It is found, that it will pass along some bodies, and not along others; that it may be received and diffused by sharp points; that a superabundance of it, in one place, acts as a repellent, in the parts immediately adjoining; and that it has a constant, and violent tendency to restore its own equilibrium in all bodies.

THE ELECTRICAL MACHINE.

Prime Conductor. *Glass Cylinder.*



527. The bodies, over which it passes freely, are all animals, most animal and vegetable substances, water, &c.; all which are called *conductors* of electricity.

But it will not pass over glass, sulphur, charcoal, silk, baked woods, or dry woollen substances; nor through air, except by force in *sparks*, to short distances.

All these bodies, therefore, are called *non-conductors.*

528. The power of exciting it, receiving it on points, and confining it to bodies, over which it freely passes, by placing these on bodies, over which it will *not* pass, gives rise to all the phenomena of practical electricity,

Hence a metallic *conductor*, provided with brass-points, and elevated on glass-legs, is placed opposite the revolving glass-cylinder, to receive by its points the electric power, which is condensed on the cylinder, but unable to escape on account of its being surrounded only by air, and supported by glass-legs, both which are *non-conductors.*

529. If the hand, or a metallic knob, be held within three or four inches from this metallic or main *conductor*, a large spark will escape, which in the dark will be forked, and of the colour of *lightning*.

There will also be a snapping noise; which, increased by larger quantities, would be likely to produce the noise of *thunder.*

In fact, *lightning* and *thunder* are effects of electricity in the clouds.

A flash of lightning is simply a stream of the electric power passing from the clouds to the earth; from the earth to the clouds; or from one cloud to another cloud; and *thunder* is the report, and the echoes of the report, between the clouds and the earth.

530. But the most wonderful effect of the electric fluid, is its power of suddenly contracting the muscles of animals, when it violently passes through them, from one place to another, to restore its equilibrium.

It will not pass through glass; if, therefore, a plate of glass, in the form of a jar, or otherwise, be coated on both sides, with either gold, silver, or tinfoil, and one side be brought into contact with the main conductor, the other side will instantly part with its electricity, and the plate of glass be said to be charged.

531. If one hand be put to the under or outer side of the said charged plate, and the other hand

be brought into contact with the other, or charged side, the equilibrium of the two sides will be restored through the body; and a violent contraction, or blow of the muscles will be felt, producing a shock peculiar to this operation.

The severity of the shock, is proportioned to the size of the plate or jar. When many jars are joined together, and charged in this way, they are called a battery; and some batteries have been made so powerful, as to kill an ox, melt gold, and produce all the surprising phenomena of real lightning.

532. Philosophers amused themselves, for a century, with experiments on the electrical apparatus; but a new mode of exciting this power, was discovered by *Galvani;* and the experiments made in his way, are called *Galvanism.*

It is found, that there are two classes of conductors:—*perfect*, as the metals; and *imperfect*, as water and the mineral acids; and that if these are laid alternately, two perfect and one imperfect, or two imperfect and one perfect, the two ends or sides, will constantly produce an electric shock.

Instead, therefore, of the glass-cylinder, conductor, coated jar, &c., used in electrical experiments, the *Voltaic pile*, or trough, is now preferred; and is so called, from Volta, its inventor.

Obs.—The common exhibition of electrical effects, is in attractions and repulsions, in which masses of matter are concerned; but there are other effects, in which, the changes that take place, operate, in a manner, in small spaces of time imperceptibly; and in which, the effects are produced upon the chemical arrangement of bodies.

If a piece of zinc and a piece of copper be brought in

2.—The most powerful combination that exists, in which number of alternations is combined with extent of surface, is that constructed by the subscriptions of a few zealous cultivators and patrons of science, in the laboratory of the *Royal Institution*. It consists of two hundred instruments, connected together in regular order, each composed of ten double plates, arranged in cells of porcelain, and containing in each plate thirty-two square inches: so that the whole number of double plates is 2000; and the whole surface, 128,000 square inches. This battery, when the cells were filled with 60 parts of water mixed with one part of nitric acid, and one part of sulphuric acid, afforded a series of brilliant and impressive effects. When pieces of charcoal, about an inch long and one-sixth of an inch in diameter, were brought near each other (within the thirtieth or fortieth part of an inch,) a bright spark was produced, and more than half the volume of the charcoal became ignited to whiteness; and by withdrawing the points from each other, a constant discharge took place through the heated air, in a space equal at least to four inches, producing a most brilliant ascending arch of light, broad and conical in form in the middle. When any substance was introduced into this arch, it instantly became ignited; platina melted as readily in it as wax in the flame of a common candle; quartz, the saphire, magnesia, lime, all entered into fusion; fragments of diamond, and points of charcoal and plumbago, rapidly disappeared, and seemed to evaporate in it. Such are the decomposing powers of electricity, that not even insoluble compounds are capable of resisting their energy; for even glass, sulphate of baryta, fluor spar, &c., when moistened and placed in contact with electrified surfaces from the Voltaic apparatus, are slowly acted upon, and the alkaline, earthy, or acid matter, carried to the poles in the common order. Not even the most solid aggregates, nor the firmest compounds, are capable of resisting this mode of attack; its operation is slow, but the results are certain; and sooner or later, by means of it, bodies are resolved into simpler forms of matter.—Davy.

534. It is ascertained, that during these shocks, an oxydation of the metallic plates takes place; and, after their surfaces become tarnished, the shock diminishes; but, on being wiped, its force is renewed.

A combination of these troughs forms *a galvanic battery*, the force of which has produced the most surprising effects; and, by disturbing the close affinity of the constituent parts of many bodies, has led to the analysis of substances, hitherto deemed simple and elementary.

Obs.—Some fishes, as the torpedo, the gymnotus electricus, and the silarus electricus, when touched, communicate shocks to the human body like those of electricity; but as there is no circuit for the fluid, in these cases, no adequate solution has yet been found of this strange phenomenon.

535. Since the identity of lightning and electric matter has been ascertained, philosophers have been led to seek the explication of aerial meteors in principles of electricity: and there is no doubt, that the greater part of them, and especially the aurora borealis, are electrical, or gazeous phenomena.

It has been observed, that the aurora borealis produces a very sensible fluctuation in the magnetic needle; and that the flashes have been attended with various rumbling and hissing sounds.

Now black, and deep, the night begins to fall,
Drear is the state of the benighted wretch,
Who then, bewilder'd, wanders through the dark,
Perhaps, impatient as he stumbles on;
Struck from the root of slimy rushes, blue,
The wildfire scatters round, or gather'd, trails
A length of flame deceitful o'er the moss:
Whither, decoy'd by the fantastic blaze,

Now lost, and now renew'd, he sinks absorpt,
Rider and horse, amid the miry gulf:
At other times, gleaming on the horse's mane,
The meteor sits; and shows the narrow path,
That winding, leads through pits of death; or else,
Instructs him how to take the dangerous ford.

THOMSON.

536. Earthquakes, the most dreadful phenomena of nature, have been ascribed, by some naturalists, to water, fire, steam, and electricity; each of these powerful agents being supposed to operate in the bowels of the earth.

Subterraneous fire, and steam generated from it, are supposed to be the true causes of earthquakes. The elasticity of steam, and its expansive force, are every way capable of producing the stupendous effects attributed to earthquakes; the force of steam being 28 times greater than that of gunpowder.

Can the poor, brittle tenements of man
Withstand the dread convulsion? Their dear homes,
(With shaking, tottering, crashing, bursting, fall;)
The boldest fly; and, on the open plain,
Appall'd, in agony, the moment wait,
When, with disrupture vast, the waving earth
Shall 'whelm them in her sea-disgorging womb.
Nor, less affrighted, are the bestial kind:—
The bold steed quivers in each panting vein,
And staggers, bath'd in deluges of sweat:—
The lowing herds forsake their grassy food,
And send forth frighted, woeful, hollow sounds:—
The dog, thy trusty centinel of night,
Deserts his post assign'd and piteous howls.

THOMSON.

537. The most remarkable changes in the form and constitution of the earth, since the deluge, have probably been produced by subterraneous

fires in volcanoes and by earthquakes; by which plains are converted into mountains, the ocean into islands, and dry land into pools.

Obs.—Half a pound of steel-filings, half a pound of brimstone, and a pint of water, will, when well mixed, acquire heat enough to make the mass take fire: and it appears, that volcanic mountains abound in these mixtures; which are ignited, no doubt, by rain falling into their craters, or by the sea communicating with their bases and lower cavities.

The fluid lake that works below,
Bitumen, sulphur, salt, and iron-scum,
Heaves up its boiling tide. The lab'ring mount
Is torn with agonizing throes. At once,
Forth from its side, disparted, blazing pours
A mighty river; burning in prone waves,
That glimmer thro' the night, to yonder plain.
Divided there, a hundred torrent streams,
Each ploughing up its bed, roll dreadful on,
Resistless. Villages, and woods, and rocks,
Fall flat, before their sweep. Mallet.

538. The eruptions of volcanoes exhibit dreadful phenomena, in prodigious inundations of liquid fire, which bear inevitable destruction with them.

The name of *lava* is given to these fiery streams, consisting of a mixture of stones, sand, earth, metallic substances, salt, &c., calcined and vitrified.

The last great eruption of Etna, was in 1669; and the progress of the lava was at the rate of a furlong a day:—it destroyed, in forty days, the habitations of 27,000 persons; and of 20,000 inhabitants of the city of Catanea, only 3000 escaped.

The other great volcanoes in Europe, are *Vesuvius*, and *Hecla*; but there are two or three hundred in different parts of the world.

XXII. *Magnetism.*

539. The power of certain ores of iron to attract pieces of iron, was known by the Greeks; but accident led an Italian to discover, that if suspended on a centre, and allowed to turn in any direction, one end would constantly point northward, and, of course, the other southward.

This ore of iron was called loadstone; and it soon became evident, that the property of distinguishing the north and south, was of the highest utility to ships at sea.

540. In the course of time, it was discovered, that *loadstone* communicated its property of turning northward to all pieces of iron and steel; and that these could communicate it to others, in a degree of strength proportioned to the number of magnets employed in transferring the property.

Natural magnets are not therefore now used; but needles are first made of the most convenient shape, and the magnetic property communicated to them, by contact with other natural, or artificial magnets.

541. The two poles or points of the magnetic needle have different properties—the south poles of magnets attracting the north poles of others; and the same poles acting repulsively towards each other; *i. e.* a north pole repels a north pole, and a south, a south pole.

A white heat destroys the *polarity*; and so will stokes of the hammer. But it will be acquired, by iron-bars that stand long in an upright position, or that are heated red-hot, and left to cool in a polar direction.

542. If a magnet be laid on white paper, and some steel-dust be suffered to fall gently upon it, the dust will arrange itself on the paper in regular curves, under the influence of the magnetic attraction.

If the magnetic bar be bent round into the form of a horse-shoe, its poles in that position will attract and operate in a higher degree than when used separately; and the strength of all magnets is increased by thus keeping their powers in action.

543. Magnets do not point exactly north and south; but in different parts of the world, with a different *declination* eastward or westward of the north; and different in each place, at different times.

In London, at this time, the needle points 24 degrees to the west of the north; or, rather more westerly than north-north-west; and the declination has increased to the west from due-north, for 160 years past.

Nor does the needle lie parallel or flat, in any place; but the north point is turned upward or downward, and in London at this time it dips 72 degrees.

Obs.—The cause of the phenomena of magnetism has hitherto, baffled the investigations of philosophers; and the more we learn of them, the greater becomes our embarrassment; but some accidental discovery will probably hereafter effect more than all reasoning; and till that occur, we must be content to class this, among the many unaccountable secrets of nature.

XXIII. *Mathematics.*

544. Mathematics, or the mathematical sciences, are divided into—

1. *Pure* mathematics; containing arithmetic and geometry, which treat only of number and magnitude.

2. *Mixed* mathematics; which treat of the properties of quantity applied to matter, as astronomy, geography, &c.

3. *Speculative* mathematics; which contemplate the proportions, relations, &c., of bodies.

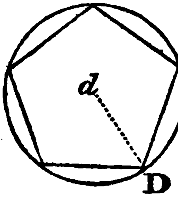
4. *Practical* mathematics, or their application to the practical uses of life.

545. Geometry is an ancient, perfect, and beautiful science; which enables us to determine the relations and proportions of superfices and solids.

Superfices consist of figures of *three* sides, called triangles; of *four* sides, called quadrilaterals, squares, parallelograms, and trapeziums; of *five* sides, called pentagons; of *six* sides, called hexagons; and of *many* sides, called polygons.

Superfices also are circles; ovals, or ellipsis; sectors of circles, or parts cut out from the centre; and segments of circles cut off by a strait line, called a chord..

A PENTAGON.



The above cut represents a *Pentagon* or *Polygon* of five sides, inscribed within a circle.

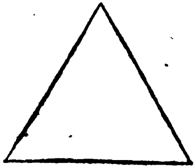
546. Solids are cubes, regular and irregular; spheres; cylinders; cones; pyramids; and spheroids, &c.

A cone cut obliquely to the base, forms an *ellipsis*; perpendicular, an *hyperbola*; and parallel to the side, a *parabola*.

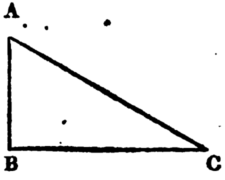
Angles are the inclinations of two straight lines meeting in a point.

A *right* angle is, when the lines are perpendicular to each other; an acute angle is less than a right angle; and an obtuse angle is greater than a right angle.

EQUI-LATERAL TRIANGLE.

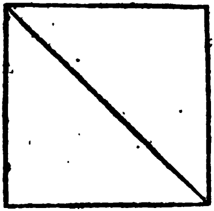


RIGHT-ANGLED TRIANGLE.



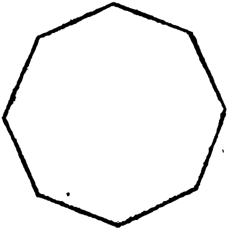
SQUARE, AND DIAGONAL A B.

A



B

AN OCTAGON.



547. Parallel lines are those, which are equidistant; diagonals are those, which cross figures from one angle to another.

Tangents are lines that touch a circle.

The circumference of every circle is equal to 360 degrees; the three angles of every plain triangle, are equal to 180 degrees; the angles of every quadrilateral figure are equal to 360 degrees.

548. By means of a scale and compasses, many kinds of figures may be readily drawn.

Triangles contain six parts; viz. three angles, and three sides, and any 1 of one, and 2 of the others being given, the other three may be found either by projection, or by logarithms.

This art is called *trigonometry;* and by means of it are performed most problems in astronomy, geography, navigation, and surveying.

It is founded on the great principle—that *all triangles which have equal angles, have all their* *sides in equal proportion.* This is the foundation of tables for calculating triangles.

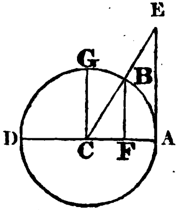
549. In every plain triangle, the three angles are 180 degrees; and as a right angle is 90 degrees, the other two angles together are, of course, equal to 90 degrees; all triangles may be reduced to right-angled triangles.

Tables, then, are calculated from the proportions of triangles; whose *hypothenuse* is 1,000,000,000, for every degree and minute of the acute angles.

Hence, if the base of a triangle be 67 yards, and the angle 36 degrees, I can ascertain the length of the other sides, by making a proportion from the tables.

Obs.—In these tables, it should be understood, that the *hypothenuse* corresponds to the *radius* of 1,000,000,000; that the *base* corresponds to the co-sine; and the *perpendicular* to the *sine.* Or, when the *base* is deemed the *radius*, the *perpendicular* is the *tangent*, and the *hypothenuse* the *secant.*

The elements of trigonometrical tables may be understood by attending to the following diagram:



D A is the *diameter;* C B is the *radius;* B F is the *sine;* C F is the *co-sine.* Or, C A is the *radius;* A E is the *tangent;* C E is the *secant.*

Tables, then, are calculated for these several lines, to every degree and minute of the quadrant from A to G; and as the sides of all triangles, which have equal angles, are in equal proportion, it is evident, that we have only to adapt these already calculated proportions to other triangles; and the latter may be calculated by the simple proportion.

