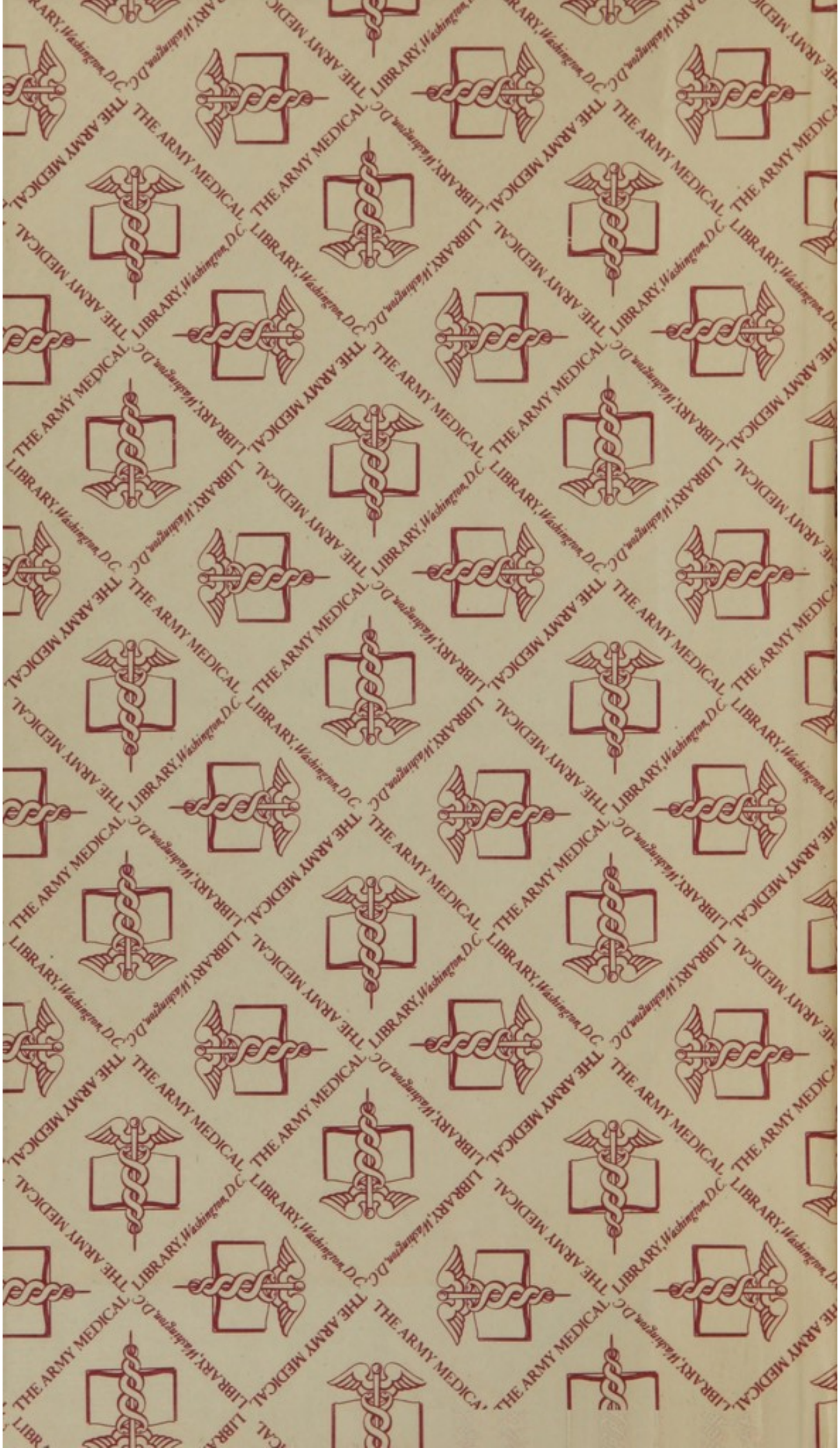
**An essay on the ultimate principles of chemistry, natural philosophy, and physiology : deduced from the distribution of matter into two classes or kinds, and from other sources / by Lardner Vanuxem.**


THE ARMY MEDICAL LIBRARY, Washington, D.C.

# AN ESSAY

ON THE

ULTIMATE PRINCIPLES

OF

CHEMISTRY, NATURAL PHILOSOPHY,

AND

Physiology,

DEDUCED FROM THE DISTRIBUTION OF MATTER INTO TWO CLASSES OR KINDS,

AND

FROM OTHER SOURCES.

BY LARDNER VANUXEM.

PART I.



*PHILADELPHIA:*
PUBLISHED BY CAREY, LEA & CAREY.
J. HARDING, PRINTER.

1827

*Eastern District of Pennsylvania, to wit:*

BE IT REMEMBERED, that on the fifteenth day of December, in the fifty-second year of the Independence of the United States of America, A. D. 1827, Carey, Lea & Carey, of the said District, have deposited in this office, the Title of a Book, the right whereof they claim as Proprietors, in the words following, to wit.

"*An Essay on the Ultimate Principles of Chemistry, Natural Philosophy, and Physiology, deduced from the Distribution of Matter into two Classes or Kinds, and from other Sources. By Lardner Vanuxem. Part I.*"

In conformity to the Act of the Congress of the United States, intituled, "An Act for the Encouragement of Learning, by securing the Copies of Maps, Charts, and Books, to the Authors and Proprietors of such Copies, during the times therein mentioned"—and also to the Act, entitled, "An Act supplementary to an Act, entitled "An Act for the Encouragement of Learning, by securing the Copies of Maps, Charts, and Books, to the Authors and Proprietors of such Copies, during the times therein mentioned," and extending the benefits thereof to the arts of designing, engraving, and etching historical and other prints."

D. CALDWELL,

*Clerk of the Eastern District of Pennsylvania.*

# PREFACE.

HAVING accepted the appointment of chief commissioner of some silver mines in Mexico, belonging to the Tlalcotal Mining Company of Baltimore, and my time of remaining here being very limited, I am induced to offer the following Essay (first part) to the public; though fully convinced it has been too hastily written, not to contain more imperfections than a work of its nature should possess.

The subject, as its title intimates, is one the publication of which at the present moment, nothing but the circumstances alluded to would justify; not only as the interests of science is concerned, but my professional character involved.

As the principles contained in the Essay are susceptible of an unlimited application, I intend, when leisure moments will permit, (unless anticipated,) to complete this Essay; showing in detail, its application to those sciences which I have cultivated; particularly to Chemistry, as regards the real nature of our *Elementary bodies*—their *atomic weight*—the cause of their combining in more than one proportion with one another; and in short, all

that is required to make this science a matter of calculation.

This Essay commences with considering matter as being of two classes, or kinds—the essential attributes of the two classes, and the general consequences arising from the reciprocal action of the two classes, &c. and terminates with the results obtained from the action of chemical elements, electricity, light, &c. all which prove that there exists matter with a repellent attribute, and matter with an attractive attribute; that the two unite together, but in inverse proportions to each other; and the laws which govern the one, are the converse of those which govern the other.

*Philadelphia, December* 10, 1827.

# ESSAY.

In the investigation of nature, man seems to take for granted, that all phenomena depend on complicated and recondite causes; and hence, what otherwise would be obvious, is overlooked, and truth generally is sought for, not where it is to be found, but in recesses too obscure to admit of the least discovery. The history of the progress of every branch of science, is an illustration of this remark.

Analysis, or the analytical method, is the only infallible guide in the field of research: where it terminates, synthesis, or classification, should take its place. In this way, the progress of knowledge is certain; and with their aid, time alone is wanting, to make known to us all that nature can reveal.

These remarks are given, for the purpose of pointing out the method which has been pursued, in investigating the subject of the following pages; and whatever merit they may possess, that merit is due to the method here mentioned.

The distribution of matter into two classes or kinds, now proposed, is founded upon the most obvious, and the most important distinctive characteristics exhibited by those particles, which have long

been known by the names of *common*, and *ethereal* matter. The essential characteristics of the two classes of particles, being the disposition of the one to form concretions, aggregates, or tangible bodies having weight; whilst the other class never forms concretions, aggregates, or tangible bodies; and its weight is wholly inappreciable by every means, which human ingenuity has as yet devised for that purpose. Gold, silver, sulphur, oxygen and hydrogen, are examples of the concreting class; whilst caloric, light, electricity and magnetism, supposing them to be distinct kinds of matter, constitute the nonconcreting class.*

* By concretion, or aggregate, I mean a solid; for every species of common matter, either by the abstraction of caloric directly or indirectly, (by combination,) can be made to assume the solid state, in which the properties of matter, as given by philosophers, are made manifest; as extensibility, solidity, impenetrability, &c.; oxygen and hydrogen, for example, when existing in the insulated or uncombined state, are invisible, gaseous; but by combination, may be made to assume the solid state, as in ice.

It may seem extraordinary and unphilosophical to assert, or take for granted, that caloric, light, electricity, and magnetism, are bodies, or different states of the same kind of matter, or in other words, consist of material particles, either of one, or of four different kinds. My reply is this:—bodies or matter are known by their properties: now gold, for example, has no known properties, (weight excepted) but those which depend upon the aggregation of its particles: all other properties are owing, either to the action of caloric, light,

This classification, founded upon differences so obvious, greatly simplifies the study of nature, giving us a clearer insight to the subject, and removing those impediments to the acquisition of real knowledge, attendant upon the old, and common metaphysical definitions of matter. The objections which may be urged to the opinions entertained of matter, as given by metaphysicians and philosophers, is, that it is knowledge inferred, not knowledge of fact; it is the result of the reasoning, from the concreted, or aggregated state of the particles

&c. or to its combination with common matter. Take from gold the concreting attribute, and substitute the repellent power: what remains? nothing but its weight. Is it then surprising that caloric, and the other kinds of ethereal matter, as they do not form concretions, from their particles being eminently repulsive of each other, should have no known properties belonging to them, and should depend upon their combination with concreting matter, for an acknowledged existence? With respect to their want of weight, the reply of those who contend for their materiality is satisfactory and unanswerable, namely: "that their weight would still be inappreciable by our imperfect means, if their relative levity to hydrogen was not greater than that of hydrogen to platina."

Besides, is there a greater difficulty in believing, that matter exists in which repulsion resides, than that matter exists which possesses attraction? Yet the latter belief is obvious and necessary, for it is self evident; for a solid has nothing but the particles which compose it; and what can keep them together, but an inherent property, or cause? and what can separate them, but matter with an opposing property?

of matter, applied to the individual particles themselves. Thus the properties of impenetrability, solidity, and extensibility, are known to us only as the consequent of the concreted, or aggregated state of the particles of matter, and not to any thing which is known of the particles themselves; whereas, the classification proposed is founded upon those properties, or rather attributes of matter, which appertain to its primary, elementary, or atomic state, which alone are obvious to common experience, and common sense; being in fact, the only self evident knowledge we have of the particles of matter.*

This arrangement of matter into concreting and non-concreting particles, as a necessary consequence, leads us to two of the most important attributes of matter; and hence, deservedly merits the consideration given to it. As the one class of particles is known by its tendency to form concretions, or bodies, whose parts cohere together, and are tangible, we have attraction, or gravitation, as its inherent principle, or attribute: and as the other class of particles, on the contrary, exhibit no con-

* The writings of the late Abbé Haüy, and Dr. Wollaston, clearly show how little is the gain of knowledge, when reasoning from the concreted state of the particles of matter, to the individual particles themselves. By the former philosopher, they are made to be polyhedral, and by the latter, globular.

cretions, nothing tangible, we must conclude that repulsion, the antagonist power to gravitation, or attraction, is the inherent principle, or attribute of the non-concreting class.*

It is evident that the particles of ethereal matter must be highly repulsive of each other, as they are unknown in the concrete, or tangible state, and from causing repulsion to take place amongst the particles of the concreting class, as they are resorted to for the purpose of producing that effect.† On the contrary, the particles of common matter are attractive of each other, as they always exist in the solid state, unless combined with non-concreting matter,‡ and are likewise attractive of the particles

* It is of no consequence whether the cause of the principles of attraction and repulsion be known or unknown; what to us is practically essential, is the knowledge of the class of bodies to which these attributes virtually belong, or in which they reside.

It is in virtue of these two opposing principles, or attributes, by which each class of particles is, as it were, held in equipoise, or neutralization, when the two kinds of particles act upon each other, that the peculiar attributes belonging to each kind of particles, are enabled to come into action; from whence result all the phenomena which constitute the physical world.

† Metals are expanded by heat; ice is converted to water, and water to steam, by the same agent.

‡ Steam exists as water below 212° of Fahrenheit; and water, below 32° is solid, as in ice.

of ethereal matter:* so that the attractive principle of the one class is not only so of its own particles, but is attractive of those of the other class; and the repulsive principle of the ethereal class is not only actively repulsive of its own particles, but causes the particles of common matter to separate from each other.

The existence of one class, or kind of matter, possessing an attractive attribute, and of another class, possessing a repulsive attribute, they acting upon each other, must produce simultaneously, attractive and repulsive effects. This result, it is hardly necessary to illustrate, for repulsion and attraction are exhibited in all cases where the two classes or kinds of particles act upon each other; for every known fact of their reciprocal action, is an evidence of it.†

Moreover, when the two classes of particles act upon each other, the particles of the non-concreting class being brought together by the attractive principle of concreting matter, a state must be exhibited by the non-concreting particles, different from the

* If doubts exist as to sensible caloric being in combination with those bodies in which it is found, none can exist as regards latent heat in water, steam, or in any other ponderable fluid matter.

† All phenomena connected either with caloric, electricity, magnetism and light, prove this consequence, or establish such a law.

one which they present, when acting as a repellent power; in the former they must manifest their peculiar properties, being in a sensible state; whilst in the latter, they must be in a hidden, or latent state. That two different states exist for the non-concreting particles, will be made evident from the following reasoning, as well as from the knowledge which we have of the properties of caloric.

The two classes of particles, in acting upon each other, tend reciprocally to counteract each other's inherent attributes. Thus ethereal matter, by gravitating matter, is brought to the sensible, from the insensible, or quiescent, or cryptic state; whilst the gravitating power of common matter, is diminished, or suspended, by the repulsive power of the ethereal matter.

