On

Light and Heat

by

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Heat, Light, and Electricity, are so intimately connected together that it is almost impossible to touch upon one without advert:ing to the other, but of the latter being rather a complex and difficult subject, and at present not having much time at my disposal, I shall restrict myself to the two former, not entering into their more minute details, but review them more as they come into action in the vital phenomena of Animal and Vegetable life, merely glancing at Electricity where it comes to bear part in the production of Heat or Light.

Heat is one of the sources which assists in the formation and development of the Animal and Vegetable Kingdom, and in producing changes and modifications in most of the Inorganic products of the earth.

It is given off like light in rays, it is not a material substance, nor has it any weight, and is either sensible or latent. Sensible Heat is that which can be felt, and will cause the thermometer to change according to its amount.
Latent Heat is not perceptible to the feelings and will produce no change in the thermometer until it is set free by some agent.

Sensible Heat is that which is so much appreciated by Animals and Plants, without which they would not be able to exist, and the amount of which causes such important changes in their Physiology and Physiognomy. It is in general given off from luminous bodies, and the most perfect example, is that which is derived from the Sun, under whose genial influence, all the Organic world seems to delight, grow, and come to perfection, and it was this heat which after forming the Earth, the Divine Creator sent to comfort our first parents, before they knew how to produce Heat artificially.

It is the most interesting of all the sources of Heat, and combined with its light is to all living creatures invaluable. What can be more glorious and striking than to see the Sun rising, when gorgeous Aurora comes forth in all her majesty, and drives her golden chariot over the expanse
of the heavens, all the flowers raise their heads, and look forth after being drooping and downcast with the chills of night, and seem as if they had been waked up into a new existence, with the feeling of warmth which they experience, and the birds and insects come from their domiciles, and give forth their notes, in expressing the comfort they derive from his genial rays, even the humblest plants seem to appreciate it. It changes with the assistance of its light, the colour and form, may arrest or hasten development, and alters the functions, what a variety it makes, according to the distance the Earth is from its influence, (According to Kepler's first law of Planetary motion) as in winter, and summer, spring and autumn, and the regions of the Earth, by the spherical form of the Globe causing them to be removed from the Equator to a greater or lesser degree, this proves that man was formed by nature to have variety, and not live a monotonous life, thus, the seasons, and the different changes
produced by those seasons, day and night, to give such pleasing contrasts, that many ideas are constantly diverted, and not permitted to feel the unbearable monotony which would otherwise take place.

As we travel over the regions of the earth, we see in a more marked degree, the effects of the Sun’s heat, combined with its light; otherwise it would not have such an effect.

In the tropics, vegetation is brought to its highest perfection, there we find expansive forests, filled with stately palms, bananas, and bread fruit, and cork trees, it is there the largest of the vertebrate move about, the Elephant, Lion, Tiger, and the largest Snakes.

In the seas we find the coral rearing up its reefs, in the form of Lagoon Islands, Barrier and Fringing reefs, which sometimes extend for thousands of miles, and seem to have been built up from the fathomless depths of the ocean, by these extremely interesting little creatures the Polypes. The forests are filled with birds of every coloured plume, the air with insects of every description, and
the plains covered with flowers and plants whose petals are of every hue, it is here also that the pigment in man's skin is of a dark or copper colour, which is of use in absorbing the rays of heat, producing evaporation and consequent cold, and his food does not consist of such oleaginous or calorific matter, as is required by those in colder climates. As we journey either towards the North or South, we find things change. Birds have not such gay plumage, animals get smaller, man's complexion lighter; the trees of the forest are not so large, and cereal grains, which form the food of the inhabitants, gradually make their appearance, there having a large supply of carbon and oleaginous matter, serving to make up for the lack of heat of the Sun, by going to form animal heat, by a process of combustion within the body. But as we journey on and get into climates of extreme cold, we find flowers and plants have almost vanished, animals and birds scarce.
but the inhabitants of the seas, very large. It is here the whale, seal, and walrus abound, and we find the skin of man to be almost white, his food is composed of oleaginous and carbonaceous matter, by the caloriferous power of which, counteracts the extreme cold, which at the poles is almost unbearable.