550. Superficial contents are ascertained by multiplying the length by the breadth; and solid contents, by multiplying the superfices by the height.

Irregular superficial figures are to be reduced to regular ones; and in solids, or casks, cones, &c., a mean or average-height or breadth is ascertained.

Lines are in the proportion to each other's respective *lengths; superfices* in the proportion of their *squares;* and *solids* of their *cubes.*

551. Every diameter of a circle is to its circumference, as 1 to 3,14159.

The superfices of every circle is to the square of its diameter, as 11 to 14, or as 0,7854 to 1 nearly.

The cube of every sphere is to the cube of its diameter, as 0,5236 to 1.

Every square foot contains 144 square inches.

Every cubic foot 1728 solid inches.

282 cubic inches are a gallon of ale, and 231, of wine.

552. The length of a pendulum vibrating seconds at London, is $39\frac{1}{8}$ inches.

The English yard is 36 inches; the mile 1760 yards; and a degree of the earth's surface, $69\frac{1}{3}$ miles nearly.

The French *metre* is the 10 millionth of the distance from the equator to the north pole; and is 39,383 inches English.

The English acre is 4840 square yards; and 640 acres are a square mile.

The surveyor's chain is 100 links, 22 yards, or 4 poles; and 10 square chains are an acre.

Obs.—As the preceding numbers are the foundation of all calculations relative to quantity, and are frequently called into use in life, every young person should be expert in the recollection and use of them.

553. The tables in which all the proportions of triangles are calculated, which have 1,000,000,000 for one of the sides, are called tables of sines and tangents, and are to be found in various books of mathematics.

The numbers are reduced to logarithms for greater ease in working the proportions; addition, in working logarithms, being a substitute for multiplication, and subtraction for division.

554. Trigonometry also calculates the sides of triangles, whose sides are parts of the circles of the earth and heavens: hence, it is highly useful to the astronomer and navigator. It enables us to calculate the *heights* of buildings and mountains, and the distance of celestial bodies.

The projection of spherical triangles, as part of the earth or heavens, and of maps on a globular principle, is a beautiful branch of practical geometry and astronomy.

555. *Logarithms* are numbers in arithmetical progression; which, set with others in a geometrical progression, express their ratios or proportions to one another, as in the two following series, viz.,

Logarithms,	0.	1.	2.	3.	4.	5.	6.	Arith. Prog.
Numbers,	1.	2.	4.	8.	16.	32.	64.	Geom. Prog.

556. It is the peculiar and useful property of *Logarithms*, that for every *addition* and *subtraction* of one series, there corresponds to it in the other, a *multiplication* and *division* of the number to which they belong.

Thus, by adding 2 and 4 in the logarithmic series you have 6, which is the logarithm of the number in the lower series 64, the product of 4 times 16; and the contrary for *division*.

By dividing a logarithm, you find the logarithm of the root of its number; so 6, the logarithm of 64, divided by 2, gives 3, the logarithm of 8, which is the square root of 64; or divide 6 by 3, it gives 2, the logarithm of four, the cube root of 64; and so of others.

Obs.—After having completed a table of logarithms for all large numbers, the tedious labour of multiplication, division, and extraction of roots, is saved by the addition, subtraction, and division of logarithms.

557. *Perspective* is that part of the mathematics, which gives rules for delineating objects on a plain superfices, just as they would appear to the sight, if seen through a transparent plane, a pane of glass, or window.

In the representation of solid bodies, buildings, &c., there are three divisions:—

1. *Ichnography*, which shews the plan or ground-work of the building.

2. *Orthography*, which exhibits the front or parts in a direct view.

3. *Scenography*, which is the perspective view of the whole building, fronts, sides, and height. —See *Drawing*, &c.

Obs. 1.—Sciagraphy, or dialling, is the art of making dials on all kinds of planes; as horizontal, erect, or de-and by restoring a and b, it will stand $\frac{23+3}{2} = y$, or $\frac{26}{2} = 13$, Eliza's age, and Emily's being $13-3$ will, of course, be 10.

2. A child, to whom the first four rules of arithmetic and the characters are known, may be made to understand this; and I advise no female or young person to pass it as a difficulty. A course of Algebra may be undertaken, after a youth is master of vulgar and decimal fractions.

561. **Fluxions** are the different velocities whereby any quantities, in a flowing state, increase or decrease, according to the ratio of the velocities.

Quantities and their fluxions are, (as in algebra) represented by letters; known quantities, by the first letters, a, b, c, d, &c.; and the *fluents*, by the last, as v, x, y, z; and their *fluxions*, by the same with a point over them, as $\dot{v}$, $\dot{x}$, $\dot{y}$, $\dot{z}$.

Obs.—As the ratios of velocities, in many cases, are perpetually altering, as in the motion of falling bodies, these fluxions vary every moment, and produce fluxions of fluxions, or second fluxions, thus marked, $\ddot{v}$, $\ddot{x}$, $\ddot{y}$, $\ddot{z}$; and the fluxions of these are third fluxions, as, $\dddot{v}$, $\dddot{x}$, $\dddot{y}$, $\dddot{z}$.

XXV. *Optics.*

562. This science is founded on the properties of Light, which derives its chief source from the Sun, and is also generated or decomposed by bodies in a state of combustion.

We ascertain the utility of light, by the introduction of a candle or ray of sun-shine into a dark room. This, in an instant, renders every thing visible, by the emission of innumerable rays, or particles proceeding from the candle or ray, to the objects, and from them to the eye, producing therein a figure of the objects; and a corresponding sensation in the brain.

Fairest of beings! first created Light!
Prime cause of beauty! for, from thee, alone,
The sparkling gem,—the vegetable race,—
The nobler worlds that live and breathe, their charms,
The lovely hues peculiar to each tribe,—
From thy unfading source of splendour, draw!
In thy pure rays, with transport, I survey
This firmament, and those her rolling worlds;—
Their magnitudes and motions. MALLET.

Obs.—Two hypotheses have been invented to account for the principal operations of light. In the first, it is supposed, that the universe contains a highly rare elastic substance, which when put into a state of *undulation*, produces those effects on our organs of sight, which constitute the sensations of vision, and the other phenomena occasioned by solar and terrestrial rays. In the second, it is conceived, that *particles* are *emitted*, or sent off, from luminous or heat-making bodies with great velocity, and that they produce their effects by communicating their motions to substances, or by entering into them, and changing their composition. The first of these suppositions, was adopted by Hook, Huygens, and Euler; the second, by Newton,—and the philosophers of the Newtonian School. Most of the phenomena may be accounted for, by either hypotheses; but the Newtonian doctrine applies more happily, to some of the facts discovered, respecting the modifications of light by double refraction and reflection.

563. By observing the regular eclipses of Jupiter's moons in different parts of the earth's orbit, it is found, that rays, or vibrations of light, travel

twelve millions of miles in a minute; yet they do not affect the eye in passing into it; and they could never be found to produce the slightest impression on the most delicate balance.

It requires 12 rays or pulsations of light to fall on the eye in every second, to produce a constant perception of the object, whence the rays or pulsations proceed.

Hence, rays or pulsations of light, in passing from distant bodies to the eye, may be 16,000 miles behind each other, and yet produce constant vision.

Obs.—The eclipses of Jupiter's moons are calculated for a mean distance of the earth; but they happen sooner or later, as the earth is nearer, or more distant from Jupiter. The number of rays necessary to produce vision, is ascertained, by turning a piece of burning wood in a circle till the circle is wholly illuminated. The twinkling of the stars, doubtless, arises from paucity of rays.

564. Pulsations of light pass freely through air, water, glass, the coats and humours of the eye, and other transparent mediums. At the back of the eye, is spread a net of nerves, called the optic nerve; to receive their impression, and communicate their effect to the brain.

The rays pass through the *pupil*, and form, on the optic nerve, a beautiful and perfect picture of the objects before the eye. A *camera obscura* acts on the principle of the eye: and a common spectacle-glass will shew the same effect, held at a proper distance, from a wall.

565. But though effects of light pass in straight lines through any medium when in it; they are turned out of their course, as they pass obliquely

out of one transparent body into another; and this effect is called *refraction*.

If a stone be thrown obliquely into water, it will be evident, that when it strikes the water, it will fall to the bottom in a direction more perpendicular than before it came into contact with the water. Such, too, is the effect of *refraction* on rays of light; which, on passing into water, or any heavier transparent body, are bent downward.

Obs.—To verify and understand this principle, put a halfpenny into an empty basin, and stand at such distance that the coin may not be visible; then, let another person pour water into the basin, and the halfpenny will become visible: this arises from the bending of the rays in their passage into air at the surface of the water.

566. Hence, when the rays of light coming from the celestial bodies, arrive at our atmosphere, they are bent downward; and those bodies appear, when in the horizon, higher than they are.

Many rays of light are *reflected* at the surface of a new transparent medium, in an angle equal to that in which they fall on the surface, and on this principle all mirrors are constructed.

567. Advantage is taken by man of the property of refraction, to construct new mediums of such shape, as that all rays that fall on them may, on coming out of them, converge in one point instead of going straight forward.

The construction of surface which produces this effect is the convex; and all rays of light which fall on a circular surface of glass, &c., are converged on the other side into a series of corresponding points, representing the objects whence the light proceeded.

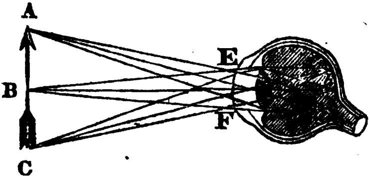
Such are spectacle-glasses, called *lenses*.

568. The eye consists of a transparent horny coat on its outside, called the *cornea;* within it, is a pure liquid called the *aqueous humour;* and within the aqueous humour, is a *lens*, like a spectacle-glass, called the *crystalline humour*.

Beyond that, is a jelly-like humour, called the *vitreous humour*, filling the ball of the eye; and at the back of the eye, is spread the optic nerve, *retina*, or fine net-work, to receive the impressions of the rays of light.

The horny coat, the *lens* called the chrystalline humour, and the other transparent humours, answer the general purpose of one spectacle-glass, with nice and wonderful powers of adaptation.

THE EYE.



The *Circle* represents the ball of the eye; and the arrow A B C, any object to be seen by the eye. Rays proceed from all points of the arrow; but some of those from A B C only, are represented, to avoid confusion. These flow from A B C in straight lines as represented. They fall on the *cornea* at E F, pass through the *aqueous* humour to the *iris* or *pupil;* thence, through the convex *lens* or *chrystalline humour*, shaded dark; and thence, into the ball of the eye, filled with the *vitreous* humour, *re-converging* and producing a perfect picture of the arrow at the back of the eye at *c*, *b*, *a*, where is spread the fine net-work, or *retina* of the *optic nerve*. The tube at the corner, is the optic nerve going to the *brain*:—such is the simple, but wonderful economy of vision!

Obs.—To comprehend the effect on the *lens* of the eye in producing vision in the different ways in which the rays may fall upon it, hold a spectacle-glass, by means of a rule or stick, at unequal distances from a wall; which wall may be supposed to represent the back of the eye. Then place a candle at such distance, or adapt the lens to that distance, and a beautiful picture of the candle reversed will be seen upon the wall. Keep the lens fixed, and move the candle nearer to it, and the image will be less distinct, and quite vanish, as it approaches; then carry the candle backward, to a greater distance than the first distance, and, in like manner, the image will again become indistinct. In the first instance, the rays fall with such a degree of obliquity, as, when operated upon by the refraction of the glass, occasion the whole of them to converge, and reproduce, in opposite and cross-directions, an image of every part of the candle; but when carried nearer, the refracting power of the glass was unequal to the great degree of convergency required, and either the image would be produced at a greater distance, that is, beyond the wall, or the rays would go out parallel; or even diverge or spread, if the candle were carried still nearer. Hence, vision depends on the parallelism or obliquity of the rays proceeding from an object, and on the power of the eye to accommodate itself to that obliquity; and when that is greater than the power, art is necessary to diminish or increase the obliquity of the rays, so as to accommodate them to the powers of the eye. Aged people require spectacles to increase the convergency; because in these, all the humours diminish, and the chrystalline lens of the eye becomes flatter, and the cornea itself less convex: hence, the power of convergency is diminished, and the images of objects fall beyond or behind the optic nerves. This can be illustrated by having two lenses of different convexities held at the same distance from the wall; and it will be proved, that when the more convex, or youthful lens, produces a distinct picture, the flatter, or aged one, produces a confused image.

569. The different distances, at which *lenses* produce on a wall the representation of objects, is called their *focal* distance; and it is the centre of the circle, of which the surface of the common double lens is a part.

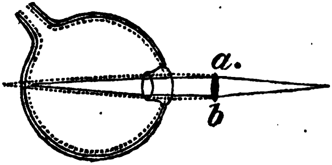
The *concave* lens has the opposite effect; it *diverges* or spreads the rays, instead of *converging* them to a focus.

Hence, when the *eye* is too flat in old age, the convex lens helps its converging powers.

And when it is too convex, as in short-sighted people, the concave lens counteracts the convexity of the eye, spreads the rays, and renders vision distinct.

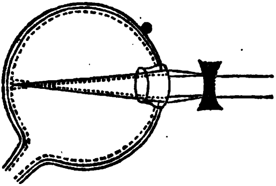
Obs. 1.—The next circle represents the ball of an aged eye; in which, owing to the decay of the humours, the cornea is not convex enough to converge the rays on the *retina*, but only a little beyond it. The object will, therefore, appear with a burr around it, or confused. If, then, a *convex lens* or spectacle-glass be interposed, as *a*, *b*, this will give a converging direction to the rays before they reach the eye; and, of course, its converging power will then be sufficient to produce the figure exactly on the *optic nerve*.

THE CONVEX LENS FOR AGED PERSONS.



Obs. 2.—In this figure, the cornea is supposed to be too convex, as in short-sighted persons; and the rays are converged before they reach the back of the eye or *retina.* The eye, in this case, performs too much; and more is given it to perform, by interposing a *concave lens,* so that the rays, instead of falling parallel on the eye, may actually fall divergent.

THE CONCAVE LENS FOR SHORT-SIGHTED PERSONS.



570. **But besides the useful invention of spectacles, arising from this power of converging rays of light in convex lenses, a very important use arises from their combination in microscopes and telescopes, the principle of which is exceedingly simple.**

Every visible object is of a visible size, proportioned to the *angle* which it makes to the eye; and that angle is also always in the inverse proportion * of the distance, which the eye is from the object.

Obs.—To prove this, try a simple microscope without any glass, and it will enable you to see an object clearly at the distance of an inch; which, with the naked eye,

* The term *inverse* signifies something like a *contrary.* Thus the size is not as the distance; because, as the distance is *greater,* the size is *less;* the proportion is, therefore, not direct, but opposite, contrary, or *inverse.*

could not be well seen at less than eight inches; and the object, suppose a grain of sand, will apparently be eight times larger in diameter, 64 times in surface, and 512 times larger in bulk! This simple microscope is nothing more, than a small hole pricked with a fine needle through a piece of blacked card. The hole, by limiting the number of rays from the object, will enable you to see the object as above, and prove that the size is as the angle, or inversely as the distance. Every object in length or breadth, is in size, in the inverse proportion of its distance; because the angle which its size subtends to the eye, is of a size inversely proportioned to the distance. Thus, a man at 100 yards distant, is but half the apparent height that he is at the distance of 50 yards, and only a tenth of his size at ten yards distance. He is magnified, therefore, ten times, by any contrivance which enables us to view him under the same angle at 100 yards distant as we should see him with the naked eye at 10 yards.

571. The object, then, of all arrangements of glasses, or lens, in microscopes and telescopes, is first to produce an image of the object, and then to dispose of the rays proceeding or diverging from the image, in such manner, as that it may produce distinct vision in the eye.

