On the properties of matter, the principles of chemistry, and the nature and construction of aeriform fluids, or gases / [E. Peart].

ON

THE PROPERTIES OF MATTER,

THE

PRINCIPLES OF CHEMISTRY,

AND

THE NATURE AND CONSTRUCTION

OF

AERIFORM FLUIDS,

OR

GASES.

IN WHICH THE ABSURDITIES OF THE THEORIES HITHERTO ADVANCED, AND GENERALLY RECEIVED, RESPECTING THOSE SUBJECTS, ARE FULLY EXPOSED; AND SUCH AN EXPLANATION OF THEM GIVEN, AS REASON, NATURALLY, POINTS OUT; AND EVERY OBSERVATION, FULLY, CONFIRMS.

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SECTION I.

On the erroneous opinions and falſe reaſonings of philoſophers, with reſpect to matter, its properties, and modes of exiſtence; particularly when in an aeriform ſtate; with an attempt, at the ſame time, to rectify them, by ſtrictly adhering to reaſon and experience.

THE metaphyſical ſpeculations of philoſophy, may lead us to doubt of the exiſtence of matter, but not without deſtroying the teſtimonies of our ſenſes, and involving us in all the inconceivable myſteries of immaterial powers, poſſeſſing the very properties, which plain ſenſe teaches us to attribute to matter.

If our ideas of ſolidity and reſiſtance ariſe from immaterial, repulſive ſpheres, ſurrounding parti-

cles of matter, what occaſion have we to ſuppoſe that there is any ſuch thing as matter?—take away the particles of matter, leave but the repulſive ſpheres, and our ſenſations and ideas of ſolidity and reſiſtance, will be juſt the ſame.

If thoſe ideas are produced by immaterial repulſive ſpheres, what proof have we—what right have we to ſay, that they have centres of ſolid matter? Would it not be the moſt conciſe and philoſophical, at once, openly, to aſſert, that, as our ideas of ſolidity and reſiſtance ariſe from repulſive powers, we have no proof that matter is contained within thoſe ſpheres, and, therefore, there is not one particle of matter in the univerſe?

This immaterial ſphere of repulſive power acting upon other immaterial ſpheres of repulſive power, metaphyſically conſidered, gives indeed the ideas of ſolidity and reſiſtance; and ſo does one ſolid particle of matter acting againſt another: and, as the idea of ſolid matter, appears to

be rather more intelligible and comprehenſible than immateriality, I ſhall think myſelf juſtified by reaſon, in prefering the ſubſtance to the ſhadow.

If it be ſaid that the ſphere of repulſion, is a property, which depends upon the particle of matter as its centre, therefore, matter is neceſſary: may I not ſay that if matter be neceſſary, ſpheres of repulſion are not: for it may be conceived that two ſolid bodies cannot, at the ſame time, be in the ſame place, and conſequently every attempt to force them, nearer than contact, muſt be in vain, and muſt give an idea of reſiſtance: but, the idea of particles of matter, not in contact, reſiſting each other, by immaterial, repulſive ſpheres, extended around them, is beyond our comprehenſion, without proof, and, very fortunately, not neceſſary. Admitting therefore, the exiſtence of matter, the only idea that reaſon or obſervation authorizes us to form of repulſion, is the reſiſtance, that two or more particles of matter, make againſt each other,

when any attempt is made to bring them nearer than contact.

Were we to purſue the doctrine of immaterial active ſpheres ſtill further, our diſſatisfaction, or our fondneſs for incomprehenſible myſteries muſt ſtill increaſe, when we are told, that within this repulſive ſphere, is another, equally immaterial, wonderful, and incomprehenſible, of an oppoſite kind ;—a ſphere of attraction.—If two particles are forced together, by a power overcoming their repulſive ſpheres, their attractive ſpheres then come into action, and forcibly hold thoſe particles together.

But, admitting theſe ſpheres, there ſeems to be a ſtrange irregularity in their extent and diſpoſition ; a certain particle will attract one thing, and not another ; ſome ſpheres of attraction require contact, and produce coheſion ; others act at a great diſtance, as in magnetiſm, and electricity ; in ſome caſes theſe attractive ſpheres *may* be ſuppoſed to be ſurrounded by thoſe of re-

pulſion, where force is neceſſary to produce the attraction of coheſion; in other caſes, ſuch a ſuppoſition is abſolutely inadmiſſible, as when a magnet attracts iron, without the leaſt appearance of firſt repelling it: in fact, the idea of particles of matter, being ſurrounded by immaterial ſpheres of attraction, and beyond thoſe of repulſion, is inconſiſtent, inſufficient and incomprehenſible; it cannot aſſiſt us in accounting for the appearances and operations of nature, but, if ſtrictly adhered to, will involve us in darkneſs and confuſion: and the ſuppoſition of an alternation of repulſive and attractive ſpheres, ſurrounding the ſame particle, only increaſes that confuſion.