Humboldt asserts that climate taken in its most general sense, signifies all those states and changes of the atmosphere which sensibly affect our organs; temperature, humidity, variation of atmospheric pressure, a calm state of the air, or the effects of different winds, the amount of electric tension, the purity of the atmosphere, or its admixture with more or less deleterious exhalations, and, lastly, the degree of habitual transparency of the air, and serenity of the sky, which has an important influence not only on the organic development of plants and the ripening of fruits, but also on the feelings and the whole mental disposition of man.
In order to understand what is meant by the term climate, let us suppose the earth to present a uniform flat surface and to be composed of a stratum of rock perfectly alike throughout. Under these circumstances, all places in each hemisphere equidistant from the equator would receive the solar rays at the same angle, and having the same capacity for absorbing and radiating heat, would keep the same temperature, and consequently the same climate. But matters are not thus arranged upon the earth's surface. There are causes which combine to modify the astronomical distribution of temperature and to produce a more equal distribution of heat over the surface of the globe than would exist under such circumstances as we have supposed; these are the influence of hills and dales, mountains and valleys, into which the surface of the earth is broken: the arms of the sea by which it is penetrated: and the network of running waters which are spread...
over its land maps, hence it is that large regions are adapted to the abode and support of man, that would else, from extreme heat or cold, have been quite uninhabitable. The chief causes which determine physical climate are, 1. The latitude of a country; that is, its geographical position with reference to the equator. 2. Elevation of the land above the sea-level. 3. The proximity to, or remoteness of a country from the sea. 4. The slope of a country, or the aspect it presents to the sun’s course. 5. The position and direction of mountain chains. 6. The nature of the soil. 7. The degree of cultivation and improvement at which the country has arrived. 8. The prevalent winds. 9. The annual quantity of rain that falls in a country. The latitude of a country and consequent direction in which the solar rays fall upon its surface, are the principal causes of the temperature to which it is subject. Within the tropics, the greatest heat is experienced, because the Sun is always outside to some portion of the globe within these limits
And the deflection is more intense when the rays are perpendicular to the surface; but as we recede from the equator they fall more obliquely, and because fewer of them are spread over a larger surface, they are less powerful, and consequently less influential in promoting temperature. Bouger calculated that out of 18,000 rays falling upon the earth's atmosphere, 8,123 arrive at a given point if they come perpendicularly; 7,024, if the angle of direction is 60°; 2,331, if it is 7°; and only 5, if the direction is horizontal.

The latitude of a place is therefore of the first importance in determining its temperature, since a decrease of heat takes place with an increase of latitude as we travel along, at the same level above the sea, from the equator towards the poles, this is true of countries lying between the tropics and the poles, but it is not true of places situated between the tropics and the equator.

If the ecliptic, as shown on a terrestrial globe, be examined, it will be seen that towards
the northern and southern limits, for a considerable distance it neither approaches nor recedes from the equator or the pole, but has a direction due east and west. This ecliptic is, in fact, the path of the point of direct heat and sun-light, over the earth's surface. Thus, then, it appears that when this point has reached its nearest approach to either pole, it does not immediately turn back toward the other pole, but remains at that nearest distance for a considerable time; or, as it were, lingers there. It has been calculated that if the space between the tropics be imagined to be divided into three equal bands of the earth, the point of direct sun-light would be found to linger in each of the two outer bands three times and a half as long as in the middle band.

This lingering of the point of direct heat and sun-light at its nearest approach to the poles is a necessary result of that simple and admirable provision by which the earth is made to revolve round the sun, rotating at the same time round
an axis which has an inclined position, and which secures its parallelism. The object of it is obviously to minister to the polar regions, in their due proportions, light and heat. From this circumstance it is inferred that there is no decrement of temperature, until we have passed the tropics; and this opinion is further strengthened by the fact that the snow line in some places near the tropics is at a greater elevation than at the equator, an evidence of higher temperature.

The mountains of South America immediately under the equator, present an epitome of the whole earth, in respect to temperature, and productions depending upon the temperature. Here, in the deep and narrow valleys, which are clift down almost to the level of the sea, intolerable heat prevails, and as one clumbs the lofty ridges, a single day's journey (though of course a laborious one upon so steep an escarpment) suffices to bring him from the temperature of the equator to that of the pole. There are some points in the steep ascents where one can stand and behold every characteristic
form of vegetation from the giant palms of
the tropics to the lichens of the arctic zone.
Looking downwards into the valleys of the Andes,
nothing appears but the richest and most
exuberant tropical vegetation, palm trees,
and the banana, and the coffee-tree, and
the sugar-cane, and the cow-tree, (whose trunk
being pierced yields a vegetable milk) the
majestic forests, the juicy fruits, the gorgeous
flowers of the tropics. Looking upwards, there are
fields of European grains and forests of oak
and pine, further up, there are plants of
the polar latitudes, and, last of all, a region
where none grow but the arctic lichens; beyond
this the Andes, or snow-clad mountains
terminate the view. The height of mountains
may be found by the rise or fall in the
thermometer. You examine the thermometer
at a level equal to that of the sea, and
when you get to the top of the mountain,
you examine it again, and as the beam
of the mercurial column is to their difference,
so is the number 32.00 to the sum required.
When the equilibrium of the atmosphere is
destroyed by changes of temperature in different portions of it—by an increase or diminution of the quantity of water it hold in a state of vapour—or in short, by anything which causes it to contract or expand, a rush of air then takes place towards the spot where the balance has been destroyed; this motion of the air is called wind.