The sole use of the object-glass is so to dispose the rays anew, as that they may produce vision by the approximation of an eye-glass; and the magnifying power will depend on the closeness with which the eye-glass enables the eye to see the image produced by the object-glass; or, on the convexity of the eye-glass.

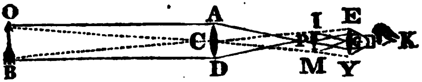
Or, in other words, the magnifying power will be in the ratio of the focal distance of the object-glass to that of the eye-glass.

Obs. 1.—If a tree, at the distance of 400 yards, subtend an angle of *one* degree to the naked eye, and an image of it is produced by the object-glass of a telescope, and

I am enabled by the convexity of an eye-glass to view that image so closely, as that the visual angle is increased to 40 degrees, the effect is the same as if I had advanced within 10 yards of the tree, when its angle would, to the naked eye, have been increased to 40 degrees. The tree is consequently magnified by the eye-glass 40 times in height and breadth.

2.—In a microscope, as the object itself can be brought so near, as to serve the purpose of the image in the telescope, the single microscope is but one lens, but the compound microscope is an arrangement of eye-glasses; which, in some of them, enables the eye to view the image within the 50th part of an inch; thereby enlarging the object in comparison with the natural vision, at six inches distance, 300 times in length and breadth, or 9000 times in surface.

THE TELESCOPE.



A D is the *Object-Glass*, or glass nearest the object.

E Y is the eye-glass.

K is the eye of the observer.

O B is the object or scene to be viewed.

O C B is the angle under which the remote object is seen by the naked eye.

I C M is the angle of the optical image produced by the object-glass, and is equal to the angle O C B, being produced by the crossing of the same lines.

The glass E Y enables the eye to see the image I M under the angle E K Y, which is the same as E P Y.

Those angles are, however, in the inverse ratio of the distances C P and P G; or, in other words, as the focal distances of the object and eye-glasses, and such, therefore, is the power of the telescope generally.

In such a glass, the image will be reversed to the eye, but by adding two other eye-glasses, it is set straight again. In *Gallileos*, however, only one eye-glass is needful. In viewing the heavenly bodies, the reversal is of no consequence.

572. As the image is reversed by a single lens, owing to the crossing of the rays in the centre of the lens, the magnified image is reversed when viewed with one eye-glass; two other glasses are therefore added; one for the purpose of restoring the image to its natural position; and the other for the purpose of viewing it as at first.

The lens within the eye, reverses objects; but the mind contemplates the top of the optic nerve, as corresponding with the bottom of the object; and the mental effect, is the result of habit, or of *learning to see* in infancy, or after the eyes have been couched in manhood.

573. Telescopes are *refractors*, when the effect is produced solely by refraction through transparent lenses; or *reflectors*, when the image is produced by the converging rays of a concave mirror; but the principle of the magnifying power is the same in all.

They are called *Gallileos* when the eye-glass is concave, after *Gallileo*, the inventor of telescopes, who made most of his discoveries in astronomy by a small telescope, which magnified but 12 times; whereas Herschel's great telescope magnifies 6000 times!

574. Of course, without light, the world would be involved in total darkness; and without the mechanism of eyes, and optic nerves to convey the varied sensations of light to the brain, all the beauties of nature derived from its diversity of colouring, all the interesting relations of day and night, and half the pleasures of existence, would be totally lost.

The cause of the various colours which adorn the creation is, of course, an object of interesting inquiry; and this discovery was the greatest of those made by Newton.

The beams of light had been, in vain, display'd,
Had not the eye been fit, for vision made;
In vain, the Author had the eye prepar'd,
With so much skill, had not the light appear'd
BLACKMORE.

575. Every one observes the beautiful colours produced by the pendant drops of cut-glass hanging to lustres and chandeliers, whether derived from candle-light or sunshine.

It is observed too, that drops of rain are coloured in like manner, when the sun shines upon them; and the regular form of the colours in the rainbow, led Newton to conclude, that these colours, as well as colours in general, were produced by some property in rays of light.

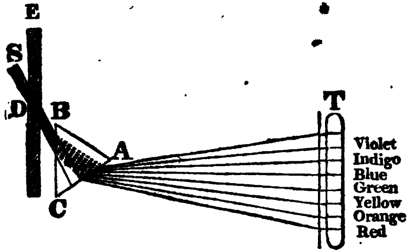
576. Newton made a beam of sunshine pass through a hole in a window-shutter, and fall on a glass prism or wedge, so as to be refracted out of its course towards the ground, and thrown upwards on the opposite wall.

He then found, that the circular beam of light was rendered oblong and regularly coloured; that the uppermost part, or the rays most refracted, were *violet*, their next division *indigo*, the next *blue*, then *green*, *yellow*, *orange*, and at bottom *red*, being the seven colours of the rainbow.

Of parent colours, first, the flaming *red*
Sprung vivid forth; the tawny *orange*, next;
And next, delicious *yellow*; by whose side,
Fell the kind beams of all-refreshing *green*;
Then the pure *blue*, that swells autumnal skies,

Ethereal play'd; and then of sadder hue,
Emerged the deepen'd *indigo*, as when
The heavy skirted evening droops with frost;
While the last gleamings of refracted light
Dy'd, in the fainting *violet*, away.—BLACKMORE.

THE PRISM AND ITS COLOURS.



E represents the shutter of a room.

D a hole in the shutter.

S rays of light proceeding from the sun passing through the hole, and falling on the glass prism B A C; on meeting which at B C, instead of going straight on, it is refracted, and leaves the prism at A C.

T is its figure on the opposite wall, spread from a circle to an oblong, and presenting the colours of the refracted rays in succession as marked.

577. A beam of *white* light is, therefore, found to consist of rays of all the colours; and it is evident, that the various colours of all the bodies in nature, depend solely on the power of the surfaces to absorb some rays, and reflect others.

It appears, too, that *white* is a due mixture of the seven primary colours wholly reflected; that *black* objects absorb all the rays, reflecting none; and that *black* is an effect of negation.

Colours are but the phantoms of the day;—
With that they're born, with that they fade away;
Like beauty's charms, they but amuse the sight,
Dark in themselves, till, by reflection bright,
With the sun's aid, to rival him they boast;
But light withdrawn, in their own shades they're lost.

HUGHES.

578. Hence, white bodies in the sun are cool, and black ones hot; because white surfaces reflect all the light, and black ones absorb it: hence also, as red rays are the least refracted, they are supposed to be the largest, and are therefore, painful to the eye; and hence, the most refrangible rays, as the smallest, are the most grateful.

Obs.—When similar thermometers are placed in the different parts of the solar beam, separated by the prism, it is found, that different effects are produced in the different coloured rays. The greatest heat is exhibited in the red rays: the least in the violet rays; and in a space beyond the red rays, where there was no visible light, the increase of temperature is greatest of all. This important discovery was made by Dr. Herschel. He estimates the power of heating in the red rays, to be to that of the green rays as 55 to 26; and to that of the violet rays as 55 to 16. A thermometer, in the full red rays, indicated an increase of temperature of 7° Fahrenheit, in ten minutes beyond the red rays, in an equal time, the increase was 9° Fahrenheit. From these facts, it is evident, that matter set in motion by the sun, has the power of producing heat without light, and that its rays are less refrangible than the visible rays. Rays capable of producing heat with and without light, proceed from bodies at the surface of the globe under peculiar agencies or changes, as well as from the sun; and the phenomena, that are usually called the phenomena of the *radiation of terrestrial heat*, are of great extent and importance, and well worthy of being studied. There is another fact, still more extraordinary, which has been called *the radiation of* *cold*, first observed by the Italian philosophers, and afterwards by Pictet. If in the arrangement of the two parallel mirrors, a piece of ice be introduced into the lower focus, the thermometer in the upper focus will indicate a diminution of temperature.

579. Rainbows arise from the rays of the sun which fall on drops of water being reflected and refracted to the eye of the spectator; and, of course, all those drops which are situated at *the same angle all round* from the eye, will present the same colour.

And, as different colours will arise at different angles; a bow composed of regular circles is a necessary consequence of showers of rain, while the sun shines.

It will, however, only be visible opposite to the sun; and the line from the sun through the eye of the spectator must be its centre.

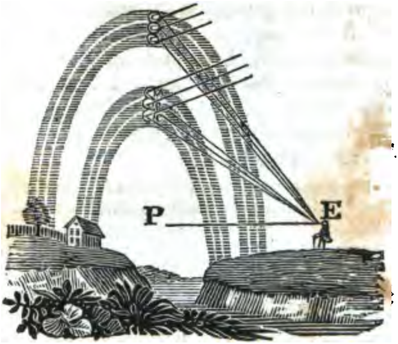
580. As rays will reach the eye from drops of rain, owing to two different causes; so there will generally be two rainbows, one fainter, however, than the other.

The strongest, or *lowermost* rainbow, is occasioned by the light being reflected from the upper part of the back of the drops of rain; and the other, or *upper* bow, is occasioned by the light being *twice* reflected within the drop from the lower part to the upper, and thence, refracted to the eye.

581. The breadth of a rainbow is about two degrees; and, of course, no two spectators can see the same rays; but every eye will be the centre of its own bow.

All circles round the sun and moon, arise in like manner, from the peculiar modifications of the rays passing through the vapours of the atmosphere in peculiar states.

THE RAINBOW.



Obs. 1.—The rays of light are shewn as passing from the sun to the drops of water, and thence to the eye of the spectator E; and all the rays at the same angle from the eye or centre P, necessarily produce the same colours.

2.—The spectator stands, of course, with his back to the sun, and his eye is necessarily the centre of the bows, each drop of the same colour having an equal angle from the eye. Rainbows, of course, are more or less vivid, as the sun shines more or less bright on the opposite rain; and they are more or less perfect, as the rain is more or less diffused. An artificial bow may be made with a fountain; and glass chandeliers reflect colours on exactly the same principles.

3.—In the inner Bow, the colours are red at top, then orange, yellow, green, blue, indigo, and violet; and, in the upper Bow, the contrary. The upper Bow makes an angle with the eye of 54° and 51°; and the lower, of 42° and 40°. The centre of the circle is a line passing from the Sun, through the eye of the spectator.

582. A *magic lanthorn* is founded on the principle of placing the image within the focus of the lens; so that the rays diverge and produce a figure as much larger as is desired on a wall; and *Phantasmagoria* are produced by magic lanthorns; in which all the parts of the sliders, except the figures, are painted black and opake.

The camera obscura, for drawing landscapes, consists merely of one lens, with a mirror to reflect the images on the rough glass placed to draw upon with a pencil.

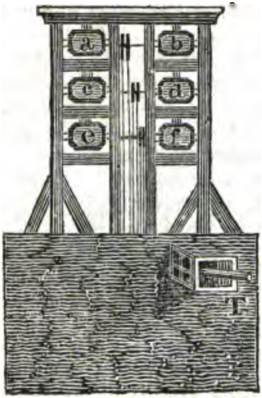
Obs. 1.—Before I leave this subject, I must recommend the tutor or student to dissect a bullock's or sheep's eye. By taking off the back delicately, he will see the landscape before the eye beautifully painted on the optic nerve; he will find in front, the *cornea*; beneath it, the *aqueous humour*; then the *iris*, so called from its various colours; the *pupil* or hole, which opens and shuts to the light; and the *chrystalline humour*, or *lens*. Then, the *vitreous* humour; and then, the *optic* nerve or *net-work*; —a curious and wonderful arrangement!

2.—The instantaneous motion of light has given rise to the TELEGRAPH, a modern invention of the greatest social importance, at present limited to purposes of governments; but capable of the highest uses to the community at large.

The telegraph consists of a large frame, in which are placed and worked six shutters, marked a, b, c, d, e, f, by means of ropes pulled in the manner of bell-ropes. By the various combinations of these shutters, 63 distinct signals may be produced, sufficient to represent the 24 letters of the alphabet, the ten digits, and various leading words. Such telegraphs are then set up on eminences at the distance of 8, 10, or 12 miles; and a line of them, by repeating each other's signals, conveys a message from the first station to the last, at the rate of a hundred miles in about five minutes!

The hole and telescope at T, is for the observer; who, in clear weather, is constantly on the look-out.

THE TELEGRAPH.



XXVI. *Meteorology.*

583. Every 100 parts of the atmosphere, is composed of 28 parts of oxygen, and 72 of azote or nitrogen, kept in a gazeous state by caloric or heat.

Atmospheric air is found to weigh in proportion to rain water, as 12 to 10,000; it is to oxygen gas, as 5 to 6; and to hydrogen, as 15 to 1; a cubic foot of it, weighing 525 grains; or one ounce and a quarter, nearly.

584. The atmosphere is found to be very elastic; and, in consequence, to press on every side, equal to a weight of 33 feet of water, or 29½ inches of mercury; and this elasticity is found to decrease, as we ascend higher and higher, so as to render the barometer a means of ascertaining heights.

Obs. 1.—This elasticity is equally powerful in a cubic inch of the atmosphere, as in the whole mass; and an inch will raise the mercury in the barometer, as much as the whole atmosphere. One cannot, therefore, but wonder at the quackery, or inconsiderateness of authors, who copy, one after another, the idle nonsense about the atmosphere pressing a man with a weight of 30,000 lbs.; when, in fact, he is not pressed to the amount of an ounce; all the vesicles of his body being filled with air, which presses outward, at least as much as the atmosphere presses inward, and also upward as well as downward. In fact, in regard to animal and vegetable bodies, the slight gravity of the air is destroyed by its elasticity.

585. Comparing the atmosphere to fleeces of wool laid upon one another, it will be lighter or rarer as we ascend in it; or, in other words, its elasticity will be diminished.

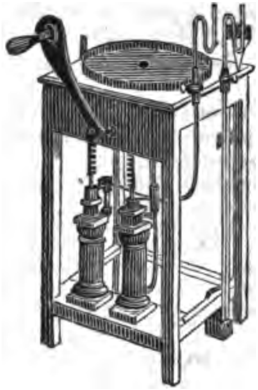
Were it all of uniform density, like water, it would be about five miles high; but the reflection of the sun's rays appears to be affected by it at the height of 44 miles; where it is calculated to be 4000 less elastic than on the surface of the earth.

The blue colour of the atmosphere is its natural colour. Its power of reflection produces the universal diffusion of light.

Obs.—On the elasticity of air, is founded the invention of the Diving Bell; by means of which, an operator descends to any depth in water, and remains there for hours together. Weights are placed at the bottom to prevent it from turning; and a forcing pipe sends in fresh air, to supply the waste of vital air from the respiration of the operator.

THE DIVING BELL.

THE AIR-PUMP.



586. By means of the air-pump, all the air may be drawn out of a large glass-vessel, and a vacuity or *vacuum* produced; in which, a great number of curious experiments may be performed, shewing at once the properties and usefulness of air.

The figure represents an air-pump on the best modern construction. The glass-receiver, as it is called, is placed at top; where there is a hole, to let out the air by the action of the pistons seen below.

587. In the ærial vacuum, a feather and a guinea will fall with equal velocity, owing to there being no resistance of air.

If a bladder, apparently empty, be tied at the neck and left in it, the small quantity of air in the bladder will swell it, and presently burst it.

A bell will cease to sound in vacuo.

The smoke of a candle, having no air to float in, will fall to the bottom by its own weight.

No animal will live, or any light burn, in vacuo.

Obs.—A bladder, tied in the same manner, will swell and burst, if laid before a fire; thereby proving the power of heat to rarefy air.

588. Common air may also be compressed, by cold or by mechanical means, into forty thousand times its ordinary space, and still maintain its elasticity; and on this principle is founded the invention of the air-gun. It has a constant disposition to maintain its equilibrium, level, or equal diffusion, like water.

Hence, if a bladder, filled with rarefied air, burst, an explosion takes place, from the rushing of the surrounding air to fill the space.

