CONVERSATION:

ITS FAULTS AND ITS GRACES;

OR,

THE BEST MANNER OF

SPEAKING, WRITING, AND PRONOUNCING THE ENGLISH LANGUAGE

CORRECTLY.

COMPILED BY

REV. ANDREW P. PEABODY, D. D.

NEW EDITION: REVISED, WITH ADDITIONS.

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"Such books as this are greatly needed, and, we are glad to see, are receiving the public attention. It is a very useful book, and may be studied with profit by all." — *Portland Transcript.*

PHYSICAL GEOGRAPHY,

FOR

FAMILIES AND SCHOOLS.

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FOR

FAMILIES AND SCHOOLS.

BY

R. M. ZORNLIN,

AUTHOR OF "RECREATIONS IN PHYSICAL GEOGRAPHY," ETC. ETC.

REVISED, WITH ADDITIONS,

By WILLIAM L. GAGE,

LATE MASTER OF THE TAUNTON HIGH SCHOOL.

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PREFACE

TO THE ENGLISH EDITION.

Physical Geography has of late years become a subject of such general interest, and now takes so prominent a place among popular sciences, that some acquaintance with its aim and the views it unfolds may be considered as one of the requirements of education. To facilitate the attainment of this knowledge is the design of the present little work, in which the subject is placed before the reader in familiar language and in a concise form, thus adapting it not only for the scholar, but also for the parent and teacher, and for all who, from previous inattention to this branch of knowledge, may be desirous of forming a ready acquaintance with the leading principles of the science.

Physical Geography owes its present state of forwardness to the combined observations of numerous individuals; and perhaps may be considered as dating its great advance from the era of the general peace of 1815; for it has only been subsequent to the cessation of war, that scientific men of various nations have obtained free access to different stations on the earth's surface, where observations have been successfully carried on; and it is by the mutual interchange of information thus gathered, that a large portion of our knowledge of Physical Geography has been acquired.

We have said that this science owes its great progress to the combined observations of numerous individuals; — we may also add, that it invites its student to observe, to give his attention to all that its passing around him in the natural world, and to verify for himself, as far as circumstances will admit, the truth of the data thus presented to his view. He may even lend his aid to the furtherance of this science. Instances are not wanting, both in our own day and in former times, of individuals from every class of society raising themselves to eminence by the pursuit of science; and the path is open to all. The inhabitant of the country may, doubtless, in this respect possess

greater advantages than the dweller in crowded cities; he may take note of the minerals and plants in his own immediate neighborhood, or may devote his attention to the habits of birds and insects, and by recording his observations may contribute his quota to the general mass of knowledge. But the dweller in towns may also perform his part: he may observe the ever-varying clouds, the temperature, the climate of the place of his abode. He, too, may enjoy opportunities denied to the other, of ready access to works of travels, and thus be enabled to trace the application of the knowledge he has acquired to all parts of the globe. Had our limits permitted, we would gladly have attempted this application in the present little treatise; but having already in a former work,* with this especial object in view, carried our friends over the various regions of the earth, we must now content ourselves with tracing the Outlines of Physical Geography, trusting that these will be found of sufficient interest to induce our readers to pursue the subject into its more minute details.

R. M. Z.

* Recreations in Physical Geography.

PREFACE

TO THE AMERICAN EDITION.

In the preparing of small school books, the English have an unquestionable superiority over us. Such treatises with them have the great merit of comprehensiveness, and avoid both childish diffuseness and merely superficial views. This little work, which we take pleasure in introducing to American teachers, will suitably illustrate this. While its range is very broad; while we are now lifted to the clouds, and anon carried far into the depths beneath our feet; transported in a moment from ocean to ocean and from shore to shore, initiated into the manifold secrets of nature, and taught on every side the greatness and the wisdom and the love of the Creator and Father of us all, we see the chain which binds together all the sciences and makes them one.

And in the study of this comprehensive science of sciences, which is termed in one word Physics, we on this side of the Atlantic have made but little advancement. Still, the impulse which Maury and Guyot, Fremont and Agassiz and Bache have given to this department of human knowledge, will not lose its force till it is felt in our schools. The day is not distant when the study of Physical Geography will not only escape neglect, but will take the same rank in American that it does in English schools. We hope that this little treatise will be the means in part of accomplishing this great end, and that in opening to the young the riches of this science, it may tempt to a deeper search than this work can afford. Those who may have acquired some interest in the fascinating study of Physics, can gratify their curiosity by consulting the pages of Mrs. Somerville, Guyot, Wittich, Murray, and the larger work by the author of this treatise, while the most mature mind may reserve its strength for the broad generalizations of Humboldt's Kosmos.

W. L. G.

Boston, October, 1855.

NOTE

TO THE TEACHER.

This work can be used by scholars of ordinary abilities from twelve to eighteen years of age. With the youngest class who may have it, let the teacher invent very numerous questions; to scholars of an older age, those at the close of the volume will suggest the contents of sentences, and in some cases of paragraphs; the pupils of the first class will need no questions, but should give a summary of the contents of the lesson, omitting no fact, however unimportant, yet not committing the words of the book to memory more than need be.

Have the locality of every place mentioned in the book known and recited.

Have the meaning of all important words given, and accustom the scholars to give full explanations of phenomena like the currents, winds, &c. Accustom the pupils to a habit of getting collateral information from all sources, and expressing it freely in the class-room.

Have the work known with perfect accuracy before it is laid aside, that the facts contained in it may be remembered through life.

PHYSICAL GEOGRAPHY.

I. THE OBJECTS OF PHYSICAL GEOGRAPHY.

Physical Geography, or in other terms, Natural Geography, consists of a description of the Earth we inhabit, and directs our attention to its structure, to the waters on its surface, to its atmosphere, to its various animal, vegetable and mineral productions, and to the laws by which these are governed.

It is called *Physical* or *Natural Geography*, because it considers the Earth under its natural features, that is, according to the nature imparted to it by its Almighty Maker, and not in reference to any artificial divisions made by man into kingdoms and states. We are thus led to regard the Earth as one great whole; and regions are determined by natural conditions, such as the climate or temperature of any portion of the Earth's surface, the prevalence or absence of particular species of plants, &c.

Physical Geography is a science of great utility, because it makes us acquainted with much that tends to man's benefit and prosperity. It also forms a very gratifying pursuit, for it presents us with numberless highly interesting facts in the natural world, which might otherwise pass unheeded, and it displays to our view the wisdom and goodness of the great Creator of the Universe.

II. THE EARTH.

The Earth belongs to a group or system of bodies termed planets, which revolve round the Sun, from which they derive both light and heat.

The Earth is of a *spherical* or globular form. A *sphere* is a *perfectly round* body: this the Earth is not, being somewhat flattened (not unlike the usual shape of an orange) at the extremities of its axis, which are called the *north* and *south poles*. The earth is accordingly not a perfect sphere, and is termed a *spheroid*.

This spheroid is called *oblate*, because it revolves about its *shortest* diameter. The peculiar shape of the Earth is that which a soft globe

assumes when put into rapid motion; and the Earth is supposed to have been once in a soft state.

The spherical form or *rotundity* of the Earth is proved by ships sailing round the globe. It is well known that Captain Cook and a host of other navigators have, by steering in either an eastward or westward direction (as nearly as the general arrangement of land and water will permit), ultimately returned to the same point from which they started.

The globular form of the Earth is also proved by the appearance presented on the surface of the ocean. If the Earth were a flat plain, the distances would seem misty and ill-defined, instead of which a sharp, clear, well-marked line, called the *horizon*, extends all round a vessel in the broad open sea, in the form of a circle, of which the vessel forms the centre. The undulations of the dry land, and the various objects on its surface, prevent us from observing this with any degree of certainty in the interior of a country; but if we stand on the sea shore, we may notice that the surface of the ocean is terminated by a clear distinctly-marked line, which constitutes the *visible horizon*.

If while we are on the borders of the ocean, a vessel should put out to sea, a most excellent

opportunity will be afforded us of observing the globular form of the Earth, by watching this vessel as it recedes from the shore. The visible horizon may be considered as extending to the distance of about 30 miles from a person standing on the beach. As the vessel recedes from the shore, it will diminish in size, but the whole will be visible until it reaches this water line. When it has passed this line, though the masts and sails will still remain in view, the hull of the ship will be below the horizon, the portion of the ocean on which it is sailing being concealed from the spectator by the globular form of the Earth, and at length the whole will be lost to his view.

Thus, if the spectator were to stand on the sea shore *sh*, the visible horizon would extend on a level with the line H Z N, and when the vessel had passed the portion of the sea to which that line extends at N, it would be descending what to the spectator at S forms the other side of the globular-shaped earth and the waters on its surface.

The Earth, or globe, is divided into two equal parts by an imaginary line called the *equator*, or

equinoctial line, the upper portion (or half-sphere) of the globe being distinguished as the *northern hemisphere*, and the lower portion as the *southern hemisphere.*

Maps of the world are frequently divided into two circular portions, called the *eastern* and *western hemispheres.* These have no marked division like that of the equator, which extends from east to west across these hemispheres, but they are useful as a mode of representing the form of a globular body like the Earth on a flat surface, and also as conveying an idea of the two great divisions of land on the face of the Earth.

The *circumference* of the Earth, that is, its girth at the equator, where it is of greatest size, is nearly 25,000 miles. Its *diameter*, or the measure of its *width through the centre* at that line, is rather less than one-third of its circumference, or about 7926 miles. In consequence of its being in some degree flattened at the poles, its diameter from north to south is about 26 miles less, or 7900 miles. The diameter may be stated, in round numbers, at 8000 miles; and the radius, or distance from the centre to the surface, at 4000.

The *Earth turns on its axis;* though this axis is only an imaginary line passing through the Earth from pole to pole. This motion is well

represented in the ordinary school globes, and may be imitated with an apple or a ball. In consequence of this turning motion, called the *rotation of the Earth*, all parts of its surface are in succession presented to the sun's rays; and since the motion takes place from west to east, the Earth always meets or turns to the sun in its eastern parts, which gives the appearance of the sun's rising in that quarter, the variation to the north or south of east being dependent on its relative position to the sun at different seasons of the year. This motion of rotation, called the *Earth's diurnal motion*, is completed in about 24 hours (correctly speaking, 23 hours 56 minutes 4 seconds), which constitutes a natural day. The rate of the Earth's rotary motion *at the equator* exceeds 1000 miles an hour; but the velocity of rotation diminishes as we recede from that line, in accordance with the Earth's diminished circumference.

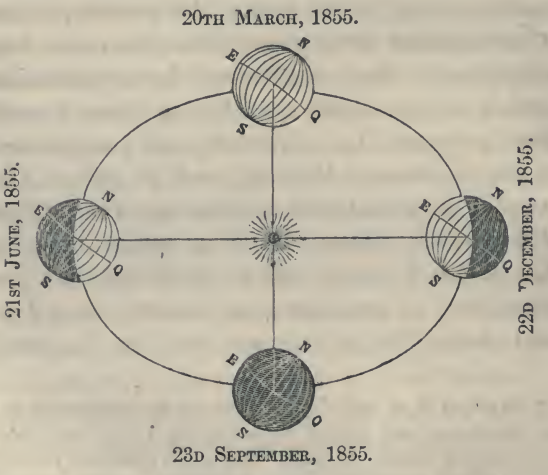
While the Earth is thus continually turning on its axis, it has also a progressive or onward motion in its *orbit*, that is, its *path round the sun*. The length of this orbit has been estimated at about 600 millions of miles, and the rate of the Earth's motion in its orbit to exceed 68,000 miles in an hour, or about 1000 miles in a second. The Earth's orbit or path is not perfectly cir-

cular, but *elliptical*,* in consequence of which the Earth is not always at the same distance from the sun, but its average distance is 95 millions of miles. The Earth completes this revolution round the sun in 365 days and 6 hours, which constitute a year.

The Earth, while performing its annual course round the sun, has not its axis placed at right angles with the line it pursues, but in an *oblique* or *slanting* direction; the consequence of which is, that the earth presents to the action of the sun's rays a greater portion of the northern hemisphere during one half of the year, and a greater portion of the southern hemisphere during the other half of the year. The period at which any particular portion of the Earth's surface is turned most directly towards the sun constitutes *mid-summer* at that particular locality; and it will at the same time be *mid-winter* at the opposite portion of the globe. Thus, when it is mid-summer in the British Isles, it will be mid-winter at the little island of Antipodes, not far from New Zealand: when it is mid-summer in New England,

* An ellipse is an *oval* figure so shaped, that the sum of the two distances of each point of the curve from two points within, called *foci*, is always the same. The *Sun's* place is a *focus* of each planetary orbit. An ellipse may be drawn with a string, two pins, and a pencil.

it is mid-winter in the northern part of the Austral Ocean. In the figure below, the orbit is made much more elliptical than it is in reality, and the Sun, which belongs in one of the foci, is put at the centre. At each *equinox*, a hemisphere is shown which reaches both the poles; but at the vernal equinox the illuminated half appears, at the antumnal the dark half; the globe in the latter case being between the Sun and the eye. Observe that the lines N S, representing the earth's axis, always remain parallel to each other.



III. LATITUDE AND LONGITUDE.

The globe or earth, for the convenience of measurement, is divided into degrees of latitude and longitude; these degrees being indicated by this sign, °.

Latitude is marked by lines or circles running *parallel* with the equator, each hemisphere being divided into ninety degrees between the equator and the north and south poles. The reckoning commences from the equator, and is distinguished as *north* and *south latitude*. The latitude of any place is therefore determined by its distance north or south of that line. Thus London is in *north* latitude 51½°. The Cape of Good Hope is in *south* latitude 35°. Any place situated on or near the equator is said to be in a *low latitude;* any place near the Arctic circle to be in a *high latitude*. Thus, Sierra Leone is in the low latitude of 8½° N., Archangel in the high latitude of 64½° N.

Each degree is divided into sixty minutes, marked thus, ′; the latitude of London being 51° 30′; that is, fifty-one degrees, thirty minutes. The number of miles comprised in a degree of latitude is nearly seventy.

Places situated in the same degree of latitude are said to be on the same *parallel*. Thus, Norwich and Berlin are on the same parallel of latitude, about N. lat. 52½ degrees.

The globe has a further division, also running parallel with the equator, marked by four *circles*, called the *Arctic circle*, the *Antarctic circle*, the *Tropic of Cancer*, and the *Tropic of Capricorn*. The tropics are situated at the distance of 23½° north and south of the equator; the Arctic and Antarctic circles, 23½° from the north and south poles, or in north and south latitude 66½ degrees.

These circles divide the earth into five *zones*, or belts, the *torrid zone*, the two *temperate zones*, and the two *frigid zones*. The torrid zone, so called from the heat of that portion of the earth which it includes, extends to 23½° on each side of the equator; that is, to the tropic of Cancer on the north, and the tropic of Capricorn on the south, of the equator. This zone is called *intertropical*, from its lying between the tropics. The northern temperate zone extends from the tropic of Cancer to the Arctic circle, and the southern temperate zone from the tropic of Capricorn to the Antarctic circle; that is, respectively from north and south latitude 23½° to north and south latitude 66½°. The frigid zones extend from the

Arctic and Antarctic, or polar, circles, to the north and south poles; that is, from north and south latitude 66½° to north and south latitude 90°. They are called frigid, from the cold temperature which prevails in those regions.

The Earth's surface is also crossed by imaginary lines passing from north to south through the poles; these are called *meridians.* The *longitude* of any place is determined by its distance (reckoned in degrees) eastward or westward from any given *meridian.* In Britain, longitude is calculated from the meridian of *London* (or, more correctly speaking, of the *Royal Observatory at Greenwich*).*

For the measurement of longitude, the equator is divided into 360 parts or degrees; the same division into 360 degrees being maintained in all parallels of latitude, though, since the girth or circumference of the earth diminishes as we recede from the equator, degrees of longitude do not contain so many miles in high as in low

* For convenience, the meridian of London is assumed as the line from which navigators reckon their longitude, yet in national calculations it is customary to make the capital of the country the point from which to determine longitude. Thus, in America, we have the meridian of Washington, the Prussians use the meridian of Berlin, the Austrians that of Vienna, &c.

latitudes, which will be evident from the following table:—

LATITUDE.	MILES.
0°	68¾
10°	67½
20°	64½
30°	59½
40°	52½
50°	44
60°	34½
70°	23½
80°	12
90°	0

We thus perceive that a degree of longitude at the equator contains nearly 69 miles, but in latitude 80°, only 12 miles, and at the poles it diminishes to nothing.

Longitude is ordinarily reckoned *east* and *west* from the meridian of Greenwich to the opposite point of the globe's circumference; there being thus 180 degrees of east longitude, and 180 degrees of west longitude. All places eastward of Greenwich are reckoned as being situated in *east* longitude; and all places westward of Greenwich as being situated in *west* longitude.

Places situated in the same degree of longitude are said to be on the same *meridian*.* The term meridian is used, because the sun will be

* Derived from the Latin *meridies*, mid-day.

at its greatest height, or it will be *mid-day*, at the same time at all places in the same longitude. Thus, Bordeaux is on the same meridian as London, and therefore it will be noon, or mid-day, at the same time at both places. It will be noon *earlier* than in London at all places situated to the *eastward* of that meridian, or in *east longitude*, and *later* at all places situated in *west longitude*. The sun will rise rather sooner at Berlin, and much later at New York, than in London. At Calcutta, which is situated in east longitude 88°, it will be noon when it is a little after six in the morning in London; and at the Feejee Islands, in the Pacific Ocean, which are situated nearly at the point where east and west longitude meet, it will be noon, or mid-day, when it is midnight in London. The sun is said to be *on the meridian* at mid-day: it is then due south, and at its greatest *altitude*, or height, for that particular day.

As the earth revolves on its axis once in twenty-four hours, the sun passes over one twenty-fourth of 360°, or 15°, in one hour. The difference of time between two places can be easily calculated by dividing the difference of their longitude by 15. This will give the number of hours and the fractional part of an hour; the latter can be reduced, if necessary, to minutes and seconds.

This difference must of course be added to obtain the time of a place east of a given meridian; subtracted for a place west of it.

IV. DISTRIBUTION OF LAND AND WATER.

The land does not occupy much more than one-fourth of the entire surface of the globe, the remainder being covered by the waters of the ocean. Thus, the extent of the whole surface being estimated at nearly 197 million square miles, the space occupied by land is considered to be about 52 million square miles, and that covered by the waters of the ocean about 145 million square miles.

The proportion of land is much greater in the northern than in the southern hemisphere; it having been computed that in the northern hemisphere the land occupies about 38 million square miles, and the waters of the ocean rather above 60 million, whilst in the southern hemisphere the land has been supposed not to occupy quite 14 million square miles, and the waters of the ocean to cover an area of about 85 million square miles. The recent discoveries of large tracts of land in the Antarctic regions, the extent

of which is yet unknown, render the correctness of the latter computation more than doubtful.

The dry land is usually considered under two principal heads: *continents* and *islands.*

The term continent has been commonly applied to four portions of the earth, and it is customary to speak of the continents of Europe, Asia, Africa, and America; but, more correctly speaking, there are only two continents, distinguished as the Eastern and Western Continents.

The Eastern Continent, called also the Old World — because it has formed the abode of civilized man from the earliest period of historical records — comprehends Europe, Asia, and Africa. The Western Continent, called the New World — because it has only been known to Europeans since its discovery by Columbus in 1492 — includes the whole of America.

These two vast continents are in fact only larger islands, being surrounded on all sides by water; but since large surfaces of land differ in their climate and natural productions from islands of smaller size, it is desirable to make this distinction, and to treat of these two grand divisions of the earth as *continents.*

The *islands* on the earth's surface are of various dimensions, and of various elevations above

the sea. The immense basin which is occupied by the waters of the ocean is apparently greatly diversified in its surface; in some parts deep depressions or submarine valleys occurring, whilst in others partially-immersed mountains rise above the waters, forming *islands* of larger or smaller extent, and in some instances mere *insulated rocks.*

Australia is by far the largest island on the face of the globe, its greatest length being about 2500 miles, and its greatest width about 1800 miles. This vast island is sometimes called a continent, but is more correctly included among the Islands. Australia, in conjunction with New Zealand and the numerous smaller islands with which the Pacific Ocean is studded, is sometimes regarded under the distinct appellation of *Oceanica.*

On referring to the map of the world, we shall perceive that the form in which the dry land is arranged differs greatly in the Old and New Continents; in the Old Continent the principal extension being from east to west, whilst in the New it is from north to south.