Solar heat is the principle agent in producing winds. When a portion of the earth's surface is heated by the solar rays to a higher temperature than that of the surrounding regions, the column of air resting upon it expands and rises until it reaches a stratum of the atmosphere of lower temperature and greater density than itself, upon which it floats, like oil on the surface of water, and spreading out in all directions, produces winds which flow from the hot towards the colder countries. While matters are thus going on in the upper regions of the atmosphere, the equilibrium is also destroyed at the earth's surface. The surrounding heavier air, moving in the direction of the least resistance, pushes
into the space which is occupied by extremely rarefied air.
Hence if two neighbouring regions are unequally heated, there is produced in the upper strata of the atmosphere a wind blowing from the hotter to the colder region, and at the surface of the soil a contrary current.
Now these winds, in sloping from high latitudes, where the rotary motion of the earth's surface is less, to where it is greatest, (The air at the poles only turning upon itself while the air at the equator shocks on through more than 1,000 miles an hour,) apparently do not at once acquire this new velocity, and as the earth glides away, as it were, they seem to "lag or hang back," and instead of being north and south winds as they would if the earth did not resolve, they become north-east and south-west winds, as they approach the equator, they acquire a more easterly direction, these winds are known to sailors as the Trade Winds.
Heat is also radiated from the earth, where
it is either stored up from the sun's rays, or generated in the interior of the earth itself. But that our planet was originally an incandescent fluid mass, there is little reason to doubt. The theory of internal heat no longer rests on conjecture, but on well-establishe facts. The shape of the earth, which is that of an oblate spheroid, flattened at the poles and expanding at the equator, is exactly that which a fluid mass revolving round a fixed axis would assume. According to Humboldt, "the geometrical form of the earth, reveals its earlier condition, an ellipsoid of revolution, indicating a once soft and fluid mass." Moreover, we find, by actual experiment at the present day, that as we descend in mines towards the centre of the earth, the heat gradually increases, and with such regularity, that the depth of the mine can be ascertained by the state of the thermometer. From thermometric observations which have been made in deep mines, and on the temperature of the water rising in artesian
wells, it has been ascertained, that as we
descend from the surface into the depths of
the earth's crust, the increase of temperature
is 1° for every 50 feet of depth, which is an
increase at the rate of 100° per mile.
According to Humboldt, if we suppose this
increase to continue in arithmetical ratio,
a stratum of granite would be in a state of
fusion at a depth of nearly 21 geographical
miles. Again, the high temperature of water
which rises in very deep borings of steaming
wells, and the occurrence of volcanoes ejecting
masses of glowing and molten earth, hot
mud, gases, and liquids, from fissures in
the earth's surface, are strong evidences of the
increase of heat to very considerable depths
in the upper terrestrial strata; and by an
alogy we may conclude, that it continues
to increase to the centre of the globe.
The true theory would therefore appear to be,
that the globe was originally a mass of matter,
kept in a state of igneous fluidity, by extreme
heat, but which, cooling down by radiation
into space, has become partially consolidated
by progressive condensation, beginning at the surface, and advancing towards the centre. This theory of internal heat, and the gradual cooling down of the globe, so as to be coated, in process of time, with a solid stony mass, is now received by the best-informed philosophers as a fundamental and well-established fact, and it will be found to be of great assistance in the elucidation and explanation of many geological phenomena.

It is to be observed, that the effect of the process of refrigeration must have been to condense the gases capable of constituting the two fluid substances, Water and Air, round and upon the globe. Water is formed by the two gases Hydrogen and Oxygen united in chemical combination; and it has been experimentally decomposed into these two constituent elements by dropping upon it fused globules of melted platinum intensely heated. It has also been shown by Mr. Romney Robinson, that as the temperature of water is increased up to 212°, the chemical affinity of its elementary gases is lessened, and eventually destroyed.
Hence it has been suggested, that when the temperature is increased to a great extent, such as that which did once exist at the surface, and which we have reason to think still exists in the interior of our globe, the gases may intermingle without a tendency to unite being kept separate by the intensity of the heat. It follows from this, that if our planet was originally a molten fluid mass which had gradually cooled down until a crust had formed on it, as the elementary gases were thus refrigerated, the chemical affinities gradually came into action, and the Hydrogen and Oxygen combined so as to form the compound water. In the same way, at a certain point of surface temperature, by the union of Oxygen and Nitrogen, its constituent gases, Air was formed. This offers us a glimpse of the process by which the Almighty enveloped our planet with its two transparent robes of Water and Air, without which it could never have become a fit habitation for the animal and vegetable kingdoms which have successively occupied it. For,
in the perfection of his works, God has always acted consistently, and in accordance with those laws which He ordained at the creation of the first elements of mundane matter; and in the production of his highest and most minute effects. He is the same, yesterday, today, and for ever.