The same principle is the cause of all *wind*, which may be traced to some local expansion or compression of air by heat and cold; thus, also, smoke is carried up chimneys.

Obs.—It is evident, that the density of bodies must be diminished by expansion; and in the case of fluids and gases, the parts of which are mobile, many important phenomena depend upon this circumstance. If heat be applied to fluids or to gases, the heated parts change their places and rise; and the colder parts descend and occupy their places. Currents are constantly produced in the ocean and in great bodies of water, in consequence of this effect. The heated water rises to the surface in the tropical climates, and flows towards colder ones; thus the warmth of the Gulf stream is felt a thousand miles from its source; and deep currents pass from the colder to the warmer parts of the sea: and the general tendency of these changes, is to equalize the temperature of the globe.

589. One of the principal foreign bodies mixed with, or dissolved in the atmosphere, is the vapour of water which is constantly rising at every degree of heat, provided the force of the vapour already in the atmosphere is not greater than that of vapour at the existing temperature.

By this perspiration of the globe, 36 inches of water per annum are raised from the surface of all seas or rivers; and, at least, 30 inches from all land.

In December and January, it is 1½ inches per month; and in July and August, more than 5 inches.

590. By this constant process of evaporation, 100,000 cubic miles of water are, every year raised into the atmosphere; the greater part of which, at a certain height, parts with its heat, and is condensed into clouds.

These are carried by the winds over the land, broken and precipitated by the action of mountains and trees; and thus rendered the means of watering the soil.

It then returns to the sea in the currents of rivers; so that there is a constant circuit of the waters! They are chiefly raised from the sea, are carried by the winds over the land; fall in rain; and then return again to the sea in rivers!

The streams, their beds forsaking, upward move,
And form again, in wand'ring clouds above:
Hence, rich descending showers; hence, balmy dews,
Their plenteous sweets o'er bright'ning fields diffuse;
Hence, shoots the grass; the garden smiles with flowers;
And sportive gales steal fragrance from the bowers.

Obs.—In the process of evaporation the salt of the sea is not taken up: the water from the clouds is therefore fresh and pure.

591. The quantity of rain which falls in Great Britain is about 24 inches per annum in the eastern counties, and 36 in the western; because these receive the first clouds as they are brought from the Atlantic by the westerly winds.

In the West Indies, 120 inches fall annually; and, in the East Indies, from 80 to 100.

As mountains are conductors of heat and electricity, and precipitate clouds, so it constantly rains in the Andes, and seldom rains in Siberia and Tartary: the clouds generally falling before they reach those countries in their passage from the oceans.

Obs. 1.—This principle of the effect of high conductors on clouds, led to a public proposal by Sir Richard Phillips, in 1793, for the erection of artificial conductors in Great Britain, and other civilized countries, by which the descent of rain might in various degrees be regulated.

2.—Of course, as much rain falls as is evaporated; and it may be supposed, from the causes above-named, that at least 75,000 solid miles of water fall every year on the land only, and the rest in the sea.

592. Springs, rivers, &c., are attributed to rain. Rain oozes down by the crannies of the stones, and enters the caverns of the hills.

These being filled, the overplus water runs over by the lowest place, and breaking out by the sides of the hills, forms springs.

These running down the vallies, between the ridges of the hills, and uniting, form little rivulets or brooks; and these, meeting in one common valley, become a river, which runs into the sea,—the common level.

I see the rivers in their infant-beds!
Deep, deep I hear them, lab'ring to get free;
I see the leaning strata, artful rang'd:
The fissures gaping to receive the rains,
The melting snows, and ever dripping fogs.
Strew'd bibulous above, I see the sands;
The pebbly gravel next, the layers then
Of mingled moulds, of more retentive earths;
The gutter'd rocks, and mazy-running clefts,
In pure effusion flow. United, thus,
Th' exalting sun, the vapour-burden'd air,
The gelid mountains, that to rain condens'd
These vapours in continual current draw,
And send them, o'er the fair-divided earth,
In bounteous rivers to the deep again;
A social commerce holding firm support.

THOMSON.

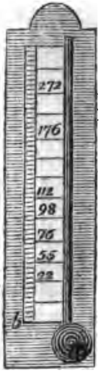
593. The instruments for making observations on the atmosphere, are the *barometer*; which ascertains the elasticity of the air, and varies in height between 30½ and 28½ inches.

The *Thermometer*; which ascertains the degree of heat by the expansion or contraction of a fluid in the bulb, which sensibly affects the quantity in a small connected tube.

Thirty-two degrees are called the freezing point; and 212° is the heat of boiling water. It is hot weather at 70; but it has been in England as high as 95; and is, in winter, sometimes 50 degrees below the freezing point, or 18 degrees below O or *zero*. At 40 below O, mercury freezes.

Obs.—Mr. Wedgewood's clay-thermometer measures variations of heat, as high as 32,000 degrees!

THE THERMOMETER.

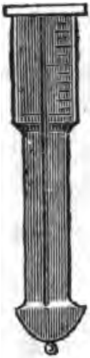


A

At A, there is a bulb or ball filled with quicksilver or spirits; which, distending or shrinking with heat or cold, raises or falls the thread of the same liquid, contained in the connected tube; and the scale and figures at the side, indicate the relative degrees of heat and cold.

For the purpose of acquiring a scale, the bulb is first plunged into melting ice, and the place where the liquid stands, is marked; the bulb is afterwards plunged into boiling water, and the same operation repeated. On *Fahrenheit's* scale, this space is divided into 180 equal parts; and similar parts are taken above and below, for extending the scale; and the freezing point of water is placed at 32°, and the boiling point at 212°—1.8 degrees of Fahrenheit are equal to one degree of the Centigrade thermometer; and 2.25 to one degree of *Reaumur.*

THE BAROMETER.



This consists of a basin of mercury at the bottom, into which a tube, closed at top, and open at bottom, deprived of its air, is plunged; the external atmosphere pressing then by its elasticity on the surface of the basin, raises the mercury in the tube to a height equal to the elastic force of the air; varying between 28 and 31 inches, and indicated by an accurate scale at the top.

594. Besides the above, there are *hygrometers*, to measure the moisture of the air; *rain-gauges*, to take the depth of rain; *electrometers*, to measure the electricity; and *anemometers*, to measure the velocity of the wind.

By these last, it appears, that wind is just perceptible when it moves two miles in an hour; that it is brisk, at 15 miles; high, at 35 miles; blows a storm, at 50 miles; and a hurricane, at

100 miles an hour: tearing up trees, and carrying away buildings.

In England, the wind blows twice, or nearly thrice as much from the west, as from the east; and the wind from the south is to that from the north, in the proportion of 3 to 2.

Of what important use to human kind,
To what great ends subservient is the wind?
Where'er th' ærial, active vapour flies,
It drives the clouds, and ventulates the skies;
Sweeps from the earth infection's noxious train;
And swells to wholesome rage the sluggish main.

595. The primary cause of all *wind* is the heat of the sun; which, during the diurnal rotation of the earth, passes over some parallel between the tropics, from east to west, every 24 hours.

Hence, as the air which is beneath the sun, is every where rarefied, there is a regular wind following the sun in the tropical parts of the world; which, in some parts, is so regular and so unruffled, particularly in the great Pacific Ocean, that the inhabitants have no idea of a change of wind, or of a storm.

Obs.—It is remarked, that the cause of all winds begins at the part towards which they flow or follow.

596. The variation of the parallel over which the sun passes vertical, from 23½ north to 23½ south, necessarily affects the winds at each pole; the heights of mountains, and local causes of heat in particular situations, also generate constant changes in the wind, in some northern and middle latitudes.

In other situations, where mountains aid the local influence of the sun, regular winds are produced; which flow one-half the year in one direction, and one-half in another.

These are called *monsoons*; they prevail in most parts of India, and their changes are attended by hurricanes, calms, and great rains.

Obs.—In the atmosphere, heated air is constantly rising, and colder air rushes in to supply its place; and this event is the principal cause of winds: the air that flows from the poles towards the equator, in consequence of the rotation of the earth, has less motion than the atmosphere into which it passes, and occasions an easterly current; the air passing from the equator towards the poles having more motion, occasions a westerly current; and by these changes, the different parts of the atmosphere are mixed together; cold is subdued by heat; moist air, from the sea, is mixed with dry air from the land; and the great mass of elastic fluid surrounding the globe, preserved in a state, fitted for the purposes of vegetable and animal life.

597. In the *northern* hemisphere, January is every where the coldest month; and its average temperature in Great Britain is 40°; and July and August are the hotest months; the average temperature being in Great Britain 62°. In the *southern* hemisphere, the periods vary by six months.

The average temperature of the tropics is 80; and of the equator 84.

The temperature diminishes also according to the height above the sea; 800 feet in Great Britain, making a difference of three degrees; and three miles on the Andes, a difference of 54 degrees.

In Great Britain, there would be perpetual snow at 1½ mile high; and there is always snow at the equator, at three miles up, on the Andes.

598. Terrestrial heat is occasioned, less by the

direct insulated rays of the sun, than by their reflections from all surrounding objects at the earth's surface; and by the heat generated by the action of the rays on the surface of bodies.

In some other respects, the earth has been compared to a vast electrical machine; and the action of the sun's rays, the winds, water, the ascent of vapour, the pressure of gravity, &c., are continually generating the electrical fluid.

The air being a non-conductor, the clouds become variously electrified; and, from various causes, discharge their electricity either between each other, or to the earth; producing shafts of *lightning*, accompanied by explosions and the echoes of explosions, called *thunder*.

Obs.—Certain changes in the forms of substances, are always connected with electrical effects. Thus, when vapour is formed or condensed, the bodies in contact with the vapour, become electrical. If for instance, a plate of metal, strongly heated, be placed upon an electrometer, and a drop of water be poured upon the plate, at the moment the water rises in vapour, the gold leaves of the electrometer diverge with negative electricity. Sulphur, when melted, becomes strongly electrical during the time of congelation; and the case seems to be analogous, with respect to non-conducting substances in general, when they change their forms. As electricity appears to result from the general powers or agencies of matter, it is obvious, that it must be continually exhibited in nature, and that a number of important phenomena must depend upon its operation. When aqueous vapour is condensed, the clouds formed are usually more or less electrical; and the earth below them being brought into an opposite state by induction, a discharge takes place when the clouds approach within a certain distance, constituting *lightning;* and the undulation of the air, produced by the discharge, is the cause of *thunder;* which is more or less intense, and of longer or shorter duration, according to the quantity of air acted upon, and the distance of the place where the report is heard from the point of the discharge. It may not be uninteresting to give a further illustration of this idea:—electrical effects take place in no sensible time; it has been found, that a discharge, through a circuit of four miles, is instantaneous;* but sound moves at the rate of about twelve miles in a minute.—Now, supposing the lightning to pass through a space of some miles, the explosion will be first heard from the point of the air agitated, nearest to the spectator; it will gradually come from the more distant parts of the course of the electricity; and, last of all, will be heard from the remote extremity; and the different degrees of the agitation of the air, and likewise the difference of the distance, will account for the different intensities of the sound, and its apparent reverberations and changes.—DAVY.

599. Rain, snow, and hail, are formed in the clouds, by any sudden change in the atmosphere.

Snow, by the cloud becoming frozen before its particles have collapsed into water.

Hail, by the freezing of the drops after they have begun to fall as rain.

Dew, or *haze*, is the falling of the vapours of the day when they part with their heat in the cool of the evening.

600. The form of the clouds is found to be regular and systematic; and, within these few years, they have been classed into different kinds, worthy of being understood and remembered.

a. The *Cirrus*, those of the greatest elevation and least density, parallel, and beginning with a few threads: these are accompanied or followed by steady high winds.

b. The *Cumulus*, convex or conical masses, of dense structure, formed in the lower atmosphere and the cloud of the day, but increasing about sun-set: these threaten thunder.

Sometime, we see a cloud that's dragonish;
A vapour, sometime, like a bear or lion;
A tower'd citadel; a pendent rock;
A forked mountain; a blue promontory,
With trees upon 't that nod unto the world,
And mock our eyes with air.———
That which is now a horse, even with a thought,
The rack dislimns, and makes it indistinct,
As water is in water. SHAKSPEARE.

c. The *Stratus*, a widely extended horizontal sheet, often touching the earth or water, and properly a cloud of the night, being in the morning converted into the cumulus.

d. The *Nimbus*, or *rain-cloud*, a horizontal sheet; above which the cirrus spreads, and the cumulus enters its side and forms beneath; neither of the former appearing to rain by themselves.

601. *Fiery meteors* sometimes appear: and *shooting stars* are very frequent. Stones, also, have been often known to fall to the earth.

Northern lights, or *aurora borealis*, are frequently very interesting; and the *ignis fatuus*, or will-o-the-wisp, affords matter of investigation.

Respecting meteors, falling stars, and northern lights, nothing certain is known of their origin or cause.

Shooting stars are supposed to be electrical phenomena; and the *ignis fatuus* is ascribed to hydrogen gas set on fire by phosphoric matter.

Obs.—The lights seen in ruins, which often terrify the ignorant, are nothing more than hydrogen gas in a state of combustion. The cause of candles burning blue in cellars, arises, in like manner, from azotic gas. Doubtless, also, the noises and explosions which take place on opening rooms long closed, or in which fruit has been suffered to decay, arise from the combustion and combination of various gases. Of the fall of stones from the clouds, there is now no doubt; and it is rationally concluded, that they arise from the explosion of meteors, and the co-mixture of gases; but in what way these are generated, must long remain a question.

602. The discovery of hydrogen gas, which is 15 times lighter than atmospheric air, suggested the plan of filling a silken balloon with it: and of its ascent in air, with an aeronaut appended to it, provided the whole did not exceed the weight of an equal bulk of atmospheric air.

Accordingly, balloons have been filled with hydrogen gas, created by mixing iron-filings, water, and sulphuric acid; which have carried through the atmosphere two, three, and four persons at a time.

Obs.—This is one of the most splendid discoveries of modern philosophy; but hitherto unattended by corresponding utility, owing to the difficulty of steering the machine. Mons. Blanchard made more than fifty voyages in all parts of Europe: Mons. Garnerin has made nearly as many; and Mr. Sadler 30.—See paragraph 504.

XXVII. *Acoustics and Music.*

603. Sound is an effect of vibràtion, and is produced by diverging waves of the air. This is evident, from the vibration of stringed instruments; and from the effect on water in musical glasses.

Sound, like heat, appears to depend on the reflection of the surrounding bodies, and also on the density of the air.

Aeronauts can scarcely hear each other speak, when high in the atmosphere; and the discharge of a pistol from an air-balloon, produces scarcely any report, for want of reflecting bodies.

Obs.—That bodies move, or tremble, when they produce sound, is evident in drums, bells, and other instruments, whose vibrations are distinctly perceptible; and it is equally clear, that a similar vibration is excited in the air; because bells, glasses, basins, and musical strings, will sound, merely by the action propagated from other sounding bodies, and will not sound in a vacuum.

604. The vibrations that produce sound, have been aptly compared to the circles produced by throwing a stone into the water; but judging by their effect on the water in a musical glass, the undulations are more pungent and decided.

A bell rung under water, gives the same tone as in air; and water is known in other respects to be a conductor of sound. Wood and the earth appear, also, to be conductors of sound.

605. Sounds, or their undulations, are found to travel at the rate of 1142 feet in a second, or about thirteen miles in a minute.

Hence, as any corresponding light is comparatively instantaneous in its progress, the distance of the report of thunder, or of a piece of cannon, may be exactly calculated.

Sounds also are reflected like light; and hence we have echoes, which are like plain mirrors, and whispering galleries, and repeating caves, like so many concave mirrors.

Obs.—Every building standing alone, is an echo, when addressed at a proper distance; but, if there are trees or other objects to the right or left, the various echoes destroy each other.

606. Speaking trumpets confine and give a limited direction to sound, independently of the mechanical effects of their reflection.