But there is an *attraction*, as is abundantly evident to every obſerver of nature; and all that we can ſay of it, is, that it is a *property:* a property, by which, the particles of matter are *actuated;* a property, by which one particle of matter is *forcibly detained* by another; but, as being a property belonging to matter, it cannot act *beyond* its particle: it cannot act where that par-

ticle is *not*: two particles can only *attract* each other, when in *contact*.

But, becauſe we cannot comprehend the nature of this property, of this attraction, are we to have recourſe to immateriality?—is not that ſolving obſcurum per obſcurius?—when we ſay one particle of matter hath the property of attracting another particle of matter, is not that more ſimple and intelligible, than to ſay that a particle of matter is ſurrounded by an immaterial ſphere, which immaterial ſphere hath the property of attracting another immaterial attractive ſphere, ſurrounding another particle of matter?—for granting, for a moment, the exiſtence of immateriality, it does not follow that attraction is eſſential to that immateriality, or implied in its exiſtence, for if it were, what would become of the equally immaterial ſphere of repulſion, attributed to matter?—therefore, if there can be an immaterial exiſtence, it may ſtill be without the power of attraction, and, conſequently, if matter be ſuppoſed to be ſurrounded by an immaterial ſphere, we muſt

likewiſe add, that that immaterial ſphere hath the property of attraction given to it ; and, therefore, it is more ſimple and rational to ſay, that *matter* hath the *property* of *attracting* matter, without any immaterial ſphere being employed, or neceſſary.

One great reaſon, therefore, why philoſophers are yet without principles, is, they aſſume the power of creating properties out of nothing, and uſe them as realities. Aſk for a clear explanation of their imaginary powers, and they cannot give it.—Bring them to the teſt of common ſenſe and they vaniſh—or, endeavour to form an Idea of them, and the mind will be found unequal to the taſk.

For when 'tis ſaid that when two particles of matter, or two bodies, at a certain diſtance from each other, refuſe to approach nearer, than that diſtance, that they repel each other, and when two bodies at a certain diſtance, ruſh together, that they attract each other ; and that that repul-

ſion, or attraction, is effected by an immaterial property, or ſphere of repulſion, or attraction, ſurrounding each particle, and conſequently, that matter can act where it is not, by an immaterial power, the aſſertion is unphiloſophical, inconceivable, and unneceſſary: and is evidently contradicted in ſome caſes, and conſequently is unneceſſary and unwarrantable in all.

For inſtance, a magnet will attract iron to a determinate diſtance:—heat the magnet to a certain degree, and it will not attract iron, at any diſtance. Had it attracted the iron, at firſt, by means of an immaterial ſphere of attraction, that immaterial ſphere could not have been affected by fire: but it is deſtructible by fire: conſequently, the power, by which the magnet attracts iron, is material; and we have means of communicating, or deſtroying it, at pleaſure.

But, if this magnetic power be material, the the magnet itſelf is alſo material: why therefore cannot we ſee, feel, and be ſenſible of the pre-

ſence of this magnetic matter, as well as of the magnet itſelf?

We can ſee and feel ice, but are not ſenſible of its preſence when thrown into the ſtate of vapour, though by the change of ſtate, its particles have not loſt their materiality. In the former caſe, when in the ſtate of ice, the particles were cloſely and firmly attracted together, in every direction, ſo as to form a ſolid body, capable of of making conſiderable reſiſtance to other bodies, preſſed againſt it, and conſequently, of making impreſſions upon the ſenſes, capable of being perceived; but, in the ſtate of vapour, thoſe particles are ſo diſtant, and ſo little attractive to each other, that they have no combined force of action upon our ſenſes, and are, ſingly, too ſmall to make any impreſſion, capable of being perceived.