If two different and opposing effects be produced, when one or more members of each of the two classes of particles act upon each other, (supposing the ethereal class, as before-mentioned, to consist of more than one kind of matter) then the cause of these different effects ought, as a necessary consequence, to exist in two different states. Thus, the concreting particles, acting upon the non-concreting particles, cause the latter to approach each other, overcoming their repulsive tendency by its attractive attribute, and exhibiting what is called their sensible state: the non-concreting particles, acting upon the concreting particles, exhibit their repul-

sive power; we must conclude, that as in the former, the repulsive power being overcome, there is a passive, or sensible state; so in the latter instance, as the attractive principle is suspended, or diminished, there must be an active, or latent state. Again—simultaneous opposing effects must have simultaneous opposing causes; we have at the same time repulsion produced amongst the concreting particles, whilst attraction is taking place amongst those of the non-concreting kind.

And finally, as there are attractive and repellent effects produced at the same time, how can these opposing effects be explained, if we ascribe not to each class of particles, or bodies, the attributes which respectively belong to them?

With respect to caloric, no fact in chemistry is better established, than that of its combination with common matter; and it is equally well known, that the effect of their reciprocal action is to cause the particles of common matter to recede from each other, whilst at the same time the particles of caloric are brought together, so as to exhibit the properties peculiar to itself. It is likewise well known, that the repellent power decreases as the attractive matter increases, and the attractive power decreases as the repellent matter increases. From these facts it follows as a necessary consequence, that in all cases where caloric and common matter act upon each other, that the attractive force of common

matter overcomes the repulsive power of caloric, and causes it to assume the *sensible state*, by bringing its particles nearer together; at the same time as caloric diminishes the force of common matter, by causing its particles to recede from each other, caloric must exhibit its repulsive, or latent state.

That caloric does manifest itself in the manner just mentioned, is well known; for all solid bodies which become fluid, and all fluids which become gases, or vapours, exhibit, or rather contain caloric, in a sensible, as well as in a latent state.

The following extracts, with some alterations, from an unpublished memoir read before the Academy of Natural Sciences of Philadelphia, July, 1826, proves the truth of the repulsive power being the latent state of the non-concreting particles of matter, and that the repulsive power increases as the quantity of common matter decreases, and decreases as the quantity of the same kinds of matter increases; and moreover, that repulsive matter occupies and pervades all space.

"It is asserted by writers on chemistry and natural philosophy, that caloric, meaning thereby caloric of temperature, is the sole cause of the expansion of bodies, (common matter;) and as a consequence, bodies without caloric must be solid.

"Assuming these premises, it follows, that as the atmosphere diminishes in temperature as we recede from the surface of the earth, (upwards) there must

be a point at which no caloric exists: consequently, the matter of the atmosphere there, must be of great density, if not absolutely in the solid state. The absurdity of this conclusion is evident, from all our positive knowledge of the atmosphere; the truth (incontestible) being, that its rarity increases with its height, and its density in the inverse degree. The conclusion in question is therefore a paradox, and clearly shows, that from these principles, we know nothing of the real cause of the expansion of gaseous bodies."

"In seeking to remove this difficulty, I found that if we supposed that latent caloric had the property of expanding gaseous bodies, or existed attached to them, in proportion to their rarity, and that caloric of temperature manifested itself in the same bodies, in the ratio of their density, then the phenomena was readily explicable; for as the density of the atmosphere diminishes, the caloric of temperature diminishes, and the latent caloric increases: on the contrary, when the density of the atmosphere increases, the caloric of temperature increases, and the latent caloric decreases."

"As the above explanation is founded upon an hypothesis, or gratuitous assumption, its merit depending upon the facility with which it explains an important phenomenon, I was led to examine the condition in which the two kinds of caloric existed in other bodies; and a mere glance at well known

established facts on this subject, shows that the explanation given, is not the result merely of an hypothesis, but of theory."

"Thus ice, at 32° (of Fahrenheit's thermometer) has the same temperature, or same degree of sensible heat, as water at 32°. In the one body, however, the particles are so fixed, so connected together, as to be incapable of motion: in the other, on the contrary, they are mobile, moving with the slightest impulse. As the sensible heat is the same in the two bodies, what then can cause this difference? Is it not evident, that as water contains 140° of latent heat more than is contained in ice, the repulsion existing between the particles of water, giving rise to its mobility, is due to this latent heat? Again—steam at 212°, exhibits the same degree of sensible heat, as water at 212°; but the former is a compressible fluid body, many times the bulk of the latter, weight for weight; whilst the water is an incompressible* fluid body. Steam, or water in vapour, has 927°† of latent heat, more than

* Incompressible in all ordinary cases, or experiments; but not so, when subjected to the pressure used by Mr. Perkins.

† If the exact quantity of latent heat be 140°, which is required to cause ice to become water, then the ratios of sensible to latent heat, will be as 1 to 4.375: (140÷32) now 212, the temperature under ordinary pressure at which water assumes the vaporous state, multiplied by 4.375, will give

water. As the material difference between the steam and the water is but the difference of the latent caloric, this latter must be the repulsive, or the vapour-making power. Thus also, if atmospheric, or any other air, or gas, be compressed in a suitable apparatus, sensible heat is given out to the surrounding bodies; and on the contrary, when the compressing force is removed, sensible heat is absorbed from the surrounding bodies. In the compression, or condensation of the air, what was latent, was made sensible; whilst in the rarefication of the same air, what was sensible, was made latent. This property, and well known experiment of air, incontestibly proves, that latent heat increases with

927°: a number which is in accordance with the mean of the experiments made to determine the latent heat of steam. It is no doubt certain that the ratios of sensible and latent heat are different in different kinds of bodies, and increase with the levity of the atoms, and decrease with the weight of the atoms, and is the cause of the discordant results which arise when different kinds of bodies are mixed together; which gave rise to the idea, that different bodies had different capacities for heat. As yet, water is the only substance which has been subjected to the action of caloric, for the purpose of ascertaining its latent caloric in its conversion to the fluid, and from the fluid, to the vaporous state.

As the quantity of latent heat is as the pressure, or the boiling point of water, every variation of temperature will produce a difference equal to 4.375 for each degree of Fahrenheit's thermometer—a fact all important, when the exact quantity of latent heat is to be determined by experiment.

the rarity of a body, (gaseous) and diminishes as the density of the body increases; and sensible heat, on the contrary, increases as the *density* of the same gaseous body increases, and diminishes as its rarity increases.*

"If the principle just established, namely, the

* That sensible heat, or caloric, increases as the density of the atmosphere increases, follows of course, and may explain the rise of temperature, when descending into the interior of the earth, when below the point of no variation.

This explanation was first given by Dr. Cooper. Vide Silliman's Journal, vol. iv. p. 243.

A consequence of some importance in the theory of the atmosphere, of the sun, and of comets, follows from the increase of the temperature of the atmosphere with its density. Gay Lussac found, that atmospheric air, when condensed so as to occupy about one-fifth of its volume, became luminous; so that any globe, whose atmosphere is equal to the density of the air in the experiment mentioned, will be permanently luminous; the degree of light increasing as the density of the atmosphere increased. The relationship of gaseous, to fixed matter, depends merely upon the presence, or absence of such fixed matter, as can combine with gaseous matter, and not to any known planetary law.

"Mr. Watt found that the latent heat of steam is less when it is produced under greater pressure, or in a more dense state; and greater, when it is produced under a less pressure, or in a less dense state. Bertholet thinks this fact so unaccountable, that he has been willing to discard it altogether." Ure's Chemical Dictionary, article Caloric—the experiments of Mr. Watt are in perfect accordance with theory and experiments on atmospheric air.

increase of latent caloric, as the matter of the air diminishes, be extended to its utmost limit, we find that this property of latent caloric leads to this result, that in proportion as we recede from the surface of our earth, or any sphere where gaseous matter exists, latent caloric increases in quantity, or degree; and finally, when we arrive at the point, or place, where the matter of our air ceases, latent caloric, as there is no limiting it, must take the place of caloric of temperature, and extend itself to infinity."

"As caloric in our atmosphere, does not exist alone, but is accompanied concomitantly by every species of non-concreting matter, or powers, which doubtless from their concomitancy, exist, each in similar opposing states, which might be shown, if we had the same tangible means of subjecting them to our manipulations, we find that Newton's idea "that all space is filled with ether," is not a notion, but a consequent truth."

It must be evident, if all space be filled with the non-concreting particles of matter, as has just been shown, and possessing a highly repulsive power, as proven by the principles of the classification adopted, that when the two classes of particles are not acting upon each other, (one being solid, the other fluid,) the influence of the two classes are, as it were, merely astronomic. But when the two classes act upon each other, then a sensible and a latent state

is made manifest. This knowledge is all important in chemistry, as will subsequently be shown; for the doctrine of heat is involved in chaotic obscurity in all those instances in which substances acting upon each other, produce a greater degree of heat, whether sensible or latent, than can be proven to belong to them.

Besides the primary differences already mentioned of the two classes of particles, they differ from each other in other important respects. The one class, the concreting particles, cannot, so far as our experience goes, be called, as it were, into existence, or made quiescent; for if a disappearance takes place, it is merely that change of state, which is not obvious to sight: they can only change their form, their presence can always be exhibited; we are always certain of their identity, for we can make them manifest to us, either by weight, measure, or otherwise. The other class, the non-concreting particles, seem in certain states of the action of the concreting particles upon each other, to be called into existence—a creation, as it were, from nothing; for no one has been able to say from whence, or from what source derived. All of them, likewise, have the common property of passing from the sensible, and latent, to the quiescent, or cryptic state.

A few examples of the mode of action of these two classes of particles, may be necessary, for those

not familiar with the subject, to illustrate these important positions, or facts.

Examples of a change of form, and apparent disappearance of concreting matter, are to be found in all those instances, where solids are made to assume the aeriform state, as in ordinary combustion: or where oxidation goes on, exposed to atmospheric air. Of this latter kind, the old calcination of mercury furnishes a beautiful and satisfactory illustration. Thus, if a given portion of mercury is put in contact with a given quantity of atmospheric air, in a close vessel, suitably arranged, and exposed to a certain temperature, the metal loses its silvery, or metallic appearance, quits its fluid for the solid state, changing first to a black, and finally to a red colour. As these changes go on in the mercury, the air is observed gradually to diminish in bulk. If the two bodies be separately weighed, the mercury will be found to have gained as much in weight as was lost by the air. If they be again put together, and a greater degree of heat be applied to them, the two bodies, the air and the mercury, will resume the state in which they were originally; neither having experienced a loss or gain of matter.

The unexceptional instances in which the non-concreting particles are, as it were, called into existence, are exhibited by chemistry in the action of dissimilar solid bodies upon each other; for in such bodies, neither caloric, light, nor electricity, can be

proven to exist in them ;* nor as before mentioned, has it been divined by what is known of these non-concreting particles, how, and whence, and why it is that they are thus called forth. A few instances of the very many known, will place this truth in the clearest point of view. When potassium and ice are put in contact with each other, the extrication of caloric and light is very great; so also when gunpowder is inflamed, or when sulphur, and certain metals unite together; and so likewise the fulminating powders, when subjected to the causes which elicit their detonating properties.†

In order to be able to conceive how it is, that these apparent creations take place, it is necessary to know the precise nature of the medium in which the experiments are made. It is very certain, that the extrication of heat and light, which attends the action of the above solids upon each other, is independent of the common material medium in which these bodies are placed; for no change of tempera-

* That is to say, they have no more heat, &c. than belongs to the medium in which they may be placed.

† Caloric, or heat produced by friction, or developed by chemical combination in the manner just mentioned, has given rise to that class of philosophers who have contended for its immateriality; considering it as the result of some peculiar motion of the particles of concreting matter. Whilst those who have studied caloric as it exhibits itself in the sensible and latent states conjointly, have, on the contrary, as strongly urged its pretensions to materiality.

ture can be discovered in them; and the experiments are the same, be they made in vacuo, or exposed to the influence of the atmosphere. Hence it is evident, that the source of heat from whence these bodies obtain their caloric, is independent of the combined caloric of the surrounding bodies.

From what has already been stated on the attributes of the two classes of particles, and the reasoning on the properties of gaseous bodies, it must be evident, that all space is filled with the non-concreting particles; and these particles must, from the attraction of the earth, increase in numbers and proximity to each other, in proportion to their proximity to the earth; so that the earth is surrounded and imbued by them in all parts admitting of their passage. These particles are not in a state of combination with concreting matter, as is the case with caloric in water, and in the air of our atmosphere, but in a state which, for want of a better term, may be called astronomic, gravitating, radiating, or planetary.

The existence of such a state of caloric and light, the knowledge of their velocity, as derived from the action of the sun upon our earth, and in our familiar experiments upon the radiation of heat, the property of radiant heat to permeate all bodies, and the knowledge known to every chemist, that caloric combines with all fluid bodies, but in different proportions with different bodies, give us the conditions required for the explanations in question.

As the subject is an important one, the following illustration may not be without its use. The solid part of our globe, like all solid matter, cannot be proven to contain combined caloric, other than the caloric of temperature, and a proportion of latent caloric, to give the repulsive power existing in such bodies; which, however, cannot be greater than the amount of sensible caloric, or experiment would long since have made the fact known to us. This is not the case with the common material fluids of our globe, water and air; the proportion of latent to sensible caloric, being 4.375 to 1 in water, over ice, and in steam, over water of the same temperatures. The relative proportions of the two kinds, or states of caloric in air, must be greater, not only from the prodigious quantity of sensible heat given out when air is subjected to compression, but from the experiments of Mr. Watt on steam—also, from all our experiments of the capacity of bodies for caloric—from what has already been mentioned, that latent heat increases as the rarity of a body increases, and from its existence as a permanently elastic body.

Every chemist is aware, that there is no difficulty in conceiving a total abstraction of caloric from the waters, and from the air of our earth, by the combination of their constituents, with such substances as form fixed, or solid bodies, at the ordinary temperature of the surface. Supposing such a state of

things to take place, is it not certain that the caloric which was sensible and latent, the caloric of fluidity, in other words, would become quiescent; and would not these particles be retained to the surface of the earth, by the force of gravity, as has already been mentioned, being material, and with particles repulsive of each other? and would not this same caloric return to its former states of sensible and latent heat, if the same solids were to regain their former states of air and water?