In the Old Continent continuous straight lines may be drawn for immense distances from south-west to north-east, over vast tracts of dry land, without encountering any great expanse of water.

Thus, a line drawn from Cape Verd in Western Africa, crossing the Isthmus of Suez, and extending to Quanlin on the borders of the Pacific Ocean, (situated a little to the north of the Japan isles,) would pass over a tract of dry land no less than 9750 miles in length. The New Continent, on the other hand, has its greatest length from north to south, extending through 120 degrees of latitude.

V. VARIATIONS OF THE SURFACE.

The dry land is elevated into *mountains* and *highlands*, spread forth in *plains*, or depressed into *valleys*, all varying in extent and in elevation above the level of the sea.

Mountains are met with in *ranges* and *groups*, or as *isolated mountains*.

Mountain ranges, or continuous ridges of mountains, not unfrequently rising to a great elevation above the adjacent districts, sometimes extend over large tracts of country, the length of the principal ridge being usually much greater than its width. In many instances we find that a general correspondence may be traced between the direction of mountain ranges and the form of

PRINCIPAL MOUNTAIN RANGES OF THE GLOBE AND CURRENTS OF THE OCEAN.

the regions they traverse, as will be evident from a reference to the accompanying map, the black lines on which indicate the principal mountain ranges.

Thus, the greatest extension of the Old World is from east to west, and a vast and nearly continuous line of mountains extends across the whole continent in that direction. The greatest length of the New World is from north to south, and in that continent a mighty mountain range stretches from its northern to its southern extremity.

The nearly continuous line of mountains which may be traced across the whole of the Old Continent, from the very shores of the Atlantic to those of the Pacific Ocean, commences in Western Europe with the *Pyrenees*, with which the Sierras, or mountain ranges of Spain, are connected. The valley of Languedoc forms an interruption to the grand chain of mountains, intervening as it does between the Pyrenees and the comparatively low range of the *Cevennes*, which extend nearly across the south-eastern part of France, and which may be considered as forming the next prolongation of the line. To this range succeeds the mighty mountain system of the *Alps*, covering a large extent of surface in Switzerland and some of the

adjacent territories, and containing the most elevated summits in Europe. The mountains of *Germany* and *Bohemia* do not attain any great altitude; these are succeeded by the *Carpathian mountains*, which skirt the north-eastern borders of Hungary. From the last range, and also from the Alps, mountain branches extend into Turkey, where the *Balkan* range carries the great line to the shores of the Euxine or Black Sea, and to the confines of Europe. In Asia Minor and Syria, it is continued by the ranges of *Taurus*, *Libanus*, and *Anti-Libanus*, and from these by the mountains of *Armenia* and *Persia*, including the *Elburz* range which skirts the southern shores of the Caspian Sea, to the borders of India. The *Caucasian mountains*, situated to the westward of the Caspian Sea, appear rather as a detached group. At the borders of India we arrive at a grand mountain knot, the *Hindoo Koh* or *Coosh*, from which mountain ranges diverge to the north and to the south, as well as to the east and west. The grand line is prolonged to the eastward by the *Kuenlun* and the *Himalaya* mountains, the latter stupendous range, which separates Hindostan from Tibet, containing the loftiest known summits on the face of the globe. The Himalaya mountains take a south-easterly course, and ter-

minate at the river Brahmapootra, whence the line is continued by ranges of mountains hitherto little explored, and finds its termination in the mountains of *China*, which carry it to the shores of the Pacific Ocean. The Kuenlun mountains skirt the north of Tibet and are prolonged by the *Khin-gan* range, which, turning northward, is again prolonged by other ranges, running in a line nearly parallel with the eastern coast of Asia, and extending almost to its most northerly limits.

The vast mountain system which extends from the northern to the southern extremity of the New World, presents a far more striking instance of the correspondence between the direction of mountain ranges and the regions they traverse. The *Rocky Mountains* extend from the borders of the Arctic Seas to the Isthmus of Panama, their general course agreeing very closely with that of the western coast line of North America. This vast range becomes twice depressed in Central America, but soon regains more than its former height, and under the name of the *Andes* extends along the whole of Western South America, its direction corresponding very nearly with that of the coast. The Andes contain a vast assemblage of elevated summits, a great number of which are covered with perpetual snow, although some of them are situated in the

hottest regions of the globe. Numerous active volcanoes also occur among the Andes. As they approach the southern extremity of the continent, these mountains lose their great elevation, and finally terminate in Cape Horn, 1860 feet above the level of the sea. The course of the *Alleghany* mountains corresponds nearly with that of the eastern coast of the United States.

The character of general correspondence between the direction of mountain ranges and the form of the regions they traverse, is often very observable in smaller portions of land, such as peninsulas and islands. Thus, the form of Italy corresponds closely with that of the direction taken by the Apennines, which extend through the whole of that peninsula. The form of Scandinavia (Sweden and Norway) agrees with the direction of the Dofrefeld mountains, which traverse that territory from north to south. Among islands, Corsica, Madagascar, Cuba, and Jamaica, afford striking instances of the correspondence of mountain ranges with the form of the land along which they extend.

Mountain ranges present some of the grandest natural scenes on the face of the globe. The form of ridges and summits is much influenced by the nature of the rocks of which they are composed. In some regions, the mountain tops are rounded,

like the limestone summits among the Apennines; in others, *serrated* or saw-shaped, like the slaty Sierras of Spain; in others, they rise in peaks or horns, like Mont Blanc and *Finsteraar-horn in the Alps; in others, in perpendicular walls 1000 or 2000 feet in height, like some portions of †Mont Cervin in the same range; or like natural castles, as in Mount Athos, in Greece; or in gigantic dome-shaped masses, like Chimborazo in the Andes. One very striking feature in elevated mountain ranges consists of the vast surface of snow which everywhere meets the eye, particularly in such mighty mountain ranges as the Himalaya and Andes. Mountain ranges are usually furrowed by deep valleys; and in some parts these valleys are filled with vast accumulations of ice and snow, called *glaciers*, which often assume the most fantastic forms, or spread forth like lakes or seas of ice, sometimes having a thickness of nearly 600 feet.‡

Mountain *branches*, or ridges, usually of inferior elevation, frequently diverge or *branch off* from the central line of a mountain range,

* In the Bernese Alps. † In the Pennine Alps.

‡ For an admirable description of the glaciers of the Old World, the reader is referred to Rollo in Switzerland, a book which may be perused with equal profit by young and old.

sometimes running almost parallel with the principal ridge, like the Jura* range, which branches off from the central line of the Alps; or else diverging from it nearly at right angles, like the Apennines, from the same grand mountain range. These are termed *lateral* or *side branches*, and sometimes *transverse branches*. From these lateral branches, smaller branches or *spurs* again extend, constituting *hills*, and the latter usually diminish in height until they are lost in the plains.

Detached or *isolated mountains* are usually of volcanic origin. In many instances they contain active volcanoes, and they sometimes attain a great elevation. Thus Mount Etna in Sicily has the altitude of 10,880 feet above the level of the sea, the peak of Teneriffe in the Canary Islands that of 12,200, and Mount Ararat that of 17,262 feet.

The loftiest summits are usually met with in extensive mountain ranges: thus, the most elevated summits in Great Britain occur in the mountain ranges of Scotland; those of Europe, among the Alps; those of Asia in the Himalaya Mountains; and those of America in the Andes: as may be observed by a reference to the follow-

* Between Neufchatel and Lake Geneva.

ing table of the height in feet above the level of the sea, of the most remarkable mountains on the earth's surface.

EUROPE.

	Feet.
Mont Blanc, Alps	15,750
Monte Rosa, Alps	15,150
Mulahacen, Sierra Nevada, Spain	11,650
Pic Nethou, Pyrenees	11,168
Mont Perdu, ditto	10,950
Etna, volcano, Sicily	10,880
Argentaro, Balkan	10,000
Corno, Apennines	9,250
Skageslöestinden, Norway	8,100
Lomnitz, Carpathians	8,750
Parnassus, Greece	8,000
Schneehatten, Norway	7,549
Mont d'Or, Auvergne	6,220
Helca, volcano, Iceland	5,210
Vesuvius, volcano, Italy	3,900

BRITISH ISLES.

Ben Nevis, Inverness-shire	4,368
Snowdon, Caernarvonshire	3,571
McGillycuddy's Reeks, co. Kerry	3,410
Helvellyn, Cumberland	3,055
Kinderscout, highest point of the Peak of Derbyshire	1,981
Beachy Head, Sussex	564

ASIA.

Kunchin-ginga, Himalaya	28,174
Dhawala-giri, ditto (about)	28,000
Juwahir, ditto	25,770

	Feet.
Elburz, Caucasus	18,400
Ararat, or Agri-dagh, Armenia	17,262
Hermon, Syria	10,000
Sinai, Arabia	9,300

AFRICA.

Kilmand-Jaro, Zanguebar	20,000
Abba Yared, Abyssinia	15,000
Cameroons, Biafra	13,000
Peak, Teneriffe, volcano	12,200
Spitz Kopf, Cape of Good Hope	10,000
Table Mount, ditto	3,500

NORTH AMERICA.

Mount St. Elias, volcano	17,860
Popocatepetl, Mexico, ditto	17,716
Fremont's Peak, Rocky Mountains	13,560
Black Mountain, Alleghanies, N. Carolina	6,476
Mount Washington, White Mountains, N. H.	6,285

SOUTH AMERICA.

Lirima, Andes	24,000 to 25,000
Aconcagua, Andes	23,907
Sahama, ditto	22,350
Chimborazo, ditto	21,415
Sorata, ditto	*21,286
Illimani, ditto	21,145
Roraima, Guiana	7,450
Itambe, Brazil	5,960
Cape Horn, Tierra del Fuego	1,860

* According to Johnston and Petermann.

OCEANICA.

Mowna Roa, Hawaii, volcano	16,000
Erebus, South Victoria Land, volcano	12,400
Peak, Tahiti	10 875
Egmont, New Zealand	9,000
Sea-View Hill, Australia	6,500

Elevated plains or *highlands*, called *plateaus* or *table-lands*, occur in various parts of the earth's surface. They sometimes rise abruptly and almost perpendicularly from the lower plains, and it is in consequence of this table-like form that the appellation of table-land has been adopted, though the term is applied to any plains of considerable elevation above the level of the sea, even though they bear no resemblance to the table-like form; some table-lands or plateaus being, on the contrary, situated between parallel mountain ranges, the mountains which support them often towering to great heights above these elevated plains.

The most considerable plateau or table-land of Europe occurs in Central Spain, which has a general elevation of 2000 feet above the sea level. The plateau or table-land of Mexico has an elevation of about 7000 feet above the sea. The table-land of Quito, which is situated between two parallel ridges of the Andes, has an elevation of 9000 feet above the sea, whilst around it

rises a vast assemblage of elevated summits, no less than eleven snow-capped mountains being visible from that plain. The most remarkable table-land on the surface of the globe occupies a large space of Central Asia, including the desert tracts of Cobi and Shamo and the elevated region of Tibet, the latter of which has an elevation of 15,000 feet above the level of the sea.

Plains or *lowlands* of greater or less extent, presenting comparatively small undulations on their surface, and rising in no part to any great elevation, are met with in most parts of the globe. A large plain or lowland occupies a considerable space in Europe, commencing on the borders of the North Sea, in the low districts of the Netherlands, and extending through Prussia and Poland into Russia, to the base of the Ural Mountains, and forming in the latter country an almost uninterrupted plain from the shores of the Frozen Ocean to those of the Black and Caspian Seas. In this vast expanse the surface is scarcely broken by any eminence except the low range of the Valdai hills, between Moscow and Toropetz, which in no part exceeds the height of 1200 feet above the level of the sea. This extensive plain is divided by the Uralian Mountains from one of yet larger extent, which

forms the great lowland of Northern Asia. The Russian *Steppes* (according to Koch) are open woodless tracts, covered with tall herbaceous plants.

One of the most remarkable lowlands on the earth's surface consists of the vast tract of barren sand which occupies the large portion of Northern Africa, called the *Sahara* or *Great Desert*, and which extends from the borders of the Atlantic Ocean to the valley of the Nile, its length being about 2470 miles, and its breadth about 900 miles. It consists chiefly of low rocky hills, and an almost boundless extent of moving sand, unrefreshed by a drop of rain, and parched and pulverized by the intense heat of a tropical sun. In some few spots, where springs of water rise to the surface, and admit of the growth of vegetation, a verdant *oăsis* or *wady*, of greater or less extent, varies the otherwise arid and dreary surface of this enormous desert, appearing like an island in the midst of an ocean of sand.

America contains some lowlands of vast extent. Wide-spreading *savannahs*, or plains, occupy a large tract of country, forming the basin, or valley, of the river Mississippi, situated to the west of the Alleghany Mountains. A considerable portion of this great lowland is remarkably level, and subject to annual inundations from

the mighty stream by which it is traversed. Other parts consist of dense forests alternating with *prairies*, or extensive natural meadows, abounding in wild animals.

In South America three remarkable plains or lowlands occur. The basin of the river Oronoco forms the most northern; these plains are usually called *llanos;* the second great plain is that which is traversed by the mighty river Amazon, and which extends from the shores of the Atlantic to the base of the Andes, having a gradual slope, and being in many parts covered with almost impenetrable forests, and in others with luxuriant herbage. These plains are distinguished as *selvas.* The third great lowland of South America, which includes the vast plains of Buenos Ayres, and extends to the cheerless wastes of Patagonia, forms the basin of the rivers Paraguay and La Plata. These plains are usually termed *pampas.*

Valleys are of three kinds: — *Principal valleys; lateral* or *tranverse valleys;* and *subordinate valleys.*

Principal valleys are usually valleys of large dimensions, enclosed between extensive parallel ranges of mountains. To this class belongs the *Valais*, or *Valley of the Rhone.* This valley is bordered on the south by the Pennine Alps, among

which we meet with Mont Blanc and some of the other most elevated mountain peaks in Europe; and on the north it is bordered by the Jura and the Swiss Alps.

Lateral valleys, or *transverse valleys*, are so termed, because they are situated among and formed by the lateral or transverse branches of mountain ranges, and their size and general arrangement therefore depend on the magnitude and direction of the mountains among which they occur.

Subordinate valleys, as the name implies, are valleys of subordinate or smaller size, which are formed by the spurs or minor branches of mountain ranges, or which are situated among hills.

Some valleys are *basin-shaped*, or of a circular form, being surrounded by a girdle of mountains, with the exception of one small outlet, which allows of the escape of the superabundant waters. Such valleys appear to have formed the beds of lakes at some previous period, the waters of which having been drained off through the small gorge or outlet, the lake has been converted into a fertile valley. The beautiful valley of *Cashmere* presents an example of a basin-shaped valley.

When valleys are narrow and difficult of

access, they are termed *ravines*, *glens*, *dells*, *defiles*, *gorges*, *gullies*, *passes* or *ports*. Narrow valleys of this description are of frequent occurrence among steep mountains, and often present scenes of great beauty and grandeur. They usually form the routes by which mountain ranges are crossed, and hence they are called *ports* in the Pyrenees, and *passes* in the Alps and various other mountain ranges. As they are not situated at the highest point, but just below the head or summit of the mountain, they are called *cols* or *necks* in the Alps of Europe. They frequently form the beds of rivers which take their rise amid the snows of mountain regions.

The valleys and plains to which our attention has hitherto been directed, though low in elevation as compared with hills and mountains, are all more or less above *the level of the sea*, which latter forms the standard by which all the undulations on the earth's surface are measured. In Central Asia a large tract of country exists which is commonly supposed to be depressed below the sea level, though the fact is denied by high authority. This extensive area includes the *Caspian Sea* and the *Sea* or *Lake of Aral*.

VI. GEOLOGY.

Geology consists of an inquiry into the nature and arrangement of the various rocks and other substances at or near the surface of the earth.

The portion of the earth which is accessible to man's observation is termed the *earth' crust*, though this forms but a very small part of the whole globe, for the deepest mine hitherto explored scarcely penetrates more than half a mile into the interior of the earth, and the inequalities on its surface arising from mountains and valleys have been well likened to the roughness on the rind of an orange, as compared with the general mass.

An examination of the earth's crust shows us that it is formed of numerous beds or *strata* of rocks, some of *limestone*, some of *sandstone*, some of *clay;* some very hard, others soft and crumbling and readily worn away by the action of running streams or the waves of the ocean. The greater number of these beds contain *organic remains*, that is, the remains of animals and plants, which are termed *fossils*. Among these the most numerous are the remains of marine

animals; in some instances, shells and corals occur in such abundance as to form the principal part of extensive beds. Every part of the earth exhibits similar or nearly similar formations; and not only are marine fossils met with in the interior of continents and at great elevations above the sea, but a vast variety of plants, corals, shells, fish, reptiles, &c. &c., are met with in a fossil state, of species dissimilar to any at present on the land or in the waters.

Besides rocks, we meet with *earthy formations* on the earth's surface. These include such loose materials as are *disintegrated* or worn away from rocks, and form, when combined with decayed animal and vegetable matter, or *humus*, the soil of meadow and arable lands, and, generally speaking, all beds which are not *consolidated*, or hardened. *Water-worn pebbles*, that is, fragments of rocks rounded by friction and the action of water, are of frequent occurrence, forming *gravel* in the beds of rivers, &c., and *shingles* on the sea-shore. When of very large size, they are termed *boulders*.

When rounded pebbles become cemented together by lime or any other material, so as to form a solid rock, the mass is called *conglomerate*, and sometimes *pudding-stone*. When angu-

lar fragments are thus cemented together, the term *breccia* is substituted.

The most abundant materials or *earths* of which rocks are composed are, 1, *silica*, or *flint;* 2, *lime;* and 3, *alumina*, or *clay*.

Silica, or *silex*, is very universally diffused over the earth's surface. It is found almost pure in *quartz*, *flint*, *opal*, *chalcedony*, *rock crystal*, and in the *flinty sand* of the sea-shore. Water passes freely through sand; and, accordingly, sandy tracts do not retain water so as to promote vegetation, and they are therefore usually barren; of which the Sahara presents a striking example.

Lime is also a very generally distributed earth, and is usually found in the form of *carbonate of lime*. Under the several names of *marble*, *limestone*, *oolite*, and *chalk*, it constitutes mountains, and even ranges of mountains.

Alumina is likewise a very abundant earth, and of great importance to mankind. It enters largely into the *clayey or argillaceous earths*. It forms part of various kinds of rocks, and its special utility arises from its property of not permitting water to pass through its substance — a property which renders it of inestimable value, both for natural and artificial reservoirs of water.

The beds or layers of rocks which form the

crust of the earth are divided into *stratified* and *unstratified.*

1. *Stratified* or *sedimentary* rocks are such as give evidence of having been formed by successive deposits of sediment in water. They are called stratified, because the materials of which they are composed appear to have been deposited in successive *strata* or *layers;* they are also called *aqueous*, because this appears to have been effected by the agency of *water;* they include *sandstones* or *freestones*, *limestones*, *clays*, &c.

Stratified rocks being formed by successive deposits of layers of sedimentary matter by means of water, it is evident that these materials must be derived from some source, and in many instances this may be traced to the *disintegration* or *crumbling away* of older rocks. Thus *gneiss* appears to be formed by the disintegration of *granite*, *conglomerate* by that of various kinds of rocks.

Although all the different kinds of stratified rocks do not occur in every part of the earth's crust, they are found to form a regular series, and those which are of more recent formation have never been met with under those which are considered as more ancient. Most of the stratified rocks contain fossils; and since each group con-

tains a certain number of fossils peculiar to itself, it is by means of these organic remains that the relative ages of the different strata have been determined.

But although the lowest stratified rocks are more ancient than those which have been deposited above them, the layers or beds do not always retain a horizontal position. Were such the case, it could only be by means of deep cuttings that we should arrive at the older strata; we, however, find, that owing to some convulsions of the earth, stratified rocks, and in some instances, whole series of stratified rocks have been thrown out of their original horizontal position, and thus the various beds *crop out* or come to the surface, as in the accompanying cut, where we perceive that no less than five different kinds of rock come to the surface.