The human voice is produced by the expulsion of air from the lungs, and by the vibrations excited in that air, by a very small membrane called the glottis, in its passage through the trachia or windpipe; and by the subtle modifications of the mouth, tongue, and lips.

Singing is performed by a very delicate enlargement or contraction of the glottis, aided likewise by the mouth and tongue for articulation.

607. The natural music of birds, and the power of singing or producing agreeable notes by the human voice, led, in the course of ages, to the contrivance of stringed instruments, as the *harp*, *lyre*, &c.; and to the invention of wind-instruments, as the *pipe*, &c.

In stringed instruments, the air is struck by the string, and the vibrations of the air produce a corresponding sound in the ear; but, in pipes, the air is forced against the sides by the breath, and its vibrations or tones are produced by the re-action of the sides.

608. Sound is varied by the rapidity and momentum of the vibrating body; and this depends on the length, tension, and size of the string.

A short string vibrates quicker than a long one, and therefore produces the sharpest and highest tones: and a short and small pipe, from a like cause, produces sharp notes; and large pipes, grave and deep ones.

Savages discovered this; and they made, and still make, instruments which please themselves and their wild companions; but art and science go further; they ascertain the causes of their pleasure, and direct them so as to increase it.

609. Hence, it was long since found, that if two strings of a harp were of equal lengths, they produced the same tone, or vibrated together, or in *unison*.

They produce the same number of vibrations exactly in the same time; their vibrations, if struck together, accord; hence, they produce the same sound to the ear.

610. It was, afterwards, found, that if one of these strings were equally divided, the vibrations became half the length of the vibrations of the whole, and the note twice as acute; but as *every other* vibration of the half-string corresponds with *every* vibration of the whole one, there is a constant *unison* or *concordance* between them: they harmonize or vibrate together for *once* in the long string, or *twice* in the short one.

Hence, there is no jarring or *discord;* but they are said to be in *concord;* and, in regard to intervening subdivisions, have been called *octaves*.

611. But as a harp, composed of strings of only two lengths, would produce little variety of sound, it was justly considered, that if other strings could be contrived, whose vibrations corresponded even with less frequency than the *octave*, the compass and variety would be increased without discord.

Hence, as the number of vibrations of a string are 1, while that of its octave is 2; the next best division would be, to produce a string, which, while the original vibrated 2, the next should vibrate 3; this was done; and this note, which is *two-thirds* of the original, is called a *fifth*.

Obs.—If, then, the original string was 120 parts, the *octave* would be 60, and the *fifths* 80, or two-thirds.

612. In like manner, another string might be divided, so as to correspond with every *fourth* vibration of the original; and this would be of *three-fourths* of its length, or 90 parts of 120, and is called *a fourth*.

So on with others, whose vibrations accord 5 for every 4, and 6 for every 5; also 5 for every 3, and 5 for every 8, till *seven* melodious or according vibrations are made of the original chord.

A harp, constructed of strings, divided in this manner, produces an agreeable melody; the vibrations according and agreeing with one another at equal intervals, although the tones are different.

613. If a string consist of 120 parts (inches, or barley-corns,) the *octave* will be 2 vibrations to 1, or 60 parts of 120.

The *fifth*, 3 vibrations to 2, or 80 parts.

The *fourth*, 4 vibrations to 3, or 90 parts.

The major *third*, 5 vibrations to 4, or 96 parts.

The minor *third*, 6 vibrations to 5, or 100 parts.

The major *sixth*, 10 vibrations to 6 (or 5 to 3,) or 72 parts.

And the minor sixth, 16 vibrations to 10 (or 8 to 5,) or 75 parts.

Obs.—These divisions of a string, constitute the *diatonic scale*; the sole and simple object of which, is to produce the greatest variety of tones with unisons of vibration, or an exact recurrence of vibrations after the nearest intervals.

614. The strings of a *piano-forte, harp*, or *violin*, are brought into accordance or successive octaves, or recurring tones, by the accuracy of the ear.

In the harp, &c., their lengths are exactly proportioned to the scale by the maker, but as the strings vary in their tension, owing to the weather and other causes; and as they cannot all have the same precise bulk, it is necessary, from time to time, to *tone* them; which means nothing more, than making each perform its proper number of vibrations in relation to the other strings.

615. These seven notes, then, are the basis of all music; and, with the addition of five half tones, are the alphabet of music, and fill all the concordant intervals of one *octave*.

Octaves may, however, rise upon each other in successive ratios or degrees, as in the piano-forte, which has 5 and even 7 octaves; or 5 sets of natural notes as above, and 5 semi-tones, or flats and sharps to each octave.

616. For the purpose of obtaining further variety in composing *tunes* or *melodies*, these several *tones* may be played shorter or longer; and, in this respect, are divided as under:—

2 minums make 1 semi-breve;
2 crochets make 1 minum:
2 quavers make 1 crochet;
2 semi-quavers make 1 quaver;
2 demi-semi-quavers make 1 semi-quaver;

32 demi-semi-quavers are to be played in the time of one semi-breve.

Again, in regard to the tune itself, there are also two sorts of *time*, slow and quick, as *common* time and *treble* time.

617. When an agreeable succession of simple notes, having a perfect beginning and ending, is played or sung, it is called a *tune*, an *air*, or *melody;* as a song, hymn, dance, or march, according to its several purposes.

When these notes, forming an air, are combined with corresponding notes, in different octaves, or on other instruments, and the whole is scientifically made to produce a concordant and agreeable effect, it is called *Harmony*.

The *bass* and *treble* of a piano-forte played at the same time with the left and right hand, constitute the most common practice of *harmony*.

Some of Handel's pieces have been played by 1000 instruments and voices, all sounding harmoniously together.

Obs.—The human soul may be moved in all its passions by music: and as a soother of the mind, and a source of exquisite pleasure, the practice on some instrument cannot be too strongly recommended as a branch of liberal education to children of both sexes.

XXVIII. *Of Physics; or, the General Properties of Matter.*

618. All existence is, what it appears to be to the powers of our senses; and is, therefore, relative, or comparative, to those powers.

Thus, there is no *intrinsic* sweetness in sugar; but the quality of sweetness is in the sense of the palate.

In a violet, there is no inherent colour; but the sense of colour, called violet, is in our optic nerve; and the sense of sweetness produced by the same flower, is in the olfactory nerve.

So, there is no sound in a *vibrating* string; but the sound, so called, is the vibrating effect produced on our auditory nerves.

And the sense of *hardness*, or substance in a stone, arises from its being harder than our fingers, which have not power to pass through it.

Obs.—It has been a favourite notion of ancient and modern philosophers, that the substratum or basis of all matter is the same; and that all the varieties exhibited to our senses, are only so many modifications, capable of producing their respective sensible effects.

619. A person, born blind, has no *sense* or conception of colours: he can *feel* the hardness, the roughness, and the length and breadth of surfaces; but he can have no perception of their various colours.

So, one born *deaf*, sees the motion of a bow on a violin, or the sticks on a drum; but has no idea of their *sound*.

In like manner, all food is alike, in *flavour*, to those who have lost their sense of taste and smell.

620. The sensations produced by things out of ourselves, are called our *perceptions;* and the property or *power* of bodies to *excite* or create particular perceptions, is, in common language, considered as the perception itself; and the body

is considered as *possessing* the sensation itself, which it only *creates* in us.

Thus, we call vinegar *sour*, oil *smooth*, and fire *hot;* though the sense of *sourness*, *smoothness*, and *heat*, is in us, not in the bodies which create those perceptions.

So, likewise, in common language, we talk of the motion of the sun and stars; though it is only our earth that moves.

621. Every collection, then, of properties, capable of affecting our senses, is called *material*, or *matter;* and it possesses *extension*, or *bulk;* *solidity*, or the power of maintaining its space; *divisibility*, or the capability of being divided into infinitely small parts; and a power, or *disposition* to coalesce or unite with other matters.

Without external force, such matter is inert or dead; but it may be put in *motion* by *powers* sufficient to overcome its *inertness*, or its disposition to unite with larger masses.

So, also, *motion*, once acquired, would continue for ever, if not checked by opposing powers, or by friction.

The *disposition* of all matter to rush or fall together, is usually called *attraction;* and is supposed, by Sir Isaac Newton and others, to arise from effluvia emitted from the respective bodies.

Obs.—This idea has been combated by Sir Richard Phillips, in the Monthly Mag. Oct. 1, 1811. He asks, how any effluvia can take hold of distant bodies; and what connection can exist between such effluvia, and the body whence they flowed, to occasion them to solicit another body, to return with them back to it? He then suggests, that all space is filled with an etherial, elastic medium, except in the points occupied by matter, as the

Sun, Stars, and Planets; that this medium solicits to enter the foreign substances of matter, in degrees proportioned to their density and peculiar construction; that these forces act in right lines infinitely extended from the substance; that the phenomenon of attraction arises from the interception of those *infinite* lines by other bodies; that the forces must then be FINITE in the direction of any two substances, but INFINITE in other directions; and that, of course, all bodies must fall towards each other in the line which joins their centres; because they are pressed FINITELY in *that* direction, but INFINITELY in every other. Thus, bodies are *pressed* to the earth, by forces infinitely extended in their zenith; but the action of those forces in their nadir is taken off, by the interposition of the mass of the earth. So, likewise, the *pressure* on the earth is always diminished on the side immediately next the sun; while it is infinite on every other side; and that pressure necessarily produces the phenomena called attraction.

622. Extension is *infinite;* at least the human mind can set no *bounds* to it, but can add millions to millions of miles in every direction.

Such matter as affects *our* senses, is, however, not visible every where; but the spaces between the stars and planets are supposed to be filled with a rare, elastic medium.

Solidity is a *relative* idea; and is measured by us, in the ratio of the attraction to the earth called *weight.*

A cubic foot of platina weighs as much as 92 cubic feet of cork, or as 230,000 cubic feet of hydrogen gas; yet the platina itself may be *light* compared with other bodies unknown, and the cork and the gas be *heavy* in regard to others.

Obs.—The whole earth, in *solid* matter, might, perhaps, be compressed into the compass of an orange; just as 1000 cubic feet of elastic steam can be re-compressed into its original foot of water. To suppose any void in creation, is blasphemy against the omnipresent Creator.

623. The property of *infinite divisibility* will be evident, from the consideration that every particle of matter, however small, must have an *upper* and an *under* side.

The power of *mutual attraction*, or rather, of *universal pressure*, is proved by the falling of all loose bodies to the ground, in a perpendicular direction, towards the centre of the earth; by the motions of the planetary bodies round the sun; by the combined or curved direction of projected bodies; and by the continually *accelerating* motion of falling bodies.

Obs. 1.—The infinite divisibility of matter is evident, in the formation of animalculæ, already treated of, and of the malleability of gold. Scents are equally subtile; and it is computed, that the millionth part of a *grain* of musk, divides itself into seven quadrillions of parts, in scenting a room. So, also, the light generated by a single grain of tallow, diffuses itself over a space two miles round.

2.—Accelerated motion, in falling bodies, is created by new impulses of attraction, or pressure, acting on a body already possessed of a given motion, and which acts at every instant, as though no motion were already acquired. The motion is, as the square of the times employed in falling. Thus,—

Seconds of time,	1,	2,	3,	4,	5,	&c.
Their squares,	1,	4,	9,	16,	25,	&c.
Feet of motion,	20,	80,	180,	320,	500,	&c.

3.—Attraction, or pressure, is always in proportion to the quantity of matter in bodies; and it decreases by the same law as surfaces increase, i. e. according to the squares of the distances of the bodies from each other.

4.—Light and heat observe the same law; and decrease according to the square of the distance of the luminous body: because, as light and heat diverge from a centre, their *density* on every *surface* presented to them, will necessarily be as the *square* of the distance, or radii of the diverging influences or rays.

5.—Kepler ascertained, and Sir Isaac Newton demonstrated, that from the combined forces of attraction and rectilinear motion, the *squares* of the periodical times of revolutions of the planets are, as the *cubes* of their distances. Hence, the distance of the earth from the sun being ascertained, and the times of all the planetary revolutions being known from observation, their several distances are ascertained by a simple rule of proportion.

6.—The following are the conclusions of Sir Richard Phillips, relative to the laws of the planetary motions:—

The rotatory motion of a planetary body subject to a uniform external pressure, from a uniformly diffused medium, is a necessary consequence of a peculiar and nicely adjusted disposition of the component parts in regard to their density.

A rotory and centrifugal motion, is a consequence of the lighter parts being fluid, and producing oscillations against the denser parts of corresponding and competent force, varying, at the same time, the centre of motion.

A motion of that centre in a circular orbit, is a consequence of the *combined* force of the oscillations, with the diminished pressure of the NEAR or inner side of the body in regard to a larger or centrical body, as in the earth and sun.

An elliptical orbit inclined to the plane of the equator of the moving body, is, then, a consequence of the arrangement of an excess of the oscillating fluid in one of the hemispheres,—as in our southern hemisphere.

No peculiar numerical laws of pressure in the universal medium, nor any given centrifugal force, are required to effect the motions of the planetary bodies. It is simply necessary, that the powers should be uniform, universal, and in a degree calculated to balance each other under the existing circumstances. Such an accommodation of powers evidently exists, in a peculiar manner, in an oscillating fluid, as applied to counteract the uniform pressure of an universal medium. Its centrifugal impetus would mechanically be increased from a pound, avoirdupois, to millions of tons, as the inverse ratio of the squares of the distances might require.

But no violence, or extraordinary force, belongs to the motions of nature. It is probable, that the pressure towards the sun in the earth, for example, is little more than is requisite, slightly to destroy its inertia. This pressure is easily counteracted, by the oscillations of the waters (and as nature does nothing abruptly, may we not add, that of the atmosphere also,) so that the progression in the orbit between the poised forces is serene, quiet, and grand; not dissimilar, perhaps, to that of a balloon on a calm day.

A centripetal impulse arising, therefore, from the pressure of the elastic fluid, or subtle medium, filling all space, inclines the planetary bodies mechanically towards each other, on their *near* sides, by a very slight and finely diminished force; which is counteracted by a centrifugal force, created by a rotative motion; which again is itself a consequence, of such an arrangement of the integral parts of the masses, with respect to density and fluidity, as constantly varies their centre of motion.

The result of the combined forces, is a progressive motion of all the systems of bodies round their common centres of motion; such as we observe in the solar system; and such as doubtless exists in every system in the universe; whether of separate bodies—of planet and satellites—of sun, comets, and planets—of suns amongst themselves—or of systems of suns in regard to each other.

XXIX. *Of Chronology and History.*

624. Chronology is the art which enables us to measure and regulate time past, and time future: and History records, classes, and recounts events which have happened in past ages; and is, consequently, a register of the experience of mankind; and a source of practical wisdom, for kings, governors, and persons in authority.

625. Nature divides time into days, nights, and seasons. Savage nations added the division of moons, which are about 29½ days. Civilized nations have agreed to reckon the period of the rotation of the earth round the sun, and call it a year; and they again subdivide this into its 12 *moons*, (*moonths*, or *months*.)

But 12 equal moons make but 354 days, and the earth is 365¼ days going round the sun; Julius Cæsar, therefore, varied the months as we now have them, so as to make 365 days.

Obs.—The Hebrews and Greeks added an extra month every third or fourth year; but as the revolution of the earth was a quarter of a day longer than 365. Cæsar directed the 6th of March to be counted twice in every 4th year, so as to keep the reckoning of mankind equal with that of the heavenly bodies. This, however, was not correct; for the actual revolution of the earth is not quite a quarter of a day more than 365, but only 5 hours, 48 minutes, and 57 seconds; consequently 11 minutes 3 seconds, are gained every year, or a whole day in 131 years.

626. In 1752, this gain of 11 minutes, 3 seconds, per annum, had carried the reckoning 11 days before its proper time; the *style* of reckoning, therefore, was altered, and 11 days dropt,

by act of parliament; the day after the 1st of September being called the 12th.

It was settled also, that in every 400 years, three leap-years in three centuries should be dropt; so that, in future, the annual recurring year will keep pace with time, within two or three seconds per annum.