Animals and above all man are not dependent all together upon external heat, but have the power of producing heat within themselves, far more equable, this is called Animal heat. Numerous theories have been put forward to account for this vital phenomena, amongst others are, Black's, he said it was caused by a process of combustion going on in the lungs, Oxygen being absorbed and Carbonic acid given off, but this would cause greater heat to be generated in the lungs, which is not so. Crawford agreed with Black, with respect to combustion in the lungs, but said that the heat developed was absorbed by the arterial blood, having a greater capacity for heat, than the venous and while circulating through the body, lost
that heat, Brodie found it was caused by nervous influence, he experimented by cutting through the spinal cord, and keeping up artificial respiration and found the animal get cool, Liebig, that it was caused by a conversion of the iron in the blood from the carbonate of the protoxide into the carbonate of the protoxide in the lungs, and vice versa as it became venous, he felt that it depended on nutrition, Ellis that it was owing to the combination of Hydrogen and Carbon, I think the true theory is, oxidation of the tissues and food, by the oxygen carried by the arterial blood from the lungs, and it therefore evidently with combustion, as shown by Lavoisier, combined with the heat caused by friction of the muscles. Food affords heat to a great extent by direct oxidation of its hydrocarbonaceous constituents and required to be varied as we change from hot to cold climates. Thus in Lapland and Iceland they require a large amount of food, and that of an oleaginous description, consisting mostly of blubber of whales, seals, &c.
The temperature of animals varies as regards their health, food, exercise, or containing medium which surrounds them, anger, excitement or irritability also increases the temperature considerably in some animals, and as well exemplified in the case of bees when stinging, when the temperature rises some 10° or 15°. The temperature of some is almost always nearly equal to that of the atmosphere which surrounds them, as in fishes, others again have an elevated temperature as in birds. The temperature of man varies very little and is generally reckoned at 98 or 100, but in fevers it sometimes rises considerably higher and is said to have reached even as high as 110°, and in Asiatic cholera as low as 84°. Man can also bear great extremes of temperature, in a range varying over 200°, and still preserve the same temperature himself. Chabert, "The fire king" is said to have borne a temperature between 100° and 600°, but the air must be dry at such high temperatures. To allow of evaporation to go on from the surface of the body, otherwise
it would be unbearable, for the vapour from
the body makes a sort of halo around it
which prevents the great heat coming in
contact with it, and thus keeps it to a
certain extent cool, as is well instanced
in some cases which we see constantly
in the present day, with the new system
commonly known as the Turkish bath, which
consists in a temperature, artificially made,
varying from 120° to 160°, which heat by
producing a relaxed state of the tissues,
causes a profuse perspiration.
In plants under peculiar circumstances we
find elevations of temperature also. In the
Aracee and some other plants, when the es-
tential organs reach maturity, there is an
increase of heat, sometimes as much as 10°
above the temperature of the air, which as
the flower withers gradually declines.
Artificial heat is one great source of our
domestic comforts, and the means by
which most of our manufactures are pro-
duced on the large scale, and velocity in
travelling accomplished, it is produced by
a group of combustion of carbon with oxygen, and the chief agent now used is that well-known mineral called coal, which is so invaluable to the British nation. How cheering and comforting is the coal fire in the cold winter time, and how it raises the spirits and sends a glow of cheerfulness throughout, which is impossible to be so fully appreciated as it is by those who are not always able to enjoy it, wise, at this season of the year, our destitute countrymen. Even the savage duly appreciates the warmth of the glowing embers, and kindles his fire by rubbing two pieces of dry wood together, which excites by the heat produced by the friction enables him to light his fire, with which he cooks his meat and warms himself. By means of this artificial heat we make water boil and produce steam, by which the engines of our mills are driven, and by means of which, the immortal Stephenson made his railway engine to surmount shed the swiftest horse. Some bodies are better conductors of heat than
others, that is they allow the heat to be conveyed through their particles, better than others. Iron is a good conductor, wool and hair bad, and that is why man clothes himself with woolen clothes to keep out the cold and retain the heat generated within his body, and warm blooded animals are covered with hair.

 Liquids are bad conductors of heat. As a general rule those bodies whose particles are firmly consolidated together are good conductors of heat, Asbestos is such a bad conductor of heat, that molten metal may be taken in the hand covered with a glove made of this material, without being conscious of the heat.

 The effects of heat are expansion and change of physical position.