The magnet, therefore, may be ſeen and felt, as being formed of a great number of ſolid particles, crowded, or forced together, in every direction, ſo as to form a ſolid, capable of making ſenſible impreſſions upon the organs of ſenſe;

while the particles of magnetic matter, may be ſimply connected by contact, in one direction only, ſo as to form lines of magnetic particles, extending from the magnet, as a centre; theſe lines not being in contact with each other, have no power of making reſiſtance, or impreſſions upon the organs of ſenſe, more than what reſides in each ſingle particle, or line of particles; which ſimple force, is too ſmall to be ſenſible to us.

A magnet, therefore, is an aggregation of particles of matter, ſo numerous and cloſely connected, in every direction, as to form a ſolid body, evident to the ſenſes: it attracts iron, at a certain diſtance from itſelf, by means of a number of particles of matter, ſimply in contact, ſo as to form lines of particles, which lines are unconnected with each other, but extended from the magnet as the centre, to the circumference, or to a certain diſtance, ſo as to form an atmoſphere around it: this magnetic atmoſphere of ſolid particles, we know exiſts, becauſe we can communicate, or deſtroy it; and, therefore, by the activity of this material, magnetic atmoſphere,

we know that the repulſions and attractions, called magnetic, are effected.

Conſequently, in this caſe, we know that the two diſtant bodies, do not *attract* each other by any immaterial ſpheres, but by a medium of *particles* of *matter*, in an *atmoſpheric* ſtate; therefore, we are under no neceſſity of ſuppoſing, that any two diſtant particles attract, or repel each other, by immaterial powers; but, reaſoning from analogy, and avoiding the multiplication of cauſes to produce effects, we muſt, and can rationally, only conclude, that *every* appearance of attraction, or of repulſion, taking place between diſtant bodies, is effected by a ſimilar intermedium of *material particles*, in the ſtate of an *inviſible atmoſphere* around *one* or *both* of the bodies, which, though diſtant, produce effects upon each other.

This concluſion is that of common ſenſe; we ſee particles attract others at a diſtance, and conceive, readily, that the attraction is effected, by means of the particles arranged around the attracting body, and extending to the body attracted,

nay we know that ſuch is in reality the caſe, in magnetical and electrical experiments, and is as eaſily and naturally conceived in every other caſe of attraction; but, that matter ſhould act where it is not,–that a body ſhould attract another, diſtant from itſelf, without any material intermedium, but by an immaterial ſphere of attractive power, is ſo inconceivable, and unneceſſary, that, after juſtly conſidering the ſubject, no man, who is capable of reaſoning, and dare think for himſelf, can heſitate, to give up an opinion founded on conjecture and incomprehenſibility, for an explanation founded on fact, and readily preſenting itſelf to the mind.

The advocates for immaterial powers, and repulſive ſpheres, will be ready to object to me, it is a preſumptive proof that reſiſtance is owing to repulſive powers, acting at a diſtance from bodies, that if a number of flat pieces of metal be placed upon each other, and an electric ſhock be tranſmitted through, or along them, the electric fluid will be viſible, as it paſſes from one piece to the other; which proves that they are not in con-

tact; for if they were, it would not be visible. This experiment indeed proves that the metal plates are not in contact; but it does not prove that there is no intermedium of what I call actuated, or atmospheric particles, upon which that seeming repulsion may depend: on the contrary, I maintain, that that very repulsion is effected, merely by the atmospheres of actuated matter, naturally surrounding every particle of matter of the other kind, and, consequently, every body, formed of what I call fixed particles of matter; the extent of these atmospheres being various, depending upon certain circumstances, which, at present, need not be considered: and it is most rational to conclude, that, if the north poles of two magnetic needles, are prevented from coming into actual contact, by means of the magnetic atmosphere surrounding each, resisting the other, so my hand is prevented from actually touching the paper upon which I write, by means of the atmosphere of active particles, surrounding the fixed particles of which my hand is composed, pressing upon the atmosphere surrounding the particles composing the

ſurface of the table; which actuated atmoſpheres, in fact, are the efficient cauſes which unite the fixed particles of matter, of which the table, or, my hand is formed, into a ſolid, compact body.

It is evident therefore, that there is no neceſſity to ſuppoſe the exiſtence of immaterial ſpheres of attraction, or repulſion; and, as we can form no idea of immateriality, we have no right to aſſume it in reaſoning, eſpecially, as we can do better without it: for reaſoning upon inconceivable principles, is reaſoning upon we do not know what; and muſt, therefore, inevitably lead us into all the abſurdities of myſticiſm, and wild conjecture.