The explanatory exposition of the apparent creation of caloric just given, applies equally to light, electricity, and magnetism; each being called into existence, or developed by the action of peculiar particles, or peculiar bodies upon each other. This explanation harmonizes with the well known economy of nature, for ample is the store of quiescent repulsive matter, for whatever changes the solid parts of our globe may undergo; and equally capacious is the reservoir which receives whatever caloric common matter may set free, in losing its fluidity.

If the believers of the material nature of caloric do not admit the explanation which has been given, they must necessarily be driven either to an acknowledgment of ignorance, and of the annihilation of, caloric, *since fluids becoming solids cause it to disappear;* or of its *creation from nothing, and of its return to nothing.*

Is the apparition of caloric, light, electricity, and magnetism more extraordinary than their disappearance? yet the facts relative to the latter are equally well known, and as numerous as those of the former.

The most unexceptionable instance in which caloric passes from the sensible, and latent, to the quiescent state, is exhibited by the action of the sun upon our earth; for as much caloric is lost as is annually gained, which ought not to be the case, unless it passed to the quiescent state, as the accumulation is constant. So also with light, for the conversion of sensible to quiescent light is evidenced, when the cause of its apparition is removed, as the termination of combustion, absence of the sun, &c. So also with electricity, when the inner and outward sides of a charged leyden jar are united, the two electricities, or its two states combine, and are instantaneously rendered quiescent; or when the charged conductor of an electrical machine is made by means of a metallic rod, to communicate with the earth. So likewise with magnetism; if a magnetic needle be heated to a certain temperature, the two fluids, or the two states of the one fluid disappear; or when placed within the sphere of an electric discharge, the same effect is produced.

By the classification likewise we are enabled to acquire certain, and well defined ideas of such terms, as the attributes, or principles, the causes,

and the properties of bodies; terms so essential in all reasonings connected with physical and metaphysical knowledge. Thus if the two classes of bodies were at rest, each under its own respective influence, and beyond the control of the other, there would be solidity for the one class, and fluidity or gaseability for the other class. If a body of the first, or concreting class, mercury for example, was to be acted upon by caloric of the second class, and with different and extreme degrees, the first effect or state would be merely the expansion of the solid mercury, its expansibility; the second would be its liquidity, and the third and last, its vapourability: these different effects would be the properties of mercury; and caloric, the cause of these different effects. So also a positive idea is acquired, of *matter*, *body*, or *power;* for it seems to me to be evident, that whatever opposes the principle of attraction in the concreting class, is *matter*, *body*, or *power*, or a cause independent of that class; if not the effect of a known or acknowledged body, or bodies of the non-concreting class, a new one must be introduced to explain the phenomenon. So also with the non-concreting class; whatever opposes the repulsive principle of its members, making them sensible, or evident, is something material, which is independent of their class: the cause is gravitating matter, for without it, from repulsion being the inherent attribute of the non-concreting

class, nothing could be known of it, its particles would remain permanently separated from each other.

The classification of the two kinds of particles of matter, lead to the following conclusions, which conclusions will be found to be in conformity with facts presented by chemistry and natural philosophy.

1st—That there exist two classes, or kinds of particles of matter, one of which classes, when not acted upon by the other, is always in the solid state, and consequently it has attraction for its inherent attribute. The other class never exhibits itself in the solid state, and is unknown, unless when acted upon by the class whose particles form solids. This class has repulsion for its inherent attribute.

2ndly—The two classes of particles act upon each other; or in other words, have an affinity for each other, and this reciprocal action counteracts each other's inherent attributes. Thus the attraction existing between the particles of solid or concreting matter, is weakened or destroyed by the action of repulsive matter, and the particles of repulsive matter are brought together by the attractive power of solid matter.

3dly—That common matter exists in three states, is well known, as the solid, fluid, and aeriform, or gaseous: now repulsive, or ethereal matter exists in three likewise, the sensible, latent, and the quiescent. The sensible and latent states, being the

states wherein repulsive matter is united to common matter, are analogous to the fluid and gaseous states of common matter; and the quiescent state, wherein there is no combination, resembling in this respect the concrete, or solid state of common matter.

4thly—That the attraction (meaning thereby quantity) of repulsive matter for common matter, is in proportion to the levity of atoms, or quantity of weight of common matter, and diminishes with the weight of atoms, or quantity of weight of common matter; or in other words, the attraction of the two classes for each other, is in inverse ratios to each other.

5thly—That there exists but one kind of repulsive matter, as will be shown, exhibiting four different states, convertible into each other, not only accordingly as it is acted upon by particles, or groups of particles forming masses, but according to the kind of particles and masses. These states of repulsive matter are caloric, light, electricity, and magnetism.

---

*Essential characters of Caloric, Electricity, Magnetism and Light.*

Caloric is essentially characterized by a burning sensation, produced when a red hot iron, for in-

stance, is touched—by producing thermometric effects—and by its agency in bringing about chemical combinations. It does not diffuse itself over the surface of bodies, but acts upon the particles of bodies; nor does it manifest itself by induction.

Electricity is characterized by its attractive and repellent properties, and by the shock which it gives to a body, on which it acts; it diffuses itself over the surface of bodies, and not amongst the particles of bodies; it acts as a divellant power, and manifests itself by induction; that is to say, when united to common matter, it has the property of causing another body to acquire a quantity equal to itself.

Magnetism differs in nothing essentially from electricity, but the property of adhering to steel, to the black oxide of iron, to cobalt and nickel; magnetism also, manifests itself by induction.

Light, exhibits neither the heating effects of caloric, nor the same repelling effects of electricity; nor does it adhere to iron, &c. as is the case with magnetism. The degree of light increases in all our operations, as the degree of the repulsive force increases, when acting upon common matter, until it reaches a certain point, when it decreases, and finally disappears. So also when the attractive and repellent states of electricity are united, light is always produced, if the quantity of electricity be considerable, &c.

As all our experiments prove that caloric, electricity, magnetism, and light, are convertible one into another, according to the relationships or quantities of repellent and attractive matter, it seems to me, that their existence as four distinct fluids, or kinds of ethereal matter, is inadmissible; for this conversion, or change of characters, is analogous to what are called the properties of bodies, and not to the bodies themselves.

The instances brought forward in the preceding pages of this essay, to prove that sensible heat becomes a repellent (an electrical) power, losing all its properties of heat, (sensible,) or when changed into a repellent power, can again be returned to its former or heating state, are not more satisfactory, than the instances given, of the conversion of heat to light, and electricity to light.

The cooling of heated bodies in the radiation of heat, depends upon the conversion of sensible heat, to the latent or repellent state; for in all cases whatsoever, if a heated body, or a body containing caloric, be presented to a smooth surface, that surface will repel the caloric, for it is converted into the latent state; but if caloric be presented to a rough body, that body will not repel nor reflect the caloric, but will absorb it. In like manner, electricity is converted into heat, or caloric, when points or particles, or a rough surface, is presented to it, and vice versa, caloric is converted into electricity,

whenever the former is made to act upon a smooth or polished surface.

The explanation of Professor Leslie's experiments of radiant heat, depends upon this conversion of caloric to the latent state, or electricity, by surfaces which are smooth, and its retention by surfaces that are rough. The canisters which were smooth upon the outside, caused the caloric of the water to pass into the repellent state, and hence was with difficulty conveyed away, by the imperfectly conducting medium in which they were placed; whilst the rough, or dark coloured canister, presenting points, or matter in relief, caused caloric to pass off, in consequence of the medium, (atmospheric air,) being a better conductor of heat than of electricity.

The conversion of heat to the repellent state, invariably takes place when water is boiled in a vessel, the surface of whose bottom is very smooth; thus, there are few glass retorts, but cause water to throw up large bubbles in boiling, and sometimes these bubbles are so great, as to cover a considerable portion of the lower surface of the water, and to cause great inconvenience. In such retorts, as is always the case, the greater the heat, the greater the repellent effect. In order to prevent such bubbling, small pieces of glass, platina, or any other material which has no action upon the fluid, is made use of; when they are present, the boiling quietly goes on. It has been suggested from this property

of particles, and not without some reason, that if the whole surface of a boiling vessel was covered with points of needles, placed side by side, adhering by their larger ends, no ebullition in that case would take place, the heat passing off, at the imperceptible points of the needles.

In the subsequent part of this essay, it will be made evident, that the conversion of caloric into the repellent state, by the action of a smooth surface, and of electricity into the sensible or heating state, by a rough surface, is owing to the quantity of matter which is presented by such surfaces; for a smooth surface presents but one side or surface of the particles which compose it, whilst a rough surface exhibits its particles in relief; as the sensible or calorific, and latent or repellent states of ethereal matter, depend upon the quantity of common matter presented to it, a rough and a smooth surface ought necessarily to produce different effects.

---

*Of the ratios of attraction and repulsion, from experiment.*

It has long been demonstrated that attraction is as the weight of common matter: now repulsion, or the antagonist force of attraction, as has already been shown, being inherent to ethereal matter, its action

or force must be in the ratio of the levity of common matter.* This being the case, it follows that those particles of common matter which are heaviest, will have the least attraction, for example, (using caloric to represent the class) for caloric; as affinity is counteracted by gravity or the concreting power, so on the contrary, those particles of matter which are lightest, attraction of gravitation or the concreting force being less, will have the greatest affinity for caloric; or in other words, the two forces acting upon each other, the action of the non-concreting attribute will be greatest, where the concreting attribute is feeblest, and feeblest, where the concreting attribute is greatest; or, using the language of chemistry, the capacity† for caloric will diminish, as the weight of the atom increases, and increase as the weight of the atom decreases.

* Attraction being as the reciprocal weight of the particles which act upon each other, those dissimilar atoms which make the nearest approach to each other, should have the greatest affinity for each other; hence, the smaller the atoms of common matter, the greater should be their attraction for ethereal matter, and vice versa; this will be proven by known chemical combinations.

† By capacity for caloric, is meant that quantity of caloric which a body takes up, in order to obtain the temperature which the bodies surrounding it possess. This term is objectionable, for caloric so taken up may remain either in the sensible state, or pass into the latent one in uniting to bodies; for no fixed signification in this respect is given to it.

This law, which follows from the action of the two classes upon each other, giving it its simplest expression, namely, *the forces being in inverse ratios to each other*, is fully confirmed by experiment; and it is to MM. Dulong and Petit, that we owe the important facts whose consequences, it appears, were overlooked, or lost, in a conclusion as singular as it was erroneous. These gentlemen made a number of experiments with different metals, for the purpose of ascertaining their specific heats; and to use the language of Dr. Ure, (Dictionary of Chemistry, article caloric,) "their result has disclosed a beautiful and unforeseen relation, between the specific heats and primitive combining ratios, or atoms of the metals; namely, *that the atoms of all simple bodies have exactly the same capacity for heat.* Hence the specific heat of a simple substance, multiplied into the weight of its atom or prime equivalent, ought to give always the same product."

In examining the table of Dulong and Petit, I found that no conclusion like the one given could be deduced: that the *relation* stated, arose from confounding the product of the specific heat and weight of atoms, with the capacity of the atoms for heat. Whereas, the true and self evident result of the experiments in question, is one not only of great beauty, but of the greatest importance in science, and confirmatory of the action of the two classes upon

each other, as has already been mentioned. The conclusion being *that the capacity of atoms for heat increases in the ratio of their levity*, and decreases in the ratio of their density, and it is to this cause solely *that their product is a constant number.*

TABLE IV.—*Of specific heats of some solids, determined by Dulong and Petit.*

| | Specific heats, that of water being 1. | Weight of the atoms, that of oxygen being 1. | Product of these two numbers. |
|---|---|---|---|
| Bismuth, | 0.0288 | 13.300 | 0.3830 |
| Lead, | 0.0293 | 12.950 | 0.3794 |
| Gold, | 0.0298 | 12.430 | 0.3704 |
| Platinum, | 0.0314 | 11.160 | 0.3740 |
| Tin, | 0.0514 | 7.350 | 0.3779 |
| Silver, | 0.0557 | 6.750 | 0.3759 |
| Zinc, | 0.0927 | 4.030 | 0.3736 |
| Tellurim, | 0.0912 | 4.030 | 0.3675 |
| Copper, | 0.0949 | 3.957 | 0.3755 |
| Nickel, | 0.1035 | 3.690 | 0.3819 |
| Iron, | 0.1100 | 3.392 | 0.3731 |
| Cobalt, | 0.1498 | 2.460 | 0.3685 |
| Sulphur, | 0.1880 | 2.011 | 0.3780 |

The experiments of Berard and Delaroche on the specific heats of gases, if more facts were wanting, fully confirm the conclusion that common matter and caloric combine in inverse proportions to each other.

| | Specific heat, that of water being 1.0000. | Weights of the atoms, oxygen being 1. |
|---|---|---|
| Oxygen, | 0.02361 | 1.000 |
| Nitrogen, | 0.02754 | |
| Hydrogen, | 0.32936 | 0.125. |

This law of the increase of the capacity of atoms for heat, in the ratio of their levity, and the decrease of the capacity for heat in the ratio of their density, is all important for the determination of the specific heats of atoms, when the weight of the atoms are known; and of the weight of the atoms, when the specific heats are known. Thus, the mean of the thirteen experiments of Dulong and Petit, makes the product of the weight of the atom and specific heat .3753; now this number divided by the weight of the atom will give the specific heat, and the number obtained for the specific heat divided by .3753, will give the weight of the atom. Thus the specific heat of hydrogen by calculation, is 3.6024, a number which differs but little, considering the difficulty of obtaining the precise weight by experiment, from the one determined by Berard and Delaroche.

The annexed table contains the weights of atoms as given by Dr. Thompson, in his First Principles of Chemistry, also the specific heats, refraction, and likewise the greatest known proportions in which oxygen, sulphur, hydrogen, and phosphorus, combine with the other simple atoms.