 Heat radiating from a body may be reflected and brought to a focus like light, and at the point of focus intense heat is produced. This is accomplished by collecting the rays of heat on a concave mirror which reflects them towards each other, and
brings them to a point or focus.
Those bodies which radiate heat best are
those, which we can Cool easiest.
Bodies cool sooner in Hydrogen gas, than
in any other.
Those substances which radiate heat best,
will also absorb heat best.
Metallic surfaces such as tin, when scratched
will radiate heat more than when it
was Plain, but on the other hand if you
take a metallic surface which has been
hammered, and scratch it, it will radiate
heat less, so that it must not be taken
as a general rule that metallic surfaces,
when scratched, will radiate heat more
than others. Uneven surfaces, and those
which are not polished, generally radiate
heat better than smoother, and it is
supposed, that it is from the foxtail
particles the rays are given off. It is
therefore necessary that all vessels which
are used for holding heated substances,
and the heat is desirable to be retained,
should be well cleaned and polished.
Heat in general expands bodies, and to a great degree, water when converted into vapor by heat expands 600 times; but on the other hand, when crystallizing into ice by cold it will also expand, this is because the crystals of water take up more room than the atoms do; ice contracts again when changing into water. Pipe clay contracts by heat.

A thermanamous body is that which allows the rays of heat to pass through it, in the same manner as the rays of light. An othermanamous body is the opposite and arrests the heat.

Rock salt no matter how thick will transmit all the rays of heat, this is not the case with other bodies, as they transmit the rays of heat in proportion to their thickness. This is proved by means of an instrument called the Thermo-electric multiplier by which the most accurate observations can be made. Up to 20° in Melloni's instrument the reflection of the needle is in proportion to the focus.
In general, heat accompanied by light, or in other words, that produced by undulations of sufficient velocity to affect the visual organs, is capable of penetrating most diathermanous media, whilst the rays of dark heat, or those of less velocity, as those emanating from a metal heated below redness, or from boiling water, are checked by many very translucent bodies. Solar heat, again, readily passes through glass, whilst the luminous heat of a bright fire is almost completely intercepted by a plate of glass screen.

Heat is also capable of reflection, refraction, and polarization.

Light produces heat if the rays are brought to a proper focus.

Electricity is capable of producing heat, and was at one time thought it would take the place of coal in generating steam for the working of engines, some nice models of which were shown at the Exhibition, but it is found to be rather expensive and not easily worked on a large scale.
Excessive heat is a great predisposing cause of disease, thus we find in tropical climates, Fevers, Cholera, Dysentery, Disease of the liver, &c. very common, and in some very hot summers in this country they become rather prevalent; there are not the effects of the high temperature, it acting merely as a predisposing cause, by unduly stimulating the secreting organs, but the exciting cause is exposure to cold, draughts, chills, or any sudden variation of temperature.

Now a secreting organ is never so apt to be affected by any exciting cause of inflammation as when the process of secretion is going on; therefore, when the body is hot and perspiring freely, any draught or sudden fall of temperature will cause the inspiration to be suddenly arrested, or the action of the liver altered, throwing the action upon some other organ; for instance on the intestines producing Dysentery &c., these again may be modified by noxious vapours or vapours, which the heat may cause to arise, producing a measm.
A very high temperature will cause death of the body exposed to it, thus if a red hot iron be applied, it will burn, char, and cause death of the part touched, and grain when germinating if exposed to a high temperature in an oven, will be killed, this is what takes place in malting.

Latent heat is that which we can not feel or are sensitive of until set free by some agent and appears to be concealed or hid.

The best examples of this, is by mixing Sulphuric acid with water, and immediately the vessel will become very hot, although both the acid and water were cold before mixing, therefore the heat must have been latent. If you drop a drop of Sulphuric acid on some sulphate of Potash it will instantly take fire, and when rubbed with Sulphur, it explodes with great violence, partly owing to the friction, but mostly to the amount of latent heat, and this is why it is not used in the manufacturing of gun powder, instead of Nitrate of Potash, lest it might explode in the manufacturing. The great cold produced in the atmosphere...
and which is felt so much, during a thaw after frost, is because the snow and ice in changing into water absorb so much of the heat of the atmosphere, which then becomes latent in the water, that the sense of cold is very much felt until the process is over, and on the contrary, during a hard frost, cold is not very perceptible, at least in proportion as one might suppose, because the water in changing into snow and ice gives off a certain amount of its latent heat, leaving the temperature of the atmosphere the same as it was before congelation.

Iodine when immersed in hydrotimmonia for a short time and then allowed to dry, it will explode with the least movement, and even sometimes of its own accord, this might be taken advantage of in time of war, when ammunition is obliged to be abandoned or left in the hands of the enemy, by inserting some of this powder among it, while still damp and when it dries sufficiently, it will explode.
of its own accord or when the least shake has been imparted to it, thus giving time for the party to retreat, and the unfortunate victims who come up thinking they have got a prize, soon find themselves the victims of a fatal delusion, for when surrounding and attempting to move it, the explosion takes place, dealing death to all those near. These are some of the effects of latent heat.