There is another great ſource of error and confuſion in philoſophy, ariſing from pretending to explain certain effects, by means of certain terms, of which we have certain ideas; but without our being capable of forming any idea, of the mode in which they muſt exiſt, ſo as to be able to produce the effects in queſtion.—In fact, 'tis too common with philoſophers to make

uſe of a jargon of words, without any ſettled ideas belonging to them. For inſtance, ſome philoſophers ſay, that pure air is formed of oxygen with caloric or fire: others that it is a farrago of I don't know what, with an atmoſphere of concentrated fire; and that other kinds of airs, or gaſes, are formed of certain kinds of matter, with atmoſpheres of fire or caloric.

Now, what idea can we form of the ſtate of this fire, when it ſurrounds a particle of matter, ſo as to render it aeriform?—If I heat a ball of metal, or ſome grains of ſand, I know they become ſurrounded by atmoſpheres of fire, becauſe they feel hot to the fingers, and expand the mercury in the thermometer. The nitrous acid may be made ſenſibly hot to the touch, and not alter its ſtate; and yet, without any evident heat, it may change to the ſtate of pure air, without feeling hot; nay, even though it feels cold: and the reaſon given for its aeriform ſtate, is, that its particles are kept aſunder, by the interpoſition of fire!—but have we a right to make ſuch an aſſertion?

Can we form any idea of the manner in which fire can form a permanent atmoſphere, around a ſolid particle of matter, of conſiderable extent, without having its conſtant effect of producing heat, or of exciting that ſenſation, which at all times accompanies it, when we know it exiſts, in a quantity, much leſs, than it is ſaid to be in, when forming the atmoſpheres of aeriform fluids, or rendering ſolid particles aeriform?—and by adding the term concentrated to it, is not the difficulty ſtill increaſed?

Fire when ſurrounding any body, in a certain quantity, gives the ſenſation of heat; for inſtance, a ſtone heated.

The atmoſpheres ſurrounding particles of matter, and rendering them aeriform, for inſtance, pure, cold, froſty air, gives no ſenſation of heat, but the contrary.

Particles of acid may have fire enough ſurrounding them to appear hot, without being aeriform.

Particles of the acid principle may have elaſtic atmoſpheres, rendering them aeriform, without being ſenſibly hot. The elaſtic atmoſpheres of gaſes are permanent, and not deſtructible by cold; but fire, itſelf, in no one caſe that we know of, ever forms a permanent atmoſphere, but readily paſſes from the body heated, to any colder body near it. Therefore, fire, and the atmoſpheres rendering bodies aeriform, have no properties alike; they are, conſequently, different things; for, it is unwarrantable, it is contrary to reaſon, to experience and to ſound philoſophy, to aſſert, that two things, having no properties alike, can be the ſame thing.

If a particle of matter, then, is not rendered aeriform by means of fire, what, more rational, or conceivable idea, are we to form?

Air is compreſſible and elaſtic, therefore not a ſolid whoſe particles touch in every direction.

It is poſſeſſed of weight and the power of reſiſ-

tance, therefore it is compoſed of ſolid matter; conſequently,

Air is compoſed of particles of matter, arranged in a certain manner, ſo as not to be in contact in all directions. But,

There is no proof of matter acting, per ſe, where it is not; neither is it poſſible to conceive, how it can act, at a diſtance from itſelf: therefore, air is compoſed of ſolid particles of matter, arranged, ſingly in contact, in a rectilinear manner, around other particles, as centres, ſo as to form elaſtic atmoſpheres.

I have ſhewn, that a magnet is ſurrounded by an atmoſphere of magnetic particles, inviſible on account of their linear arrangement; that magnetic atmoſphere hath no properties in common with fire, and, very juſtly, was never ſuppoſed to be fire: is it not eaſy, is it not natural, then, to ſuppoſe, that other particles of matter, as well as iron may have atmoſpheres of ſome kind or other, ſimilar in their mode of atmoſpheric arrangement,

with thoſe forming the magnetic atmoſphere ?—may not a ſingle particle have its complete atmoſphere of this ſomething, which is not fire ?—and may not its elaſticity, levity, and inviſibility, depend upon thoſe atmoſpheric particles ? Certainly, if the north poles of two needles, have each an atmoſphere of ſomething, different from fire, which prevents their approaching each other, nearer than contact, 'tis allowable, 'tis natural to ſuppoſe that two ſimple particles of matter, may each have an atmoſphere, of ſomething different from fire ; which, will prevent their coaleſcence ; and, if forced, nearer, than where thoſe atmoſpheres come in contact, ſo ſoon as that force is taken away, the atmoſpheres will recover their due arrangement, and recede to their proper diſtance, giving the ideas of repulſion, and elaſticity, in the ſame manner as the two north poles of two magnetic needles do.