627. The year is also divided into 52 *weeks*, and one day over; the weeks into seven *days*, or *rotations* of the earth on its own axis; those rotations into 24 *hours*; each hour into 60 *minutes*; and each minute into 60 *seconds*, or periods, in which a pendulum that is 39,2. inches long, will vibrate.

The vibration of such a pendulum, or a second, is therefore the first measure of time; but a pendulum of a *fourth* the length, will vibrate *half* seconds; seconds are also, in calculations, divided into 60 thirds, fourths, &c.

628. The names of the days of the week are derived from the names of certain Saxon objects of worship:—

As Sunday, or the first day, from the *Sun*.

Monday, from the *Moon*.

Tuesday, from *Tuisco*, a German hero; whence they call themselves *Tuitschen*, or Dutchmen.

Wednesday, from *Woden*, their god of battle.

Thursday, from *Thor*, the god of winds and weather.

Friday, from *Friga*, the goddess of peace and plenty.

And Saturday, the seventh day, from *Seator*, the god of freedom.

Obs.—The Romans called the days after the planets:—

as Solis, Sun; Lunæ, Moon; Martis, Mars; Mercurii, Mercury; Jovis, Jupiter; Veneris, Venus; and Saturni, Saturn.

629. The names of the 12 moons, or months, are derived from the Latin, as under:

January, from *Janus*, the god of new-born infants.

February, from *Februa*, the mother of Mars.*

March, from *Mars*, the god of war, the first month of the Roman year.

April, from *Aperio*, signifying to open the year, or the blossoms.

May, from *Maia*, the mother of *Mercury*.

June, from *Juno*, the wife of Jupiter.

July, from *Julius* Cæsar, the Roman emperor.

August, from *Augustus* Cæsar, the Roman emperor.

September, from *Septem*, the seventh month of the Roman year, which began in March.

October, from *Octo*, the eighth month of the Roman year.

November, from *Novem*, the ninth month of the Roman year.

December, from *Decem*, the tenth month of the Roman year.

630. It will be readily supposed, that owing to the various lengths of years, and the different modes of calculation practised by different nations, great differences of opinion have existed in regard to the date of past events.

The great difficulty was, to fix the period of certain great event, as a sort of land-marks, from which to ascertain and correct others: these are—

Before Christ.	Years.
The Creation	4004
The Deluge	2348

* According to Cæsar, the mother of Mars was Juno, and Februa was a feast of atonement, held in the month of February, which, thence, received its name.

The Call of Abraham	1921
The departure from Egypt	1491
The taking of Troy by the Greeks	1183
The Building of Solomon's Temple	1012
The Building of Rome	753
The Death of Cyrus	526
The Battle of Marathon	490
The Death of Socrates	396
The Death of Alexander	323
The Destruction of Carthage	146
The Death of Julius Cæsar	44
After Christ.	Years.
The Destruction of Jerusalem by Titus	70
The Eastern Empire began at Constantinople	339
The Death of King Arthur	514
The Flight of Mahomet from Mecca	622
The Death of Charlemagne	820
The Death of Alfred	890
The Landing of William I.	1066
The Death of Edward III.	1377
The Death of Tamerlane	1410
The Discovery of Printing	1450
The taking of Constantinople by the Turks	1453
The Death of Richard the Third	1485
The Discovery of America	1492
The Reformation begun	1520
The Spanish Armada Defeated	1588
The beheading of Charles I.	1649
The English Revolution	1688
The Battle of Blenheim	1704
The American Declaration of Independence	1776
The French Revolution	1789
The Bank of England stopt Payment	1797
The Battle of Marengo	1800
Napoleon crowned Emperor of France	1804
The Battle of Trafalgar	1805
The Battle of Austerlitz	1805
The Battle of Jena	1806
The Peace of Tilsit	1807
Moscow burnt by the Russians	1812

All the Kings and Potentates in Europe subsidized by England against Napoleon . . . 1813
Napoleon, abdicated 1814
———, restored and abdicated . . . 1815

Obs.—The preceding dates should be accurately remembered by every one, who would talk and reason on historical facts. But there is an art of short memory, worthy of being known; by which, all numbers and dates may be converted into syllables, and added to the word to which the date belongs. For this purpose, a set of vowels and diphthongs, and a set of consonants, are assigned to every one of the digits; and in forming a date into a syllable, either vowels or consonants may be taken at pleasure; thus,

a	e	i	o	u	au	eu	ei	ou	y
1	2	3	4	5	6	7	8	9	10
b	d	t	f	l	s	p	k	n	z

In the vowel-line, the five first digits are represented by the five vowels, and 6, 7, and 9, are diphthongs, formed from combining vowels that make up their numbers. Ei are the two first letters of the word *ei*ght, and y for 10, is the occasional vowel.

In the consonant-lines b is the first consonant, and t, f, s, and n, are the first letters of their respective digits; *d* is the first letter of duo, two; l stands for *5* or *50*; p stands for *7*, from its full sound in septem, seven; and *z* is the last letter in the alphabet.

As the year of the Creation can never be forgotten by the lowest intellect, I shall begin with the Deluge, and dropping *uge*, affix a syllable to *Del*, corresponding with 2, 3, 4, 8. Looking to the table, and taking d for 2, i for 3, f for 4, and k for 8, I make the syllable *difk*, which added to del, makes del*difk*. Or, to vary the example, I can make a different termination by taking e for 2, t for 3, o for 4, and k for 8, which added to del, make del*etok*, either of which may be easily remembered; but the former is to be preferred, because only one syllable.

It is, therefore, an easy task for the student to make syllabic terminations to all the preceding dates; and then commit the whole to memory. He may, also, extend the art to other dates, distances, and numbers, and 2 or 300 such, will easily be recollected through life.

631. History is one of the most agreeable studies; but unhappily, there are few authentic histories.

The causes of political events are often unknown; and the real characters of those who direct the affairs of mankind, are generally perverted by prejudice, falsehood, or flattery.

It will, however, be useful in many respects, to be acquainted with the revolutions of empires; and for this object, recourse must be had to general and particular histories.—*See Robinson's Grammar of History; and also his Ancient and Modern History.*

632. It has been already observed, that the first families, or tribes, were shepherds or hunters. The quarrels of these led to wars; wars to conquest; and conquest to increased dominion, and to empire.

The first conqueror, according to holy writ, was Nimrod, a powerful hunter; who built Babylon, and laid the foundation of the *Assyrian Monarchy.*

He was succeeded by his son *Ninus;* who built Nineveh, and extended his dominions all over Asia, from India to the Mediterranean.

633. Ninus was succeeded by his wife *Semiramis;* who for a length of time, wore a man's habit, and extended her empire over Egypt, Ethiopia, and other countries of Africa.

Her son *Ninias* succeeded her; and he had thirty successors, during a period of 1300 years, when Sardanapalus burnt himself in his palace at Nineveh; and the Assyrian monarchy was divided into the Chaldean and Persian empires.

634. These empires continued separate, about 200 years; when both were united by Cyrus, (Cy-*les*) who established the *second* universal empire, called *the Persian empire*, which lasted more than 200 years. It was then conquered by Alexander the Great, king of Macedon, who in his own person established, for a few years, the *third* universal empire, called *the Macedonian empire;* which included Greece, Asia from the Mediterranean to the Indies, and Egypt in Africa.

635. On the death of Alexander, which took place at Babylon in the 33d year of his age, owing to a fever brought on by intoxication, his vast dominions were divided by his generals, who desolated the world by their mutual wars for many years afterwards.

During these ages, civilization was confined to a few countries of Asia and Africa, and to Greece: the rest of the world was in a state of barbarism; and nothing is known of its history.

636. Soon after the death of Alexander the Great, in 323, (Alexan-*tet*) a new power arose more to the west, the ambition of which in time, spread its dominions over barbarous, as well as civilized nations.

This was *the Roman empire;* which commenced from the city of Rome, built by Romulus, in 753 (Rom-*put*) before Christ. By degrees it spread itself over Italy; thence to Greece and Africa; afterwards over the civilized parts of Asia (except China and India;) and finally over all Europe, even to Scotland, and became the *fourth* great monarchy.

637. Greece, in its greatest extent, included Hellas, Thessaly, Macedonia, Thracia, Peloponnesus, and some colonies in Asia.

The most remarkable events, which took place in Grecian history, were, the invasion of Greece by Xerxes, 480; the Peloponnesian war; and the reduction and subjugation of Greece, by Philip of Macedon.

The most celebrated political and military characters in that country, were Miltiades, Themistocles, Aristides, Pericles, Cimon, Lysander, Alcibiades, Thrasybulus, Conon, Epaminondas, Agesilaus, Phocion, and Xenophon.

638. The Roman empire, in the time of Augustus, was bounded on the west, by the Atlantic and Northern Ocean; on the north, by the Rhine and the Danube; on the east, by the Euphrates; and on the south, by the sandy deserts of Arabia and Africa.

It extended above two thousand miles in breadth, and more than three thousand in length, of chiefly fertile and well-cultivated land.

639. Among the most celebrated characters of Rome, may be reckoned Junius Brutus, Camillus, the two Scipios, Marius, Sylla, Pompey, Julius Cæsar, the two Catos, Cicero, Brutus, Cassius: all of whom flourished in the time of the Republic.

The most remarkable events of Roman history were,

The invasion of Italy by the Gauls under

Brennus, who plundered and burnt the city of Rome;

The subjugation of the Samnites, after a war of thirty years;

The invasion of Italy by Hannibal, the Carthaginian;

The reduction of Macedon and Greece;

The fall and destruction of the fine city of Carthage, after the third Punic war;

The division of the empire into east and west, by Constantine;

And the annihilation of the Roman power, by the Goths, Vandals, and Turks.

640. The extensive empire of Germany, the head of which was, till lately, called the Roman emperor, subsisted in its late form, from 912 till 1808.

The most remarkable events which took place in Germany, were

The contentions between the emperors and the popes;

The rise and progress of the reformation;

And the union of the German empire and the kingdom of Spain, in the person of Charles V.; who was the most celebrated emperor of the house of Austria.

641. The French monarchy commenced 481. The most remarkable events which have taken place in France, were

The subduing of the greatest part of Europe, by Charlemagne;

The conquest of the greater part of France by the English, under Edward III. and Henry V.

The successes and defeats of Louis XIV.;

And the late revolution in 1789.

The victories and conquests of Napoleon le Grand, 1795 to 1814.

The most celebrated sovereigns of France, were Charlemagne, Henry IV., Louis XIV., and Napoleon, crowned emperor in 1804.

642. The English monarchy includes England, Scotland, Ireland, and Wales. The Saxon heptarchy was united in 827; and thus was laid the foundation of the kingdom of England. The most remarkable events in English history have been

The invasion of the Romans;

The subjugation by the Saxons;

The accession of the Danish prince Canute;

The conquest of England by the Normans;

The contests between the houses of York and Lancaster in the fifteenth century;

The beheading of Charles I.;

The revolution in 1688;

And the separation of America.

The most celebrated sovereigns of England, have been Alfred the Great, Edward I., Edward III., Henry V., Elizabeth, and William III.

643. In ancient times, the names, as well as the divisions of countries, were different from what they are at present: their correspondence is given beneath:

Ancient Latin Names.	*Modern Names.*
Scandinavia, Scandia, vel Baltia	Norway and Sweden.
Scritofinni	Lapland and West Bothnia.
Suiones	Sweden proper.
Gutæ et Hilleviones	Gothland.
Finningia	Finland.
Chersonesus Cimbrica	Jutland.

Sarmatia Europæ . .	Russia in Europe.
Hirri et Æstii vel Ostiones	Livonia and Esthonia.
Gallia	France.
Celtæ	Normandy, Brittany.
Aquitani . . .	Gascoigne and Guienne, &c.
Allobroges, Centrones .	Dauphine and Savoy.
Lingones, Ædui, Sequani	Burgundy and Franche-compte.
Lutetia Parisiorum .	Paris.
Prisii	Holland and Friezland.
Batavi	Utrecht and the islands of the Rhine.
Belgæ, &c. . . .	Netherlands.
Manapii, Tungrii .	Dutch and Austrian Brabant.
Toxandri . . .	Antwerp.
Nationes Germanicæ .	Germany.
Saxones . . .	Upper, Lower Saxony, &c.
Rhætia . . .	Bavaria.
Vindelicia . . .	Swabia.
Boiohæmium . .	Bohemia.
Germano Sarmatæ . .	Poland.
Hispania, vel Iberia .	Spain.
Gallæcia . . .	Gallicia, Asturia, and Biscay.
Tarraconensis . .	Navarre, and Catalonia.
Lusitania . . .	Portugal.
Helvetia	Switzerland.
Ambrones . . .	Bern, Friburg, Basle.
Tigurini . . .	Schaffhausen, Zurich, &c.
Italia . . .	Italy.
Gallia Cisalpina . .	Piedmont, Milan, Venice.
———Narbonensis .	Languedoc.
———Togata . .	Lombardy.
Samnium, Apulia, Campa Marsi . . .	Kingdom of Naples.
Latium, Umbria, Picenum, &c.	The Popedom.
Sicilia, Sicania, vel Trinacria	Sicily.
Sardo, vel Sardinia .	Sardinia.
Cyrnus, vel Corsica .	Corsica.

Melita	Malta.
Dacia	Transylvania.
Pannonia	Sclavonia.
Illyricum	Croatia.
Epirus	Albania.
Thracia	Romania.
Peloponnesus . . .	Morea.
Corcyra	Corfu.
Cephalonia	Cephalonia.
Creta	Candia.
Eubæa	Negropont.
Britannia	England, Scotland, & Wales.
Vecturiones . . .	Edinburgh.
Picti	Lanark, Dumbarton.
Scoti	Ross.
Dumnonii	Cornwall and Devonshire.
Regni	Surry, Sussex.
Simeni vel Iceni . . .	Norfolk and Suffolk.
Coritani	Lincolnshire, Nottinghamshire, Derbyshire, &c.
Ottadeni	Northumberland & Durham.
Brigantes	Westmoreland,Cumberland.
Mona Insula	Anglesey.
Ordovices	Flintshire, Montgomery, &c.
Silures	Radnorshire, Brecknockshire, & Glamorganshire.
Hibernia, vel Ierne .	Ireland.
Blanii	Dublin and Kildare.
Coriondi	King and Queen's County.
Thule	Shetland and Orkneys.
Ebudes Insulæ . .	Western Isles of Scotland.
Monæda vel Mona .	Isle of Man.
Asia Minor . . .	Natolia.
Babylonia, Chaldæa .	Irak.
Mesopotamia . . .	Diarbeck.
Armenia	Armenia.
Armenia Major . . .	Turcomania and Georgia.
Persia	Persia.
Iberia, Colchis, et Albania	Georgia, Gangea, and Dagestan.

Bactriana	Balk, Sablustan, & Candahar.
Susiana	Chusestan.
Parthia	Irak Agem.
Sarmatia Asiatica . .	Astracan.
Sinæ	Chinese Tartary.
Mauritania Tinigitana .	Morocco.
Mauritania Cæsariensis	Algiers.
Numidia, Africa Propria	Tunis.
Tripolitana . . .	Tripoli.
Cyrenaica, Libya Superior	Barca.
Ægyptus . . .	Egypt.
Lybia Inferior, Gætulia	Bilidulgerid.
Solitudines . . .	Zaara, or the Desert.
Antololes . . .	Negroland.
Æthiopiæ, et Lybiæ pars	Upper Ethiopia.
Æthiopiæ pars . .	Lower Ethiopia.

N. B. For other particulars, consult Dr. Robinson's Grammar of History, and his Ancient and Modern Histories.

XXX. *Mythology.*

644. Mythology, Fable, or Fiction, is the creature of the imagination, and derives its origin from a love of the marvellous and wonderful; a passion, of which legislators and teachers, in early ages of society, took advantage.

Obs.—These tales of ignorance, barbarism, and superstition, fill a large portion of many books of education; but I think these few pages quite enough on so obsolete and useless a subject.