Not only is facility thus afforded us to become acquainted with the nature of the lower rocks, but many of the most valuable products of the earth are by this means rendered more accessible to man.

2. *Unstratified rocks* are such as appear to be of *igneous* origin; that is, to have been formed by the action of *fire* or *intense heat;* they are called unstratified, because, instead of having been deposited in successive layers, like the stratified rocks, they seem to have been formed by the *fusion* or *melting* of the materials of which they are composed, and the subsequent cooling and hardening of the melted matter into one great mass. *Granite*, *basalt*, *lava*, &c., belong to this class of rocks.

Unstratified rocks may be divided into three classes: — 1. *Plutonic;* 2. *Trap;* 3. *Volcanic.*

Plutonic rocks are rocks which appear to have been formed at a considerable depth in the interior of the earth by the agency of heat, and in consequence of their having *cooled under the pressure of superincumbent*, or *over-lying rocks*, to have become greatly compressed and hardened. The principal rock of this class is *granite*, which is a very universally diffused rock, though in very many parts of the earth it is concealed from our view by the stratified rocks which rest upon it. In some parts, granite veins or branches extend upwards into the stratified rocks. Granite occurs in all of the New England States, but the purest and most easily wrought is found at Quincy and Rockport in Massachusetts.

Trap rocks are formations which are considered to be the products of *volcanoes which have been long extinct.* These rocks, like the Plutonic, are supposed to have been in a state of fusion, but to have *cooled down under the pressure of deep water*, probably of a profound ocean. *Basalt* is one of the most abundant rocks of this class. It sometimes occurs in tabular masses, but more frequently in regular columns, usually called *basaltic columns.* The *Giant's Causeway*, in the north of Ireland, presents a remarkable instance of a formation of this kind. Trap *dikes* are masses of trap which have forced their way into or through other rocks, and are sometimes of great extent.

Volcanic rocks are less compact and less hardened than either plutonic or trap rocks, which is supposed to be owing to their having *cooled in the open air.* The principal volcanic rocks are, *tufa* or *calc tuff*, *pumice-stone*, and *obsidian. Loose sand*, *scoriæ* or *cinders*, and *ashes*, are also ejected from the *craters* or mouths of volcanoes, and some volcanoes pour forth streams of muddy water, whilst all emit volumes of gaseous matter and steam.

The regions where volcanic action is at present displayed in the greatest energy include *Mount Vesuvius* and *Mount Etna*, and the adjacent seas;

the *islands* of the *Indian Archipelago; Central America* and the *Andes*; some of the *islands* of *Oceanica; Iceland* and *Kamtschatka*, in the cold regions of the north; and *South Victoria Land*, amid the perpetual snows of the southern polar regions.

Terrific as are the effects sometimes produced by volcanic eruptions, there seems reason to conclude that in many instances they may rescue the districts where they occur from the yet more destructive visitations of earthquakes. For it appears that the melted matter in the interior of the earth, being enlarged in its volume by the action of internal heat, strives to force its way through the rocks which form the earth's crust; but on encountering the outlet afforded it by the crater of a volcano, this melted matter pours forth on the surface of the ground. The melted matter or lava ejected by the volcano of *Skaptar Yokul*, in Iceland, in the year 1783, was of immense volume. Two streams of lava flowed in opposite directions, the width of one stream being about twelve or fifteen miles, its depth about one hundred feet, and it extended to about fifty miles from the mouth of the volcano. The second stream was of equal depth, but not of so great width, nor did it extend beyond forty miles. Had this mighty mass of melted matter not found

a vent, we may well suppose that it might have shattered the rocks to atoms, and given rise to the most fearful earthquakes. And in fact it frequently happens, that in volcanic regions, earthquakes cease at the very moment that eruptions commence from adjacent volcanoes, and occasionally even from volcanoes comparatively remote from the convulsion. It thus appears that in certain portions of the earth's crust, underground communication must extend to considerable distances. This is strikingly displayed in the *Andes*, and a wide extent of country at their base.

The effects produced by earthquakes are sometimes very remarkable, convulsions of this kind occasionally agitating immense tracts of country, shattering and displacing rocks, and even permanently raising continuous tracts of land above their former level, or causing the depression of others; thus effecting great alterations in the surface of the countries where they occur.

Earthquakes of great severity sometimes occur in regions remote from any active volcano; of this the tremendous convulsion which took place at Lisbon in the year 1755 forms an instance. On that occasion the agitation of the earth's crust extended to the British Isles, and even to the West Indies and some parts of North Ameri-

ca. Slight tremors of the earth are occasionally felt in all parts of the globe.

Extinct volcanoes occur in various parts of the earth's surface; and in such cases we may infer, that though at some former period earthquakes and volcanic eruptions may have taken place in those localities, these have now ceased, and the melted mass has cooled down and formed a solid rock.

Igneous rocks have in many cases forced their way up through stratified rocks, forming what are termed *intrusive rocks*, because they have *intruded* into the region of rocks of another class. These igneous formations, whilst still in a molten state and intensely hot, coming in contact with the aqueous or stratified rocks, have usually changed the character of those portions immediately near them, thus forming what are called *metamorphic* or *transformed* rocks. By such means *limestone rocks* have become transformed into *crystalline marble*.

The effects produced at remote periods by violent convulsions of the earth may also be traced by the *dislocations* or *faults* to which they have given rise. A *dislocation* or *fault* is so named because any bed or stratum of rock where it occurs has been rent asunder and *dislocated* or *displaced*, so that one portion is either

raised above or depressed below its former level: the stratum being therefore no longer entire and continuous, an interruption or *fault* takes place.

As sandstone and limestone rocks permit water to *percolate* or *pass through* their substance, which clay does not, these dislocations or faults are of great importance in the natural world, the clay strata frequently, in consequence of their altered position, arresting the water and causing it, instead of remaining concealed beneath the surface in an extended sheet, to gush out in the form of a spring at the point where the dislocation has occurred. The *fissures* or *crevices* where these displacements have taken place are not unfrequently found filled with clay and other materials, which arrest the water in its progress. In some localities fissures are found to contain metallic substances, and are then distinguished as *metallic veins.* Such fissures are frequently found partially filled with *calcareous spar* or *crystallized carbonate of lime*, which forms the *matrix* or *covering* in which the metals are inclosed.

Metallic or *metalliferous* veins are supposed to have been partly filled by *mechanical means*, that is, by particles of metallic substances being conveyed into them by the action of water or some other power; and partly by *chemical action*, that

is, by *sublimation*, or *fumes rising from below*, causing deposits to take place in these fissures. The rich lodes or metalliferous veins of Cornwall in England occur in fissures, more than one dislocation having in many instances apparently taken place.

Some metallic deposits appear to occur in situations where igneous rocks have intruded themselves into stratified rocks, and converted them into crystalline rocks. Gold is supposed to be found almost invariably under such circumstances. Such appears to be the case in the rich deposits near the Ural mountains in Asiatic Russia; as also in California and in Australia; in all which places it is met with in *quartz*. It is in pebbles and sand of the same rock that it occurs in the beds of rivers, and in some cases is found spread over a large extent of country.

Copper, though frequently met with in veins, is also found in extensive masses or beds, interposed between layers of rock. The same remark applies to *tin*, *lead*, and *silver*. *Iron* is a very generally diffused metal, and is met with in beds, and also in *nodules*, or rounded masses, which occur in great abundance among some kinds of rocks.

VII. THE WATERS OF THE GLOBE.

The waters of the globe may be considered under four heads;—1. *Springs;* 2. *Rivers;* 3. *Lakes;* 4. *The Ocean.*

Springs, or *natural fountains of water*, take their rise from reservoirs, or sheets of water, stored beneath the surface of the ground. A sheet or body of water has a tendency to maintain the same level surface, or to rise to the same height, wherever it may spread; the height to which a spring will rise depends therefore on that of the surface of the reservoir of water from which it is supplied. If the internal reservoir of water be situated in a hill, and the spring should gush out in a valley, the water may rise to a considerable height above the surface of the ground, and form a natural fountain; but, on the other hand, if the reservoir be situated at some depth below the surface of the ground, the water may never reach the surface, and the aid of a bucket or a pump may be required to obtain water from such a source.

These internal reservoirs of water are in great measure supplied by moisture derived from rain, snow, mist, and dew. This atmospheric water enters the earth through porous rocks, or by

means of fissures, and continues to sink until arrested in its progress into the interior of the earth by rocks such as clay, which will not permit water to pass, or else by faults, which check it from spreading into a wider sheet. The water then will gush forth as a spring of greater or less size, according to the supplies it may have received. The peaks or pointed summits of mountains, owing to the small surface they present for collecting the rain, snow, or dew, are not favorable for the formation of copious springs.

All springs contain a certain proportion of air and gas, and also some solid matter, usually in the form of salts. When this does not exceed a three-thousandth part of the whole, they are termed *soft;* but if the solid contents exceed this proportion, the water becomes *hard.* When these salts are in great abundance, the water becomes wholly unfit for domestic use, and *mineral springs* are formed. Such springs are found in Worcestershire in England, and in America, throughout the states of Ohio, Kentucky, and New York. The springs in Onondaga county, N. Y., are the most valuable, and have long been worked.

Medicinal springs contain in addition to common salt, sulphate of soda and sulphate of magnesia, commonly known as Glauber's and Epsom

salts. The Cheltenham springs in England are an example of these.

Mineral springs may be divided into six classes: 1. *Acidulous;* 2. *Chalybeate;* 3. *Sulphureous;* 4. *Saline;* 5. *Calcareous;* 6. *Siliceous.*

Acidulous waters present a sparkling appearance, which arises from their containing *carbonic acid gas.* Of this, the pleasant beverage called Seltzer water forms an example. Carbonic acid gas has the property of rendering soluble in water the oxide of iron and various other mineral substances, and therefore these springs usually contain some earthy or saline ingredients. The springs at Saratoga belong to this class.

Chalybeate springs, properly so called, are such as hold in solution either the *carbonate* or *sulphate of iron.* A small spring of this description occurs near Brighton in England.

Sulphureous springs contain *sulphur* either in the form of *sulphuretted hydrogen*, as the springs of Avon, N. Y., or the numerous sulphur springs of Virginia; or in that of *sulphate of lime*, like the springs of Baden, near Vienna.

Saline springs are of two kinds, *brine springs* and *medicinal salt springs. Brine springs* contain, besides some other mineral ingredients, a greater or less proportion of *chloride of sodium*, or

common salt, some springs yielding one-fourth of their weight in salt.

Calcareous springs, or springs highly charged with *calcareous* matter, are met with in *limestone* rocks, from which they derive their calcareous ingredients. Water has the property of dissolving the calcareous rocks over which it flows or through which it filters, and of again depositing it, so as to form as the water evaporates an incrustation and in process of time a solid rock. The Dropping Well at Knaresborough affords an instance of such a spring. The water falls in the form of a shower from a projecting ledge of rock, and if plants, or shells, or the bones of animals are placed so as to allow the water to fall on them, they become embedded in the *tufa* or *travertine*, as it is called, and apparently converted into stone, in which state they may be permanently preserved. And hence these springs are usnally termed *petrifying* or *mineralizing springs*.

In some instances when water *percolates* or filters through limestone rocks into cavernous recesses, very beautiful formations called *stalactites* and *stalagmites* are met with; the stalactites being suspended from the ceiling of the cavern like icicles of stone, and the stalagmites being formed by successive deposits on the ground and rising in all varieties of form from the floor.

Stalactites and stalagmites in some caverns meet and unite, presenting the appearance of columns supporting an edifice. Travellers who have visited Mammoth Cave in Kentucky describe the splendor of the natural halls and the vast pillars as they glitter in the torch-light.

Siliceous springs are so named from holding *silica* or *flint* in solution. These springs are all *hot* or *thermal*, as well as mineral springs. The most remarkable springs of this class are the *Geysers* of *Iceland*.

Thermal or *hot springs* are met with in all parts of the globe. They may be arranged in two classes: 1. Those which owe their high temperature to the natural heat of the earth at certain depths; and 2. Those which derive it from volcanic action.

It has been found that on penetrating into the earth below the depth of 100 feet, an increase of temperature takes place, both in solid rocks and in internal reservoirs of water, the increase being at the rate of about one degree of Fahrenheit's thermometer in 45 feet. And, accordingly, springs which have their sources at greater depths possess a higher temperature than those which derive their supplies nearer the surface. This has been proved by water obtained from

Artesian wells at various depths. One of these near Paris is 1800 feet deep. The water as it rises to the surface is 50 degrees above the freezing point. At this rate of increase in the temperature, all water is in a boiling state two miles below the surface; at a depth of ten miles, if the temperature increases at the same rate, (and we have no reason to think that it does not,) metals are at a red heat; at thirty, all known substances must be in a state of fusion.

The hottest springs are those situated near active volcanoes. Among these the *Geysers* of Iceland hold a prominent place, their temperature being rather above the point of boiling water. Some springs connected with extinct volcanoes have a very high temperature. Many of these are found in the south of France.

Bituminous or *pertroleum springs*, that is, springs charged with *bitumen*, *petroleum*, *naphtha*, *asphaltum*, &c., are of common occurrence in volcanic districts, or in districts where traces of igneous action are distinctly observable.

RIVERS.

THE sources or first waters of *rivers* are usually derived from springs, or from the melting of

accumulations of snow. They do not therefore receive their largest supplies from the actual summits of mountains, for copious springs are rarely met with in such situations, nor are glaciers formed on the highest points of mountains, but more usually on the declivities or slopes of the upper mountain valleys. It is accordingly in the latter localities that many of the largest rivers take their rise. Thus the Rhone has its source in the glaciers of the Alps, at the elevation of 10,000 feet above the level of the sea.

It not unfrequently happens that several rivers take their rise in one mountain ridge, some of the rivers flowing in one direction, and others taking an opposite course. This ridge is termed the *water-shed.* The mountainous districts of Westmoreland form the principal water-shed of the north of England. The Eden flows in one direction, the Tyne and Tees in another, the Ouse in a third, &c. The chief water-shed in Europe is formed by the Alpine system, and its prolongation into Germany. Thus the Rhine, the Rhone, and the Danube, all take their rise in the Alps, the first discharging itself into the German Ocean, the second into the Mediterranean, and the third into the Black Sea. In Eastern Europe the water-shed is formed by the low ridge of the Valdai Hills, not more than 1200

feet above the level of the sea. From this the Volga flows, which pours its waters into the Caspian Sea, the Dwina,* which falls into the Baltic, and the Dnieper, which enters the Black Sea.

Thus the Appalachian Chain, including the Cumberland and Alleghany Mountains and the Blue Ridge, is the chief water-shed of the eastern United States. It sends the James, the Rappahannock, the Santee and the Savannah to the Atlantic, the Cumberland, the Monongahela, the Kentucky and the Tennessee to the Ohio.

The portion of country through the course of which a river lies, and which is drained by it and its tributary streams, is called its *basin.* The extent of the basin of the Thames is estimated at about 5000 square miles. The area drained by the river Thames and its tributary streams is very small, compared with that drained by some of the great rivers of the globe. The largest river basin in Europe, as will be observed in the following table, is that of the Volga, the largest in the world that of the Amazon.

* On many American maps the name of this river is spelt Duna. The pupil must not confound it with another river of the same name which flows into the White Sea.

RIVER BASINS.	SQUARE MILES.
Thames	5,000
Rhine	89,000
Danube	312,000
Ganges	443,000
Volga	653,000
Mississippi	1,100,000
Amazon	1,920,000

The velocity of a river depends in a great degree on the nature of the country in which it takes its rise, and which it traverses. The Thames has its source at an elevation of only a few hundred feet above the level of the sea, and, since its whole course lies through a comparatively level country, it flows with a moderate velocity and presents no instances of torrents, rapids, or waterfalls, a circumstance which renders it particularly available for the purposes of navigation; and thus though it may appear insignificant when compared with some of the mighty streams on the earth's surface, it possesses advantages superior to most rivers, having also an unimpeded entrance, and being navigable for large vessels to the very banks of the metropolis.

Rivers which take their rise in elevated mountain districts usually flow with great velocity in the earlier part of their course, rushing down in torrents, or leaping down in *cascades* or *cataracts*. When waterfalls are of an impetuous character,

they are generally termed *cataracts;* when more gentle, they are called *cascades.* Waterfalls are very numerous among the Alps and other mountainous regions. When a continued slope occurs in the bed of a river, *rapids* are formed.

It occasionally happens that, owing to local peculiarities at the mouths of rivers, accumulations of sedimentary matter take place in the middle of the stream, dividing it into two or more branches. By this deposition of alluvium, deltas are formed, many of them, those of the Ganges, the Orinoco, the Mississippi and the Rhine, for example, being of great extent. The term delta is applied to these on account of their triangular form, like the letter △ of the Greek alphabet.

Some rivers which fall into the ocean, and have *estuaries* or wide channels at their mouths, are subject to a great swell or sudden rise of the waters when the tide enters the river. This is called the *bore.* It occurs especially at spring tides, when a more than ordinarily large volume of water enters the mouth of the river. The bore may be observed in the *Severn,* and some other rivers of Great Britain, and is displayed on a grand scale in the rivers *Ganges* and *Amazon.* In the latter river, for three successive days at the time of the equinoxes, five waves from 12 to

15 feet high follow each other up the river, presenting a truly singular spectacle.

Most rivers are subject to an occasional, and, in some instances, periodical increase in the volume of their waters. In the rivers of Great Britain and the United States, these *flood seasons*, or *freshets*, as they are termed, are by no means regular, being partly dependent on the melting of the snows, and partly on occasional heavy falls of rain. In countries where the climate is less variable, these flood seasons in the rivers are usually periodical. Thus the flood season in the *Volga*, being dependent on the melting of the snows in Northern Russia, takes place in June. The rise of the *Nile* being dependent on the periodical rains which fall abundantly on the mountains where its source is situated, almost invariably begins in the middle of June, and the waters continue to increase until the end of August or beginning of September, when the river is at its greatest height and the whole valley of Egypt is usually inundated.

The number of considerable rivers which pour their waters into the ocean is estimated at about 440 in the Old World, and 140 in the New World.

The following table gives the length and situa-

tion, and also the termination of some of the principal rivers on the surface of the globe.

RIVER.	LOCALITY.	TERMINATION.	MILES.
Mississippi and Missouri	United States	Gulf of Mexico	4200
Nile	Nubia and Egypt	Mediterranean Sea	3600
Amazon	Brazil	Atlantic Ocean	3600
Yang-tse-Kiang	China	Pacific Ocean	3300
Niger	Nigritia	Gulf of Guinea	3000
Mississippi proper	United States	Gulf of Mexico	2400
Volga	Russia	Caspian Sea	2200
La Plata	Brazil and La Plata	Atlantic Ocean	2200
St. Lawrence	Canada	Gulf of St Lawrence	2000
Indus	Hindostan	Indian Ocean	1800
Danube	Germany, &c.	Black Sea	1700
Euphrates	Turkey in Asia	Persian Gulf	1700
Oronoco	Venezuela	Atlantic Ocean	1550
Ganges	Hindostan	Bay of Bengal	1500
Colombia or Oregon	United States	Pacific Ocean	1500
Dnieper	Russia	Black Sea	1200
Gariep or Orange	South Africa	Atlantic Ocean	1050
Ural	Russia	Caspian Sea	950
Ohio	United States	Mississippi	950
Rhine	Switzerland, Germany & Holland	North Sea	760
Seine	France	English Channel	440
Connecticut	United States	Long Island Sound	400
Hudson	United States	Atlantic Ocean	350
Thames	England	North Sea	215

NOTE. — This list of rivers is changed but slightly from the English edition. While it should be so thoroughly learned, that the pupil can give the locality, termination and length of any river taken at random from the table, still the teacher should impress the fact that the lengths of many of the largest rivers of the globe have never been obtained with exactness, and that neither this table, nor in fact any table in the present state of geographical knowledge, can be appealed to as final authority upon the

length of rivers. We find, on collating various statistics bearing upon this point, a deviation in one instance of 1300 miles from the length given by Miss Zornlin. This, it is true, is an extraordinary case; the river is the Kiang-Ku or Yang-tse-Kiang, an immense and splendid stream, but not well known.

LAKES.