The exciting causes of heat are, Friction, Perfusion, Chemical action, Electrical action, and Vital action.
Light.

No element in the material universe deserves our study more than light, for to none are we more deeply indebted for the preservation and comforts of life. Two theories have been advanced in regard to the nature of light. The first of these is the corpuscular theory.

According to the first, the corpuscular, light is supposed to consist of material particles emitted from luminous bodies, by some unknown force, and reflected from the surface of all ordinary bodies. The rays of light are thus supposed to resemble the effusion, which odorous bodies are constantly giving off from their substance, and which, though infinitely small, are still material particles, and act mechanically on the organs of smell. This theory was adopted, at least in its nomenclature, by Sir Isaac Newton, and afterwards by a large number of the English Philosophers, but it is now very generally abandoned, inasmuch as,
though adequate to explain most of the phenomena of optics, it totally fails to explain some of the most remarkable results of modern experiments.

According to the second, the undulatory theory, the one now commonly received and adopted, we understand light to consist of vibrations, pulsations, or oscillations, excited by luminous bodies in an elastic medium, like waves on the bosom of a placid lake, when a pebble is dropped to form the centre of propagation. The elastic medium, through which the waves of light are transmitted, is called the luminiferous ether, and if such exist, it must fill all transparent bodies, and extend to the remotest distances in space. By this theory, the rays of light are considered analogous to the pulsations that are imparted to the air by a sounding body, and are supposed to be transmitted to the eye, in much the same way, and according to nearly the same laws, as sounds are transmitted to the ear.
Of the actual existence of a luminiferous ether pervading the universe, we have no very decisive proof. Its existence is as yet only an hypothesis, framed to account for certain phenomena which cannot be otherwise satisfactorily explained. How particles of light, on the emulsion theory, or waves of light, on the undulatory theory, are transmitted from ten thousand different objects in all parts of space, without collision, without losing their individuality, or even in the least being identified with each other, is a problem which has not yet been determined, but the fact that it is so, is both startling and grand. A number of rockets let loose in the same atmosphere would soon mingle and be confounded, waves propagated from adjacent centres, on the bottom of a smooth lake, would soon unite and destroy each other, but the rays of light creep and pass each other in all directions, yet each holds on its own way, separate and distinct from its companions, telling its own tale, and performing its individual work.
A ray of light is not as we would at first suppose, simple and undivisible; on the contrary, it is composed as Newton has shown, of three different coloured media, called a spectrum, and are Red, Yellow and Blue, with the compounds which they make, Orange, Green, Indigo, and Violet, these all combining to constitute what we call white light, and artists know by mixing these colours together they can produce a sort of white. What a beautiful idea this gives us of the Infinity in Unity, the three separate and distinct, yet so intimately combined together, that their individuality becomes invisible. The rainbow is a familiar illustration of the beautiful diversity of colour that lies hid in every ray of light, for a rainbow is nothing else than the white light of the Sun, broken into its component parts, by the rain cloud, through which it is passing.