645. As a means of civilizing the world, the priest and the poet, among ancient nations, made use of the same means to convey their maxims and instructions to the vulgar.

It was often, also, a mode of honouring whatever was useful or honourable in nations: the

Chinese having their Fohi; the Hindoos, their Brahma; the Greeks and Romans, their Jupiter; and the Scandinavians, their Woden.

646. Mythology was first reduced to a system by the Hindoos; and afterwards, by priests of Egypt, who were the depositories of Eastern learning, as well as religion, and who monopolized all the arts and sciences.

647. Fables are the tales of former times, when there existed neither records nor chronology.

By the Chinese mythology, *Fo* or *Fohi*, probably (the Noah of holy writ,) the founder of their empire, was born in a supernatural manner, and was inspired by heaven with knowledge which qualified him to teach all arts and sciences, and compose their laws.

Of their *Confucius*, they believe, that he was not born as other men; but able to reason profoundly from his childhood.

648. The mythology of the Hindoos is much connected with their casts or tribes; into which, the Indian nations are divided.

Some of their fables relate to the creation, the general deluge, and to Vishnu or Brahma; who, they say, was miraculously born; (in Sweta, the White Island, or Britain!) and that at thirty, he began to promulgate his doctrines, which have since spread all over India, and a great part of Asia.

His principal dogma, was that of the transmigration of souls, after death, into the bodies of other animals;—a doctrine which gave rise to idols in the shape of monsters, quadrupeds, &c.

649. The Persians supposed the world to have been repeatedly destroyed; but re-peopled by creatures of different formation, who had been successively annihilated for disobeying the Supreme Being.

Their mythology related to the exploits of Tahmuras, one of their ancient kings, who attacked and vanquished the dæmon that opposed the happiness of the country; and also to the labours and adventures of Rostan, another Persian chief, similar in character to the Hercules of Greece and Rome.

650. In the Egyptian mythology, the revolutions of the heavenly bodies, are referred to the reigns of their early monarchs.

Hence, the number of years, included in the reigns of the superior gods who filled the Egyptian throne; and to these, they say, succeeded twelve demigods.

The imaginary exploits and absurd adventures of the gods and demigods, furnished an inexhaustible fund of mythological romance.

651. The adventures and exploits of Osiris, Oris, Typhon, and Isis, and the transformation of the gods into various animals, are the foundations of the Egyptian mythology. Objects animate and inanimate were, at first, created as emblems of the deities, and were worshipped as deities.

Thus, Jupiter Ammon was worshipped under the figure of a ram; Apis, as a cow; Osiris, as a bull; Pan, as a goat; Thoth, or Mercury, as an ibis, &c.

652. Thoth, or Mercury Trismegistus, was

also represented as the inventor of letters, geometry, astronomy, music, architecture, and all the branches of science and philosophy, in which there is no doubt, the Egyptians greatly excelled.

653. The mythology of Greece is partly founded on that of Egypt; and is furnished chiefly by the adventures of Jupiter, Juno, Minerva, Neptune, Venus, Mars, Vulcan, Vesta, Apollo, Diana, Ceres, and Mercury.

Besides these twelve deities, called the superior gods, there were second and third classes of gods, and a multitude of others, of inferior dignity, but connected with them.

654. *Jupiter*, or the *Thunderer*, was esteemed the most powerful of the Grecian gods, and was son of Saturn and Rhea. After delivering his father from the tyranny of the Titans, he became master of the universe, which he divided with his brothers; reserving heaven for himself, giving the sea to Neptune, and the infernal regions to Pluto.

Having overcome his enemies, he gave himself over to all kinds of pleasure; but notwithstanding, obtained universal homage and worship.

He was the king and father of gods and men; his power extended over all the deities, and every thing but the Fates was subservient to him.

He was the Vishnu of the Hindoos, the Osiris of Egypt, the Ammon of Ethiopia, and the Belus of Babylon.

655. *Juno*, the sister and wife of Jupiter, was famous for her jealousy, her implacable revenge, and her quarrels with Jupiter. She presided over empires and riches; and was worshipped

with solemnity, as the protectress of married women.

She had three children, viz. Hebe, Mars, and Vulcan. Iris, the rainbow, was her chief attendant.

656. *Minerva*, the goddess of wisdom, sprung from the head of Jupiter; she was the patron of the arts, and an emblem of wisdom and prudence. The cock and the owl are emblems of her valour and wisdom.

657. *Neptune* was worshipped as the god of the ocean. He was ruler of the seas, and held dominion over all maritime affairs. Polyphemus, one of the Cyclops, was his child, and a giant who devoured all who fell into his hands.

658. *Venus*, the goddess of love and beauty, said to have sprung from the froth of the sea; on the surface of which, she was wafted in a shell to the island of Cythera. On the sea, she was surrounded by Cupids, Nereids, and Dolphins; and in the heavens, her chariot was drawn by doves, and swans.

659. *Mars* was represented as a warrior riding in a chariot drawn by horses, driven by a Fury: Discord preceded them, and Distraction, Rage, Fear, and Terror, attended his progress.

The dog for his vigilance, the wolf for his fierceness, the raven for feasting on the bodies of the slain, and the cock for his watchfulness, were dedicated to this god of war. Bellona was his sister.

660. *Vulcan* was the god of fire and of workers of metals, and the inventor of the art of fabricating arms and utensils from metals. Temples were erected to him at Athens, Rome, &c.; and

at Memphis, a magnificent one was dedicated to him, before which stood, his statue seventy feet high.

He was said to forge the armour of the gods, and the thunder of Jupiter. He was the son of Jupiter, the husband of Venus, and the father of Cupid.

661. *Vesta* was the daughter of Saturn, and the goddess of fire: an altar was raised to her; and virgins, called Vestal Virgins, were employed in maintaining the sacred fire which burned in the temples in honour of the goddess.

Obs.—The temple of Vesta at Rome, was supposed to contain, besides the sacred fire, the household gods, which Æneas saved from the destruction of Troy.

662. *Apollo*, the son of Jupiter and Latona, presided over the fine arts, and was skilled in the practice of music; he is represented with his lyre, and crown of laurel.

Diana, the sister of Apollo, was goddess of chastity, of the chace, and of the woods. She was adored as Luna in heaven, as Diana on earth, and as Hecate in the infernal regions; and was generally attended by Cupid, Hymen, and the Hours.

663. *Ceres*, the goddess of production and fertility, said to have taught the art of tilling the earth, sowing corn, and making bread: she had a daughter named Proserpine.

664. *Mercury*, the messenger of the gods, was the inventor of letters, and of the arts and sciences; also the reformer of language, and denominated Hermes, for his eloquence. He is represented with wings fixed to his cap and sandals;

and in his hand, a caduceus or wand, round which, are entwined serpents.

665. There were also numerous other divine personages, who had inferior parts assigned them; as

Saturn, the father of Jupiter, and son of Heaven and Earth. His wife was Rhea, or Cybele.

Pluto, the son of Saturn and Ops, king of the infernal regions, and ruler of the dead; so called from his teaching the rites of burial.

Bacchus, who presided over the grape, and the god of wine.

Hebe, the goddess of youth, &c.

666. The three *Graces* were daughters of Jupiter, by Eurynome; and the nine *Muses*, by Mnemosyne. He was also the father of *Apollo* and *Diana*, by Latona; and of *Mercury*, by Maia.—*Minos*, *Rhadamanthus*, and *Æcus*, were inexorable judges, who examined the dead.

Tisiphone, *Alecto*, and *Megæra*, were the gaolers and executioners of *Tartarus*, or hell, armed with snakes and lighted torches.

Charon, conducted the souls of the dead across the *Styx*, where they drank the waters of *Lethe*, or oblivion.

667. The Elysian Fields were the paradise of the good. The Fates were *Clotho*, who held the distaff; *Lacheris*, who spun the thread of destiny; and *Atropos*, who, with his scissars, cut it asunder.

Hercules, or Alcides, the virtuous hero of antiquity, was the son of Jupiter and Alcmena, and performed twelve famous labours, among which, were the killing of the Namæan lion: and the cleansing the stable of 3000 oxen of king Augeus in one day, which had not been cleansed for thirty years.

Amphitrite, was the mother of the Nereids, who with syrens and tritons, attended Neptune.

Somnus, was the god of sleep; *Morpheus*, of dreams; *Erebus*, of darkness; *Nox*, the goddess of night; *Plutus*, the god of riches; and *Momus* of folly.

668. In the mythology of the northern nations, *Odin* or *Woden* was the chief divinity.

His exploits and adventures furnish the principal part of their mythological tales. He is supposed to have come from the east; and is represented as the god of battles, and as killing thousands at a blow.

His palace, called *Valhalla*, was situated in the city of *Midgard*, where the souls of heroes who bravely fell in battle enjoyed supreme felicity, and spent the day in hunting matches or combats; and at night, assembled in the palace of *Valhall*, where they feasted on the most delicious provisions, and solaced themselves with mead, the Scandinavian nectar, out of the skulls of their enemies.

669. *Sleepner* was the horse of Odin. From *Hela*, their hell, comes our word *hell;* and from *Sinna*, the wife of the evil genius, comes our word *Sin*.

They had giants also, called *Weynar*, *Farbauter*; *Bilupher*, and *Hellunda;* and a prophet called *Fola*, whence comes our word *fool*.

Their *Folaspa*, or book of prophecies, contained the history of the world, the fairies, &c.

XXXI. *Drawing, Painting, &c.*

670. Drawing is that art of polished society, which teaches us to represent and preserve the likenesses of men and things. It is a source of pleasure; because it enables us to familiarize ourselves with the most beautiful and graceful objects; and it is, at all times, an agreeable recreation.

It is practised on paper with chalk, black-lead, crayons, Indian ink; and water colours; and on board and canvass, with oil colours.

*** See Hamilton's Practical Elements of Drawing, with its numerous engravings, as excercises to copy from.

671. In learning to form the hand, the student should begin with circles, ovals, cones, cylinders, and globes; and these latter he should shadow, so as to give the effect of solidity.

He may then proceed to inanimate objects, as flowers, fruits, trees, and houses, giving each its proper light and shade; thence, to animals; and finally, to the human figure, at first naked, and then clothed.

672. To draw a landscape or groupe of figures, a knowledge of perspective is required; and this is nothing more, than the art of representing every object in its proper bearing, and under its proper angle, which angle is always *in proportion to the distance of the object from the eye.*

Just conceptions should also be formed of light and shade; the foundation of which, is the obvious principle—that *the light always proceeds from one point;* and, consequently, that all shadows fall one way. The true disposition of light and shade, is called *relief.*

Obs.—To give effect to particular objects, the student must copy the subjects from Hamilton: and after doing this for some time, if he have genius or taste, he will begin to copy nature, and afterwards, contrive for himself, and design originally.

673. The art of drawing in PERSPECTIVE, purposes to represent every object in its proper place and relative size and figure, as it is seen from the spot where the view is taken.

The eye of the draughtsman is supposed to be fixed; and he is to pourtray every object, as though he saw it on a pane of glass, the size of his paper or canvass.

The general principles are not difficult, provided two or three technical terms are well understood.

674. The *ground-plane*, is the plane or level, on which both the spectator, and the objects that are to be drawn, stand.

The *perspective-plane*, is a supposed plane standing perpendicularly upon the ground-plane; and on this plane, as on a pane of glass, the images of objects are supposed to be intercepted; so that their perspective appearance, when drawn, is the appearance they would have on this plane.

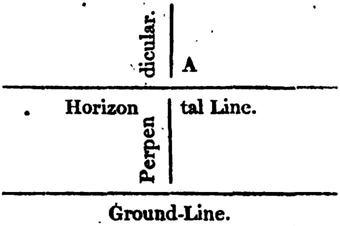
The *ground-line*, is the line, on which the perspective plane is supposed to rest.

675. The *point of sight*, is that point in the perspective plane which is nearest or opposite the

eye; and is at the same proportional distance from the ground-line, as the height of the eye is above the ground-plane.

The *horizontal line*, is a line upon the perspective plane, drawn through the point of sight, and parallel to the ground-line.

The *perpendicular*, is a line on the perspective plane, drawn through the point of sight, perpendicularly to the ground-line, and to the horizontal line.



The point A, where the perpendicular and horizontal cross, is the point of sight, or vanishing point, of all lines perpendicular to the perspective plane.

676. *Points of distance* are points on the perspective plane set off from the point of sight; sometimes on the horizontal line, sometimes on the perpendicular;—at the same proportional distance from the point of sight, as the eye itself is from the objects.

Measuring points are points, from which any lines in the perspective plane are measured, by laying a ruler from them to the divisions laid down upon the ground-line.

Vanishing points are points, on the perspective plane, in which parallel lines seem to meet, or vanish.

677. The rules for drawing are,

1. That all lines perpendicular to the ground-plane, should be perpendicular to the ground-line; and all lines parallel to the perspective plane, must be drawn parallel to each other.

2. That all *parallel lines meet, or have vanishing points*, in some part of the perspective plane.

3. If the lines lie upon the ground-plane, they will vanish somewhere in the horizontal line; which is, therefore, called the vanishing line of the ground-plane.

4. If parallel lines be perpendicular to the ground-line, they will vanish in the point of sight.

5. If they be oblique to the ground-line, or have a declination from such perpendicular, then the angle of this obliquity or declination must be set off.

678. All the measures of lines upon the ground-plane, are to be laid down upon the ground-line, and the measuring point of all lines parallel to the ground-line, is either of the points of distance on the horizontal line, or the point of sight.

The measuring point of any line, perpendicular to the ground-line, is in the point of distance on the horizontal line; and the measuring point of a line oblique to the ground-line, is found by extending the compasses from the vanishing point of that line to the point of distance on the perpendicular, and setting it off on the horizontal line.

Obs.—The above rules committed well to memory, will, with some practical instructions from a master, or by practice only, enable the student in drawing, to place all his objects in due perspective.

679. The art of painting in oil-colours is the most deservedly admired of scientific arts, when carried to perfection. The requisites of a great painter are,

Correct drawing, without which, all other art is lost.

Just perceptions of *grace* and *beauty*.

Invention, which implies a perfect knowledge of his subject in all its relations, and a choice of the subject adapted to his art.

Composition, or the agreeable distribution, and effective grouping, of his figures and objects, in his rough, preparatory *design*.

Colouring, or the imitation of nature in her happiest moods; and this branch of art avoids all violent transitions and unnatural glares, and renders distant objects less distinct than near ones.

680. Paintings, in regard to their subjects, are called historical, landscape, or portrait: and to the painters, they are divided into schools or countries;

As the Italian school,
The German school,
The Flemish school,
The Dutch school,
The French school,
And the English school.

Each of these schools has treated the practice of painting in its peculiar manner, and each, with exquisite beauty and admirable effect.

Obs.—Nothing can be more unlike, than an historical painting of the Italian and Dutch schools; nor than a portrait of the German and English schools; yet, each has its admirers, and distinctive merits.

681. The great masters of the *Italian* school, were Michael Angelo, Raffaelle or Raphael, Titian, Corregio, the three Carraccis, Carlo Maratti, Carlo Dolci, Guido, del Sarto, Parmegiano, Salvator Rosa, Romana, Caravaggio, Paul Veronese, and Guercino: besides a hundred others, some original, and some copiers of the great masters.

The great painters of the *German* schools were Albert Durer, Holbein, Kneller, and Mengs.

682. Of the *Dutch* school, were Rembrandt, Gerard Dow, Mieris, Ostade, Polemberg, Berghem, and Wouvermans.

Of the *Flemish* school, were Reubens, Teniers, Jordaens, and Vandyck.

The admired painters of the *French* school, are Claude, Poussin, Le Brun, Le Sueur, Vien, and David.

The *Spaniards* also have had their Murillo, and Velasquez.