The aſſertion, therefore, that gaſes owe their their elaſtic, expanded ſtate to the preſence of fire, forming atmoſpheres around their baſes, is unphiloſophical, unnatural, and unneceſſary ; and

all that appearances allow us to conclude, in this caſe, is, that the *ſolid baſes* of air, are ſurrounded by *atmoſpheres* of particles, in a *rectilinear* arrangement, which keep them aſunder; and, that thoſe atmoſpheres, having no properties reſembling fire, are *not fire*, but *ſomething elſe*, capable of taking that atmoſpheric ſtate of arrangement, around thoſe particles of matter, of which the baſis of air is formed.

There is ſtill another fundamental error, the corner ſtone of modern philoſophy, from whence, in a great meaſure, ariſes thoſe inconſiſtences, and uncertainties, ſo repugnant to common ſenſe, and ſo obſtructive to the progreſs of true knowledge; which, can never be hoped for, till we have true principles, upon which to eſtabliſh it. The falſe reaſoning I allude to, is, attributing different and irreconcilable effects to the ſame cauſe, in ſimilar circumſtances.

As an example, I bring the preſent, univerſally adopted theory, that *all gaſes* owe their aeriform ſtate to the fire ſurrounding, or ſome how, or

other, connected with the baſes of the different gaſes.

Modern theory ſays, that vitriolic acid air is formed of the acid particles and caloric; that is, the particles of acid are ſurrounded by fire, which forms itſelf into elaſtic atmoſpheres around them; in conſequence of which, any two particles of acid cannot come into contact, on account of the atmoſphere of fire, ſurrounding each; therefore, two atmoſpheres of fire repel, or refuſe to come nearer than the point of contact with each other.

In the ſame manner it explains the production of alkaline air from volatile alkali; the alkaline particles become ſurrounded by atmoſpheres of fire, which atmoſpheres, reſiſting each other, prevent the particles of alkali from coming into contact; and, conſequently, keep them aſunder, in the ſtate of an elaſtic fluid.

Atmoſpheres of fire, then, when they ſurround particles of acid, or of alkali, according to the modern doctrine of aeriform fluids, have no at-

traction to each other; and prevent the acid, or alkaline particles they ſurround, from touching, or acting upon each other, when ſimilar.

But, if we mix a quantity of acid air with alkaline air, the two amoſpheres rapidly unite; the acid and alkaline particles are drawn into contact, and, by combination, form a neutral ſalt, which is precipitated; and the bulk of the two airs, depending upon their elaſtic atmoſpheres, diſappears.

This experiment, therefore, contradicts the former concluſion; for, if the atmoſphere of fire ſurrounding one particle, be repulſive to a ſimilar atmoſphere inveſting another, and keeps them aſunder in one caſe, it ought to do ſo in all; for as the atmoſpheres, by their reſiſtance to each other, prevent their reſpective central particles from coming into contact, it cannot affect that repulſive property, whether the central particles be both acid, both alkaline, or one acid and the other alkaline: but, this experiment fully declares, that the atmoſphere ſurrounding a particle

of acid, attracts and combines with an atmoſphere ſurrounding an alkaline particle; and they diſappear together. Conſequently, it proves, that the doctrine of fire being the cauſe of the elaſticity of all gaſes, is falſe; becauſe it makes two ſimilar atmoſpheres of fire, to be repulſive in ſome caſes, and attractive in others, which is attributing contrary effects to the ſame cauſe, in ſimilar Circumſtances; which is unphiloſophical, inadmiſſible, and repugnant to reaſon; and would not have been thought of, but to ſupport a lame theory.