Lakes are of different kinds. Some may be considered as tanks or reservoirs which receive the first outbreakings of a spring; and in lakes of this description, if the volume or quantity of water be of small amount, the evaporation from the surface may be sufficient to dispose of the whole supply from the spring; and therefore such a lake will require no outlet. Such is the case with a large number of small lakes and ponds in all parts of the globe. If the amount of water sent forth by a spring be more than will fill the hollow which forms the basin of the lake, the water will scoop out for itself a channel, and issue forth either in the form of a little brook, of a rivulet, or of a river. Many important rivers have their sources in small lakes. Thus the river *Volga* commences its course by issuing from the small *Lake of Ternoff*, the *Amazon* from *Lake Reyes*, and the *Mississippi* from *Lake Itasca.*

Other lakes consist of basins or reservoirs which occur in the line of a river's course, into which its waters flow, and which, having filled the cavity, issue forth from some other point. A river may form numerous lakes of this kind in its progress. Thus the *Mississippi*, in the earlier part of its course, passes through no less than eight such lakes, some of which are of considerable size. Most of the lakes or loughs* of Ireland are thus formed. Indeed, the Shannon river is but a succession of these.

Some lakes consist of basins or cavities into which rivers flow, but which on account of their depression or their mountainous surroundings have no outlet. Instances of this class are the Caspian Sea and the Sea of Aral, which are great inland lakes, and Lake Asphaltites or the Dead Sea. The rivers which supply them are continually bringing down a portion of salt which they have dissolved from the soil through which they pass, and which occasions the brackishness of most river water. As evaporation proceeds, the purer portions only are removed, the saline matter remains, and thus salt lakes are formed. The Dead Sea receives the waters of the Jordan on the north, of the Arnon on the east, and of

* Pronounced *locks*, nearly.

the brook Kedron or Cedron on the west. Its waters are salter than those of the ocean, and this fact is accounted for, partly by the explanation just offered, and partly by the circumstance that it is constantly dissolving the blocks of salt which are found on its southern shore.

Lakes are sometimes formed in the craters of extinct volcanoes, and in such cases the waters are usually strongly impregnated with sulphur and bitumen.

Some lakes are *periodic;* that is, subject to have their basins alternately empty and full of water. Of this description is the *Lake of Zirknitz*, in Carniola, which in midsummer is dry and allows a luxuriant crop of grass to cover its bottom, but is filled in autumn, and continues full through the winter and spring.

The lakes in the British Isles are of small size. Windermere is the largest English lake, not exceeding eleven miles in length and one mile in width. The largest European lakes are the lakes of *Ladoga* and *Onega* in Russia. The *Caspian Sea* may be considered as the largest lake on the face of the globe, its length being about 700 miles, and its width about 210 miles. North America contains the largest *fresh water* lakes in the world, and, indeed, a vast chain of connected lakes occupies a wide surface of coun-

try in its more northerly regions. This chain includes *Lakes Superior*, *Huron*, *Michigan*, *Erie*, and *Ontario*, the surplus waters of which, after having formed the grand *Fall of Niagara* between Lakes Erie and Ontario, are discharged into the Atlantic by the river St. Lawrence. The frequent and violent storms to which large lakes are eminently subject are produced by the violent rushing of the wind down the sides of the mountains by which they are surrounded. The scenery of small lakes is the most beautiful in the world.

THE OCEAN.

THE extent of the vast mass of waters called *the Ocean* greatly exceeds, as we have already seen, that of the dry land on the surface of the globe. This is an arrangement of great importance in the natural world, for abundant supplies are thus afforded, by *evaporation* from its vast surface, for the large amount of moisture required to water the earth, which descends in the form of showers and dew.

The ocean consists of *one* great fluid mass; and in accordance with the laws by which fluids are governed, its waters flow into and occupy the great depressions on the Earth's surface which

form its bed, maintaining a general level in all parts of the globe, whatever may be the undulations of the ground on which it rests.

Although thus in fact one mighty whole, the ocean has received in geographical descriptions several nominal divisions and subdivisions.

The two principal divisions of the ocean are those of the *Atlantic* and the *Pacific*, which are formed by the two great continents. The *Austral* or *Southern Ocean* may be regarded as forming a third division, and occupies that portion of the ocean not included in the two former divisions. Its limits may be traced by a line passing round the globe, and touching the Cape of Good Hope, Cape Horn, and the southern extremity of Tasmania (Van Diemen's Land).

The Atlantic Ocean is sometimes subdivided into three portions; the *Northern Ocean*, which includes the *Polar Seas*, and extends to an imaginary line drawn across the ocean, from the northern extremity of the British Isles to the southern extremity of Greenland; the *North Atlantic*, extending from that line to the Equator; and the *South Atlantic* from the Equator to the southern extremities of Africa and America, that is, to the Austral or Southern Ocean.

The Pacific has also three subdivisions; the *North* and the *South Pacific*, and the *Indian Ocean.*

The division between the North and the South Pacific is marked by the line of the Equator; and the latter extends to the southern coasts of Australia. The Indian Ocean comprises the seas extending from Australia and the western limits of the Indian Archipelago to the eastern coasts of Africa.

In various parts of the great continents, deep inlets, called *branch* or *inland seas*, occur, penetrating far into the interior, and communicating with the main ocean either by narrow straits, as the *Red Sea*, the *Mediterranean*, and the *Baltic;* or by wider channels, as the *White Sea*, the *Yellow Sea*, *Baffin's Bay*, &c.

Smaller inlets of the sea are of frequent occurrence, especially in districts where mountain ranges approach the borders of the ocean. Such are the *lochs* of Scotland, the *voes* of the Shetland Isles, and the *fiords* of the coast of Norway. The term *lagoon* is usually applied to the lake-like inlets on the shores of the Adriatic Sea, in the midst of one of which the city of Venice is built.

The ocean varies greatly in its *depth*, but is supposed generally speaking, to be deepest at a distance from land, and shallowest in channels and straits and near islands, though it differs much in its depth in the immediate vicinity of dry land,

according to the character of the surface, whether the shores may be flat or rise abruptly from the sea. The *mean* or *average* depth of the sea round the comparatively level coasts of South Britain, is considered not to exceed 120 feet; off those of Scotland, to be about 360 feet; and off the western coast of Ireland, where rocks of a precipitous character abut upon the sea, to have the depth about 2000 feet. In some parts of the mid-Atlantic Ocean the plumb-line has been let down to the depth of 27,000 feet, without reaching the floor of the ocean, and it is probable that we shall never be able to ascertain with certainty the greatest depth, for no line can be made strong enough to bear its own weight, and yet be manageable, if we attempt to go much beyond five miles and a half (27,000 feet).

The *temperature* of the ocean's surface appears generally to agree with that of the climate in which it is situated, that is, with the temperature of land at the level of the sea. In warm climates the temperature of the deep sea diminishes with the depth below the surface, until a certain depth is reached, below which it appears to retain an equable temperature, this being about 40° Fahrenheit. In the Polar Seas, where the temperature at the surface of the ocean is lower than 40°, the temperature is found to increase until it

reaches that point. About N. lat. 70° the temperature of the ocean is considered to be the same at all depths.

The waters of the ocean are *salt*, holding in solution various saline matters which impart to to them a disagreeable taste, and render them unfit for the beverage of man. The saline ingredients amount to rather more than thirty-five grains in a thousand grains of sea-water. The most abundant of these is *chloride of sodium*, or *common salt*, which in general forms above one-third of the whole saline matter. Besides this, sea-water contains some *magnesia*, *lime*, *potash*, and traces of *iodine* and *bromine*. The *specific gravity* or *weight* of sea-water is greater than that of pure water. Pure water (at the temperature of 60°) is reckoned at 1000; the specific gravity of sea-water is 1027. Sea-water in the vicinity of land is usually less salt than in the deep ocean; probably owing to the drainage of the land and the influx of rivers. For the same reason, branch or inland seas are ordinarily less salt than the ocean. Thus, the waters of the *Baltic Sea*, into which numerous important rivers pour their streams, are much less salt than those of the ocean.

The *Mediterranean Sea* forms an exception to the general rule of the inferior saltness of branch

or inland seas, the waters of that sea being found to contain a larger proportion of saline matter than those of the Atlantic Ocean. This peculiarity is supposed to be attributable to the proximity of this branch of the ocean to the burning sands of Africa, and also to the parching winds which, passing over this sea after traversing those desert tracts, cause an extraordinary amount of evaporation to take place from its surface.

The *freezing point of water* is affected by its saline contents. The freezing point of fresh water being 32° Fahrenheit, that of sea-water is 28° or 29°. The waters of the ocean therefore require a greater degree of cold than do those of a fresh water lake, to convert them into a solid mass of ice; and it is only in very cold climates that ice is formed in the open sea.

Icebergs, or mountains of ice, though occasionally formed in the sea itself by the accumulation of ice and snow, appear more frequently to consist of glaciers which have been originally formed on the shores, and which, becoming detached and falling into the water, have been floated out to sea. Icebergs are met with in great numbers about N. lat. 70°, but they are sometimes carried by currents into much lower latitudes, having been observed in the northern

hemisphere in the parallel of 40°, and in the southern hemisphere in that of 36°. Some icebergs are of enormous size, being two or three hundred feet in height above the water, and probably having about eight times that depth below the surface, and extending sometimes for two miles or more. These are found not so often alone as in groups, and the surface which they expose is sometimes so great as perceptibly to freshen the sea in their vicinity.

Sea-water when seen in small quantities seems to be colorless, but when seen in a large mass, its natural *color* appears to be sky-blue. Since the water acts like a mirror and reflects the hues of the changing skies, it may often appear to assume different tints, as the sky is clear or cloudless, or according to the position of the sun. Thus at times it will appear of a dull dead color, at others it will present varied tints of purple and green, at others, shine like burnished gold.

In some cases, however, the general color of the ocean is affected by the nature of its bed, especially if the water be shallow; for yellowish sand mingling its color with the natural blue tint of the ocean imparts a greenish hue to the whole mass. If the bed of the sea be red, as is the case in some parts of the Mediterranean,

(probably owing to the red coral which abounds in some parts), this red hue combined with the bright blue of the waters of that sea gives a purple tint. When the water is very clear, the red hue prevails, and the waters appear tinged with that color. Thus, in the *Bay of Loango*, off the western coast of Africa, the water appears so red that it might be supposed to be mixed with blood.

Sometimes color is imparted to the ocean by the presence of innumerable minute living creatures. Thus, in the Polar Seas, the water in some parts appears of a green hue, in consequence of its being filled with myriads of yellow *semi-transparent medusæ*. From a similar cause, the ocean in other parts appears of a brown color, in others of a milky white, and in others of a deep red hue.

The *luminosity* or *phosphorescence* of the ocean appears in some instances to be produced by decaying animal and vegetable substances, but in others to arise from the presence of vast numbers of living animals, which, like the glow-worm, have the power of emitting light. Some of these luminous animals shine like liquid silver, and others sparkle like amethysts and emeralds.

VIII. TIDES, WAVES, AND CURRENTS.

The waters of the ocean are in perpetual movement from the effects of *tides*, *winds*, and *currents*.

The waters of the ocean are retained in their bed on the surface of the globe by the *attraction of gravitation*, that is, by the power which has been imparted to all particles of matter to *draw towards them* or *attract other particles of matter*. This power of attraction is great in proportion to the mass of any body, a large mass of matter having a much greater power of attraction than a small one; and as the earth is of much greater mass than the particles of water on its surface, it attracts them and keeps them in their assigned place. But the sun and moon also possess this power of attraction, and notwithstanding their distance from the waters on the earth's surface, attract and draw them up to a certain elevation in the wide open ocean.

The vast mass of the waters being drawn up by the influence of the moon into a great mountain or curve of water in the wide open sea, forms what is termed the *great primary wave*, or *tidal wave*. When the waters of the ocean

are thus drawn up to form this great wave, they necessarily recede from our shores, thus giving rise to *ebb tide* or *low water*. But when the temporary attraction ceases, the waters having been raised above their ordinary level naturally flow down and spread in all directions, returning to our shores, and forming *flood tide* or *high water*.*

This *culmination* or rising of the waters in this great wave takes place twice in twenty-four hours and fifty minutes. The combined influence of the sun and moon at new and full moon augments the size of this wave, and causes the *spring tides* at those periods. The great Atlantic tidal wave arrives first at the western shores of the British Isles; it then divides into two branches, the principal of which passes round the coast of Scotland, and travels southward

* An attempt to popularize the theory of tides must lead to much misconception, but Miss Zornlin's explanation is so lucid, so far as it extends, that we have preferred to retain it, with the hope that it may induce the pupil to consult more elaborate works, and make himself master of this interesting subject. It will be noticed that no explanation is attempted of the flood-tide on the side of the earth which is turned from the moon. If the class is sufficiently mature to profit by the explanation, the teacher can avail himself of the black-board to illustrate that portion of the subject. For a full and lucid exposition of the theory of the tides, the editor would refer to Murray's Encyclopædia of Geography.

until it reaches the mouth of the Thames, where it encounters the lesser branch, which has swept along the western shores. High water at the various points along the coasts is dependent on the arrival of this great wave, though some variations are caused by local peculiarities, such as the form of the coast, &c.

The height of the tides varies greatly in the different parts of the earth, but as a general rule it depends upon the nature of the shore. Where the waters accumulate, as in those bays which communicate with the sea by wide channels, the tides rise very high; as for example, at Bristol in England, where the rise is about fifty feet. Perhaps the most remarkable instance is the well-known tide wave of the Bay of Fundy, which in some seasons of the year attains the height of seventy feet. At the shores of small islands, on the contrary, the elevation of the wave is not great. At St. Helena it never exceeds three feet, and at some of the islands of the Pacific the spring tide is but five feet in height, the neap tide not over two-and-a-half.

The waves of the sea which are caused by the action of the wind, and which are called *secondary waves*, or *wind waves*, are of a totally different character from the tidal wave. There is much appearance of confusion in an agitated

sea, but in the midst of this apparent disorder order reigns, and it seems to be in a great measure owing to the continual slight shifting of the wind, that waves appear so frequently to cross and intercept each other. The influence of the wind is supposed not to extend to a greater depth than forty or fifty feet, the deep sea, though raised in a great mass by the grand tidal movement, being free from agitation. Wind waves at a distance from the shore are comparatively long and low, but as they approach the coast where the water is shallow, they assume a greater curvature, and fall on the beach either in gentle ripples, or in magnificent breakers, according to the depth of the water and the force of the wind.

The heavy swell which occasionally takes place on the northern coasts of some of the West Indian Islands, called the *ground sea*, is supposed to originate in distant storms of wind in the Atlantic Ocean. The sea, although the air is calm, suddenly rises as if agitated by a heavy gale, and wave follows wave in quick succession, crested with foam and bursting on the beach with great impetuosity.

*Currents** in the ocean arise from various

* The chart of the currents will be found on page 18.

causes: they may be produced by long-continued gales of wind; by the melting of the polar ice; or by any cause that may give rise to onward movements of limited portions of the great mass of waters. Some currents of the ocean are permanent: the most remarkable of these are the *polar currents*, and the *equatorial currents*.

The *polar currents* are produced by the perpetual movement of the waters from the polar regions to the equator. In accordance with the laws of mechanics, an accumulation of the waters of the ocean takes place in that part of the globe which has the greatest velocity of motion: and as the earth in turning on its axis moves with far greater velocity at the equator than it does in high latitudes, the waters consequently flow continually towards that line, thus forming currents in the ocean which move from the north and south poles to the equator.

This *culmination* or accumulation of the waters of the ocean at the equator, tends to produce the *equatorial currents*, which consist of the continuous progression of the tropical seas in a westerly direction. When the mass of water brought by the polar currents arrives at the equator — coming as it does from regions

where it naturally has less velocity — it does not at once acquire the velocity of the earth at the equator; and since the rotation of the earth is from west to east, this portion of the water lagging behind, forms a stream or current which has an *apparent* motion from east to west, that is to say, apparent as regards the earth, but real in relation to the adjacent land and water. The trade winds, which in this zone blow perpetually in the same direction, lend their aid in maintaining the equatorial current.

An extensive system of currents appears to commence in the Antarctic Ocean. A current of cold water flowing northwards joins the equatorial current in the Pacific. Entering the Indian Ocean, it maintains its westerly course until it approaches the shores of Africa. Then bending southwards, it rushes through the Mozambique Channel, and doubling the Cape of Good Hope, travels northwards until it arrives at the Bight of Benin. This current there joins the equatorial current, and crossing the Atlantic from the coast of Guinea to that of Brazil, it is divided into two branches by the projecting headland at Cape St. Roque. The smaller branch flows southwards along the eastern coast of South America, where it meets the Antarctic current to which it owed its commencement.

The northerly branch of this current skirts the shores of Brazil and Guiana, where it receives the waters of the rivers Amazon and Oronoco. After passing the island of Trinidad, this great oceanic current enters the Gulf of Mexico. The waters there acquire the high temperature of about 88° Fahrenheit. Sweeping round that extensive inland sea, they again pour forth into the Atlantic, forming the most powerful of known currents, called the *Gulf Stream.* On issuing from the Gulf of Mexico this current of warm water rushes with considerable force through the straits of Bahama. Then taking a northward course, it travels along the eastern shores of North America, until it approaches Newfoundland, where it is turned to the eastward, by an opposing cold current which sets in from Baffin's Bay. It now maintains an easterly direction, and crossing the Atlantic arrives at the Azores in about twenty-eight days, and divides its waters on the coast of France and Spain; a portion goes southward, and at length joins the grand current which sets from the coast of Guinea, while a portion travels northwards. Thence it extends to the Bay of Biscay, and travelling northwards skirts the western coasts of Europe, sometimes wafting to and depositing on its shores and also on the western

coasts of the British isles the products of tropical America, and probably imparting to the whole of the Northern Ocean some portion of its more elevated temperature.

IX. THE ATMOSPHERE.

The Earth is surrounded by its *atmosphere*, which like a transparent covering envelopes it and revolves with it. This atmosphere is considered to extend to the height of about forty or fifty miles, its height being greater at the equator than at the poles.

The *air*, which expands into and forms this atmosphere, is an elastic fluid consisting of a mixture (not a compound) of *oxygen gas* and *nitrogen* or *azotic gas*, in the regular proportions of twenty-one parts of oxygen to seventy-nine parts of nitrogen. The atmosphere also contains a small quantity of *carbonic acid gas*, and a yet smaller quantity of *ammonia*. *Water* in the form of *vapor*, in which state it is invisible, is also always present in the atmosphere, though the quantity is subject to great variations. All

these substances move freely among each other, and are continually changing places; the oxygen being ever ready to perform the office assigned to it of sustaining life and combustion; the carbonic acid, to promote the growth of vegetation; the nitrogen, to perfect the fruits of the earth; and the vapor, to descend to the thirsty ground in the form of showers and dew.

The air being *elastic* is therefore capable of *expansion*, or of spreading in all directions; and also of being compressed into a smaller space; and when compressed, becomes more *dense*, or thicker, and consequently is heavier. And thus, if a closed vessel of any size be filled with compressed air, and another of similar size be filled with air which has not been compressed, the former is found to have more *weight* than the latter, in proportion to the degree of compression.

The consequence of this weight or elasticity of the air is, that it is much lighter and thinner in the upper regions of the atmosphere than nearer the earth's surface: for at the level of the sea, the air has the weight of the *whole* atmosphere above it to compress it and give it greater density; but at an elevation of 10,000 feet, the pressure from above being diminished, the air is less dense and lighter: because its elasticity

causes it readily to become compressed near the level of the sea, and to expand in the upper regions of the atmosphere. And hence, air is thinner or more *rarefied* on elevated mountains than at the level of the sea; the decrease in density being in regular proportion, according to the height above the sea level. In consequence of the air becoming so much thinner or more *rare* at great elevations, travellers who ascend lofty mountains usually find their respiration much affected, and they are sometimes compelled to seek relief by throwing themselves on the ground, which enables them to breathe more freely.