683. The eminent painters of the *English* school, are Hogarth, Wright, Reynolds, Wilson, West, Northcote, Gainsborough, Morland, Barry, Copley, Westall, Devis, Smirke, Tresham, Wilkie, Daniel, Turner, Garrard, Lawrence, Pocock, Bone, Opie, and many others still living, whose works may be seen in the annual exhibitions of the Royal Academy.

XXXII. *Heraldry.*

684. During the Holy Wars, and the ages when close armour was worn, the warriors *emblazoned* or painted their *shields*, and wore *crests* in their *helmets*, to distinguish them in the field of battle.

These were, in subsequent periods, borne as trophies by their families; and the methods of adorning a shield were reduced to a science; still generally used, and, therefore, of consequence to be understood.

685. Heraldry is the art of blazoning or displaying coats of arms, in proper colours and metals, on the *shield* or *escutcheon*.

The points of an escutcheon are *nine;*

Three on the upper part; of which, the middle is called the *chief;* that in the right corner, the *dexter chief;* and that in the left corner, the *sinister chief.*

Three perpendicularly in the middle part of the shield: the first called the *honour-point;* the second, the *fess-point;* the third, the *navel-point.*

Three points horizontally, at the bottom: the middle one called the *base-point* the other two, the *dexter* and *sinister base points.*

686. Tinctures are armorial colours; as, or, gold; and argent, silver; azure, gules, sable, vert, and purpure; and ermine, and vair.

Obs.—These colours are represented on copper-plate prints as follow: 1. *Or*, is known by small pricks or points. 2. *Argent*, by the natural whiteness of the paper, without any strokes or points. 3. *Azure*, by hatches or strokes across the shield from side to side. 4. *Gules*, by lines from top to bottom. 5. *Sable*, by hatches crossing each other. 6. *Vert*, by hatches from dexter chief to sinister base. 7. *Purpure*, by hatches from sinister chief to dexter base. 8. *Tenne*, by cross hatches from right to left, and from left to right. 9. *Sanguin*, by hatches from right to left, and others from side to side.

687. Of the nine honourable charges,

The *cross* signifies afflictions for religion;

The *chief* denotes that the first bearer was a person in authority;

The *pale* imports him skilled in mining;

The *bend* shews him to have been valiant in war;

The *fess* denotes a worthy general;

The *inescutcheon* shews him to have been one who disarmed his enemy;

The *chevron* declares him to have been the head of his family;

The *saltier*, implies he behaved honorably at some siege;

And the *bar* shews him to have been serviceable in raising fortifications.

688. The lines which compose or bound these charges, are esteemed additional notes of distinction; as, invected, ingrailed, waved, nebulee, imbattled, raguled, indented, &c. They are always mentioned in blazoning; as, a chief invected, a pale ingrailed, a fess indented, &c.

689. The field of the escutcheon, is generally divided into two or more equal parts, by lines across the same; which partition must be mentioned in blazoning.

Thus, if a line perpendicular to the horizon divide the shield equally, it is said to be parted, *per pale*; if the line be parallel to the horizon, it is parted, *per fess*; if from right to left, it is parted, *per bend*; and so of any other.

690. *Common charges* are those figures which are painted within the field of the escutcheon; and they are taken from every kind of beings, natural and artificial.

a. Angels, cherubim, &c., denote celerity in business, messengers of peace, &c.

b. Men are honourable ensigns, as *saints* shew that the first bearer was some bishop, &c. *Heads* shew him to have done service against Saracens, Turks, &c. *Hands* or *arms* signify strength and fortitude. *Eyes* denote his judgment. *Legs* and *feet* indicate his swiftness: and the *heart* knowledge and understanding.

c. Beasts of prey are more honourable than beasts of chace. The male is more honourable than the female. The whole is nobler than any of the parts; the natural or proper colour is better than any other. The free and regular posture, than the irregular and constrained.

d. Of *birds*, the female is more honourable than the male, except the cock. Their native colours are better than artificial; and birds of prey, as eagles, falcons, &c., are most honourable.

e. Of *fishes*, the dolphin is the principal; and the most honourable bearing of fish, is *nayant*, or swimming; the next, *springing;* and then *hauriant*, or in an erect posture.

f. Insects are rarely borne in arms; but the Ant denotes industry; and the Bee, a laborious and beneficent person.

691. The postures are of great account; as, *couchant*, lying down; *passant*, walking; *combatant*, fighting; *rampant*, reared on his right legs to fight; *saliant*, leaping at; *guardant*, looking towards you; *regardant*, looking back or behind: *dormant*, sleeping; *seiant*, sitting with the forefeet straight; *endorsed*, two in a rampant posture, with their backs towards each other.

692. The chiefs, or heads of families, or houses, bear two sorts of charges: a *label* of three points; and *border*, which are either plain, compound, indented, &c. For consanguinity, or kinsmen, the differences are according to the branch of a family from which they originally descended.

First son		A label with three points
Second son		A crescent . . . .
Third son		A mullet . . . .
Fourth son	Bears	A martlet . . .
Fifth son		An annulet . . . .
Sixth son		A fleur-de-lis . . .

693. Since these are the bearings of distinction, for persons of the first house; those of the second house, which is the family of the second son, have their distinctions as follow:

	Eldest son		A label	
	Second son		A crescent	
	Third son		A mullet	
The	Fourth son	Bears a crescent with	A marlet	upon it.
	Fifth son		An annulet	
	Sixth son		A fleur-de-lis	

In like manner, the sons of the third house bear those differences respectively on a mullet; the fourth, on a martlet; the fifth, on an annulet; and the sons of the sixth house bear them on a fleur-de-lis; and though there be differences for every son, yet there are none for daughters, as they are all deemed equal in point of honour.

694. Of hatchments, or funeral *achievements*, the following things are observable.

1. When a bachelor dies, his arms may be depicted single or quartered, but never impaled; and on the hatchment he may bear a crest, and the ground without the escutcheon, must be all black.

2. If a maid dies, her arms must be placed in a lozenge or rhombus, single or quartered, with the ground all black; and the hatchment must have a shell over it instead of a crest.

3. When a married man dies, his wife's arms are impaled with his own, with the ground black on his side of the hatchment, and white on his wife's side.

4. When the wife dies, the arms are with the ground on her side black, but on her husband's white; instead of a crest, her hatchment must have a shell over it.

5. If a widower dies, his arms are impaled with those of his wife, with a crest, &c., and the ground is all black.

6. If it be a widow, her arms with her husband's are impaled within a lozenge shield, with a shell over it, instead of a crest, and the ground all black.

7. When the deceased is the last of a family, then, instead of a crest or shell, there is placed on the hatchment a death's head. Little shields, that draw hearses at pompous funerals, are called *chaperonnes*

XXXIII. *Literature.*

695. After the invention of letters, the genius of man taking different directions, some of them excelled in poetical, and some in prosaic compositions. These again assumed different characters, according to the subjects treated of.

Hence, we have in *Verse*, epic poems, descriptive poems, and elegiac, dramatic, and satirical poems:

And in *Prose-writing*, we have historical, descriptive, didactic, and epistolary compositions of an almost infinite variety of kinds and qualities.

696. Poetry is the glowing language of impassioned feeling, generally found in measured lines, and often in rhyme.

Most ancient people have had their poets; and among the Hebrews they were called prophets.

David was an inspired poet of the Hebrews:
Homer, one of the earliest poets of the Greeks:
Ossian, an ancient poet of the Scots:
Taliesen, an ancient poet of the Welsh:—
And Odin, an early poet of the Scandinavians.

697. The Greeks were the fathers of poetry, literature, philosophy, and arts. Homer was the first and the prince of poets; and he celebrated the siege of Troy in the Iliad and Odyssey, two epic poems, which never have, and perhaps, never can be, surpassed.

In the same line of poetical composition, he was followed, after 900 years, by Virgil, in the Æneid:

By Tasso, after another 1500 years, in the Jerusalem Delivered:

And by Milton, about 150 years ago, in Paradise Lost;—the finest poem ever written after the Iliad.

698. The Greeks, besides, boasted of their Pindar and Anacreon, in lyric poetry; and of Aristophanes, Euripides, Sophocles, and Eschylus in dramatic poetry.

Followed by them, among the Romans, were Ovid and Tibullus; among dramatists, Plautus and Terence; of didactic and philosophic poets, they had also Lucretius, Virgil, Horace, and Silius Italicus.

All these, were so many miracles of human genius; and their works afford so many models of their respective species of composition.

Obs.—Most of the works of the ancients have, in sentinent, if not in spirit, been translated into English. Thus, we have Pope's and Cowper's *Homer;* Dryden's *Virgil;* West's *Pindar;* Colman's *Euripides* and *Sophocles;* Garth's *Ovid;* Busby's and Good's *Lucretius;* Francis's *Horace*, and others.

699. Approaching nearer to our own times, as the literature of the ancients, after a long night of monkish superstition and darkness, was revived in *Italy* in the 15th century, so the first exertions of modern literature were made in that country:

Hence, their Dante, Ariosto, Petrarch, and Tasso.

These were followed in *France*, by Racine, Corneille, Boileau, Voltaire, Fontaine, and Delille.

And, in *England*, by Chaucer, Spencer, Shakspeare, Milton, Dryden, Pope, Thomson, Young, Collins, and Gray.

700. Besides these great names, there has been in England, at least, twenty other poets; whose works would vie with others of any age, or country.

Thus, they have in didactic and sentimental poetry, Goldsmith, Cowper, Darwin, Mason, Addison, Johnson, Akenside, Armstrong, Porteus, Blackmore, W. Dyer, Robinson, Watts, Cumberland, and Dermody.

In satirical poetry, Butler, Anstey, and Churchill.

In pastoral, Shenstone, Gay, Cunningham, and Ramsay.

In lyric poetry, Cowley, Smith, and Burns.

Obs.—Among admired living poets, may be named Wolcot, Hayley, Sheridan, Crabbe, Roscoe, Southey, Coleridge, Rogers, Campbell, Bloomfield, Wordsworth, Cottle, Sotheby, Colman, Shee, Taylor, Barbauld, Byron, Moore, Mathias, Scott, Dibdin, and some others; whose meritorious works will be impartially judged and estimated by a future age; but to which, for the present, we can only wish due immortality.

701. Poetry is classed under the heads *epic*, or heroic; *dramatic*, or representative; *lyric*, or suited to music, as odes, songs, &c.; *didactic*, or instructive; *elegiac*, or sentimental and affecting; *satirical*, *epigrammatic*, or witty and ludicrous; and *pastoral*, or descriptive of rustic life.

Versification, in the English language, depends on the modulation of the accents, and the disposition of the pauses. It is either rhyme, or recurring rhyme, alternate, or interchanging rhyme, or in triplets of three lines; or blank verse, in which the metrical principle is in the pauses, the lines flowing into each other.

702. The heroic verse consists of ten syllables; and its harmony depends on the regular distribution of accented and unaccented syllables; and its character of solemnity or liveliness, depends on the order of those syllables.

Thus, when the accent is on every other syllable, it is called *iambic* verse; as,

A *shep*herd's *boy*, he *seeks* no *high*er *name*,
Led *forth* his *flock* be*side* the *sil*ver *Thame*.

703. The monotony of recurring accents, is obviated by the varied disposition of the *cesural* pause. When this pause is on the fourth syllable, the strain is smooth and airy; as,

Soft is the strain | when zephyr gently blows,
And the smooth stream | in smoother murmur flows.

Or, it is still quicker, when placed at the second syllable; as, Not so | when swift Camilla scours the plain.

704. The following afford instances of various pauses, which give as many different effects to the lines:—

O friend | may each domestic bliss be thine;
Be no unpleasing melancholy | mine.

Or,

Me | let the tender office long engage,
To rock the cradle | of declining age.

Or,

O cruel, beauteous, | ever lovely, | tell
Is it in heaven | a crime to love too well.

705. The *anapestic*, or dactyl verse, is where the accent falls on every third syllable; as,

I am *mon*arch of *all* I sur*vey*,
My *right* there is *none* to dis*pute*;
From the *cen*tre all *round* to the *sea*,
I am *lord* of the *fowl* and the *brute*.

Or,

'Tis *night* | and the *land*scape is *love*ly no *more*;
I *mourn*; | but ye *wood*lands | I *mourn* not for *you*;
For *morn* is ap*proach*ing, your *charms* to restore,
Re*fresh*ed with fresh *fra*grance, and *glitt*'ring with *dew*.

Various other kinds of verses are to be found in the works of the poets; but the above are the most common.

706. The first historian among the Greeks was Herodotus; they had also Thucydides and Xenophon.

The orations of Demosthenes and Isocrates, are master-pieces of eloquence.

The moral writings of Epictetus, Æsop, and Plato, are deservedly cherished.

In philosophy, Aristotle was a universal and wonderful genius; and Euclid and Pythagoras were the fathers of geometry and music.

They also carried painting and statuary to the highest pitch; of the former, we have no perfect specimens; but the statues of Phidias and Praxiteles are still unrivalled.

707. The Greeks were followed by the ROMANS in history, by their Livy, Tacitus, Justin, Polybius, and Sallust.

In eloquence, by Cicero.

In morals, by Seneca, Pliny, and Plutarch.

In criticism, they had their Quinctilian and Longinus; and numerous other writers in every branch of knowledge.

The Romans were followed by the ITALIAN Guicchardini, Davila, Petrarch, Poggio, &c.

FRANCE boasts of its Montesquieu, Voltaire, D'Alembert, and Marmontel.

GERMANY, of its Schiller, Kotzebue, Klopstock, and Wieland.

And SPAIN, of its Cervántes and Lopez de Vega.

708. The genius of ENGLAND, favoured by political liberty, has proved itself little inferior to that of ancient Greece; it has excelled in every branch of literature.

In historical compositions, they have had Clarendon, Robertson, Hume, Gibbon, Belsham, Roscoe, and Gillies;

In morals, Locke, Addison, Johnson, Swift, Hawkesworth, Paley, and Blair;

In philosophy, Bacon, Hervey, Newton, Boyle, Clarke, Priestley, Halley, Franklin, Hunter, Berkeley, and Jenner;

In legislation, Coke, Blackstone, and Mansfield.

In mathematics, Briggs, Newton, Simpson, Emerson, Waring, and Hutton;

In chemistry, Black, Priestley, and Davy;

In agriculture, Young;

In romance, Richardson, Fielding, Defoe, Smollett, Sterne, and Burney.

709. To concentrate and give effect to individual labours, societies have, latterly, been formed in all parts of the world: and on these now depend, in a great degree, the further improvement of man.

Thus, in England, there is the Royal Society, the Antiquarian Society, the Royal Academy, the Society of Arts, and the Board of Agriculture.

In France, there is the Imperial or Royal Institute; and at Berlin, Madrid, and Petersburg, royal societies like those of London.

America likewise has its societies; and there are others in India:—all labouring for the promotion and propagation of knowledge.

Obs.—Effect has been given to study; and improvements have been accelerated, in every branch of knowledge, by means of the Art of Printing. In England, alone, this art is the means of producing 800 new publications per annum; besides 70 magazines, journals, and reviews; and 250 several newspapers. Of the Monthly Magazine, esteemed the best in Europe, nearly 5000 are regularly sold; and of all the monthly works, at least, 100,000 per month. Of the newspapers throughout the United Kingdom, above half a million are sold per week.—Such a vast engine, is the press, for the diffusion of knowledge, and for the promotion of truth, virtue, and happiness! It must not, however, be concealed, that it is an instrument capable of being perverted, by power and wealth, to the worst purposes; that it may be the means of making the worse appear the better cause; and may be made to aid and abet the bad passions and base views of wicked rulers and unprincipled ministers. The *good* use of the press is a great, social blessing; but the *abuse* of it may be the greatest of national curses. Against such abuse, young persons should be on their guard; and before they believe all they see printed, relative to passing events, they should examine into the character and motives of the writers; and, above all, should constantly *think for themselves.*

THE END.

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OF THIS VOLUME.

CONTENTS.

N. B. The Solar System should face the Title; and the Map of the World, the Article Geography, at Page 107.