And where is the neceſſity for having recourſe to ſuch inconſiſtency?—A magnet gives us the idea of matter and ſolidity, its magnetic atmoſphere ſhews us that there are particles of matter, *different* from *fire*, which are capable of ſurrounding ſolid bodies, in an *atmoſpheric* form; and, as before obſerved, we are ſupported by reaſon and analogy, when we ſuppoſe that a particle of air, is a particle of matter, with an atmoſphere of ſome ſuch kind as that, ſurrounding the magnet—an *elaſtic atmoſphere*, *different* in its nature and properties from *fire*. And will not the ana-

logy help us ſtill further?—will it not aſſiſt the mind to comprehend and explain the difficulties in queſtion?—The north pole of every magnet attracts iron, it hath therefore an atmoſphere of magnetic matter: ſo, for the ſame reaſon, hath the ſouth pole of every magnet.

Particles of vitriolic acid, when rendered aeriform, are much more diſtant than when in their acid ſtate, therefore, they muſt have atmoſpheres, of ſome kind, ſurrounding them, which prevents their coaleſcence: for the ſame reaſon, particles of volatile alkali, when they become aeriform, muſt have elaſtic atmoſpheres of ſome kind, or other, around them.

The north poles of two magnets will not come into contact, on account of the reſiſtance made by the atmoſpheres ſurrounding them, preſſing againſt each other: neither will two ſouth poles, for the ſame cauſe.

Two particles of vitriolic acid in the ſtate of air, cannot come into contact, by reaſon of the

elaſtic atmoſphere ſurrounding each particle; neither will two particles of alkali, in an aeriform ſtate, naturally, approach each other, nearer, than where their reſpective atmoſpheres begin to touch each other.

The north pole of one magnet will ſtrongly attract, and be rapidly drawn into contact, by the ſouth pole of another, ſo ſoon as their reſpective atmoſpheres of magnetic fluid come into contact, in which ſtate they will remain forcibly held together; which fully proves, that the magnetic atmoſphere ſurrounding the north pole of *one* magnet, is *powerfully attractive* to the atmoſphere ſurrounding the ſouth pole of *another*.

Particles of alkaline air will rapidly combine with particles of vitriolic acid air, by which means, the acid and alkaline centres are drawn into contact, combine, and form a neutral ſalt; which proves, that the *atmoſphere* ſurrounding a particle of *acid*, ſo as to render it aeriform, is *attractive* to the *atmoſphere* enveloping a particle of *alkali*.

It is evident then, that the aeriform ſtate of bodies, ſtrongly reſembles the magnetic ſtate of iron; but, the magnetic fluid was *never* ſuppoſed to be *fire*, but an *active fluid*, of ſome kind, very *different* from it: conſequently, we have *no reaſon* to ſay, that the aeriform ſtate of bodies depends upon fire; ſince the atmoſpheres, ſurrounding bodies, upon which their aeriform ſtate depends, are *ſo different*, in their mode of exiſtence and properties, from *fire*; and, the analogy of magnetic fluids, ſo ſtrongly authorizes our ſuppoſing and aſſerting, that active particles, capable of forming elaſtic atmoſpheres around bodies, *do exiſt*, which are very different from fire.

Since, then, we are not under the neceſſity of ſuppoſing, that every elaſtic atmoſphere is fire; ſince we know that there are particles of matter, diſtinct from fire, which have the property of arranging themſelves around certain particles, or bodies of matter, in an atmoſpheric ſtate, we are perfectly at liberty to ſuppoſe, that if there is *one* kind of *active particles* of matter, which have that property, there may be *two*; and the ſuppoſition

is not only admiſſible, but probable; nay, even demonſtrable.

The north poles of two magnets will attract iron, at a certain diſtance; ſo will the ſouth poles of two magnets: therefore, each is certainly ſurrounded by an atmoſphere of magnetic particles, of a certain extent.

The north pole of one magnet repels the north pole of another; therefore, two *ſimilar* magnetic atmoſpheres, will not combine, but *reſiſt* or *repel* each other.

The *north* pole of *one* magnet, will *attract* the *ſouth* pole of *another*; therefore, the atmoſphere ſurrounding the north pole, is *different* from that around the ſouth pole: otherwiſe it would repel it, in the ſame manner as it did the north pole: but it does not repel it; therefore, as contrary effects cannot ariſe from the ſame cauſe, cæteris paribus, the atmoſphere ſurrounding the north pole of a magnet, is an active fluid, *different* from

and attractive to the atmoſphere around the ſouth pole; and both are very different from fire.

Reaſon, then, ſhews us, that there muſt be, and are *two active fluids*, capable of forming *atmoſpheres* around certain bodies, as is abundantly evident in magnetic experiments; and to purſue the analogy, our reaſon will point out to us, that thoſe two active fluids, are the cauſes of the aeriform ſtates of bodies: for, *without two* ſuch active fluids, we cannot explain thoſe ſtates; and *with* them their natures are readily conceived, and naturally explained, without a difficulty.