If the imaginary rapidity with which a ray of light passes from one part of the universe to another, even imagination fails to form
the faintest conception. By us whose eyes are dazzled and whose breath is nearly stopped when a railway engine moving at the rate of 60 miles an hour dashes us by. What idea can be formed of an element that is constantly moving towards us at the rate of 192,000 miles a second, that would belt the Earth, a distance of 25,000 miles, in the eighth part of a second, that travels from the Sun to us, a distance of 95 millions of miles, in eight minutes and 13 seconds. Yet such is the undoubted fact. Nearly connected with the rapidity of light is the amplitude or breadth of its waves or particles. By a series of marvellous experiments, Newton ascertained that the waves or particles of red light are so minute that 40,000 of them are comprised within the space of one inch; these are the largest, while the waves of violet light are the smallest. Though the size of these waves are such as to be inappreciable, by the utmost stretch of the imagination, yet in it depends, the splendour and variety of colours. Lights are
of various hues according to the size of their
wavers, just as musical sounds are of varied
tone, and pitch, according to the magnitude
and volume of their aereal pulsations.
It is to light, our Planet is indebted for
all the beauties and coolness with which
it is clothed, and is essential to the existence
of vegetable life, to withdraw the solar beams
and leave the earth to the rule of darkness,
would speed in the speedy destruction of
bud and flower, of grass, shrub, and tree.
How much the plant longs to bask in
the full strong light of the Sun, is seen in
the common but most curious phenomenon
of the plant, which has been placed in
the shade, bending towards the light, as
if to catch its rays, and enjoy as much
of its pleasant influence as possible. So
this bending posture does it not seem
as if we could hear the spirit of the plant,
saying with the inspired writer “Truly the
light is sweet, and a pleasant thing it
is to look upon the Sun.”
The sun-beam consists of three distinct
powers of Luminous, Calorific, and Actinic rays, thus giving another beautiful illus-
tration of the Finitude of Unity.
The luminous rays are visible, their union making up the ordinary white light, before
mentioned, the Calorific or heat rays, to
whose agency is due the warmth that always
accompanies the sun-beam, and the actinic
or chemical rays, by which the changes on
the photographic tablet are mainly if not
exclusively produced, are invisible, and
known only by their effects.
Each of these powers it has been satisfactorily
proved, is essential to the plant at one
stage or another of its growth.
The seed that is buried in the earth requires
the stimulus of the actinic ray, before it will
sprout into existence. If by any process, as by
placing a yellow glass above the soil, you
exclude these rays, though all the other condi-
tions necessary to germination be fulfilled, the
seeds will be motionless and dead.
The beautiful green, Chlorophyll, as it is
called by botanists, so essential to the
health of the plant, and deprived of which, the plant after a short season struggling, will die of actual starvation, is the product of the luminous rays, which enable the plant to decompose the carbonic acid of the atmosphere and secrete within its tissues the Carbon by which its life is supported. In some countries, where the sun is invisible for some time, large forests have lost their beautiful green appearance, and become almost white, but when it again comes forth, they regain their beauty. On the other hand, flowers are produced under the influence of neither the actinic nor the luminous, but of the calorific or heat rays, which while checking the vegetable sleep, perfect the reproduction. Light is thus the life of the plant from the first sprouting of the bud, till it expands into the full glory of the blooming flower, and ripened fruit. Plants kept excluded from the light, not only do not absorb carbonic acid, but have rather a tendency to give it off, and are for the
most part white, therefore it is highly objectionable to keep plants in bed-rooms or other apartments which are much used at night. The difference which the plant exhibits in the different seasons are due to the relative strength of these three constituents of the solar beams. During the Spring, the season for the development of the germ, the actinic rays prevail; during the Summer, the season for the growth of the plant, the formation of the chlorophyll and the elaboration of the woody fibre, the actinic rays diminish; and the luminous rays increase in power. In the Autumn, the season of fruit comes on, the calciferous rays increase in activity, the other rays decreasing in proportion, hence the ripening of the flower and fruit, the golden glory of the harvest fields, and the reddening, but luxuriant browning of the forest foliage. The varieties in the vegetable productions of different climates and countries may be traced to the same causes, namely the preponderance of one or other of the three rays of the Sunbeam.
Luminous, photosynthetic, or calorific.

To differences in the constituent qualities of the sun beams are due, the distinguishing peculiarities of the flora of each zone. The spice and incense bearing plants of the Equator will flourish nowhere else, the orange tree yields the most sweetly perfumed blooms and the richest fruit in Spain and Italy, with us the oak is native of the soil, waving its majestic boughs so grandly in the breeze and singing its wild music, so bravely amid the storm, while in the cold north, where even the water-lilies disappear, the reindeer moss drinks from light and air what nourishment it needs, and flourishes a thing of life and gladness amid snow and frost. Whence these changes? The sun the source of light is the main cause of them all. Under his smile Earth blooms, under his frown, Earth languishes, yet even his frowning countenance wears a gladsome aspect, and conceals a friendly purpose. Classical mythology, tells us of the Goddess Flora and her attendant nymphs,
clothed in beauty, wreathed in flowers, and
basking in the glorious sun light. Northern
romance tells us of the potent enchantress
at the lightest touch of whose wand, the
hills are clad in loveliness and whose touch
is the birthplace of flowers, but modern sci-
ence reveals to us a power, more potent than
the wisest enchantress, more lovely than those
in her sweetest mood, more glorious by all
the distance between the infinite and the
finite, between God and man, than the
most spiritual and ethereal creations of
human understanding. Over the wide wide
Earth, the Sunbeams travel from the tops
of the highest mountains, penetrating into
the recesses of the deepest valleys, resting on
meadows, moor, and prairie wild, and where- ever they go, divinest forms attend them,
and spirits of loveliness in myriad troops
rise to give them greeting. Never had monarch
such a train of grand and noble following
him in gay triumphal procession, nor such
a wide dominion, nor such a gladsome sway
as has the Sunbeam, the Spirit of brightness.
the ogress of gladness, the fountain of
light and of love.
The influence of light on animal life is en-
veloped in much obscurity, nevertheless we have
reason to conclude it too is essential to or-
ganization, health, and life, for we find
where light is totally excluded as in the far
depths of ocean, animal life ceases to exist.
There is however one instance, and only one
as far as I am aware, apparently at variance
with this general law. The Proteus anguineus
says, Sir Humphrey Davy, is an animal to
whose the presence of light is not essential,
and which can live indifferently in air and
in water, on the surface of the rock and in
the depths of the mud. This singular creature
is found in the subterranean waters, in the
deep and dark recesses of the Corinthian
Caves, where it seems scarcely possible for
the light of heaven to penetrate, it is not
irreplaceable of eyes, and its colour is white.
But may not the influences of light be
more subtle than we would at first sup-
pose, and be capable of reaching to such
an extent as to sustain life, into even the subterraneous waters where the Proteus dwells. To perceive the immense influence exercised by light on the human frame, we have only to compare the equalised wretchedness of the toilers of the coal mine, whose habitation from his birth to his death is within the dark bowels of the earth, with the robust and cheerful look of the swarthy peasant, whose home lies in the bright sunshine, both are sons of toil; but one is a child of the night, and the other of the day; the one dwells in the blackness of darkness, the other in the genial light. Or contrast those who live in the dark lanes and alleys of an overcrowded city, where the cheering beams of the sun never get leave to penetrate, shine he ever so brightly, with those whose civilization is no better, the wandering gipsy, the roving Indian of the American forest, or the degraded Negro of the Guinea Coast, who may almost be said to live in the dark. The one claps we find weak, shrivelled, often hideously deformed, the waifs of humanity in their
Physical constitutions their homes are lairs of fearful diseases, of fever, consumption, ptyal, and the chosen retreat of cholera, where its pestilential breath ravages our land. The other clays though in intellectual and moral characteristics are at the very bottom of the scale, and though in their habits every way uncleanly, yet in the build of their body, in the regular conformation of every organ, in their health and strength, in their comparative freedom from disease, in their capacity for enduring toil, in the prolonging of their life to a healthy old age, in short in whatever may be regarded as constituting a sound "Physique" they rank among the foremost of their race.