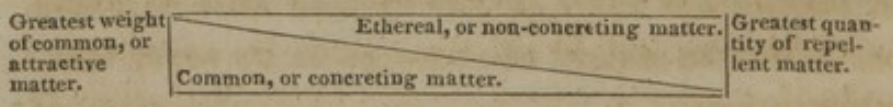
3780 divided by the Specific heat will give the weight of the atom

The atomic weights as given by Dr. Thompson, *though defective*, make the nearest general approximation to the truth of any heretofore calculated; but they are subject to an objection particularly, which renders them of little value for the purpose of accurate theoretical investigations; as for instance, when the specific heats are to be deduced from them. Thus Dr. Thompson makes the atomic weight of many of the simple substances the same: now all simple particles or atoms whose weights are similar, in uniting together ought not to exhibit chemical properties, or properties different from the particles themselves, their union should produce cohesive attraction only; for atoms which have the same weights ought to belong to the same kind of matter. Atoms which exhibit different properties when they unite together, may have weights which make a near approach to each other, but they cannot have the same weights, as has been made evident from theory—from the experiments of Dulong and Petit on the specific heat of atoms, and from the weight of atoms given by every other philosopher.

Heat being but another name for repellent matter, a still more important consideration than the one mentioned arises from the experiments of Dulong and Petit; namely, as the quantity of attractive or common matter, and the quantity of repellent or ethereal matter are in inverse ratios to each other,

the same degree of force which acts upon the particles of common matter, producing attraction, must conversely act upon the particles of ethereal matter, producing repulsion; and as atoms of the same weight of common matter exhibit attraction only, (as is exemplified in cohesive attraction,) atoms of different weights must exhibit simultaneously attraction and repulsion: and when two dissimilar atoms, for instance, unite, the degree of attraction will be equal to the weight of the smaller atom, and the difference between the two will be repulsion. Now in ethereal matter, atoms, or quantities of the same kind, must exhibit repulsion from its attribute: whilst atoms, or quantities of different kinds, must exhibit repulsion, equal to the smaller atom, or quantity; (for instance, when two atoms, or quantities unite together,) and an attraction equal to the difference of the two atoms, or quantities.

Diagram of the action of the two classes, from Dulong and Petit's experiments.




The laws, or ultimate principles deduced from the experiments of Dulong and Petit, are better or more clearly expressed numerically. Thus the first series of numbers below exhibit the series of ethereal atoms, or quantities; and the numbers in converse order, the atoms, or quantities of common matter.

*Atoms of Ethereal matter.*

1. 2. 3. 4. 5. 6. 7. 8. 9.

*Atoms of Common matter.*

9. 8. 7. 6. 5. 4. 3. 2. 1.

As ethereal and common matter are in inverse ratios to each other, being antagonist forces, atoms, or quantities of the same kind of matter, from their attributes respectively, exhibit attraction in the atoms of common matter, and repulsion in those of ethereal matter; but dissimilar atoms must exhibit attraction and repulsion, as in common matter, and repulsion and attraction, as in ethereal matter; and the degree of either of these forces will be in the ratio of the difference of their atoms. Thus in the atoms of common matter of the above series, between atom 1 and atom 4, for example, the attraction will be 1, and the degree of repulsion will be 3; for this number is the amount of repulsion which atom 1 has over atom 4. So also if any other two atoms be taken, as 3 and 8, the amount of attraction will be 3, the weight of the lightest atom, or smallest quantity, and the repulsion will be 5, the excess of repulsion which atom 3 has over atom 8.

As the converse of this law holds for ethereal matter; between atom 1 and atom 4 of this kind of matter, the repulsion will be 1, and the attraction will be 3, this number being the amount of attraction which 4 has over 1. So also between atoms 3

and 8; the repulsion will be as the number 3, and the attraction will be 5, for this will be the force exerted by 8 over 3. It must be obvious to every one, that the laws of ethereal matter in its latent state, are those which belong to the planetary, or astronomic system.

These laws, or consequences, are fully shown by electricity, and in the union, or combination of che mical atoms with one another. Thus oxygen, for example, in combining with the other simple bodies, the quantity of this element required to saturate, or neutralize their attractive powers, increases with the levity of their atoms, and decreases with the weight of their atoms; for the weight of atoms is determined by the quantity, or weight of oxygen, which neutralizes, or saturates the different simple substances; and this difference of saturating weight, can depend upon no other cause, than the affinities of common, (concreting) and repulsive matter, (non-concreting,) being in inverse ratios to each other: the less the weight of common matter, the greater the affinity (quantity) of repulsive matter; the greater the weight of common matter, the less the affinity of repulsive matter; or taking the effect for the cause, the difference of weights produce, or give rise to a repulsive, or non-attractive, or non-combining power.*

* The same law holds also with sulphur, hydrogen, and phosphorus, as will be seen by the annexed table; and in fact, it is universal in chemistry.

Under the head of *Light* in this essay, I shall show that ethereal matter enters into combination with common matter, for all chemical compounds contain it, and is a consequent of the result of Dulong and Petit's experiments: so in treating of electricity, it will be seen that common matter is combined in the gaseous state with ethereal matter, for no electricity can be accumulated unless air be present.

At present, I shall say nothing of the real nature of chemical elements, for that canon of chemistry which *regards all bodies simple, unless proven experimentally to be otherwise*, should not be lost sight of. But, in speaking of light, or in the second part of this essay, I shall draw the conclusion which the *principles* arrived at clearly warrant.

*Table showing the weights of the simple atoms—that specific heat and refraction, and also oxygen, sulphur and phosphorus, in combining with simple atoms, follow the general law of inverse proportions, or ratios of the weights of atoms.*

| Names of the simple substances. | Atomic weight by Dr. Thomson. | Specific heat. | Refraction air being 1.000. | Greatest proportion of Oxygen in 100 parts. | Greatest proportion of Sulphur in 100 parts. | Greatest proportion of Hydrogen in 100 parts. | Greatest proportion of Phosphorus in 100 parts. |
|---|---|---|---|---|---|---|---|
| Hydrogen | 0.125 | 3.2936 | 6.61436 | 88.94 | 94.176 | | 94.04 |
| Carbon | 0.75 | | 2.62909 | 72.64 | 84.23 | 26.05 | |
| Boron | 1.00 | | | 74.17 | | | |
| Oxygen | 1.00 | 0.2361 | 0.86161 | | | 11.06 | 43.97 |
| Silicium | 1.00 | | | 50.30 | | | |
| Aluminium | 1.25 | | | 46.71 | | | |
| Lithium | 1.25 | | | 43.90 | | | |
| Magnesium | 1.50 | | | 38.71 | | | |
| Phosphorus | 1.50 | | | 56.03 | | 8.69 | |
| Nitrogen | 1.75 | 0.2754 | 1.03408 | 88.59 | | 17.64 | |
| Sulphûr | 2.00 | 0.1880 | | 59.86 | | 5.824 | |
| Fluorine | 2.25 | | | | | | |
| Glucinium | 2.25 | | | 31.17 | | | |
| Calcium | 2.50 | | | 28.09 | | | 43.38 |
| Sodium | 3.00 | | | 34.02 | | | |
| Cobalt | 3.25 | 0.1498 | | 28.89 | 35.36 | | |
| Nickel | 3.25 | 0.1035 | | 28.86 | 35.23 | | |
| Iron | 3.50 | 0.1100 | | 30.66 | 54.26 | | 22.43 |
| Chrome | 3.50 | | | 46.71 | | | |
| Manganese | 3.50 | | | 35.99 | 36.12 | | |
| Titanium | 4.00 | | | 30.89 | | | |
| Copper | 4.00 | 0.0949 | | 20.17 | 20.27 | | |
| Tellurium | 4.00 | 0.0927 | | 19.87 | 33.28 | 2.99 | |
| Yttrium | 4.25 | | | 19.90 | | | |
| Zinc | 4.25 | | | 19.87 | 33.28 | | |
| Chlorine | 4.50 | | | 52.30 | | | |
| Arsenic | 4.75 | | | 34.70 | 39.08 | 4.06 | |
| Zirconium | 5.00 | | | 33.95 | | | |
| Selenium | 5.00 | | | 28.74 | 44.79 | 2.44 | |
| Potassium | 5.00 | | | 37.98 | 29.11 | | 28.59 |
| Strontium | 5.50 | | | 15.45 | | | |
| Rhodium | 5.50 | | | 16.67 | 28.69 | | |
| Antimony | 5.50 | | | 23.66 | 27.23 | | |
| Molybdenum | 6.00 | | | 33.45 | | | |
| Cerium | 6.25 | | | 20.70 | | | |
| Cadmium | 7.00 | | | 12.55 | 22.41 | | |
| Tin | 7.25 | 0.0514 | | 23.66 | 29.10 | | |
| Barium | 8.75 | | | 31.17 | | | 18.36 |
| Bismuth | 9.00 | 0.0288 | | 10.13 | 18.49 | | |
| Platinum | 12 00 | 0.0314 | | 14.13 | 24.87 | | |
| Lead | 13.00 | 0.0293 | | 13.38 | 13.45 | | |
| Silver | 13.75 | 0.0557 | | 9.99 | 12.95 | | |
| Iodine | 15.50 | | | 13.64 | | | |
| Tungsten | 15.75 | | | 19.90 | 24.99 | | |
| Mercury | 18.00 | | | 7.32 | 13.71 | | |
| Gold | 25.00 | 0.0298 | | 10.77 | 19.53 | | |
| Uranium | 26.00 | | | 8.70 | | | |

Thorinium, Columbium, Osmium, Palladium, and Iridium are little known as to their combinations.

Chemical affinity, or that species of attraction or power which causes particles of different kinds of common matter to unite together, is different in its degrees or force in different kinds of matter, when combined with each other; some yielding readily to the action of ordinary agents, whilst others resist the same agents, and require complicated means to effect their separation from each other. The union of such dissimilar particles gives rise to products with properties, different from the particles or substances which compose them, and differ in this respect from the aggregates of similar particles; these latter having no new properties, with the exception of those due to cohesive attraction only.*

The attributes of the two classes or kinds of matter, namely, that attraction which causes the particles of common matter to concrete together, and the repulsion of ethereal particles, are the antagonist or opposing forces, as is well known, of chemical action. As these forces increase in opposite ratios to each other, the attractive power increasing as the weight of the atoms increase, and the

* If cohesive attraction or the attraction of similar particles of common matter, either integrant or constituent, alone existed, neither caloric, electricity, magnetism, light nor life, would be developed or made manifest; for these powers are dependent upon the action of dissimilar particles upon each other, of dissimilar bodies or masses upon each other, and of the combined or simultaneous action of dissimilar particles and dissimilar bodies or masses.

repellent power increasing as the weight of the atoms decrease, it must be evident that those dissimilar atoms having the greatest atomic weight, and greatest attraction for ethereal matter, (all other circumstances being the same,) have the greatest affinity or chemical attraction for each other, (the two forces in such particles being nearly counterbalanced,) and affinity must diminish as the atoms differ from each other in weight, in consequence of the concreting and non-concreting attributes increasing with the difference in the weight of atoms.

Besides the two modifying causes of chemical action just mentioned, and whose effects are in opposite ratios to each other, there exists another cause whose laws are not so easy to investigate, and will probably remain unknown, so long as the knowledge of the ultimate or true nature of the simple bodies, so called, remains undiscovered. I allude to the attraction of cohesion, or the attraction of similar particles for each other. This force in the simple bodies seems altogether independent of atomic weight, and is seemingly analogous to the power or force developed by organization. Thus, the force which unites the particles forming the diamond, is greater than in any other known substance; sulphur, which is nearly allied to carbon in atomic weight, has but a feeble hardness; and mercury, whose atomic weight is amongst the heaviest of all substances, is fluid, in almost every part of the globe.

It is useless to cite other instances of the anomalous nature of cohesive attraction in the simple bodies, the facts are well known to every chemist and philosopher. With respect to cohesive attraction in compounds of the simple atoms, the laws which have been observed will be spoken of in their place: these laws probably may throw light upon those bodies which are now deemed elementary.

The combined attraction of the concreting attribute (atomic weight,) and cohesive attraction, furnish us with one of the most useful laws in the practice of chemistry, and which long was considered as the type of the force of chemical affinity: I allude to the one by which precipitates are produced, namely, that if the elements of an insoluble compound exist in solutions which are mixed together, a precipitate will take place; being the insoluble salt whose elements were soluble before the mixture was made. This effect or insolubility in a menstruum, is very different from chemical affinity, as will be further shown; for substances which unite together in small proportions,* and substances which are readily decomposed by those agents which form solutions, are often insoluble.†

* The sulphates of mercury, silver and lead, are insoluble; those of iron, cobalt, nickel, &c. are soluble.

† Most of the metallic carbonates are insoluble, but are decomposed by nitric acid, for example, and form soluble salts. Solubility or insolubility depend altogether upon the menstruum.

The want of accurately designating the really opposing forces of the action of dissimilar particles, has made affinity to be one of the most difficult and complicated branches of chemical science.

Attraction in general, is as the weight of atoms, and the number of atoms. Chemical affinity is as the *weight* of dissimilar atoms and the *number* of dissimilar atoms. Those atoms which are nearest in weight, are those which combine in the greatest proportion with each other; and those atoms which combine in the least proportion with each other, are those which are most dissimilar in weight.

This view of chemical affinity is the only one which admits of a general expression; for when it was made to depend upon menstrua, as water, acids, caloric, &c., it was necessary to admit that affinity varied as the menstrua varied; or, in other words, chemical affinity was subjected to as many modifying causes, as there were menstrua or fluid agents.

The *number* of dissimilar atoms is the modifying cause of the affinity of atoms for one another; this is the action of the *mass* of Bertholet, wherein the united weights of many light atoms may cause atoms which are individually heavier, to cede their place to the former ones.

*Laws of chemical action, or the action of atoms upon each ohter.*

*First.*—Bodies or substances, the atomic weight

of whose particles are the same, are attractive of each other, and exhibit no repulsive property; for the concrete state of common matter is dependent upon this property, and this state is destroyed only by the action of the repulsive power.

*Second.*—Two bodies acting upon each other, whose particles are different, have an attraction for each other equal to the weight of the smallest particle. The repulsion being the difference between the weights of the two particles acting upon each other; the greater the difference, the greater their repulsive power. Thus, oxygen and silicium combine in nearly equal proportions, and so also do the bases of the other earths with oxygen: these oxides are the most difficult of the known compounds to decompose; oxygen, and hydrogen, or water, are decomposed by the greater number of the other simple bodies, and the oxides of gold, silver, platina, &c. are reduced to the metallic state by the action of heat alone.