Particles of acid air repel each other, to a certain diſtance; becauſe thoſe acid particles are, each, ſurrounded by an atmoſphere of one and the *ſame kind* of active fluid.

Particles of alkaline air repel each other; becauſe, each hath a *ſimilar* atmoſphere of active fluid.

And, as the north pole of one magnet is attract-

ed by the ſouth pole of another, ſo a particle of acid air is attracted into combination, by a particle of alkaline air, ſo ſoon as their reſpective atmoſpheres touch each other; therefore one is of *one kind* of active fluid, and the other of the *contrary* kind, and ſtrongly attractive to it.

It may be aſked, why ought we to ſuppoſe that the *ſame two* active fluids which produce the phenomena of magnetiſm, form alſo the atmoſpheres of aeriform fluids?

I would anſwer, becauſe we have no right, or reaſon to admit of more cauſes than are neceſſary to explain effects; and becauſe the *reſemblance* between *atmoſpheres* of *every* kind, is *ſo great*, as to lead us, naturally, to ſuppoſe, that *all* are formed of the *ſame principles*.

The north pole of a magnet, the ſouth pole of a magnet; a body electrified by means of glaſs, a body electrified from reſin; a particle of acid air, and a particle of alkaline air have *each* an inviſible, atmoſpheric arrangement of active parti-

cles, around their reſpective ſolid centres; becauſe they can act upon certain bodies, diſtant from themſelves: the north poles of two magnets, the ſouth poles of two magnets; two bodies electrified from glaſs, two bodies electrified by reſin; two particles of acid air, and two particles of alkaline air reſiſt, or repel each other, and will not approach, nearer than where the two atmoſpheres come in contact; if they are made to approach nearer, by force, ſo ſoon as that force is taken away, the active particles, by the force with which they recover their due, rectilinear arrangement, again puſh each other to their former diſtance; and hence their elaſticity.

So far, *all atmoſpheres*, whether magnetic, elaſtic or aeriform, ſtrongly *reſemble* each other, and ſeem to be the *ſame active fluid*, only in *different* circumſtances and ſtates of excitement.

The north pole of one magnet, powerfully attracts the ſouth pole of another; the electric atmoſphere communicated to a body by means of glaſs, ſtrongly attracts an electric atmoſphere

acquired, by another body, from reſin ; and the atmoſphere rendering a particle of acid aeriform, forcibly attracts the atmoſphere around a particle of alkali, when in the ſtate of air.

Can there be a doubt, then, that the active fluid, giving magnetic properties to the north pole of a magnet, is of a *different* kind from that ſurrounding the ſouth pole ?—and is it not equally evident that the electric fluid excited by means of glaſs, is ſpecifically different from, and attractive to that formed by reſin ; and, for the ſame reaſons, is not the aeriform ſtate of an acid particle, cauſed by a *different* atmoſpheric fluid, from that which ſurrounds a particle of alkali in an aeriform ſtate, and which it powerfully attracts ?—In magnetiſm, in electricity, and in aeriform fluids are there not, evidently, *two fluids*, forming thoſe atmoſpheres, *ſimilar* in their modes of arrangement, and in their being attractive to each other ?—and have we not reaſon, then, to conclude, that the *ſame two active* principles, produce *all atmoſpheres*, whether magnetic, electric, or aeriform ? the peculiar properties, wherein they

differ, being produced by the *different ſtates* of the bodies giving them excitement, and the *different degrees* of excitement they acquire. As a further argument for their being the ſame principles, in three different ſtates, will not the electric fluid give magnetic atmoſpheres to iron? and will not electricity render certain bodies aeriform, by giving them the atmoſpheres, upon which their aeriform ſtates depend? in ſhort, the only objection to their being the ſame kinds of active fluids, is, that magnetic, electric and aeriform atmoſpheres have no ſenſible effect upon each other; which objection, merely reſolves itſelf into this, that, of two fluids, naturally attracting each other, one, or both may be ſo circumſtanced, that that natural attraction *cannot* become *evident*; which, in reality, is no objection at all; as experience daily proves: to give one inſtance—vitriolic acid may be converted into air, in which ſtate, its particles are ſurrounded by atmoſpheres of one of the active fluids, as is evident from their diſtance and repulſion to each other.