Sir James Hylie late Physician to the Emperor of Rupia, tells us that in the Hospitals of St. Petersburg there were apartments entirely without light, and upon comparing the number of patients who left these apartments cured, he found that they were only one fourth of the number of those who went out cured from properly lighted rooms.
If we wish to rejoice in a good constitution to have "Sana mens in corpore sano", we need not only good food, good clothing, and good air, but also good light, the bright sunshine of heaven, God's free and beautiful gift to the children of men.

Light also produces heat, as is well seen in a field covered with snow; the snow will be found to melt slower in the middle of the field than near a tree or a wall. The reason of this is, that the rays of light striking against the tree or the wall, will be converted into rays of heat.

Electricity is also a source of light, producing the well-known electric light, electric spark, lightening &c. The diver can also obtain light under water by means of an electric lamp, which burns with a brilliant blue light.

Polarized light is so well known, that it is unnecessary to describe it. It is of the greatest use to the Geologist in enabling him to distinguish between the different crystals he may find, and their relative value, and is now
of great use to the Chemist in detecting the adulterations of food and drinks, by it we are enabled to determine the commercial value of saccharine juices, it assists in the diagnosis of certain obscure and fatal diseases, and in the detection of poisons.

Since the discovery of Polarized light by Euler in 1808 it has been making rapid strides to perfection, and by means of the many ingenious and beautiful Polarscopes now in use, the minutest particle of matter can be thoroughly analyzed and examined.

Photography is another effect of the influence of light, and has certainly done credit to its inventors, Talbot and Daguerre, who have enabled us to figure from nature, having the rays of light as our pencil, every object we may take an interest in and from the one picture thus taken we are enabled to take innumerable copies as perfect as the first, that even the microscope can detect no flaw. The Medical man has thus a means of portraying the natural appearance of any disease.
or complaint he may wish to describe, truthfully and more perfectly, than the most graphical description or book he could write on the subject.

Coloured glass will only transmit the rays of light of the same colour as itself. If you get a piece of coloured glass, and introduce a flame of the same colour, it will transmit all or nearly all the rays, but if you make a different coloured flame, and apply the same glass, it will not transmit the rays. This effect will not take place with common flame, as it contains, as was before shown, different coloured rays.

Wide and vast is the power of light over all the organisms of this world of ours, but after all, how small is the field of its operations here, compared with the grand universe beyond us, in all whose domains it spreads with an influence seemingly as active, and with a glory quite as bright and majestic.

In the free spreadings of light what an emblem is afforded of the omnipresent
Creator, in the majestic swiftness of its march, what an illustration of the infinitude of the Almighty's power; and in the life and beauty which everywhere spring into existence at its touch, what a pleasing moment of the unvaried beneficence of Him who is the Author of every good and perfect gift. We may truly exclaim while contemplating them,

"O Lord how manifold are thy works, in wisdom hast thou made them all."

---

Henry Saltot, Higginson

Edinburgh

1863
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