*Third.*—Two bodies, whose particles are different, being united together, any third body whose particles are heavier than those of the lightest one, will take the place of the lightest particles, or in other words, will decompose the compound, and unite with the heaviest particles: the affinity of bodies being as the weight of their atoms; (the quantity of matter present being in saturating or equivalent proportions; for mass modifies affinity.)

*Fourth.*—Bodies or substances whose atomic weight is different, their combination will be opposed by the concreting force when solids act upon each other; and by the repulsive or divellent force, when fluids act upon each other: or by the two forces conjoined, when the two forces exist in the substances acting. As repulsion is an antagonist power to combination, atoms or particles cannot unite or keep together, if the weight of the repulsive, or in other words the permanently gaseous matter, be greater than the fixed matter. This being the case, Berzelius' proportion of oxygen in silex, cannot be correct, for it is greater than the weight of fixed matter (silicium.) This law is exemplified by every other known chemical combination, for when atoms are lighter than the atom of oxygen, this latter is in excess as regards weight: and when atoms are heavier than that of oxygen, the former are in excess. (See table.)

*Fifth.*—Two kinds of dissimilar particles uniting together, one of them being fluid under ordinary circumstances: a fluid will be the result if the number and weight of the atoms of the latter

for fluidity is in proportion to the weight of the atoms which have the greatest attraction for repulsive matter. But should the number and weight of the fluid atoms be less in number or in weight, the solid state will be that of their product; for the converse of the fluid state is in proportion to the

predominance of those atoms, which have the least affinity for repulsive matter. The same applies to solubility in water, or any other menstruum.

*Sixth.*—All metallic oxides, whose metals do not decompose water, either when cold or hot, are decomposed by hydrogen: for if the affinity of the metal for oxygen, be not so great as the affinity of oxygen and hydrogen for each other, oxygen when combined with such metals, must quit them to unite to hydrogen—to this law there may be one or two exceptions, arising from the forces being counterbalanced?

*Seventh.*—Metals which are united to oxygen in less proportion than required to saturate them, form oxides or alkalies, and can combine with acids or bodies containing oxygen in excess: on the contrary, metals which contain more oxygen than can combine with acids, do not unite to acids, but unite to oxides. As all metallic combinations with oxygen do not unite to acids, and the atomic weight being determined by the neutral combination of acids, and oxides, a difficulty is created as regards the atomic weight of metals so combining: for if the acid combines in a lower proportion than a certain degree of oxygenation, its result is a hydrate; if in a still less proportion, an insoluble salt; and if in an intermediate proportion, a soluble one. The difficulty of determining the neutral state of the different simple bodies when united together, is one of the principal

causes of the errors, and of the differences of atomic weight given by different chemists.*

---

## *Electricity.*

The following facts constitute the science of electricity; and whatever principle will explain the whole of these facts, that principle will be its theory: or in other words, upon it the phenomena of electricity will depend.

Electricity is produced by the contact of dissimilar particles or bodies—by the friction or rubbing of dissimilar bodies upon each other—by the fusion of inflammable bodies—by evaporation—by the disengagement of gaseous matter—by evaporation—by the disruption of solids—by a change of temperature—by crystallization—and in fact, in all cases of the action or motion of dissimilar particles, or groups of particles, forming bodies acting upon each other, whether the action be a chemical or a mechanical one.

* It will be seen by the table of the atomic weight, that the *atom of nitrogen is too great:* for its *specific heat*, its *refractive power*, and its combination with *oxygen* and *hydrogen*, place it between *carbon* and *boron*. I have not Dr. Thomson's "First Principles" by me, and consequently cannot say from which of the oxides of nitrogen the atomic weight was deduced.

Experiment proves that certain bodies, by friction, or other means, exhibit or retain electricity; and that other bodies not only do not exhibit it, but conduct it away from those bodies on which it has been accumulated. Hence some bodies are called electrics, or non-conductors of electricity, and other bodies are called non-electrics, or conductors of electricity.

If, however, the conducting bodies be insulated from all other bodies by means of the non-conducting bodies, then by using the means which develop electricity in an electric, the non-conducting bodies become electrics also. So that all bodies are in reality electrics, but not so under ordinary circumstances.

Experiment proves that such bodies as sulphur, diamond, glass, resinous bodies, and some of the metallic oxides, &c. are electrics or non-conductors, whilst the metals, charcoal, &c. are conductors of electricity.

Experiment proves that bodies when rubbed, whose composition is the same, but whose surface is different as to polish, exhibit different degrees or kinds (using theoretical language) of electricity; as a glass tube in its ordinary state, and a part of the same depolished or roughened.

Experiment proves that electricity diffuses itself over the surface of bodies which accumulate it, and not amongst the particles which compose such

bodies; that it is retained upon the surface of such bodies by the pressure of the atmosphere; for the greater the pressure, the greater the quantity which can be accumulated, and the less the pressure, the less the quantity which can be accumulated. In the vacuum of an air pump bodies do not retain electricity.

Experiment proves that when two different kinds of bodies are rubbed together, which produce electricity under ordinary circumstances, the two bodies receive each the same quantity or degree of electricity; for they can mutually saturate each other or return to the quiescent state. Such bodies, when electrified, have an attraction for each other.

Experiment proves that if two bodies like the last mentioned, be rubbed, and then presented to the former bodies whilst under electrical excitation, and according to their nature or kinds, that they will repel each other; but if they be presented to their opposite kinds they will attract each other, for similar bodies when electrified, repel each other.

Experiment proves when electricity is developed in a body, that body has the property of causing any other body presented to it, to acquire or receive electricity likewise. The fluid obtained under such circumstances is called *induced* electricity, the electricity by *influence* of the French electricians. The quantity of electricity received in this

manner is always equal to the quantity in the body which induced it; as they unite together they are considered to be different electricities. It is on the principle of induction that the electrophorus is constructed and the Leyden jar is charged.

Finally, all electrical phenomena are phenomena of attraction and repulsion; the first effects being invariably those of attraction, the second, those of repulsion; that if the quantity be small which is accumulated, there is attraction only; but if the quantity be considerable, attraction and repulsion are exhibited. Electricity is essentially characterized by its attractive and repellent properties, and by the shock (the consequent of repulsion,) which it gives to bodies on which it acts.

Electricity is that state of ethereal matter, which, when united to common matter, manifests the greatest degree of repulsion. It may be called the latent state of ethereal matter.

The theory, or rather exposition of electrical phenomena, is, that there exists ethereal or repellent matter, in a quiescent or uncombined state throughout nature; that this state is disturbed by whatever changes dissimilar particles, or dissimilar masses may undergo; for such changes cause combinations more or less permanent to take place between particles of ethereal or repellent matter, and common or attractive matter, (as has been fully shown in the preceding part of this essay;) that the attraction of

ethereal for common matter, is in the inverse ratio of the atoms of common matter, and the particles of ethereal matter have a repulsion for each other the converse of the attraction of the particles of common matter for each other.

All electrical phenomena must depend upon the principles deduced from the combination of ethereal and common matter in inverse ratios to each other: these principles, to repeat them again, are first, that atoms, or quantities of the same kind, repel each other; and atoms, or quantities of different kinds, attract each other—the degree of repulsion being equal to the weight of the smallest atom, or quantity, and the difference being the attraction belonging to common matter. These principles explain all the facts which constitute the science of electricity, as given at the commencement of this article, and the application of them to the following all-important and fundamental facts, will afford examples of its power and truth.

The attraction of common and repellent matter for each other being in the ratio of the levity of the atoms of common matter, is the reason why those atoms which are lightest, are those which produce, or retain electricity when rubbed, &c. as the diamond, sulphur, &c. The same applies to compound light atoms which present smooth surfaces, as glass, resin, &c., in fact, all substances which are formed of, or contain light atoms, if their surfaces be

polished, as the oxides of the alkaline and earthy metals, and their combinations with one another forming salts. Whereas, such atoms as are heavy, as the metals, are non-electrics, or conductors of electricity. The metals, however, when united to an excess of the non-metallic substances, become electrics also.*

The attraction of common matter for ethereal matter being different in different bodies, varying as the weights of the atoms of common matter, different bodies must receive or retain different degrees, or quantities of repellent matter.

Bodies whose particles are composed of the same kind of atoms, should alike receive the same degree, or quantity of repellent matter, as their attractive and repellent powers are the same; therefore, such bodies, when they receive an accumulation of repellent matter, should repel each other: hence the cause of similar bodies when electrified, repelling each other.

As the quantity of electricity or repellent matter which is accumulated by the friction of two bodies follows the converse law which governs the parti-

* It will no doubt be discovered, that all bodies which contain ethereal or repellent matter in excess over attractive or common matter, are electrics, or non-conductors of electricity; and on the contrary, all bodies which contain common or attractive matter in excess, over ethereal matter, are non-electrics, or conductors of electricity.

cles of common matter, the degree, or quantity of repellent matter being as the weight of the lightest atom, or body composed of the lightest atoms, the difference between the atoms of the two bodies being attraction; therefore, bodies whose particles are composed of atoms different from each other, as they receive different quantities of repellent matter, must attract each other: hence the reason why dissimilar bodies, when electrified, attract each other.

Similar bodies, when electrified, repel each other, and dissimilar bodies, when electrified, attract each other. A body being electrified as it attracts other bodies, and then repels them likewise, if they be relatively small, the same relationships must exist between ethereal and common matter in the bodies attracted, and the body which attracts in this instance, as exists between dissimilar bodies when rubbed upon each other; namely, the repulsion will be as the weight or quantity of the smallest atoms of the bodies, and the difference between the atoms or quantities, will be attraction. Such bodies, when ethereal matter is accumulated upon them in the manner just mentioned, if they be insulated, will be *electrified bodies* also. This is the theory of *induction*, or electricity produced by *influence*.

*Of the decomposition of light by the prism.*

Light, when made to pass through a triangular prism, is decomposed, and exhibits a series of colours arranged in a determinate order; these colours and the order of their arrangement, are as follows: red, orange, yellow, green, blue, indigo and violet. The red is found to be nearest the point where the rays of light would have gone, had they not been subjected to the prism, and the violet colour is farthest from that point. Light, from exhibiting these different colours, is supposed to be a compound body, having particles of different size or weight, the largest of which produce the colour of the red end of the spectrum, and the smallest the violet end. The former are said to be the least refrangible, and the latter the most refrangible. Besides colour, light so decomposed exhibits properties or powers important in chemistry and natural philosophy: these powers are heating or combining effects—decomposing or divellent effects—illuminating and magnetic effects. It is found that the greatest heating effects are near the red end of the spectrum, and that they diminish as they approach to the violet end: that with these heating effects are attractive or combining effects; for substances which readily combine with oxygen, when presented to the red end, unite with it. The violet end has no

property of this kind: on the contrary, it exhibits a divellent power, decreasing as it approaches to the red end: it decomposes muriate of silver, (chloride of silver,) and deprives many substances either of a portion or the whole of their oxygen. The quantity of light, or, in other words, the illuminating power presented by light so decomposed, like heat and the divellent power, has a particular location: it is found to be in the yellow colour, nearest the green rays. The magnetic effects are greatest in the blue rays.

These properties, exhibited by the solar spectrum, are in harmony with the principles deduced from the classification—from the relationships of concreting atoms, as to their capacity for caloric; or, in other words, the nonconcreting attribute.

Chlorine and hydrogen, according to sir Humphrey Davy, act more rapidly upon each other when exposed to the red ray, than when placed in the violet, and the combination is without explosion. Gay Lussac, and Thenard, found that when chlorine and hydrogen were exposed to the violet rays, they immediately exploded.

These effects are readily explicable; as the heating effects decrease from the red end to the violet, and the divellent effects fr[illegible] the violet to the red end, combinations should [illegible]e place without explosion at the red end, [illegible] the divellent power

is feeble; and explosion should be the effect at the violet end, where this power is greatest.

Sir Humphrey Davy found that a solution of chlorine in water became a solution of muriatic acid, most rapidly, when placed in the most refrangible rays in the spectrum. The rationale of this experiment is very obvious, as there was common matter for the hydrogen and oxygen of the water to unite with, being also in contact with caloric of fluidity; a divellent force was alone wanting to separate them from each other, in order to unite with chlorine to form other compounds.

The same chemist found that oxide of mercury from calomel and water of potash (the black oxide) was not changed in the most refrangible, but became red in the least refrangible rays. In these experiments the violet end could not decompose the oxide of mercury, nor cause oxygen to unite to it from its divellent nature, but as mercury could take up more oxygen, it combined with another portion of it when exposed to the red end of the spectrum.

The red oxide of mercury, moistened with water, and acted upon by the violet rays, was in part decomposed; the same effect was produced upon it as is produced by hydrogen gas. Thus the violet rays have the property of reducing the red oxide to the black or protoxide, and confirming the explanation of the last mentioned experiment.

"Berard, by concentrating the rays from the

green to the extreme boundary of the violet, and the rays (by another lens) of the other half, found the focus of a white light so brilliant that the eye could not endure it: yet in two hours it produced no sensible change on muriate of silver. On the contrary, the focus of the other half, whose light and heat were far less intense, blackened the muriate in ten minutes. This experiment proves that light depends for its greatest powers of exhibition on particles whose atoms correspond with those which are to be found within the range of the red and the green rays; and the greatest repellent powers, as before mentioned, are from the green rays, towards the violet end of the spectrum."

"Sir Humphrey Davy says that the maximum of heat is at the positive pole* where the power of combining with oxygen is given to bodies, and the agency of rendering bodies inflammable is excited at the opposite surface, and similar chemical effects are produced by negative electricity, and by the most refrangible rays of the solar beam."

* Positive pole here means the zinc end of the galvanic battery; the attractive and not the repellent or the divellent pole.

*Newton's scale of the solar spectrum divided into three hundred and sixty parts.*

| Greatest calorific effects at the farthest extremity of the red rays. | | Greatest illuminating powers. | | Magnetic powers. | | Greatest divellent powers as regards chloride of silver & certain oxides is at the farthest extremity of the violet rays. |
|---|---|---|---|---|---|---|
| Red | Orange | Yellow | Green | Blue | Indigo | Violet |
| 45 | 27 | 48 | 60 | 60 | 40 | 80 |

Greatest illuminating powers when all the rays at this end of the spectrum are concentrated.