The weight of the atmosphere at the level of the sea is equal to about *fourteen pounds and a half on every square inch.* This is called the *weight of an atmosphere*, and is balanced by a column of mercury thirty inches in height; but at the elevation of 18,000 feet, it would be balanced by a column only fifteen inches in height, at that of 36,000 by one only seven inches and a half in height, and so on. It is on this principle that the mercurial barometer has been constructed; and since the mercury in the barometer is found (with slight local variations) to stand at the same point at all places at the level of the sea, and to fall in a regular ratio as

we ascend above that level, this instrument forms a most useful standard for measuring the altitude of any place, either mountain, hill, or plain, to which a barometer can be carried. The mercury is considered to fall one degree in about every 950 feet. Baron de Humboldt, when he visited Chimborazo in the Andes, found that at the level of the sea near that mountain the barometer stood at 30°; but at the height to which he ascended, it fell to fourteen inches, eight lines; and accordingly he came to the conclusion that the elevation he had attained was 19,353 feet. Air is subject to variations in its density, even at the same level, being affected by the presence of vapor in the atmosphere, by currents of wind, by electrical action, &c.; and hence the mercury usually falls at the approach of rain, of wind, or of a thunder-storm, and hence the daily and even hourly fluctuations which take place in the barometer.

The *temperature* of the air likewise diminishes as we ascend above the level of the sea. The rate of decrease does not appear to be absolutely regular, but is considered to be about one degree of Fahrenheit's thermometer for about every 340 feet; and accordingly (though variations occur from local causes) the thermometer generally

stands lower in elevated districts, than in those nearer the sea level in the same latitude; and hence it is, that even in the hottest regions of the earth, very lofty mountains are covered with perpetual ice and snow.

WINDS.

The aerial currents called *winds* appear to be caused by partial changes in the density of the atmosphere, in great measure arising from the different distribution of heat in various parts of the earth's surface. When air is warmed by the heat of the sun or any other cause, it becomes less dense, and the space it occupies has therefore more *capacity*, or more room to admit an additional portion of air. If an adjacent stratum of air be cooler, it will, on coming in contact with the warmer air, expand and pour into the space occupied by the latter, thus forming a current, or wind. The greater the difference between the temperature of the one portion of air and the other, the greater will be the force with which the cold portion will rush into the space occupied by the warm portion, or, in other terms, the more violent will be the wind. This is well displayed in the violent winds

which in some warm regions almost daily rush down from the adjacent mountains into the plains, as soon as the latter become heated by the mid-day sun.

In the United States, and, generally speaking, in temperate climates, the winds are *variable;* but in some parts of the globe they blow with great regularity, and in others are subject to periodical changes.

The most remarkable permanent winds are those termed the *trade-winds.* The air at the surface of the sea between the tropics is much warmer than in high northern and southern latitudes; and since air expands and becomes less dense when heated, the light warm air in intertropical regions perpetually rises from the surface, and its place is as perpetually supplied by the colder air, which glides in from the regions both to the north and to the south of the tropics. If it were not for the earth's rotation on its axis, these would be merely northerly and southerly winds; but, like the equatorial currents in the ocean, these cool currents of air, coming from regions which have not an equal velocity of rotation with the air at the equator, pause and hang back, and thus these aerial currents acquire a westerly direction, forming permanent north-easterly winds in the northern hemisphere,

and south-easterly in the southern. In the immediate vicinity of the equator, where the two aerial currents from the north and south meet, they so completely counteract each other, that a zone about five degrees and a half in width exists, which is comparatively calm and free from any prevalence of easterly winds, though subject to storms of thunder and lightning. This zone is called the *variables*. The trade-winds form two great belts, extending on either side of this zone, to north and south latitude 28°. A deviation from their regularity is caused by the proximity of land; and they are less regular in the Pacific* than in the Atlantic, and less steady in the North than in the South Atlantic.

While this interchange of air gives rise to easterly winds in the tropical seas, it at the same time causes *westerly* winds to prevail in higher latitudes. The warm air which has changed places with the cooler northern and southern air, carries with it the velocity belonging to its former situation near the equator, into regions where the earth's surface moves at a slower pace,

* The innumerable islands of this ocean will account for this want of regularity, while the fact that the westward current traverses the South Atlantic may not be without weight in determining the reason of the greater uniformity of the trade-wind in that ocean.

and consequently, as this air travels northwards or southwards, it moves at a more rapid pace than that portion of the earth's surface it now occupies, thus giving rise to the *south-westerly* gales so prevalent in our latitude, and to the *north-westerly* gales of the same portion of the southern hemisphere.

The *monsoons*, or periodical winds of the Indian Ocean, appear to owe their origin to the same cause which gives rise to the trade-winds, though they acquire a different character in consequence of the proximity of land. In the southern portion of the Indian Ocean, which is remote from this cause of disturbance, the trade-wind blows with its wonted regularity; but in the seas occupying the region between the eastern coast of Africa on the one side, and the Malayan peninsula and Sumatra on the other, the course of the trade-wind is reversed for half the year. This change occurs from April to October: the sun at that period being vertical north of the equator, and the land in the adjacent regions acquiring in consequence a high temperature, and the air over the sea being cooler than that over the land, a south-west wind prevails. This wind, called the *south-west monsoon*, commences at about three degrees south of the equator, and, passing over the ocean, arrives charged with moisture, and

accordingly usually deposits copious supplies of rain in India and some of the adjoining territories. In the remaining half of the year, that is, from October to April, the wind resumes the ordinary north-easterly direction of the trade-wind.

Sea breezes occur in regions bordering on the sea in hot climates. They are produced by causes similar to those which give rise to the south-west monsoon. The surface of the land being more heated during the day than that of the sea, and the air consequently becoming rarefied, the cooler heavier air rushes in from the surface of the sea, thus giving rise to the sea breeze. This usually commences at about ten o'clock in the morning, and continues throughout the day until about six o'clock in the afternoon, when it gradually sinks away. In some situations the reverse takes place at night, the sea at that time retaining a higher temperature than the adjacent land and causing a *land breeze* to spring up. This usually commences at about eight o'clock in the evening, and dies away before six in the morning; it is much fainter and less regular than the sea breeze, and also of less common occurrence; for the sea breeze may generally be observed in all warm countries, and even, in sunny weather, on our own shores.

Hurricanes are storms of wind which sweep or whirl round in a regular course, and are at the same time carried onward along the surface of the globe. In the northern hemisphere the whirling motion follows the course of east, north, west, south, to east again; in the southern hemisphere it takes the opposite course. In the Atlantic Ocean, the principal region of hurricanes lies to the eastward of the West Indian Islands. They are of frequent occurrence in the Indian Ocean, at no great distance from the Island of Madagascar. The *typhons* of the China Seas and the *ox-eye* of the Cape of Good Hope are also considered to be revolving storms.

The *tornadoes* of the western coast of Africa, the *pamperas* of South America, and the storms called *arched squalls*, appear to be of a different character, and not to possess a revolving motion.

The *sirocco* of Italy and Sicily, and the *solano* of Spain, as also the *simûn* or *simoon* (sometimes called *simoom*) of Arabia, and the *harmattan* of Western Africa, are all winds which owe their origin to the parched and heated surfaces of Africa and Arabia. The principal difference between these winds appears to be, that the sirocco and the solano acquire some moisture in their passage across the Mediterranean Sea, and therefore do not possess that extreme degree of

aridity which forms the distinguishing character of the simûn and the harmattan.*

Water in the form of *vapor* is always present in the atmosphere. Warm air is capable of holding suspended a larger quantity of moisture than cold air, and therefore the amount of vapor present in the atmosphere is subject to great variations. If water be exposed to the air, it gradually disappears, finding its way into the atmosphere by the process called *evaporation*. If not exposed to the air, as for instance, if kept in a closely-corked bottle, the quantity will remain undiminished for years; but if we leave the bottle uncorked, the water will ere long be dried up, or evaporated; and if we pour the water into a plate, a larger surface being thus exposed to the air, the process of evaporation will be carried on much more rapidly. Warm air being capable of holding a larger quantity of moisture than cold air, evaporation proceeds more rapidly in warm than in cold weather, and hence a pond, or moist garden mould, will be dried up much more rapidly in summer than in winter.

* The subject of Winds is becoming better understood and more reducible to law, every year. It would be a triumph of physical science, too great to expect, to be able to determine the exact sequence of winds in any portion of the earth, and thus to predict the state of the weather with certainty, yet we may be assured that our knowledge of winds is but in its infancy, and that large discoveries are yet to be made in this direction.

The fact that warm air is capable of holding a larger quantity of moisture than cold air, accounts for the formation of *dew*. A *cubic* foot of air, at the temperature of 32° (the freezing point), has not capacity for holding more than two grains and a half of moisture, while at the temperature of 70°, it will hold about five grains and three-quarters; and in intermediate proportions between these temperatures. It will therefore be evident that if the air become heated during the day, its capacity for holding vapor being thus increased, evaporation will proceed with greater or less rapidity, and the air will become more or less charged with moisture, according to the nature of the surface on which it rests or over which it passes, and its own temperature. But when a cold night succeeds to a hot day, the air being no longer capable of holding this watery vapor, it will, as the temperature gradually diminishes, be gradually and gently deposited in the form of dew. Dews will therefore usually be most abundant when cool nights succeed warm days, which in our climate more frequently happens in summer and autumn than in spring and winter. The air usually becomes much colder on clear nights than when the skies are obscured by clouds, and accordingly dew is generally more abundantly deposited on starlight than on cloudy nights.

It is also essential for the copious formation of dew that the ground, or other substance on which it is deposited, should be much cooler than the superincumbent air; for if the ground be warm, it will impart its temperature to the air near its surface, and dew will not be formed. The surface of trees, and of vegetation in general, is much colder than that of bare rocks, or even garden mould, and, consequently, dew is more abundantly deposited on the herbs of the field and the trees of the forest, than on barren and stony ground.*

When the surface of the ground or water is warmer than the superincumbent air, *mists* and *fogs* are frequently formed. And since water and marshy surfaces cool less rapidly than dry land, mists and fogs are of more common occurrence in low damp situations than in dry elevated districts. They are formed by the *condensation of the vapor*, or, in other terms, its *transformation into minute drops of water*, which, instead of descending to the earth in the form of dew, remain suspended above the land or the water. A re-

* The pupil must bear in mind that those things which are the slowest heated, are also those which best retain their heat; hence rocks, gravel paths, &c. do not readily receive the dew, as they radiate slowly the little heat which they have absorbed during the day.

markable stationary fog exists off the coast of Newfoundland, which owes its origin to the chilly atmosphere of that region, and the comparative warmth of the adjacent ocean, the temperature of which is apparently raised by the waters of the Gulf Stream.

Clouds are formed by the condensation of vapor at considerable but various elevations in the atmosphere. Vapor is always invisible; clouds, therefore, are not vapor, but water, and consist of a fine watery powder, the size of each particle being exceedingly minute; and consequently they are so light, that clouds formed of an accumulation of such particles are readily borne forward by the wind. Clouds are sometimes suddenly formed, and as suddenly disappear; probably owing to sudden and partial changes of temperature in the region of the atmosphere where they occur. When a considerable difference of temperature prevails in the aerial currents, or strata of air, which may come in contact in the atmosphere, a further condensation takes place, and the particles of this fine watery powder unite into drops, and becoming heavier, fall to the earth in the form of *rain*, *hail*, or *snow*. When two strata or currents of air of different temperature, moving with great rapidity in opposite directions, come in contact, a sudden and

heavy fall of rain takes place. If one of these strata be very cold, hail may be formed. Snow is formed under the same circumstances as rain, only the formation takes place in cold climates, or at great elevations in the atmosphere.

Clouds are continually varying in their form and appearance, but may be classed under four principal heads: — 1, the *cirrus;* 2, the *cumulus;* 3, the *stratus;* 4, the *nimbus.*

1. The *cirrus* is a light fleecy cloud, resembling a lock of hair or a feather.

2. The *cumulus*, or summer cloud, is generally a massive cloud, of a rounded form; sometimes of small size, and sometimes nearly covering the whole sky; and occasionally appearing in the horizon like mountains capped with snow.

3. The *stratus* is a horizontal misty cloud, sometimes observed on fine summer evenings comparatively near the ground, and often crossing the middle regions of mountainous or hilly districts.

4. The *nimbus*, or *rain-cloud*, has a uniform gray tint; it is fringed at the edges, when these are displayed, but usually covers the whole sky.

The region of clouds is a zone extending in the atmosphere from about one to four miles above the surface of the globe. The most elevated clouds are the light fleecy clouds which

are comprehended under the name of cirrus, and the lowest are those which are called stratus.

The *cirro-cumulus*, *cirro-stratus*, and *cumulo-stratus* are only modifications and combinations of the above four classes of clouds.

The quantity of *rain* that falls in different parts of the earth is very variable; though (since the amount of evaporation is augmented by the higher temperature of the atmosphere) it may be considered as a general rule, that larger quantities of rain fall in low than in high latitudes; and it appears that a gradual decrease in quantity takes place, as we recede from the equator towards the poles. In the island of Tahiti, the annual fall of rain amounts to 150 inches; at Bombay, to 80 inches; in the British Isles, to about 25 inches; at St. Petersburg, to only 17 inches.

Rain is more abundant in the New than in the Old World, which is probably owing to the different configuration of the two great continents, the longer and narrower being more exposed to the moist winds from the sea than the shorter and broader. Thus the annual fall of rain in tropical America amounts to 115 inches, whilst in similar parallels of latitude in the Old World it does not exceed 76 inches. In the temperate zone in the New World, again, the annual quantity of rain is 37 inches, whilst in the Old World it is only 31½ inches.

In some parts of the earth, extensive tracts exist, where rain is never known to fall, or if at all, only at intervals, and then in small quantities. The rainless districts in the New World include the flat territories of Northern Chili and Peru, some parts of Mexico, and some parts of California. In the Old World, an extensive rainless band extends from the western shores of Africa to the central regions of Asia, including the Great African Desert, Egypt, part of Arabia, and the Desert of Cobi. Countries so circumstanced — unless, like Egypt, rendered fertile by the overflowings of a great river — constitute the most arid and desolate regions of the earth.

The quantity of rain which falls in any region depends greatly on local causes, such as the variations of the surface, the prevailing winds, the proximity of the ocean, &c. Rain is usually more copiously deposited in mountainous and well-wooded islands than in any other description of surface, of which the island of Tahiti affords a striking example; for this beautiful island, surrounded as it is by the waters of the ocean, covered with luxuriant vegetation, and containing mountains rising to the height of 10,000 feet above the level of the sea, possesses every requisite condition for the copious deposition of rain. The warmth of the air causes a

DISTRIBUTION OF RAIN OVER THE EARTH, TRADE WINDS AND MONSOONS.

large amount of evaporation to take place from the ocean which surrounds it on all sides, and this vapor becomes condensed by the cool surface presented by its elevated and richly wooded mountains and hills;* and hence the extraordinary quantity of rain in that island. The rainless district of Peru, on the other hand, though it borders on the Pacific Ocean, is flat and nearly destitute of trees, whilst on the inland side the Andes rise abruptly to a great elevation, the consequence of which is, that the moisture brought by the westerly winds from the ocean does not become condensed in its passage across the hot surface of the flat districts of Peru, and therefore rain scarcely, if ever, falls in that region, but an abundant deposition takes place on the elevated mountains in the interior. And thus again, if elevated hills border on the ocean in any district, whilst the interior consists of flat plains, the moisture usually is deposited on the elevated land, and the interior tracts receive small supplies of rain; such is the case with the rainless portion of Arabia.

The annual fall of rain in the British Isles, amounts, as has been stated, to about 25 inches; but the quantity differs greatly in the eastern and

* The pupil will see at once the analogy between the formation of rain and of dew in this respect.

western districts. The winds sweeping over the expanse of the Atlantic Ocean arrive charged with abundance of moisture, but deposit a considerable portion before they reach the inland and eastern districts. Thus, the amount of rain that falls annually at Glasgow is nearly eight inches more than at Edinburgh. The number of rainy days in England is estimated at about 154 in the year, and on the western coast of Ireland at no less than 208. The amount of rain does not, however, necessarily depend on the number of rainy days, for though the amount of rain within the tropics is so much greater, the number of rainy days does not usually exceed 78 or 80.

In New England the amount of rain which falls is greater than in the British Isles, being about 38 inches. The quantity decreases as we go westward, and at St. Louis it is 32 inches. The southern and western states are, however, largely affected by the warm and moist winds from the Gulf of Mexico.

In intertropical regions the rains follow the sun; that is, when he is north of the equator, the rains prevail in the northern tropic, and when he is south of that line, in the southern; this forms the *rainy* and *dry seasons*, to which countries so situated are subject. This does not, however, apply to the whole of the intertropical

regions, for in a zone extending from the fifth to the tenth degree of latitude on each side of the equator, there are two rainy and two dry seasons. In the narrow belt, called the *variables*, which is situated between the regions of the north and south trade-winds, rain is almost incessant, accompanied by thunder and lightning. In intertropical countries, during the rainy season, the rain pours down in such torrents, that a larger quantity sometimes falls in a few hours than in a whole month in the British Isles.

Beyond the tropics some countries possess rainy and dry seasons, and, generally speaking, greater abundance of rain falls at particular periods of the year, though to the north of the 45th parallel of latitude the rains are usually variable, of which we meet with an example in the British Isles.*

X. CLIMATE.

The term *climate* is used to express the combination of temperature and moisture which pre-

* For more enlarged generalizations and more extensive details on the subject of rains, the reader will consult that very valuable book, Guyot's Earth and Man.

vails at any particular place, or, in more familiar terms, the *prevailing weather*.

The most prominent causes of diversity of climate are, the *heat of the sun*, the *relative position of land and water*, and the *elevation of land above the level of the sea*. To these may be added, as producing considerable though less marked effects, the *nature of the soil*, the *prevailing winds*, the *position of mountain ranges*, and the *currents of the ocean*.

The *sun* is the grand agent in diffusing heat over the surface of the globe, the temperature of any part being almost wholly dependent on its exposure to his rays. Whilst the sun is above the horizon of any place, that place is receiving heat; and when the sun is below the horizon, it is parting with heat by the process called *radiation*, that is, the emission of heat through the atmosphere into the regions of space. Whenever, therefore, the sun remains more than twelve hours out of the twenty-four above the horizon of any place and consequently less than twelve hours below, the general temperature of that place will be above average; and when the reverse occurs, it will be below average.

In consequence of the daily rotation of the earth, successive portions of its surface are presented to the sun's rays; and owing to the incli-

nation, or slanting position of the earth in its orbit, the northern and southern hemispheres are brought alternately more directly under the solar influence,* and thus by this admirable and beneficial arrangement the high temperature of the tropical zone is moderated, and heat more generally diffused over the earth's surface. The power of the sun's rays is great, in proportion to the *vertical* or *upright direction* in which they strike the earth;† and if the sun's rays had been permanently vertical in equatorial regions, the heat in those parts of the earth would have been greatly more intense, and, on the other hand, the yet more slanting rays of the sun in higher latitudes would not have possessed sufficient power to ripen the fruits of the earth in the present temperate zones, nor should we have enjoyed the grateful change of spring, summer, autumn, and winter.

We have seen that the earth has been artificially divided into five zones; the torrid, the two temperate, and the two frigid zones. If the temperature of any place depended solely on the heat of the sun, this might convey a tolerably accurate view of the respective climates in

* See plate on page 8.

† It is a singular fact that the earth is three millions of miles nearer the sun in winter than in summer.

those divisions of the globe; but it is so greatly modified by other circumstances, that considerable differences prevail in countries situated in the same parallels of latitude.

The *relative position of land and water* forms one leading cause of the diversity of climate. The waters of the ocean are of very equal temperature, widely differing in this respect from the surface of the dry land. This arises from the waters of the ocean always preserving a nearly uniform level, from their tardiness to become heated (because water is a bad conductor of heat), and from their not possessing the same radiating power as dry land, so that they are not subject to be cooled down during the absence of the sun. The ocean, therefore, has a tendency to moderate both heat and cold wherever its influence extends. Thus, when a cold wind passes over the sea, it becomes warmed, and the rigor of winter will be moderated. A hot wind, on the contrary, becomes cooled in passing over the sea, and the summer temperature of the adjacent regions will be lowered. And thus we find that the climate of islands and countries bordering on the sea usually differs considerably from that of the interior of continents, the former generally experiencing milder winters and more temperate summers than the latter. Such countries are

said to possess an *insular climate.* Thus, the British Isles possess an insular climate. But when any region experiences great severity of cold in winter, and at the same time a considerable degree of heat in summer, it is said to possess an *excessive climate.* The most striking instances of an excessive climate are drawn from places like Yakutsk, situated in the depths of Siberia, where the difference between the average temperature of winter and of summer amounts to the astonishing sum of 101.°

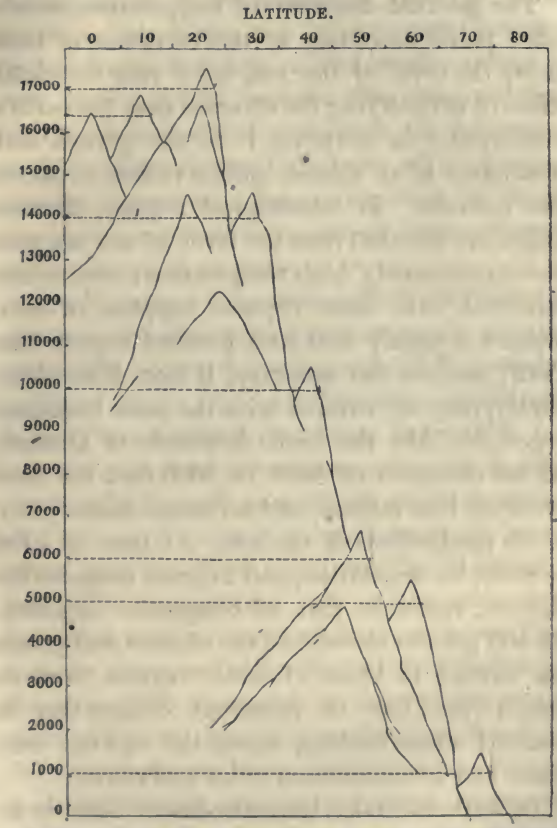
The effect produced on climate by the relative position of land and water is exhibited on a large scale in the temperate zones of the northern and southern hemispheres. The space occupied by the waters of the ocean in the southern hemisphere, is far greater than in the northern, and consequently a much more *even* temperature prevails in the regions occupying that portion of the globe, than in those in the northern hemisphere.

The *elevation of land above the level of the sea* forms another leading cause of the diversity of climate. A gradual decrease in temperature takes place as we ascend above the level of the sea, until we attain a point where perpetual congelation takes place. This line, which is called the *snow-line*, or *line of perpetual snow*, varies in dif-

ferent latitudes, and sometimes, owing to the different causes which may give rise to diversity of climate, the height of the snow-line differs at places in similar latitudes. As a general rule, however, it may be considered, that a gradual decrease in the elevation of the snow-line above the level of the sea takes place as we recede from the equator towards the poles. The height of the snow-line within the tropics varies from 16,000 to 17,000 feet above the level of the sea; and (in the northern hemisphere) this line descends to the very level of the sea at about latitude 80°.

The annexed tabular view of the snow-line in different latitudes may convey a general idea of the limits of perpetual congelation in the northern hemisphere.

It will be perceived that the snow-line is higher at the distance of twenty degrees from the equator, than at the equator itself. This is explained by the circumstance, that the sun at the equator is never more than twelve hours above the horizon; whereas, near the tropics, the longest days are thirteen hours and a half in length; and as the sun at that period of the year is vertical, or nearly so, in that portion of the globe, the *summer* heat, on which the line of perpetual snow depends, is greater than immediately under the equator.



TABULAR VIEW OF THE SNOW-LINE IN DIFFERENT LATITUDES IN THE NORTHERN HEMISPHERE.

The gradual decrease of temperature which takes place, according to the elevation of land above the level of the sea, has a very beneficial effect in diversifying the climates over the earth's surface, and in adapting it to the growth and sustenance of an almost endless variety of plants and animals. In intertropical regions, districts which are situated near the level of the sea possess an extremely high temperature; and unless furnished with most copious supplies of rain, present a highly arid and parched aspect, like Peru; but, on the contrary, if rain falls abundantly, they are covered with the most luxuriant vegetation, like the fertile lowlands of Guiana. At the elevation of 3000 or 4000 feet, the heat becomes less intense, and a change takes place in the productions of the soil. At that of 7000 or 8000, the vegetation, and in great measure the climate, resemble that of temperate countries. At still greater elevations, the climate and plants are similar to those of arctic regions; and at length the line of perpetual congelation is reached, where nothing meets the eye but bare rocks and accumulations of ice and snow.

In warm latitudes, the snow-line is found to be higher on mountains which inclose or border on elevated table lands, than on isolated mountains, or on such as rise precipitously from low plains.

This appears to be caused by radiation from the elevated plains; for these, having become heated during the day, radiate or part with this heat during the absence of the sun, and thus tend to maintain the temperature of the mountains in their vicinity during the night, whereas isolated mountains, being surrounded by the atmosphere, part with heat, instead of receiving it, during the sun's absence.

The Himalaya Mountains afford a striking example of the effect thus produced by an elevated table-land. On the *southern* side of that mighty range, in N. lat. 30, the mountains rise directly from a flat country, not more than 1000 feet above the level of the sea, covered with a close jungle, which tends to cool the superincumbent air; and on this side of the mountains the height of the snow-line does not exceed 12,000 or 13,000 feet. On the northern side of the same vast mountain range, the elevated table-land of Tibet extends, rising to the height of 15,000 feet above the level of the sea; and in the vicinity of this great plain, the snow-line reaches the height of 17,000 feet above the level of the sea. In very cold climates the reverse takes place: ice-covered table-lands have a tendency, by absorption of heat, to lower the temperture of mountains which are situated near them; for the tempera-

ture of isolated mountains in icy regions is sometimes found to be higher than that of the plains at their base.

The *nature of the soil* produces some effect on the climate of any region. *Sandy soils* are subject to become rapidly and intensely heated, and when the sun's rays are withdrawn, they rapidly radiate and part with the heat they have acquired, thus increasing the general temperature of the surrounding districts. *Clayey soils*, on the other hand, become slowly heated, and as slowly part with heat. *Swampy ground* chills the air, and *extensive forests* produce a similar effect; and thus, cultivation not unfrequently causes a change in the climate of a country; for the draining of marshes and the clearing of dense forests may raise the winter temperature of a cold country, as has been effected in some parts of North America, whilst irrigation and the culture of trees may tend to improve and moderate the climate of hot dry lands, as has been experienced, though hitherto on a small scale, in some parts of California.

The *prevailing winds* produce considerable effects on the climate of any region. Countries where the prevailing winds sweep across a wide expanse of ocean are not subject to extremes of heat and cold. Thus, the climate of the British

Isles is moderated, because the most prevalent winds pass over the Atlantic Ocean. In the eastern portion of the New England States the south wind is marked for its warmth. This comes in from the Gulf Stream and the Ocean. Winds which traverse large tracts of land vary in character according to the nature of the surface over which they pass. Hence in the Atlantic States, the west and the north winds are dry and cold.

The *position of mountain ranges* also produces considerable effect on the climate of any region, especially when elevated ridges extend from east to west, and thus either form a screen from the north, or leave a country unsheltered in that direction. Thus, the Carpathian Mountains screen Hungary from the cold blasts of the north, and consequently that territory enjoys a remarkably mild climate; whilst Poland, which is situated to the north of that range, and therefore unprotected from those piercing winds, suffers from a very cold and humid climate.

The *currents of the ocean* form very influential causes of the diversity of climate. The polar currents, as we have already seen, carry towards the tropics, not only vast streams of cool water, but also floating masses of ice, which tend in a great measure to lower the temperature of the

regions near which their course extends. The Gulf Stream, on the other hand, traverses the Atlantic Ocean, carrying with it a high temperature, which it imparts to Western Europe, and in all probability to the whole of the Northern Ocean.

The waters of the Gulf Stream bear with them from the Gulf of Mexico large quantities of a species of sea-weed called *sargasso;* this accumulates (probably owing to the meeting of some currents) in a portion of the ocean lying between the 33d and 35th parallels of north latitude, and covers an area extending about 2000 miles from east to west, and 350 from north to south. The water in this tract of the ocean is nearly stagnant, and being continually supplied with fresh streams of water which have become heated in the Gulf of Mexico, its temperature is maintained to the height of from 7° to 10° above that of the Atlantic in the same latitude. This is called the *Sea of Sargasso*, or the *Recipient of the Gulf Stream*, and there appears reason to conclude, that this mass of warm water materially affects the climate of the regions to which its influence extends, both in Europe and North America.

The causes which produce diversity of climate being so various, great difference of temperature

is found to prevail in similar parallels of latitude, and no rule can be laid down relative to the climates on the earth's surface. It may, however, be considered that, generally speaking, the eastern districts of both the Old and New Continents possess more *excessive* climates than the western districts of either; that the climate in the interior of continents is more excessive than either; and that islands have a more equable or less variable temperature than large masses of land.

In intertropical regions, comparatively little variation occurs in the temperature throughout the year; in some places there being scarcely more than four degrees between the average temperature of the warmest month and that of the coldest month. In temperate zones the difference is usually much greater. Thus, in London, the *mean* summer temperature is about 63°; and the mean winter temperature is about 39½°; the difference between the mean summer and winter temperature being twenty-three degrees and a half. In New York, the mean summer temperature is about 71°, and the mean winter temperature about 30°, making a difference of forty-one degrees.

With the view of ascertaining the general distribution of heat over the surface of the globe,

observations relative to the mean annual temperature of various portions of the earth have been made, and lines called *isothermal lines*, or *lines of equal temperature*, are traced on the globe, indicating the various points on the earth's surface where the same *mean annual temperature* has been observed to prevail. These lines do not coincide with the equator, or with the parallels of latitude, places possessing the same annual temperature being often situated in widely different parallels of latitude. Thus, London and New York possess very nearly the same mean annual temperature, that of 51° ; but London is situated about eleven degrees further north than New York, and, as we have just seen, the summer and winter temperature of the two cities differs considerably. It is therefore evident, that though these isothermal lines convey a general idea of the *distribution of heat over the earth's suface*, they do not determine the *climates* of the regions where the observations have been made. Lines indicating the mean summer and mean winter temperatures, called *isothĕral* and *isochimenal lines*, when these shall have been carried out on the surface of the globe, may tend more fully to accomplish this object.

The line of *highest temperature*, which is nearly 83°, takes its course generally to the north of the

equator, crossing the Isthmus of Panama, and passing through Africa at about the 11th parallel of latitude. The interior of the latter region is considered as the hottest portion of the earth.

The line of lowest temperature in the northern hemisphere, is not, as we should suppose, in the immediate vicinity of the North Pole, but commencing at Hudson's Bay, it crosses Greenland, bears somewhat towards the north, and afterwards declines to the central part of Siberia.

XI. ELECTRICITY AND MAGNETISM.

Electricity produces an infinity of changes in the natural world. It may be artificially elicited or called forth by friction, and then it is termed *ordinary electricity;* or by the contact of certain substances, and the action attendant on this contact, and then it is called *voltaic* or *galvanic electricity.*

All substances are supposed to contain a cer-

tain portion of electricity, and if by friction, or any other means, any substance acquires more electrical action than it would naturally possess, it is said to be *positively electrified;* and if, on the other hand, there appears to be less electrical excitement than it would possess in its natural state, it is said to be *negatively electrified.* Substances, when positively electrified, *attract* or *draw towards them* other substances which are in a state of negative electricity, or even those which are in a natural state; but will *repel* or *force from them* substances which are positively electrified.

The electrical state of substances is easily disturbed, and even without actual contact, any substance in a state of positive electricity may produce negative electricity in a substance near it. The sudden contact of bodies in an opposite state of electricity is attended with vivid light, called the electric spark, and accompanied by an explosion and shock. This is exhibited on a splendid but awful scale in the lightning's flash and the thunder clap.

The *earth* is considered to be always in a state of *positive electricity*, the *air*, when pure, to be in one of *negative electricity.* Atmospheric air, however, is subject to incessant variations, both as to the character and degree of its electrical

excitement, for it is liable to be affected by the evaporation and condensation of moisture, by the various chemical processes which are continually carried on in the natural world, &c., and thus the *electrical equilibrium* of the atmosphere, or its natural electrical state, is subject to be disturbed. This equilibrium will be restored when an explosion has taken place, and hence it is that in peculiar states of the atmosphere, thunder storms act a beneficial part in restoring the air to a healthy condition, or, in other terms, restoring the electrical equilibrium.

The intensity of electricity is greater during the day than at night, and also in summer than in winter; and is considered to diminish from the equator to the poles.

Electricity is perpetually effecting great changes in the earth's crust; not perhaps so much in its loud and fearful displays, which are evident to man, as in its unseen quiet operations; in very many instances unquestionably acting on the principle of *voltaic electricity*, the electrical action in such cases being produced by long-continued electrical currents.

Terrestrial magnetism may be regarded as a peculiar exhibition or state of electricity, and may be considered under two heads — viz., *magnetic direction*, and *magnetic intensity*.

The magnetic power of the *loadstone* to attract iron or steel is well known; if a bar of iron or steel be subjected to a continued current or stream of electricity, or even be allowed to remain in contact with the earth in a vertical or upright position for a lengthened period, as old iron railings may have done, it acquires this magnetic power, or becomes *magnetized.*

If a nicely-balanced *bar* or *needle* of *magnetized steel* or *iron*, be suspended from its middle by a piece of untwisted silk, free to move in all directions, both horizontally and vertically, it will turn itself to one particular position, and if disturbed, it will invariably return to the same position, pointing downwards to the earth at a particular angle, and also in a particular northward and southward direction. This is called the *magnetic direction* of the needle. If placed on a pivot, in a box or case, so as to confine it in a horizontal position, it will be found to assume the same regular northward and southward direction; not *due* north and south, but northward and southward. At one period the magnetic needle was supposed to point so truly to the poles of the earth, that the phrase, "true as the needle to the pole," has become a proverbial expression; and hence the north and south ends of magnets were termed their *north* and *south*

poles; and in fact it appears that in 1659 the needle actually pointed thus in London.

It is on the above principle that the mariner's compass has been constructed, which was supposed to point invariably due north and south. It is now well known, not only that the magnetic needle does not point *due* north and south in all parts of the globe, but that it does not permanently maintain the same direction at the same places.

The present north magnetic pole, or point to which the needle is directed on this side of the equator, was found by Sir James Ross, in lon. 115° W. and lat. 70° N., north of Hudson's Bay. The magnetic pole of the southern hemisphere has not yet been ascertained with certainty, but is with great probability supposed to be in lon. 152° E. and lat. 72° S.

We have seen that the magnetic needle, if freely suspended, does not settle itself in a direction parallel with the horizon, but *dips* or *inclines downwards;* this is called its *dip* or *inclination.* This dip or inclination of the magnetic needle, like its declination, differs in different parts of the earth's surface, and, like that, has undergone considerable changes in its direction.

The observation of navigators shows that there is a line encircling the earth, at every point

of which the needle will take a true horizontal position. This is called the *magnetic equator*. It is not a great circle of the earth like the terrestrial equator, and its form and position are continually varying.

XII. GEOGRAPHICAL DISTRIBUTION OF PLANTS.

Plants, in an almost endless variety of forms, are spread over the surface of the globe, affording sustenance to man, and to a vast number of the other creatures of God's hand.

Some plants are adapted to thrive more particularly in cold climates, or in mountain regions; others attain the greatest perfection in temperate zones, and others belong exclusively to the hottest regions of the earth. Some plants will not flourish unless furnished with copious supplies of moisture, whilst others are so constituted that they can endure long-continued drought. Some plants prefer a clayey soil, others a chalky soil, others a sandy soil, whilst others grow in the crevices of rocks. Some plants are inhabitants of *salt marshes*, some of *fresh-water lakes*, some of *running streams*, some of the

ocean, and some of the *dark caverns* of the earth. We thus find that each portion of the globe has its own appropriate vegetable productions, specially adapted to its climate, its soil, and its elevation above the level of the sea.

Plants are divided with respect to their *flowers* into two departments, *phænogamous* (or *phanerogamous*) and *cryptogamous;* and the former of these, with respect to the *structure* of the plants, into two classes, *endogenous* and *exogenous.*

Phænogamous plants are such as bear a plainly distinguishable flower. This class is found almost exclusively in the torrid zone, largely in the temperate, but scarcely at all in the frigid zones.

The *cryptogamous*, or *flowerless plants*, called also *a-cotyledonous*, because they have no seed-leaf, are plants whose flowers and seeds are either so minute as to be scarcely discernible, or are altogether concealed from our view. This class ranks as the lowest in the scale of vegetable productions, and includes *lichens*, *mosses*, *the fungous tribes*, *ferns*, *algæ* or *sea-weeds*, &c.

Endogenous plants are so called because their growth or increase takes place from *within*, and also *mono-cotyledonous*, because when their seeds germinate they have only *one seed-lobe* or *leaf*, as may be observed in the springing up of grass,

which belongs to this class; it also includes wheat, rye, barley, rice, maize, lilies, palms, &c. In the divisions of the flowers and fruit of the plants belonging to this class, the number *three*, or its *multiple*, prevails. Of this the lily forms an example, which has twice three (or six) petals.

Exogenous plants, which form the highest class in the vegetable world, are so called because their growth takes place *externally*, that is, at or near the surface, and outside of the pith. The yearly increase in some trees is so distinctly marked in rings or circles, that their age can be nearly determined. Plants of this class are also called *di-cotyledonous*, because they have *two seed-lobes* or *seed-leaves*, as may be seen in the mignionette, the laburnum, &c., which belong to this class. The number *five* generally prevails in the division of the parts of the flowers in this class. This class includes a large proportion of the trees of the forest, and also most of the flowering shrubs and herbs. The oak, pine, elm, ash, beech, poplar, chestnut, walnut, &c., belong to this class, as do also the rose, mallow, heath, daisy, pea, cabbage, &c. &c.

The number of different kinds of *exogens*, or *exogenous plants*, is far greater than that of *endogens*, or *endogenous plants*. In tropical regions the proportion is about four to one, and in tem-

perate zones about six exogens to one endogen. In the arctic regions, the proportion is not above two to one, but in these regions, forest trees are few in number and dwarfish in growth; and cryptogamic plants are very abundant.

Some plants are *perennial*, that is, live for a greater or less term of years, some species attaining a very great age. The oak appears to arrive at perfection at about the age of sixty years, but lives for a much longer term; yew trees are much longer lived than the oak. Some plants are *annual*, springing up, producing flowers and fruit, and decaying in one short season. Other plants are *biennial*, usually only sending forth stems and leaves in the first year, and perfecting their flowers and fruit in the following season.

Some plants are *deciduous*, or cast their leaves in the autumn, and renew them in the spring; others are *evergreen*, and never destitute of foliage. The temperate zone may be considered as more especially the region of deciduous trees. The never-ceasing energy with which vegetation proceeds in intertropical regions imparts to the plants of those climates a luxuriance unknown in the temperate zone, and at no time are the trees bare of leaves; a screen being thus afforded to the inhabitants of those regions, at all seasons

of the year, from the scorching rays of the sun. The evergreen trees of the cold regions of the earth are of a totally different character, consisting chiefly of pine and fir trees, whose needle-shaped leaves are adapted to withstand the rigors of a northern winter, and whose thick foliage, often sustaining a mass of snow, forms a shelter both to man and to animals from the severe and long-continued cold.

Plants derive their nourishment from the atmosphere and from the earth. The leaves of plants constantly imbibe both moisture and carbonic acid gas from the atmosphere, during the hours of daylight, and more particularly of bright sunlight. Carbonic acid gas is a compound of carbon and oxygen; this carbonic acid gas the green parts of plants have the power of *decomposing*, or of *separating into its two component parts* of carbon and oxygen; the carbon enters into their composition, and the oxygen is returned pure into the atmosphere. As plants possess less energy in the shade, or in dark gloomy weather, they have not, under such circumstances, power to decompose the whole amount of carbonic acid they imbibe, and a certain portion of carbonic acid as well as of oxygen is given out by the leaves. At night they no longer emit pure oxygen, but, on the

contrary, return a portion of the carbonic acid into the atmosphere. Carbonic acid gas is deleterious both to man and animals, and hence it is that plants in our apartments, if placed in the full light, are healthful, but are likely to prove injurious at night.