Greatest divellent powers when concentrated.

The Newtonian theory of light, which makes the different effects to arise from light being composed of particles different as to size, is objectionable, from the complex composition which it gives to this important fluid. By this theory, light is not only composed of as many different kinds of particles as there are colours presented by the solar spectrum, but there are different kinds of particles also for heating effects, for magnetic effects, and for repellent or electrical effects.

All the different phenomena which light presents, can readily be explained by the supposition of one kind of repellent, imponderable, light, elastic fluid particles, namely, the ethereal matter of the classification, this matter acting upon common matter, in non-saturating, or in saturating proportions. This supposition is supported, not only by the means used to effect what is called the decomposition of light,

but by all the phenomena of colorization which the atoms of common matter present, in combining chemically with one another, when colour is produced, as well as by the action of the two classes of matter upon each other, (colour and magnetism excepted,) as has already been spoken of.

The decomposition of light is effected by means of a triangular prism of glass, (or any other transparent substance of that form,) composed, as in common glass, of silicium, potassium, or sodium, and oxygen; and in the case of flint glass, of silicium, lead, potassium, and oxygen; so that the kind of particles which forms the decomposing medium is not the cause of the effects produced, but these effects are owing to the peculiar manner in which the particles are placed, as regards quantity in this medium, they forming a series from the smallest to the greatest relative quantities of matter. The particles which constitute glass are so arranged as to form a homogeneous body.

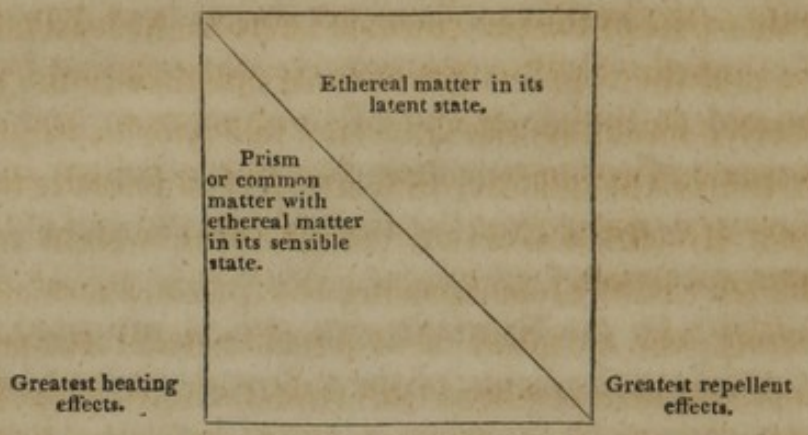
Ethereal or repellent matter in the state of *light*, when a triangular prism is presented to it, finds itself in contact with every degree of relative attractive force which common matter possesses, from the least, as before mentioned, to the greatest; for a body of that form or figure presents every degree of force, from the extreme of the infinitely small, to the extreme of the infinitely great.

As the two forces or attributes of the two classes

of matter, namely, attraction and repulsion, are in inverse ratios to each other; the repellent or latent state of ethereal matter must be greatest where the attractive force is least, and hence must be greatest at that part of the prism where there is the least matter, and the repellent force must diminish as the attractive force increases, or in other words, in proportion to the quantity of matter of the prism acting upon it, (the attraction being as the weight and number of the atoms forming the prism,) and conversely, the quantity of ethereal matter attracted must be greatest where the attractive force is greatest, and must diminish as the attractive force diminishes. Hence, caloric or the heating effects, the sensible state in other words of ethereal matter, must be greatest at the point of the greatest quantity of matter, and must be least where there is the least quantity of matter.*

* This action of light is the result of the general law, mentioned in the preceding part of this essay, namely, "that the repulsive state increases with the levity of matter, and decreases with the density of matter; and the sensible state of repulsive matter increases with the density or weight of matter, and decreases with the levity of matter." Thus the action of light—the action of the two classes upon each other—the reasoning upon atmospheric air, and the conclusion from the experiments of Dulong and Petit, all harmonize with each other.

*Diagram showing ethereal matter in its latent state, when acted upon by the least quantity of common matter, and the same in its sensible state when acted upon by the greatest quantity of common matter.*




Colour produced by the solar spectrum, is owing evidently to the two forces of attractive and repellent matter not counterbalancing, neutralizing, or saturating each other; for experiment proves that the greatest repellent or divellent effects are without the spectrum at the violet coloured end, and the greatest heating or attractive effects, are without the spectrum at the red coloured end; moreover, these forces decrease as they advance toward each other, or recede from the point where these forces are greatest. So colours being within the range of attractive and repellent matter, the different colours are owing to the different degrees or quantities of the two kinds of matter combined or acting together. Thus the greatest quantity or proportion of attractive or common matter, with the least

quantity or one proportion of ethereal matter, form the red rays or colour, and the greatest quantity or proportion of ethereal matter with one proportion of common matter, constitute the violet rays or colour. All the other colours are owing to an increase of ethereal matter over attractive matter going from the red to the violet end of the spectrum, and an increase of common matter over the repellent state of matter, going from the violet to the red end of the same spectrum.*

Light by the Newtonian theory, is supposed to be owing to the union of the different colours of the solar spectrum; for when a ray of light is decomposed by one prism, these colours can be re-united (so as to form white light) if a second prism be so connected with the former prism as to form a rectangular figure, for when two triangular prisms are so united, the attractive and repellent powers are neutralized or counterbalanced.

As colour is caused by the combination of ethereal matter with common matter, in non-saturating

* It is shown by chemistry, that when substances whose atoms are light, and consequently have the greatest attraction for ethereal matter, unite to heavy atoms, the colours presented, if they combine in various proportions, follow the order of the spectrum going from the red coloured end; on the contrary, when a compound body loses light atoms, the change of colour is from the violet to the red coloured end of the spectrum.

proportions, light (meaning white light) which, according to Newton, depended upon the union or combination of the different coloured rays, must be the effect, not of an unequal, or non-saturating proportion, but of equal mutual attractive, or saturating, neutralizing proportions. This consequence of light, being the result of the union of common and etherial matter, wherein attraction and repulsion mutually counterbalance each other, is proven by the union of the two triangular prisms,—by the greatest illuminating power being in the yellow coloured ray, which is the lightest in colour, and which experiment proves to possess the greatest illuminating power; and is further proven by most of the neutral *chemical compounds*, for such compounds, as is well known, are white.*

The theory of light here given, namely, that all its phenomena depend upon the action of the two classes of matter upon each other in different degrees or proportions, is confirmed by chemical phenomena, or the action of the particles of common matter upon each other. Thus iron, in the metallic state, is white; a certain quantity of oxygen, or non-metallic matter, makes it black; a greater quantity

* I have no doubt that all neutral compounds are white, that is to say, attraction and repulsion counterbalancing each other, must produce this effect according to the view given of chemical affinity. This I shall further show in the second part of this essay.

changes it to a red. Combining it with water, adding to it in this way a greater proportion of non-metallic matter, its colour is yellow; and a still greater quantity of non-metallic matter, as carbonic acid, produces white; whilst a greater quantity, as of prussic acid, produces a blue colour. It must be remembered that the quantity of ethereal matter increases as the levity of the atoms of common matter increases.

*Quantity of Non-Metallic Matter combined with Iron in* 100 *parts.*

| | | | |
|---|---|---|---|
| | oxygen, | 28.21 | black. |
| | do. | 30.61 | red. |
| Water | oxygen and hydrogen, | 39.00 | yellow. |
| Carbonic acid | carbon and oxygen, | 52.63 | white. |
| | prussic acid and oxygen, the protoxide, | 59.75 | white, changing rapidly to a green, and then becoming blue, by an increase of oxygen. |
| | prussic acid and oxygen, the peroxide | 77.90 | blue. |

*Quantity of Non-Metallic Matter combined with Mercury in* 100 *parts.*

| | | |
|---|---|---|
| Protoxide, | 3.80 | black. |
| Deutoxide, | 7.32 | red. |

| | | | |
|---|---|---|---|
| Turpeth mineral, | oxygen and sulphur combined, | 16.60 | yellow. |
| Chloride, | | 26.47 | white. |

The same law which holds in the combination of iron and mercury, also exists when copper combines with non-metallic matter or light atoms.

*Quantity of Non-Metallic Matter combined with Copper in* 100 *parts.*

| | | | | |
|---|---|---|---|---|
| Protoxide, | | | 11.22 | black. |
| Deutoxide, | | | 20.17 | red. |
| Protochloride, | | | 35.80 | light yellow colour. |
| Green carbonate, | carbonic acid, | 19.85 | 46.10 | green. |
| | oxygen, | 18.02 | | |
| | water, | 8.05 | | |
| Blue carbonate, | carbonic acid, | 25.43 | 48.28 | blue. |
| | oxygen, | 17.65 | | |
| | water, | 5.20 | | |

These instances are but a few of the innumerable examples of the accordance of the theory of light and of chemical action, which, from the principles deduced from the experiments of Dulong and Petit, is neither more nor less than the union of the two classes of matter, since different atoms generate, for instance, a repulsive force in common matter equal to the difference of its atoms or quantities, and an attractive force in ethereal matter equal to the difference between its atoms and quantities.

The same exhibition of prismatic colours, by the change of ethereal matter which takes place in inorganic matter, is likewise presented by the vegetable kingdom; thus the leaves of a tree at the approach of winter, when its life begins to diminish, lose their green colour, assume that of a greenish yellow—then yellow—orange—red—brownish,—and finally, when life has completely departed, all colour is lost, for then they are black. Similar changes are presented by the animal kingdom, but not so varied.

---

## *Magnetism.*

It has been mentioned that magnetism differs in nothing essentially from electricity, with the exception of its retention by steel, and by certain other metallic substances, which, under ordinary circumstances, are conductors of electricity.

It having been shown that caloric, light, and electricity are merely different states of ethereal matter, dependent upon its union with common matter in different proportions, it would be necessary to show that magnetism results from the same ethereal matter, in union with the same common matter, were it not for the opinion which now prevails, that electricity and magnetism depend upon

one *common principle*, the former being convertible into the latter, whenever electricity, developed by ordinary means, or by galvanism, is made to act upon certain metallic substances; for upon this conversion the science of electro-magnetism is founded.

That magnetism and electricity differ a little from each other, might be inferred from the decomposition of light by the prism, the blue rays being those which produce magnetic effects; these rays having greater attractive powers than those which exhibit electricity only, and less attractive powers than those which produce light.

In looking over the table of the weights of atoms, I found that those metals were magnetic which had the greatest atomic weight joined to the greatest specific heat, proving that the degree of attraction of ethereal matter, which produces magnetism, was not only as the specific heat, but as the weight of the atom.

It has been supposed that magnetism was connected with the interior of the earth: this opinion has been proven to be erroneous; for Col. Gibbes found that oxydule of iron, taken fresh from below the surface, where it was not exposed to atmospheric influence, exhibited no polarity or magnetic effects, whilst the same kind of ore, found on the surface, possessed polarity, or exhibited magnetism.

According to M. J. B. Biot (Traité de Physique, t. II. p. 75,) "The magnetic action of the terrestrial

globe is not limited to its interior or its surface: it extends into space, as M. Gay Lussac and myself have proved, in an aerostatic ascension. It even seems from our observations, that the intensity of this action decreases slowly in proportion to the distance from the terrestrial surface; for we found *no sensible diminution* of it at the height to which we were elevated." (20,000 feet.)

I have long thought that terrestrial magnetism was owing to the centrifugal force of the earth, motion producing those changes in the common matter of the atmosphere which cause combinations more or less permanent to take place between its particles and those of ethereal matter. This opinion is founded upon the decrease of magnetism in advancing towards the poles from certain latitudes, and its absence or loss where the action of the centripetal force prevails. Secondly, from the observations of Col. Gibbes, which prove that magnetism is not connected with the interior of the earth, but with its surface; thirdly, and lastly, the observations of MM. Gay Lussac and Biot, showing that it does not diminish in ascending into the atmosphere, so far as they ascended.*

* Whilst in the college at Columbia, S. C. I tried to prove by experiment that magnetism depended upon the centrifugal force, by subjecting a magnetic needle to great pressure, but my apparatus was insufficient for the purpose.

If terrestrial magnetism, as it is called, depends upon the centrifugal force giving motion to the atmosphere, will not the three magnetic equators be owing to the expansion produced by the action of the sun being different in different places at different periods of the year, and remaining expanded at the different places or points for certain periods? Thus, when the sun is at capricorn, the greatest volume or height of the atmosphere will be at that point; when, on the contrary, it is at cancer, its greatest volume is thrown from the north to the south; and when at the equator, its greatest expansion will be at that point. The extreme points of the earth, upon which the sun periodically exerts its greatest influence, being forty-seven degrees, great effects ought necessarily to result, since the diurnal motion of the earth alone, as regards the action of the sun, and other comparatively feeble actions, are known to produce appreciable effects.

If terrestrial magnetism be really caused by the motion of the earth, may not the aurora borealis owe its existence to the changes which the two states of the atmosphere must necessarily experience; since one being more dense than the other, any cause which will reduce any portion of the centrifugal atmosphere, to the polar or centripetal atmosphere, will produce light; for light is always a concomitant or product of the condensation of gaseous matter. So also the atmosphere exhibiting two states, as

regards density, it becomes an electrified body by motion; and any cause which will unite the two must exhibit light, if the accumulation be considerable.*

The fact that the aurora borealis can be seen in lower latitudes in the winter than in the summer season, is in accordance with the cause assigned; for in mid-winter the atmospheric equator is removed 47° from the point which it occupies in the summer season.

---

## *Galvanism.*

Galvanism differs from electricity not only in its powers of decomposing compound substances, but in the mode in which its powers are elicited or developed. In all electrical machines, and in every way in which electricity is made manifest, it is by the action of dissimilar substances, or bodies rubbed, or otherwise made to act upon each other. It is always the action of bodies or masses. Galvanism, on the contrary, depends for its development not only upon the action of bodies and masses upon each other, but also of particles acting simultaneously

* This effect is often seen between clouds, and between the clouds and the earth.

with the action of bodies or masses. Every galvanic battery, or instrument, consists of dissimilar masses, (plates of zinc and copper for example,) and a menstruum capable of acting chemically upon the particles, which compose one of the masses. Thus electrical effects, and calorific effects, are the concomitant results of the galvanic battery when in action,—for, as before mentioned, electrical effects are the result of the action of dissimilar masses, as is proven by natural philosophy; and all chemical phenomena show, that the action of ultimate dissimilar particles produce heat or caloric.