The *carbon* thus derived from the atmosphere enters into the composition of plants, and forms their solid parts; they also imbibe *ammonia* from the atmosphere, the latter (which is a compound of nitrogen and hydrogen) appearing to be essential for the perfection of the flowers and fruit. The roots suck up both carbonic acid and ammonia, as well as moisture, from the soil; from whence they also derive *potash*, *soda*, *lime*, *silica* or *flint*, and various other substances, which give to vegetables their hardness. Thus, to bring wheat to perfection, it requires a supply of moisture and carbonic acid to promote the growth of the blade; silica to give the culm or stem its hardness and firmness; and ammonia or nitrogen for the nourishment of the grain; and, above all, the sun's rays to give energy to the whole, for wheat will not succeed in regions where the *mean summer* temperature is below 57° or 58°.

Intertropical America is no less distinguished for the splendor and luxuriance of its vegetable

productions than for their *variety*, the number of plants which are natives of that portion of the globe being more than double that of those which are *indigenous* to, or natives of, Europe. The whole of Asia and its islands possess a smaller number than Europe; Oceanica, including Australia, New Zealand, and the islands in the Pacific Ocean, less than Asia; and Africa (as far as hitherto explored) a smaller number than any other portion of the globe of similar extent.

Some species of plants are met with only in very limited districts, to which they appeared to be wholly confined; thus the Irish yew appears to grow naturally nowhere except in Ireland. Other plants have a much wider range; thus the Scotch fir is met with not only in Scotland, but in various other regions possessing a nearly similar climate. It however appears that, generally speaking, particular kinds of plants form the *prevailing* vegetation in certain portions of the earth's surface, and, accordingly, botanists have attempted to divide it into *botanical regions*, each region being named from the *preponderance* of certain plants. Thus the southern portion of the United States is called the *Region of Magnolias*, because that plant grows in remarkable abundance and to a splendid size in

those regions. The lowlands of Mexico and of some adjacent countries are called the *Region of Cacti*, from the preponderance in those districts of the cactus tribe of plants.

We have seen that a similarity exists between the temperature of land near the level of the sea in high northerly and southerly latitudes and that of elevated mountains in hot climates. We also find that a remarkable correspondence occurs between the plants which are natives of regions bordering on perpetual snow (and, therefore, possessing nearly similar climates) however remote they may be from each other, or however different may be their elevation above the level of the sea. The temperature of the middle region of mountains in equatorial regions usually approaches that of temperate zones, and the plants growing in those respective regions usually bear much resemblance, though they by no means exhibit so great a similarity as those of frigid regions. The *flora*, or assemblage of plants, in equatorial regions, may be considered as peculiar to those portions of the globe.

Baron de Humboldt divides the surface of the earth into eight zones of vegetation, which are named from the prevailing plants of each zone or region.

1. The *equatorial zone*, or *region of palms and*

bananas, which extends to about 15° on each side of the equator, and corresponds to about 3000 feet above the level of the sea under the equator. The vegetation in this region consists of dense forests, which never lose their foliage, and to which the preponderance of palm trees imparts a peculiar character. The luxuriant and lofty trees are interlaced and overtopped by gigantic creeping plants, or covered with singularly-formed *orchidaceous* plants, which derive their sustenance from the atmosphere.

2. The *tropical zone*, or *regions of tree-ferns and figs*, extending from about latitude 15° to the tropics. Tree-ferns do not arrive at their greatest perfection at the level of the sea under the equator, their range being from about 1300 feet to 5000 feet above the level of the sea. In the South Pacific Ocean, owing to the more equable climate of that portion of the globe, tree-ferns succeed in much higher latitudes, these trees being very prevalent in the forests of New Zealand.

3. The *sub-tropical zone*, or *region of laurels and myrtles:* from the tropics to about 34°.

4. The *warm temperate zone*, or *region of evergreen trees:* from 34° to 45°.

5. The *cold temperate zone*, or *region of deciduous trees:* from 45° to 58°.

6. The *subarctic zone*, or *region of pines :* from 58° to the arctic circle.

7. The *arctic zone*, or *region of andromedas* and *alpine rhododendrons :* from the arctic circle to 72°.

8. The *polar zone*, or *region of alpine plants* (gentian, ranunculus, &c.) : from 72° to the farthest limits of vegetation. In this region lichens and mosses are very numerous. Alpine plants grow under the equator to the elevation of 12,000 or 13,000 feet above the level of the sea. Owing to local peculiarities, some species grow at still greater elevations in the Himalaya mountains, springing up as the snow melts, at the height of more than 16,000 feet.

In the temperate climate of Europe the effects produced by elevation above the sea level, though less striking than in equatorial regions, are nevertheless of great importance. Thus, in the lowlands of Italy and Sicily, and the south of Spain, palms and other plants of the warm regions of the earth come to perfection ; these are succeeded by the orange, the fig, and the olive ; the two latter of which thrive in the southern valleys of Switzerland, but do not succeed beyond 1000 feet above the level of the sea. In the latter region, the vine may be successfully cultivated to the elevation of 1600 feet ; the

walnut to 2400 feet; and the chestnut to nearly 3000 feet. The range of the oak, ash, and maple, extends to about 3800 feet; that of the larch to about 6000 feet; of the pine to 6800 feet; and of the spruce fir to 7400 feet, which is about 2000 feet below the snow-line in that region. Beyond the region of trees, heath and furze, interspersed with some low shrubs, form the principal occupants of the soil, though abundance of valuable alpine grass is met with in some parts. At still greater elevations, lichens and mosses grow in the crevices of the otherwise bare rocks; and, even beyond the line of perpetual congelation, the singular vegetable production called the *palmella nivalis*, or *red snow*, which occurs abundantly in the arctic regions, is occasionally found amid the perpetual snow of Mont Blanc.

An acquaintance with the various zones and elevations above the sea-level, at which plants of utility to man will succeed, is of extreme importance to all settlers in newly-colonized countries; for, as it would be a vain attempt to introduce into England plants adapted to flourish only in hot climates, so would it lead to disappointment were we to cultivate in intertropical regions such as will only thrive in temperate zones, in cold regions such as require a high summer temperature, or in dry regions

such as require abundance of moisture. Now, wheat will not succeed at or near the level of the sea in intertrópical regions, nor will it come to perfection in climates where the summer temperature is below 57° Fahrenheit. It, however, may be cultivated with great success, even under the equator, between the elevations of 4500 and 10,000 feet above the level of the sea. Its northern or polar limits in North America have scarcely yet been determined; its successful cultivation does not extend beyond N. lat. 58° in the British Isles, but reaches to lat. 64° in Norway, though in Sweden not beyond 62°, and in Russia not much beyond N. lat. 60°. The successful cultivation of oats extends to the northern extremity of the British Isles, and that of barley to Faroe Isles.

The great practical utility of this department of Physical Geography will be evident to all; it will also be readily conceived that a further pursuit of the subject must lead to great gratification. And in truth, the more our attention is directed to it, the more shall we be convinced that "The Lord God has made to grow every tree that is pleasant to the sight, and good for food."

XIII. GEOGRAPHICAL DISTRIBUTION OF ANIMALS.

The distribution of animals over the surface of the globe is, like that of plants, greatly influenced by climate and temperature. Animals also, like plants, belong to particular regions, or have their natural *stations* and *habitations*, though, since a considerable number of animals possess the power of transporting themselves from one region to another, these cannot in all cases be so determinately fixed.

The animal kingdom has been arranged in four great departments: I. *Vertebrata*, or vertebrated animals; II. *Articulata*, or articulated animals; III. *Mollusca*, or molluscous animals; and IV. *Radiata*, or radiated animals.

The *vertebrated animals* are so named from the bones of the neck, which are called *vertebræ*. Animals belonging to this department all possess a skull and a back bone; they have organs of sight, hearing, smell, and taste; and have never more than four limbs, though in some classes of animals these limbs are not so perfectly developed as in others. This division includes *man*, *quadrupeds*, *birds*, *serpents*, *frogs*, *tortoises*, *croco-*

diles, and such *fish* as *cod*, *herrings*, &c., all of which have a bony skeleton.

This department of the animal kingdom is divided into four classes: 1, *mammalia*, or animals which suckle their young, such as man, the cow, bat, whale, &c.; 2, *birds;* 3, *reptiles*, such as serpents, turtles, frogs, the crocodile, &c.; 4, *fish*, that is, such fish as possess a bony skeleton.

The *articulated animals* are so named from *articulus*, "a little joint," on account of their peculiar formation, which consists of a head and successive portions *jointed* together. To this division belong the *insect tribes*, the *earthworm*, *crustaceous animals* or *crustacea* (such as *lobsters*, *crabs*, *shrimps*, &c.). Some articulated animals have jointed limbs attached to the side of the body, like the *fly*, *centiped*, *lobster*, &c.

The *molluscous animals* are so named from *mollis*, "soft," because their bodies are soft and are without a bony skeleton. Many molluscs have shells forming a covering and defence for their soft bodies; the *oyster*, *snail*, &c., possess these protecting shells: others are destitute of this covering; of this we find instances in the common garden *slug*, the *cuttle-fish*, &c.

The *radiated animals* form the fourth great division of the animal world. They are called *radiated*, because in the greater number of the

animals belonging to this division, the organs of motion and sense are considered to radiate from a common centre, like the *petals* or flower-leaves of a daisy or anemone. To this division belong the *coral animal*, the *sea-anemone*, &c. Animals of this division are also termed *zoophytes*, from *zo-on*, "animal," and *phyton*, "a plant," because, though in fact they are living creatures, they sometimes bear a great resemblance to plants in their structure.

When animals are *identical* in their anatomical structure, they are considered to belong to the same *species*. When two or more kinds of animals are very nearly alike in their structure, though with some differences, they are considered to belong to the same *genus* (plural *genera*). When the differences are greater, they are arranged into a group, called an *order*. And when only a few points of resemblance can be traced, they are regarded as belonging to the same *class*. A *department* contains several classes. Thus, the dog belongs to the *department* vertebrata, to the *class* mammalia, to the *order* carnivora, to the *genus* canis, and to the *species* dog. Different systems of classification vary the names of the orders of mammalia. One system gives three orders, the *carnivora*, *herbivora*, *cetacea;* another gives as many as

twelve. Among some species, we also meet with *varieties;* thus the varieties of the dog are the mastiff, greyhound, terrier, &c.

The same species of animals are not met with in all parts of the world, and even some genera are found to be peculiar to particular regions. Thus, the royal lion is met with only in Africa, the Asiatic lion being of a different species and of a smaller size. The tiger is peculiar to Asia and some of the Asiatic islands; the giraffe to Africa; the elephant is found in Africa and in some parts of Asia, but the African and Asiatic elephants are of different species.

The animals of the Old World generally differ in species from those of the New World. Thus, besides those we have already enumerated, the ape and baboon, the hyæna, panther, rhinoceros, hippopotamus, horse, ass, camel, buffalo, crocodile, python, &c., are all inhabitants of the Old World.

The puma (sometimes erroneously called the American lion), the jaguar, the sloth, armadillo, bison, lama, alligator or cayman, boa constrictor, rattlesnake, &c., are all peculiar to the New World.

In the most northerly parts of both continents alone are the same species of animals found; thus, the Polar bear and the Arctic fox inhabit

the whole of the icy regions extending from Spitzbergen and Siberia to Arctic America; these animals being capable of enduring the severe cold of those high latitudes, and of traversing the frozen surface from one continent to the other.

The annals of a country, taken collectively, constitutes its *fauna*. That of Australia includes some very singular forms. Among these are the various species of opossum and kangaroo, the ornithorynchus, or duck bill, &c. The flying squirrel, or flying cat, is found in Australia and some islands in the Indian Ocean. Bats of various species are met with in almost all the warm and temperate regions of the earth.

Birds, like other animals, have their natural geographical limits; and though some have a very wide range, others are confined to particular regions; thus, the birds of paradise are found only in New Guinea and some adjacent islands; the beautiful sun birds are confined to Africa, and the humming birds are peculiar to the New World. The powers of flight possessed by most birds, and the migratory instinct which leads some species of birds to remove their quarters at the change of season, cause them to possess a very wide range, and to enjoy at all times a climate especially adapted to their wants.

In the animal as well as in the vegetable kingdom, the largest number of species is met with in the warm regions of the globe, and a gradual decrease, in the number both of genera and species, takes place as we recede from the equator. It is in intertropical regions also, that mammiferous quadrupeds are most remarkable for their magnitude, strength, and ferocity; that reptiles are larger and more venomous; that birds are decked with the most splendid plumage, and the insect tribes distinguished for their size and the brilliancy of their tints. These effects of light and heat appear to be extended even to the inhabitants of the ocean; sharks and some other fish are larger and more ferocious in the seas of tropical regions, and some species of fish are adorned with gayer colors, than those of temperate zones. It is also from the warm regions of the earth, that the greater number of the most beautiful shells of molluscous animals are obtained, and there, likewise, do the coral animals and other radiata occur in the greatest variety and abundance.

Animals, like plants, are adapted for the stations or situations in which Creative Wisdom has placed them; and thus we find animals belonging to cold climates provided with warm furry coats, which would be unsuited for the

inhabitants of hot regions. Sometimes, when animals of the same species inhabit countries possessing different climates, the garb of the one will differ from that of the other, in accordance with the difference of climate. Thus, the skin of the stoat in England is comparatively thin, and of a dull grayish brown color; but in northern Russia and Siberia, the coat of the animal is transformed into a beautiful thick fur, of a clear white in every part except the tip of the tail, which is of a deep black, affording, under this form, the well known fur called ermine.

If by accident, or the agency of man, animals are removed to places uncongenial to their natures, they either perish altogether, or some change takes place to fit them for their new abode. Thus, the race of sheep now inhabiting some of the valleys of intertropical South America, which were originally transported from temperate European regions, possess, instead of their warm woolly fleeces, a coat of glossy hair, better adapted to the heat of the climate in which they have now become naturalized. Thus, again, a species of dormouse, which is a native of the warmer regions of the earth, does not in its natural habitation, where it can at all seasons of the year obtain abundance of food, become torpid, or *hybernate;* but if removed to England,

where its means of subsistence fail during the winter, it acquires the habits of the English dormouse, and passes that season in a state of torpidity.

XIV. GEOGRAPHICAL DISTRIBUTION OF MAN.

The geographical distribution of man forms a subject of totally different character from any that has hitherto engaged our attention. Instead of speaking of genera and species, we have now to direct our inquiries to the *diversities of language*, and the *varieties of form and color*, in the human race, and to the distribution over the earth's surface of these diversities and varieties.

The number of languages at present spoken in the world, is estimated at not much less than 2000; but many of these appear to be derived from one common root or origin. Thus, the Hebrew, the Babylonian, Syrian, Arabian, and Abyssinian, are considered to have one common origin. They are collectively called *Semitic*, from Shem, the son of Noah, from whom the nations speaking these languages are supposed to have descended. This is called a *family of languages*.

DISTRIBUTION OF MAN.

Another family of languages, which is called the *Indo-European*, includes a large number of the languages or *idioms* of Europe and Asia. 1. The *Sanscrit*, and all its dialects in India. 2. The ancient *Zend*, or *Medo-Persic* language, and all the idioms now spoken in Persia and Armenia. 3. The *Greek* and *Latin* languages. 4. The *Sclavonian.* 5. The *Gothic* or *Teutonic.* 6. The *Celtic.*

The languages of some nations, though not so distinctly traceable to the same origin, are often found to bear a great resemblance to each other, and they are then considered to belong to the same *school* or *class* of languages. Such are those termed *monosyllabic*, from their consisting of words of one syllable. To this class belong the languages of China, Thibet, Siam, and nearly all the Indo-Chinese countries.

Another class of languages is those termed *polysynthetic.* These consist of long words of many syllables, and very elaborate in their construction. To this remarkable class of languages belong all the numerous dialects or idioms of both North and South America.

A dispersion and separation into families and tribes having taken place at an early period of man's history, considerable differences in the features and the color of the skin appear before

long to have become hereditary in certain tribes or nations, probably occupying comparatively remote regions of the earth. These peculiarities having formed permanent distinctions, naturalists have attempted to class the human species into certain *races* or *varieties*, according to the color of the skin and the form of the skull.

The three leading divisions are the *Caucasian*, the *Mongolian*, and the *Ethiopian* races: to which may be added, the *Malayan* and the *American* races.

The *Caucasian*, or *White race*, is characterized by a fair skin, sometimes with color in the cheeks, an oval face and expanded forehead, eyes varying from blue to dark brown; nose thin and slightly aquiline or straight, small mouth, and a full and rounded chin; soft hair, varying in color from black to light brown and flaxen, and waving or slightly curled.

The most refined and civilized as well as most powerful nations of the earth have belonged to the Caucasian race; and it is in the regions inhabited by this race, that both the Semitic and Indo-European languages have prevailed, and do still prevail. The ancient and modern inhabitants of the regions bordering on Mount Caucasus, the higher castes of India, the Afghans, the Medes, Persians, and Arabs, the inhabitants of

Northern Africa, and the Jewish people, all belong to this race.

In Europe, the Caucasian race includes the ancient Greeks and Romans, and the present inhabitants of Greece, Italy, France, and other nations which derive their language and descent from the Greeks and Romans; the Sclavonians, who occupy Russia, Poland, and parts of Austria and Turkey; the Teutonic or Gothic tribes, who occupy Norway and Sweden, Denmark, Holland, Germany, Prussia, parts of Belgium, Austria and Switzerland, and a large portion of the British Isles; and the Celtic race, who inhabit the north-western districts of Scotland, the west of Ireland, Wales, and some parts of Cornwall. This race, intermixed with the descendants of the ancient Romans, is also spread over Belgium, France, Switzerland, Italy, Spain, and Portugal.

We thus find that the Caucasian race inhabits the whole of Europe, with the exception of Lapland, Finland, and part of Hungary; a large portion of the south-western regions of Asia; the northern part of Africa, from about N. lat. 20° to the borders of the Mediterranean Sea; and through European colonists, a considerable portion of America, and of various other regions of the globe.

The *Mongolian* race is characterized by a yel-

lowish or olive-colored skin, a broad and flattened face, with a low and narrow forehead; small black eyes obliquely set, a wide mouth and thick lips; black hair, lank and thin. The Mongolian race at the present day occupies a large portion of Asia, to the north and east of the Himalaya Mountains. The nomadic or wandering Mongolian and Kalmuc tribes belong all to this race; as do also the Chinese, the Samoieds, and the inhabitants of Kamschatka. This race also occupies Finland, Lapland, Greenland, and part of Hungary, though in the last territory the characteristic features of the Mongolian race are much less strongly marked.

The *Ethiopian* or *Negro* race is characterized by a black or very dark skin; a narrow compressed skull, a low and narrow forehead, black eyes, a flat broad nose; thick lips, especially the upper lip; a small chin; woolly, crisp, coarse hair, collected into little knots. This race is considered to occupy nearly the whole of Africa to the south of the Great Desert; parts of Madagascar, Australia, and New Guinea; and some of the islands included in the Indian and Polynesian groups.

The *Malay* or *Malayan* race bears much resemblance to the Mongolian, though in the Malayan race the color of the skin is darker, and the

face less broad. This race occupies the Malay Peninsula, and a large portion of the islands of the Indian Archipelago.

The *American* race is characterized by a reddish colored skin; by a high and receding forehead, with generally regular features, and a rather prominent and frequently aquiline nose. This race, though fast diminishing from the face of the earth, includes the aboriginal inhabitants of the whole American continent. All the tribes occupying that vast range of country speak dialects or tongues allied to each other and belonging to that singular class which is formed of long polysyllables. The number of different dialects in America is estimated at no less than 1500.

The diversities of language on the face of the globe tend to the disunion of man from his fellow man: and undoubtedly we must look to the spread of the Gospel, as the sole efficient means of restoring union among mankind, and of leading all the different members of the human race to feel that they belong to one great family, that they are all brethren, and children of one FATHER. It may be little that we individually can do to promote this grand object, but we may endeavor to perform our part. By the acquirement of foreign languages, we may be

better enabled to meet every man as our brother; and by the exercise of kindly feelings, and the mutual interchange of good offices, not only amongst our kindred and our countrymen, but amongst strangers and foreigners from every part of the globe, we may be instrumental in promoting "peace on earth, good-will towards men."

EXERCISES FOR THE EXAMINATION OF PUPILS.

I. The Objects of Physical Geography. (p. 1.)

What is meant by Physical Geography? — Why is it called Physical or Natural Geography? — What advantages may result from its pursuit?

II. The Earth. (p. 2.)

To what group of bodies does the earth belong?

What is the form of the earth? — Mention three different modes by which the rotundity of the earth may be proved.

How is the earth or globe divided into two parts? — How are maps of the world frequently divided?

What is the circumference of the earth? — What is its diameter from east to west? — What from north to south?

Give some account of the earth's turning on its axis; or of its diurnal motion. — Also of its motion in its orbit. — How is the earth placed in its orbit? and what is the consequence of this position? — Relate some particulars about mid-summer and mid-winter.

III. Latitude and Longitude. (p. 9.)

How is the earth or globe divided for the convenience of measurement? — How is latitude marked? and how many degrees of latitude are there? — From what is latitude reckoned? — What is meant by high and low latitudes? — How are degrees subdivided? — How many miles are there in a degree of lati-

tude? — What is meant when it is said that places are on the same parallel of latitude?

How is the earth divided by circles running parallel with the equator? — Mention the zones into which these divide the earth; also the parallels of latitude to which they extend; and for what cause particular names have been given to these zones.

How is longitude determined? and from what is it reckoned? — How many degrees of longitude are there? — Give some particulars about the number of miles contained in degrees of longitude; and their difference in different latitudes. — What is the length of a degree of longitude on the parallel of London? — Give the meaning of the terms east and west longitude. — When are places said to be on the same meridian? — What is meant when we speak of the sun's being on the meridian?

IV. Distribution of Land and Water. (p. 14.)

What is the estimated proportion of land to water on the surface of the globe? — What in the northern and southern hemispheres?

Under what general heads may the dry land be considered? — Give an account of the two great continents. — Why are they called the old and new continents?

Describe islands. — Mention the largest island on the earth's surface. — What regions are included under the appellation of Oceanica?

How is the land arranged in the eastern, and in the western continent? — Mention the direction of the greatest extension of land in the two continents.

V. Variations of the Surface. (p. 17.)

Describe the variations of the earth's surface. — Mention the usual arrangement of mountains.

Give some account of mountain ranges. — What direction do they usually appear to take?

Give the names of the principal mountain ranges which extend across the old continent. — Give the names of the mountain ranges which extend from north to south in the new continent.

How are mountain ranges frequently disposed, in peninsulas and islands?

Give some particulars about the appearance and form of mountains, and about glaciers. — Describe mountain branches, and spurs. — What are detached or isolated mountains? — Where are the loftiest summits usually met with? — Give the heights of the principal mountains.

Describe table-lands, or plateaus. — Mention the most remarkable plateau or table-land in Europe. — Mention table-lands in Mexico, in the Andes, and in Asia.

Describe plains or lowlands. — Mention the most remarkable in Europe; in Asia; and in Africa. — Describe the lowlands of North and of South America; and mention by what names they are distinguished.

What are the various kinds of valleys? — Describe principal valleys; lateral or transverse valleys; and subordinate valleys. — Describe basin-shaped valleys. — Give the various terms applied to narrow valleys; and for what cause some of these terms have been applied.

What forms the standard by which all the undulations of the earth's surface are measured?

VI. Geology. (p. 33.)

What is Geology? — What is meant by the earth's crust? — Of what does the earth's crust consist? — Mention the various kinds of rocks. — State also the meaning of the term fossil; and give some particulars about the general diffusion of fossils in all parts of the earth's crust.

Describe earthy formations; also pebbles, gravels, shingles, and boulders. — What is conglomerate, or pudding-stone? — What is breccia?

Mention the most abundant earths. — In what mineral substance is silex found in a pure state? — In what form is lime usually met with? — What useful property does clay possess?

How are rocks classed? — What are stratified or sedimentary rocks? — How do they seem to have been formed? — How are stratified rocks arranged? and how is their relative age determined?

By what means are the lower rocks sometimes brought to the surface? — Give the meaning of the term "crop out." — Mention the advantages which may result from this.

What are unstratified rocks? — Mention the apparent mode of their formation; and name the principal rocks of this kind.

Into what three classes are unstratified rocks divided? — Describe plutonic rocks. — State under what circumstances they are supposed to have become consolidated. — Describe trap rocks. — Mention the principal rocks of this class. — Describe volcanic rocks. — Mention the principal products of active volcanoes.

In what regions of the earth do the most remarkable active volcanoes occur? — How may volcanic eruptions prove beneficial? — Give some account of a tremendous eruption in Iceland. — State the apparent connection between earthquakes and volcanic eruptions.

What effects are sometimes produced by earthquakes? — Do earthquakes occur in regions remote from active volcanoes?

Give some account of extinct volcanoes. — Describe intrusive rocks, and metamorphic rocks. — Give an instance of a transformed rock?

What are dislocations or faults? — What benefit results from faults? — What do fissures sometimes contain?

Give some particulars about metallic veins. — Where is gold usually found? — Where are copper, tin, lead, silver, and iron usually found?

VII. The Waters of the Globe. (p. 45.)

Under what heads may the waters of the globe be considered?

From what do springs take their rise? — How are internal reservoirs supplied with water? — What does spring water contain? and what forms the distinction between soft water, hard water, and mineral water?

How may mineral springs be classed? — Describe acidulous springs. — Describe chalybeate springs. — Describe sulphureous springs. — Describe the two kinds of saline springs. — Describe calcareous springs; and give some account of their mineralizing or petrifying properties. — Describe stalactites and stalagmites. —Describe siliceous springs.

Are thermal or hot springs of frequent occurrence? — Describe the two kinds of hot springs. — Give some particulars about the temperature of the earth at various depths; and mention by what means this has been ascertained. — Which kind of springs has usually the highest temperature? — Name some remarkable hot springs. — Describe bituminous springs.

From whence do rivers derive their supplies of water? — What is meant by the term water-shed? — What constitutes the basin of a river? — Give the area of the principal river-basins.

On what does the velocity of a river in great measure depend? — Describe cataracts, cascades, and rapids. — Describe deltas; and estuaries. — What is meant by the bore? — Give some particulars about flood-seasons, or freshets. — What is the number of considerable rivers in the Old World? — What in the New? — Give the length, situation, and termination of the principal rivers.

Give some account of the various kinds of lakes. — Describe lakes at the sources of springs; lakes in the course of a river; lakes in depressions of the earth; lakes in the craters of extinct volcanoes; periodic lakes. — Mention the largest lake in England; the largest lakes in Europe; in Asia; in North America.

What advantages result from the great extent of the ocean?

— Does the ocean form one vast mass of waters? — Give its geographical divisions. — Describe branch or inland seas. — Describe lochs, voes, and fiords.

Give some particulars about the depth of the ocean; about its temperature; about its saline contents. — Mention the usual degree of saltness of inland seas; and what sea forms an exception to the general rule.

What is the freezing point of sea-water? — Give some account of icebergs.

Does it appear that sea-water has any color? — Is its color sometimes influenced by its bed? — Also by the presence of minute animals? — What causes the luminous appearance of the ocean?

VIII. Tides, Waves, and Currents. (p. 68.)

What causes the perpetual movement of the waters of the ocean? — By what attraction are the waters retained in their bed on the earth's surface? — By what attraction is the great primary or tidal wave formed? — How is ebb-tide or low water on our shores produced? — How is flood-tide or high water produced? — What are spring tides? — State the course of the Atlantic tidal wave; and the difference between high and low water at various places.

Describe secondary or wind waves. — Describe the ground sea.

What causes the currents of the ocean? — And which are the most remarkable currents? — Describe the polar currents. — Also the equatorial currents. — And the great system of currents commencing in the Antarctic Seas. — Describe the Gulf Stream.

IX. The Atmosphere. (p. 75.)

Describe the earth's atmosphere; and mention its height. — Of what is atmospheric air composed? — Give some account of

the elasticity and the density of air. — Mention the consequences to which these gives rise. — State what is meant by the term "weight of an atmosphere;" and give some particulars about the barometer.

What effects are produced on the temperature of the air by height above the sea-level?

What appears to give rise to winds? — Give some particulars about winds. — Give an account of the trade-winds. — What causes south-westerly and north-westerly winds to prevail in higher latitudes? — Give a description of monsoons. — What causes sea-breezes, and land-breezes?

What are hurricanes? and what are typhoons and ox-eyes? — How do tornadoes, pamperas, and arched squalls differ from hurricanes?

Describe the sirocco, solano, simun or simoon, and also the harmattan.

In what state is water always present in the atmosphere? and by what means does it find its way there? — How is dew formed? and when is it most abundantly deposited? — On what substance is dew usually most copiously deposited?

When are mists and fogs likely to be formed?

How are clouds formed? and of what do they consist? — Mention also how rain is formed, and under what circumstances hail and snow are formed.

What names are given to the principal forms of clouds? — Describe the four principal kinds of clouds. — At what height in the atmosphere is the zone of clouds? and which are the highest, and which the lowest clouds? — Mention the names of the combinations of the principal kinds of clouds.

In what parts of the earth does the largest quantity of rain fall? — Is it more abundant in the New than in the Old World? Mention the rainless districts of the earth. — State the cause of the difference in the amount of rain in different regions. — What difference is there in the quantity of rain in the eastern and western parts of the British Isles?

Give some particulars about rainy and dry seasons; and also relative to the belt or zone called the "variables." — Give an account of the fall of rain in intertropical countries, and in countries beyond the tropics.

X. Climate. (p. 95.)

What is meant by the term CLIMATE? — What are the most prominent causes of diversity of climate?

What is the grand agent in diffusing heat over the earth's surface? — Mention the effects produced by the earth's diurnal rotation; and also the beneficial results from its inclined position in its orbit.

How far does the artificial division of the earth into torrid, frigid, and temperate zones correspond with the climates of those regions?

Mention another leading cause of the diversity of climate? — What is signified when we speak of an insular climate? — What by an excessive climate? — Mention an instance of the effects produced by a large surface of water in tempering or moderating the climate of some regions of the earth.

Mention another leading cause of the diversity of climate; and give an account of the height of the snow-line in different regions. — Refer to the tabular view for its height in various latitudes. — What appears to be the cause of its greater height at certain distances from the equator, than under that line? — Mention the beneficial results arising from the different temperature at different heights. — Describe the effects produced on vegetation by elevation above the sea-level, in the hot regions of the earth.

Give some account of the temperature of mountains near table-lands. — Mention the Himalaya Mountains as an example; and state some particulars about isolated mountains in different climates.

What effects are produced on climate by the nature of the soil?

— What by the prevailing winds? — How do mountain ranges affect climate? — What effects are produced by the currents of the ocean? — Give some account of the Sea of Sargasso; and mention the effects it produces on the temperature of the Northern Ocean.

What districts usually possess more excessive climates? — Does the temperature vary as much in intertropical, as in temperate regions?

What are isothermal lines? — Do they run parallel with the equator? — What are isotheral and isochimenal lines? — What is the average degree of heat of the line of highest temperature; — What regions does it cross? — Which is considered to form the hottest region of the earth?

XI. Electricity and Magnetism. (p. 109.)

Does Electricity act any part in the natural world? — Mention what is meant by ordinary electricity, and how it may be called forth, and what is meant by voltaic electricity.

What is meant when it is said that any substance is positively electrified? and what when negatively electrified? — Give some particulars about the electrical state of substances, and of the effects produced if they come in contact.

In what state of electricity is the earth considered always to be; and in what pure atmospheric air? — Mention, also, by what means the electrical equilibrium of the air is liable to be disturbed, and how it is sometimes restored. — At what periods of the day and of the year is electrical intensity greatest?

What effects does it appear that voltaic electricity is continually producing in the earth's crust? and what substances are supposed to be formed by its powerful agency?

What is terrestrial magnetism? — Under what heads may it be considered? — How may the magnetic, or attractive power of the loadstone be imparted to iron or steel, or how may it become magnetized? — What is meant by the magnetic direction of the compass needle? — In what direction does the needle point? —

Is this subject to variation, and what is the variation termed? — What is meant by lines of eastward and westward variation? — What by lines of no variation?

What is meant when we speak of the dip or inclination of the magnetic needle? — Describe the magnetic equator.

XII. Geographical Distribution of Plants. (p. 114.)

Give some particulars about the plants on the earth's surface? Mention the adaptation of plants to all parts of the earth.

Into what classes are plants naturally divided?

Describe cryptogamic, or a-cotyledonous plants. — Describe endogenous, or mono-cotyledonous plants. — Describe exogenous, or di-cotyledonous plants.

Which class of plants includes the greatest number of species? — What is the proportion of the different classes in different zones?

Describe perennial annual, and biennial plants. — Describe deciduous plants; and mention in what parts of the earth they most abound. — Give an account of the peculiar character of the evergreen trees of hot regions, and that of those of cold regions.

From what do plants derive their nourishment? — What effects are produced on plants by light? — Give some particulars about the composition of plants, and what is required to bring them to perfection.

In what regions of the earth are the vegetable productions most varied? — State the relative proportion in the different zones.

Are the same plants met with in all regions possessing similar climates? — How is the earth divided into botanical regions?

Give some account of the correspondence between the plants of Arctic regions and those of high mountains in hot climates; also of the resemblance between those of temperate regions and of the middle region of such mountains. — Give Baron Humboldt's

division of the earth into eight zones. — Give the scale of vegetation at various heights in temperate Europe.

On what account is it important to be acquainted with the zones and climates in which plants will succeed? — Mention the highest northern limit of the successful cultivation of wheat, oats, and barley, in Europe. — State how gratifying the pursuit of this science is likely to prove.

XIII. Geographical Distribution of Animals. (p. 126.)

Does it appear that the distribution of animals on the earth's surface is influenced by climate?

Mention the four great departments of the animal kingdom.

Why are vertebrated animals so named, and what is their peculiar characteristic? and what animals are included in this division? — Into what four classes are vertebrated animals subdivided?

Why are articulated so named, and what animals are included in this division? — State, also, what animals are called crustaceous. — Why are molluscous animals so named, and what animals belong to this division? — Why are radiated animals so named, and what animals belong to this division of the animal kingdom?

Which of these four divisions ranks as the lowest among living creatures? and which is the highest? — Which forms the highest class among vertebrated animals?

Give the meaning of the several terms species, genus, order, class, and department; and give the example.

Do we find that certain species of animals are peculiar to particular regions? — Mention some of the animals peculiar to the Old World. — Mention some animals peculiar to the New World. — What animals are met with in the more northerly regions of both continents? — Mention the peculiarity of the group of animals inhabiting Australia.

Give some account of the geographical distribution of birds.

Are the animals inhabiting warm regions usually more conspicuous than those of temperate regions?

Give some account of the adaptation of animals to the regions which form their natural habitations; and give instances of the changes which sometimes take place when animals are removed to other climates.

XIV. Geographical Distribution of Man. (p. 133.)

How many languages or dialects are now spoken in the world? — What are languages called, which appear to be derived from the same root or origin? — Why is one family of languages called "Semitic?" — Give an account of the Indo-European family of languages.

What are schools of languages, or classes of languages? — What languages are included in the mono-syllabic class? — What languages are included under the class called poly-synthetic?

To what consequences did the dispersion of mankind apparently lead? — Mention the leading divisions or varieties of the human race.

What are the characteristics of the Caucasian race? — What regions have they occupied, and at present still occupy? — What are the characteristics of the Mongolian race, and what regions do they occupy? — What are the characteristics of the Ethiopian or Negro race, and what regions do they occupy? — What are the characteristics of the Malay or Malayan race, and what regions do they occupy? — What are the characteristics of the American race, and what portion of the globe do they occupy?

What has tended to disunite mankind, and what may tend to restore union among the human race?

QUESTIONS FOR INVESTIGATION.

TO THE TEACHER.

After closing the study of this book, it will be well to enter upon these questions, which are intended to call into action the reason of the pupil as well as his memory. In many instances it will be necessary to direct the pupil to other sources of information than those mentioned in the preface, and to give oral instruction to the class.

What does Physical mean?

What is meant by commerce?

Can a knowledge of Physical Geography promote Commerce? How?

What does the word diameter mean?

Has the earth more than one diameter?

Has it several of the same length?

What does spheroid mean? spheroidal?

How is the earth supposed to have obtained its spheroidal shape?

Suppose that a round ball of putty were placed on a rapidly revolving spindle, would it retain its round shape?

What shape would it assume?

What is meant by centrifugal force? by centripetal force?

Wille the centrifugal force be greater at the equator or at the poles? Why?

Would a leaden bullet weigh the same at the equator as at the poles?

Would a pendulum vibrate with equal rapidity at the equator and at the poles?

Give the reason for your answer.

How far is it from the poles to the centre of the earth?

What is the most common mineral found in the earth?

Is it commonly found pure?

What town do you think to be at the middle of Europe? of America?

What is the middle of the Eastern Hemisphere? of the Western?

You may name some benefits which result from the preponderance of water over land on the globe.

What is the chief cause of the unevenness of the land?

If the earth presented a flat surface, what would be the consequence?

Which is the largest of the oceans?

Does the same climate always exist within the same zones?

If North America be considered as main land, what immense peninsula extends from it?

Name another immense peninsula.

What country seems to have the most coast-line in proportion to its size? What the least?

What country then has the most numerous harbors?

Compare Asia with South America in this respect?

Which way do most large peninsulas turn?

Mention exceptions?

Mention some of the uses of mountains?

What kind of vegetation would you expect to find at the summits of the highest mountains?

Describe a glacier.

How fast are they supposed to move?

What are avalanches?

Can you find an account of an avalanche among the White Mountains?

From what do volcanoes receive their name?

From what is the crater called?

What does steppe mean?

Where are steppes found?

What important use do deserts subserve?

How are the lowland plains of North America situated?

Point out a water-shed in Europe; in Asia; in Africa?

What is a rolling prairie?

What general shape have islands which lie along the coasts of continents? Give examples.

How can you account for this?

Generally speaking, are the largest islands found near to, or remote from, the shore?

What exceptions can you name?

What are volcanic islands?

Give examples of them?

Are volcanic islands always permanent?

Can you find any instance of the disappearance of volcanic islands?

How are coral rocks formed?

What are Atolls?

What are the principal causes of change in the earth's surface?

What are the advantages of such changes to a country?

How are waterfalls formed?

Can you show the wasting effect of the water at the Falls of Niagara?

How fast are these Falls thought to recede?

Then how long has it taken for them to recede from Queenstown to their present place, a distance of seven miles?

How are lakes formed?

What is the cause of whirlpools?

Give an instance of one.

What peculiar danger do they bring to mariners?

What are inland seas?

How do they differ from lakes?

Describe the fiords of Norway.

How is the surface of the earth heated?

Is the earth nearer the sun in summer or in winter?

Upon what does the amount of heat depend?

What do you mean by perpendicular rays? by slant rays?

Do perpendicular or slant rays give the more heat?

Over what zone does the sun's course through the year lie?

Why are the tropics so called?

Does the sun move round the earth, or the earth round the sun?

If the axis of the earth were not inclined, where would the sun's rays fall perpendicularly?

How often in the year does the sun shine vertically on the equator?

Why are these occasions called equinoxes?

When does the sun shine vertically on the Tropic of Cancer? of Capricorn?

What are these occasions termed?

When the sun shines vertically on the Tropic of Cancer, how many degrees beyond the North Pole can any of the slant rays fall?

How many beyond the South Pole, when he is at the Tropic of Capricorn?

Then what do the Arctic and Antarctic circles show?

How long is the day at the North Pole? Why?

The night? Why?

How many days and nights in the year at the South Pole? Why?

If the sun were shining vertically now on the Tropic of Cancer, which would be the longer here, the day or night?

If upon the Tropic of Capricorn?

If upon the Equator?

What is the shortest day of the year to persons in the Northern Hemisphere? the longest?

(The questions given immediately above must be resolved with the assistance of a globe.)

When it is noon at London, what will be the time at Boston?

At six o'clock, A. M. at Boston, what will be the time at St. Louis? at St. Petersburg?

When it is three o'clock, P. M. at London, what will be the time at Bordeaux?

What is the latitude of Cape Horn?

What is the Aurora Borealis?

How is it thought to be produced?

Is a garden bean a cryptogamous or a phænogamous plant?

Is it mono-cotyledonous or di-cotyledonous?

Is it endogenous or exogenous?

What is the effect of light on the colors of blossoms?

Describe the banian tree, and quote Milton's description of it (P. L. ix, 1100).

Give so far as you can the flora of the state in which you live.

Give its fauna.

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