According to the manner in which the plates composing a galvanic battery are arranged, so are the effects produced; these effects prove the real nature of this important instrument, as has already been mentioned.

If the plates be few, the menstruum used producing a strong chemical action, heat alone is the result, for a battery of this kind will neither decompose water, nor produce shocks. On the contrary, if the plates be many, the chemical action feeble, electrical effects are the product; and the greatest calorific, and the greatest electrical effects, result from the joint action or combination of the two modes of arrangement, or means used.

Considering galvanism as simultaneously eliciting caloric, *the sensible state of the nonconcreting particles,* and electricity, *the latent state of the same*

*particles*, conjoined with the affinity or attraction which the nonconcreting and the concreting particles have for each other, and the knowledge also that their attraction for each other is inversely as the weight of the atoms of concreting matter, every experiment with this agent meets with a ready explanation.

*Of the decomposition of Water by Galvanism.*

Caloric will not decompose water unless aided by a substance capable of uniting with oxygen. This is no doubt owing to the ratio of latent to sensible heat being extremely great in the two gases which compose water. Sensible caloric, the state in which it is considered in this instance, combines with the constituents of water, but has not the divellent power which is necessary to cause its hydrogen and oxygen to separate from each other.

Electricity will not decompose water, unless by Wollaston's method, wherein by extremely minute points, it is brought in contact with the particles of water. In ordinary cases it acts upon the water as a mass; repelling it as a whole, and diffusing itself over its surface. It is a divellent power only.

Water, when presented to galvanic action meets with an attractive and a divellent force; its constituents, hydrogen and oxygen, unite to caloric, the sensible state of the nonconcreting matter; and the

latent, or repellent state, acting conjointly with the sensible state, causes them to separate from each other; the hydrogen going to the copper end, where atoms have the least attractive power; and the oxygen to the zinc end of the battery, which produces the chemical action. Ethereal matter, or caloric, *sensible and latent,* is a powerful divellent to the attraction or combination of hydrogen and oxygen, for it exists in them, in their gaseous state, in the ratio of 3.2936 for hydrogen, and 0.2361 for oxygen, and explains the easy decomposition of water, when subjected to galvanism and other chemical agents, which elicit a combining or attractive, and a divellent or repellent power.

I am persuaded, that when decompositions are effected by the agency of galvanism, that as the affinities of common matter are reversed, the laws of ethereal matter in its latent state, common matter being in the fluid or gaseous state, take the place of the laws of common matter, subjected to ethereal matter in its sensible state. Against this opinion, is the atomic weight of copper, as given by all chemists, who make it greater than that of zinc.

The laws of ethereal matter in the latent state, explain all the mysteries connected with the decomposition of neutral salts, &c. either as to the distance their constituents traverse, or the more mysterious passage of the acids of neutral salts,

through alkaline liquors; or their alkalies, through acid liquors.

The difficulty of conceiving the modus operandi of galvanic action, and the transfer, or passage of gaseous matter from one pole to another, has often been mentioned to me; and I have always been satisfied with the following explanation:

Attraction and repulsion are the products of the action of the masses, and of the particles which compose a galvanic battery, as before mentioned; or in other words ethereal matter, by the simultaneous action of bodies and particles, is exhibited in its two states. These two forces, if they be equal to each other, decompositions must take place, not at the extremities of the two wires as is generally supposed, but where the two forces meet; namely, at equal distances from the wires.* The point of the union of the two forces is the point where the constituents of compounds of common matter separate from each other, and unite with ethereal matter. Thus in the case of water; oxygen and hydrogen combine with ethereal matter in its sensible state, and are repelled from each other, and carried to their respective poles, or wires, by ethereal matter in its latent state.

* If the forces be equal, the distance from the wires is equal: if unequal, the distance will be so likewise: the greater the attraction, the nearer to the attractive pole, &c.

The galvanic action of the passage of common matter through space which is appreciable, cannot be a chemical action, for all chemical actions take place at insensible or inappreciable distances only: but if it be admitted that the particles are subjected to ethereal matter in its latent state, then there is no limit to the distance at which the latent state of ethereal matter can act, but the absence of common matter. The power of ethereal matter in the latent state being as the quantity accumulated, it is not surprising that acids and alkalies should be carried through opposing menstrua.

If the laws of ethereal matter in its latent state are the true cause of the passage or transfer of common matter by galvanic action, then the lightest atoms will go to the pole, composed of the heaviest atoms; as repulsion is as the weight of the lightest atom, and attraction as the difference of the two. But if chemical or ethereal matter in its sensible state be the true cause, the heaviest atoms must go to the pole, or to that metal composed of the heaviest atoms.

The analogy between the effects of galvanism and the effects of animal life, have long been remarked; and the conclusion likewise, that many of the phenomena of animal life and galvanism were more or less identical, is equally well known; but, no one, so far as I have read, has pointed out resemblances

other than those which their phenomena or their effects presented.

Galvanic action, as before mentioned, consists in the action of dissimilar masses, and of dissimilar particles, simultaneously producing, the one repellent, or divellent, the other, calorific or attractive effects.

All organized bodies are composed of dissimilar parts, and dissimilar parts acting upon each other produce repellent or electrical effects. As all organized bodies depend for their growth, sustenance, or continuance of life, upon nutriment, or matter taken into their interior from without, which nutriment giving rise to the action of particles, thereby producing heating, or calorific effects, it is not without reason, that galvanic action and vital action, or the effects of the cause of organization, should be compared with each other.

As the higher classes of animals show that the organs wherein digestion, secretion, &c. carry on their operations, are connected with the brain, (a mass of parts,) by means of nerves, in form like the wires or conductors of a galvanic battery, the analogy is still further extended, for in each organ simultaneously, electrical, or divellent, and heating, or combining effects take place.

As the action of particles predominate, so heating, attractive, and combining effects predominate: on the contrary, when the action of the brain

predominates, repellent, divellent, and non-combining effects predominate.*

The action of two states of ethereal matter, or of two agents in the operations of life, is the reason why inorganic chemistry, or the chemistry of the laboratory, has so little subserved the purposes of the physician. In the laboratory, heat alone is the state in which ethereal matter is made to act upon common matter; but if common matter had been subjected to galvanic action, its elements so arranged that the two opposing states of ethereal matter would be elicited or developed in the same relative proportions in which the different organs, both in the healthy and diseased states of an organized body exhibit them, then analogous results would have been presented, and organic affinities, or the affinities of common matter in relation to the sensible and latent states of ethereal matter, would have given an organic, physiological, or medical chemistry.

The reciprocal action of the two classes or kinds of matter upon each other, namely, the concreting or common matter, and the non-concreting or ethe-

* In proportion to the action of particles, so is the heat produced, and in proportion to the action of the brain, so are the repellent effects produced: these, however, are convertible one into another; for if particles containing caloric act upon surfaces, repellent effects are produced; and when surfaces, over which repellent matter is spread, act upon particles, heating effects are produced.

real matter, give rise to the sciences of chemistry, natural philosophy and physiology.

Chemistry is the science of common matter, wherein ethereal matter is in the sensible or calorific state. It is the simultaneous action of dissimilar atoms or quantities upon each other, and of similar atoms or quantities acting upon each other. When similar atoms or quantities unite, attraction alone is exhibited; the union of such particles, under certain circumstances produce inorganic forms, or homogeneous bodies, or crystals, the cause or action of which is crystallization.* Dissimilar atoms when they unite, exhibit not only attraction, but repulsion likewise; and the laws which govern their combinations with one another, are that the attraction is as the weight of the smallest atom, when two atoms combine together; and the difference between the weight of the two atoms, is repulsion.

Natural philosophy is the science of ethereal matter in its latent state, wherein common matter is in the fluid or gaseous state; for electricity in the latent state does not exist where fluid gaseous matter does not exist; for the action of electricity or the quantity which can be accumulated, is as the

* Chemistry is generally considered as treating of the action of dissimilar atoms or particles only of common matter upon each other, so that the action of similar particles which produce crystals, &c. would seem to belong neither to natural philosophy nor chemistry.

density or pressure of the atmosphere. As chemistry is the science of similar atoms or quantities, and of dissimilar atoms or quantities, natural philosophy, likewise, considers similar quantities and dissimilar quantities of electricity. As similar quantities of electricity are repellent of each other, dissimilar quantities are repellent and attractive of each other—the repulsion is as the smallest quantity when two quantities act upon each other, and the attraction is as the difference of the two quantities acting upon each other.

Physiology is the science of life, or that power which organizes matter, so as to produce bodies or beings possessed of the powers of attraction and repulsion, and with the property of producing others similar to themselves.

No principle is better established, than that where attraction alone exists between particles of common matter, either simple or compound, crystals or homogeneous bodies alone are the result; so that where attraction and repulsion exist, heterogeneous bodies, either of simple or compound particles, must be the result.*

* The polyhedral forms belong to all inorganic matter, for such are the forms of crystals. It is worthy of remark, that when substances crystallize they become brittle, whilst in the uncrystallized state they are more or less tough. Thus, pure iron is extremely tough, and exhibits no crystalline appearance; but, if it be combined with a small portion of car-

As attraction and repulsion, the attributes of common and ethereal matter, are essential charac-

bon, phosphorus, sulphur, silver, &c. it loses its toughness, and acquires a crystalline or lamellar fracture. Silver, when suddenly congealed, is a brittle metal, for it is then in the crystalline state; but when melted, if it be slowly cooled, it loses its crystalline state and becomes tough. Zinc is extremely brittle at the ordinary temperature of the atmosphere, and is highly crystalline in its fracture, but if heated to a certain degree, it becomes a malleable metal.

The fibrous state of minerals appears to be a semi-crystallized state, for the fibrous varieties of the same species of minerals are more tough than those varieties which are crystals, or present a higher degree of crystallization than the fibrous state.

These facts, and others equally well known, make it certain, that malleability is owing to combined heat: for the toughness which inorganic matter acquires by its combination with heat, can arise only from the tendency which heat has to produce the globular form, or state; for that state, as it causes particles to present a greater surface to one another when struck, from the flattening produced, must have their attractive powers increased: whilst in polyhedral forms, no property of this kind can exist.

These facts, and others equally well known, of the effects of heat upon inorganic matter, confirm the opinion advanced by some physiologists, namely, that the elementary particles of organic matter were globular; and accounts for the greater toughness of organic matter, compared with inorganic matter; as well as for the opinions entertained of the forms of matter; for we find that particles of common matter, uncombined with ethereal matter, are polyhedral; but when combined with ethereal matter are globular.

teristics of all organized bodies, so these two opposing kinds of matter must form the material of organization. As the tendency of the one kind of matter is to assimilate or accrete, so the tendency of the other kind is to de-assimilate or de-accrete; as these opposing powers, or their substrata, are ethereal matter in its sensible and in its latent state, and common matter in its fluid and its solid state, so the ultimate laws or principles of physiology are the ultimate laws or principles of chemistry and natural philosophy.*

---

## CONCLUSION.

From what has preceded, it is evident that organized beings are compounded of dissimilar atoms or quantities of common matter, and dissimilar quantities of ethereal matter; the two states of ethereal matter being very different in the different beings which form nature's chain of living matter.

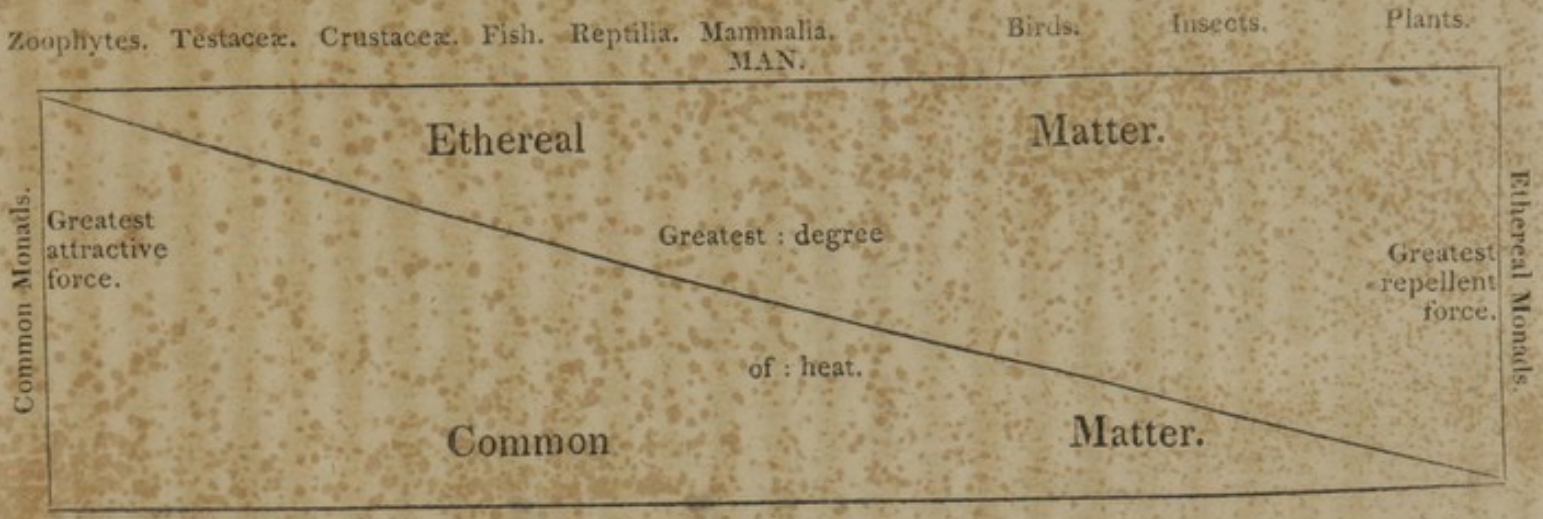
Upon these principles the following diagram is constructed, wherein the relative proportions of the

* Attraction and repulsion resulting from the union of dissimilar particles or bodies, if the two forces counterbalance each other, there will be neither gain nor loss: if, however, the attractive powers predominate, the body increases, but if repulsion predominates the body decreases.

two forces are exhibited, by the various classes of organized bodies which constitute what is called natural history.

It must be remembered that the quantity of ethereal matter, in the latent state, is as the levity of the atoms of common matter; and the sensible, or heating state of ethereal matter, as the quantity of ethereal and quantity of common matter; for less the quantity of common matter, and greater the quantity of ethereal matter, the greater the degree of repellent force, and less the degree of heat; the greater the quantity of common matter, and less the quantity of ethereal matter, the greater the attractive force, and less the degree of heat: whilst the greater the quantity of ethereal matter, and quantity of common matter, the greater the degree of heat.

Those atoms which are lightest, using common language, are more combustible than those atoms which are heaviest. Plants are combustible, i. e. composed principally of carbon and hydrogen; whilst the substance called fat, the composition of which is nearly all carbon and hydrogen, is confined to birds, mammalia, reptilia, and fish; for the lower orders of organization contain none, and present but an appreciable quantity of combustible matter.


Zoophytes. Testaceæ. Crustaceæ. Fish. Reptilia. Mammalia. MAN. Birds. Insects. Plants.
Ethereal Matter.
Common Monads.
Greatest attractive force.
Greatest : degree
of : heat.
Greatest repellent force.
Ethereal Monads.
Common Matter.

This scale of organization shows that there are two species or kinds of elementary organic atoms, or monads,—one wherein there is but one atom or quantity of common matter united to many atoms of ethereal matter in the latent state—the other wherein there is one atom of ethereal matter in the latent state united to many atoms of common matter. The former may be called ethereal or atmospheric monads, from the predominance of ethereal matter, whilst the latter may be termed common, or aquatic monads, from their density, requiring water or aqueous matter for their existence or development.

The causes which generate miasma favour the idea of atmospheric monads, for these causes are all essential conditions of organization, to wit: heat, moisture, vegetable or animal matter in decomposition, and oxygen.

These monads, by combining one with another, in different proportions, produce all the infinite variety of organized beings which form the vegetable and animal kingdoms of nature.

---

## *Of Plants.*

Plants are composed of carbon, hydrogen, and oxygen, with a minute quantity of iron, manganese,

silex, and lime; at least these latter substances are always found in plants, but the quantity is so small that chemists consider the three former substances as alone composing them. As analysis shows that plants essentially contain none but the lighter atoms, almost the whole of their material being highly inflammable and resolving itself into gaseous matter, they must consequently contain the greatest proportion of ethereal matter, or retain the greatest quantity of ethereal matter in the repellent state. Hence they rise into the air, opposing by so doing the laws of gravity. Plants are without locomotion, which appears to be the case with all organized beings formed either of an excess of ethereal matter, or of an excess of common matter, as the zoophytes.

It seems to me that the greatest analogy exists between plants and zoophytes. The woody parts of the one corresponding with the stony parts of the other, and those parts of plants which contain the sexual organs, analogous to the animal parts of zoophytes. It will no doubt be discovered that nitrogen is just as essential to the composition of the efflorescence of plants as it is to the production of animal matter; and if so, plants and zoophytes will present analogies as strong as exist, for example, between insects and crustaceæ.

It is worthy of remark, that all our common and most powerful stimulants, are taken from the vege-

table kingdom, for with the exception of certain insects and the red blood of animals, none other is to be found excepting in the production of chemistry, either of organic or inorganic matter.

Insects are next to plants in the order of the scale advancing to the point where the two attributes or kinds of matter counterbalance each other; they are less inflammable than plants, but more so than the organized beings to their left on the scale; for they leave but a small residue when burnt; they are all locomotive, and the greater part of them can rise against gravity, or in other words, fly. The greatest known degree of organic force is to be found amongst insects, if we except the force exhibited by certain plants in their growth.

Birds, from their organization, are placed between insects and the mammalia. In their native state, nearly all rise against gravity, but by domestication their weight is increased, which renders it difficult for them to obtain any great elevation. The circumstance of birds flying shows that a repellent force is generated in them greater than is to be found in the series of animals to their left in the same scale. It is worthy of remark, that those birds which feed on flesh alone, are most rapid in their flight, attain the greatest elevation, and are rarely fat; whilst those which feed on grain, grass, and other vegetable productions, are less rapid in their flight, seek less elevated situations, and possess the most fat.

Of all organized beings, the mammalia are those which seem to possess the two powers in nearly equal degrees; and of its species, man is as it were the centre or pivot of the scale: if other animals exhibit individual faculties more highly developed than his own, his advantage is, in possessing the whole or the means of obtaining the same result, and to a degree greater, collectively, than is to be found in any other species. All the mammalia are warm blooded animals, but of less temperature than birds, particularly those of the carnivorous kind.

The reptilia exhibit less heat; like birds they bring forth their young by eggs; many of them are amphibious, requiring a denser fluid than atmospheric air for their well being, and consequently proving that the force of gravity is greater in them than in any of the organized beings spoken of. By a natural gradation the reptilia pass into fish, which live alone in water, but possessed of locomotive powers, and by the same gradation, that is, a diminution of ethereal matter and increase of common matter, the crustaceæ succeed fish; these are succeeded by the testaceæ, and finally the zoophytes terminate the scale above given.

To those who have pursued natural history in detail, the analogies of the organic beings of the one end of the scale and those of the other, are but too obvious. Thus plants and zoophytes are alike, from the arborescent structure of many of their produc-

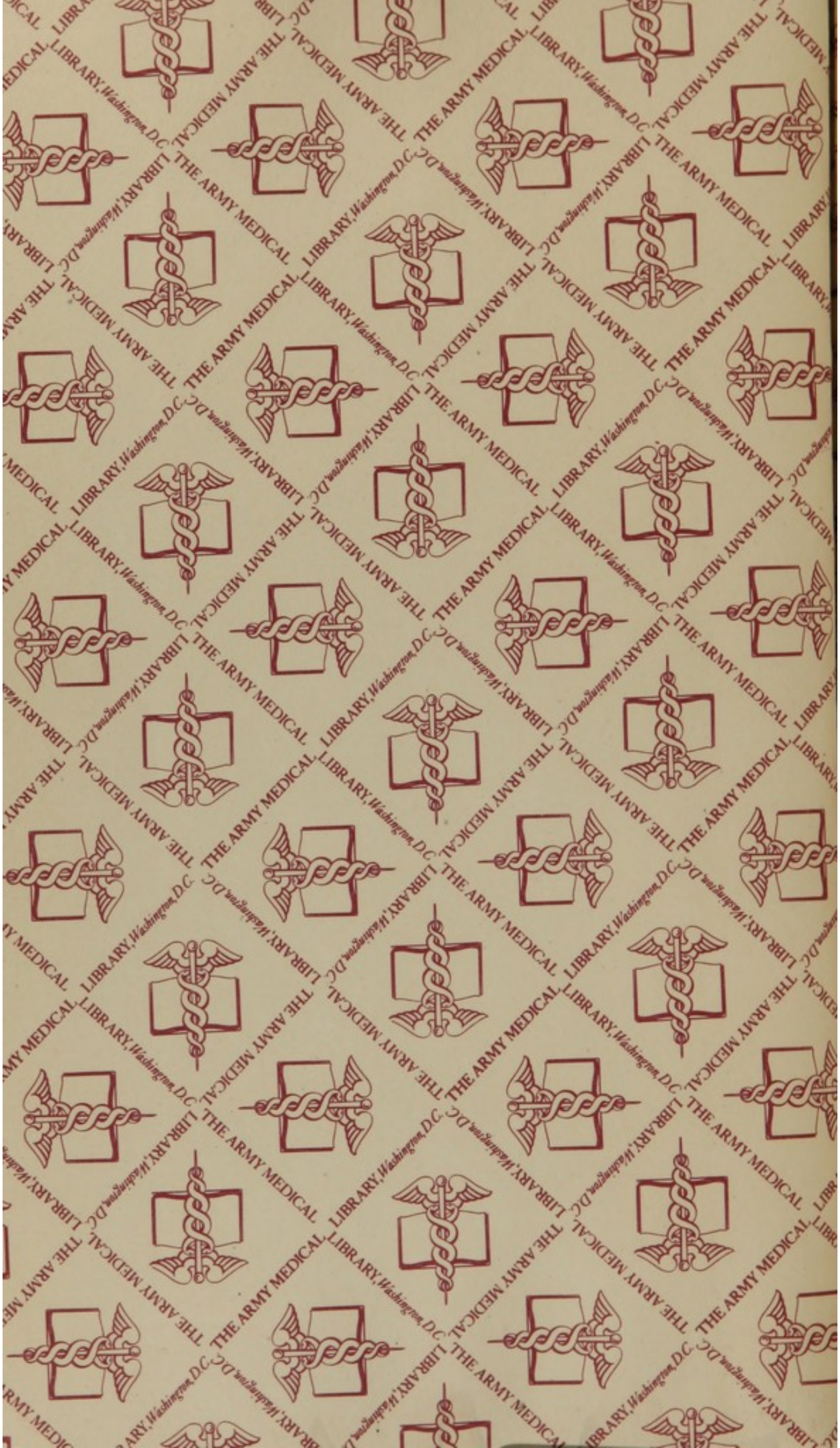
tions, both rising against gravity; but one in a rare medium, the other in a dense medium, neither having locomotive powers.

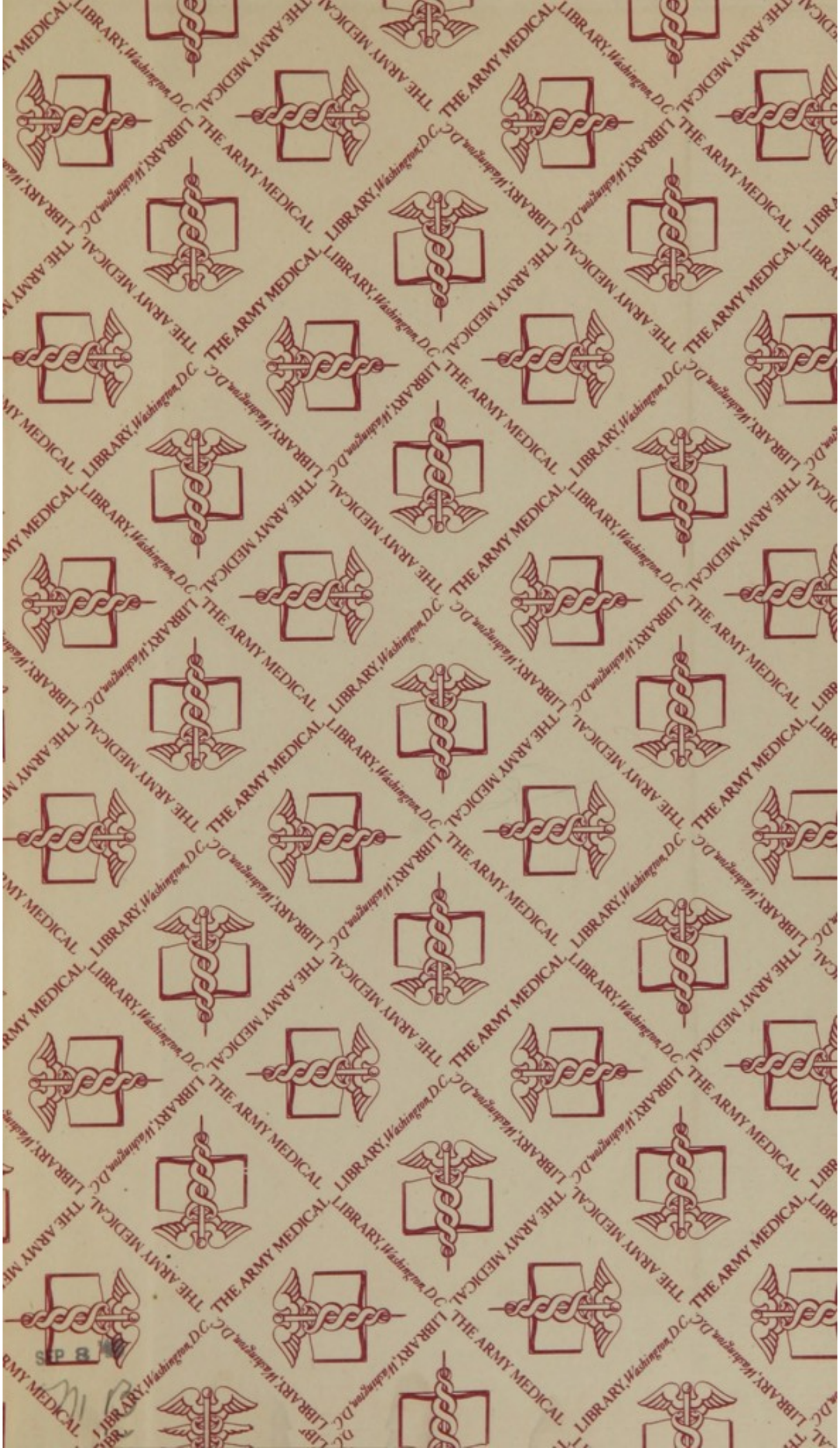
Insects and the crustaceæ are analogous to each other, and so are some of the birds with fish. These are but a few of the most prominent in their resemblances, and no doubt, the analogies extend to every part of their conformation; but the want of accurate knowledge of their nature, in detail, and the want of time at present, prevents me from further pursuing the subject.

END OF PART I.

## ERRATA.

Page 7, first line of the note, "for combination with common matter," read, for combination with other common matter.
Page 10, last line but one of the page, for "and light," read, or light.
Page 11, fourth line from the bottom, for "overcoming their repulsive tendency by its attractive attribute," read, the attractive attribute of the former overcoming their repulsive tendency, &c.
Page 13, beginning of the line at the middle of the page, "proves" should be prove.
Page 16, fourth line above the note, for "rarefication," read, rarefaction.
Page 61, sixth line from the bottom, omit the word "light."
Page 72, last line of the first paragraph, after "appreciable," insert magnetic.


THE ARMY MEDICAL LIBRARY, Washington, D.C.


THE ARMY MEDICAL LIBRARY, Washington, D.C.