Volatile alkali may become aeriform, by its

particles being ſurrounded by atmoſpheres of one of the active fluids; the fluid ſurrounding each alkaline particle being of the ſame kind.

If theſe two gaſes be mixed together, the atmoſpheres will mutually attract each other, and drawing their reſpective centres of acid and alkali together, will leave them united in the form of a neutral ſalt; conſequently, the atmoſpheres ſurrounding the acid particles, were of *one* kind, and thoſe around the alkaline particles, of the *other* kind of *active fluid*.

In this experiment, *one* kind of fluid is *attractive* to the other. But, electrify the alkaline air, and its bulk will be increaſed, by the acquiſition of more of the atmoſpheric fluid, which, extending the atmoſphere around each alkaline particle, puſhes them ſtill further aſunder; in this ſtate, by an increaſe of atmoſphere, it acquires new properties, or rather, a different degree of activity. If it be now mixed with vitriolic acid air, they will be found to have *no action* upon each other, though the atmoſpheric fluid ſurrounding

the alkaline particles, is of the *ſame* kind as before ; and, is, conſequently, of the *contrary* kind to that ſurrounding the acid particles, which before attracted it, when leſs expanded in the ſtate of alkaline air : which proves, that the *two* fluids, though naturally attractive to each other, may be ſo circumſtanced, as to have *no ſenſible action* one upon the other ; and, that leads us to conclude, that the *two active* fluids, in *ſimilar* ſtates of *excitement*, are capable of acting upon each other ; but, in *very different ſtates* or *degrees* of *excitement*, that action is *not evident*.

But this ſubject, in this place, I ſhall ſay no more of ; having particularly examined it in my Elementary Principles of Nature, where, having explained my principles, I was more at liberty to fully conſider it.

Having thus pointed out ſome of the errors, of philoſophy, and the cauſes of many other philoſophical inconſiſtencies ; having proved that there is no neceſſity for ſuppoſing immaterial powers, and in fact, that the ſuppoſition is ridiculous in

itſelf, without one idea of their nature, or one proof of their exiſtence ; having proved that matter, alone,is ſufficient to explain the very phenomena, in which immaterial powers were thought neceſſary,—matter, with ſuch properties as we know, to a certainty, it may, and does poſſeſs ;—having, in ſhort, pointed out the true principles of nature, which reaſon teaches when the prejudices from the falſe chimeras of philoſophy are removed, it would be a laborious and unpleaſant taſk, to examine all the faſhionable follies of philoſophy ; there, however, are a few glaring inconſiſtencies, in one modern theory, which I muſt mention, and thoſe ſo groſs as to make me wonder, how any ſenſible man could advance a theory ſo full of them ; or how any others, who poſſeſs any degree of diſcernment, ſhould ſo readily overlook thoſe inconſiſtencies, for the ſake of adopting the theory. I have ſo great an opinion of Mr. Lavoiſier's good ſenſe, as to firmly believe that he knows, and feels with dread, the defects of his own theory, ariſing from its inconſiſtency ; an inconſiſtency, which his theory cannot be made to obviate, and which therefore, proves its im-

perfection and fallacy. But ſince others have been blind enough, or kind enough to overlook it, he hath never troubled the world with his own apprehenſions.

Mr. Lavoiſier ſays that mercury is a ſimple ſubſtance; that pure air, or oxygen gas is compoſed of oxygen and caloric or the matter of heat, or fire: he allows that, by means of heat, mercury will attract the oxygen from caloric; and he allows, likewiſe, that by means of heat, caloric will attract oxygen from its combination with mercury; which is attributing contrary effects to the ſame cauſe, without aſſigning any cauſe for thoſe different effects; or without having it in his power to aſſign any, conſiſtent with his theory; which is, therefore, inconſiſtent with itſelf, and conſequently imperfect: for, were mercury a ſimple ſubſtance, and oxygen gas compoſed of oxygen and caloric, it is impoſſible that ſuch different reſults could ariſe, by their being expoſed to any quantity of caloric whatever.

He likewiſe ſays that azotic gas is formed of azote rendered aeriform by caloric ; and that oxygen gas is formed of oxygen and caloric : when theſe are mixed together and expoſed to the action of the electric ſpark or fluid, the oxygen combines with the azote, and forms nitrous acid ; in which ſtate, being no longer aeriform, they muſt have parted, at leaſt with a great part of their caloric : conſequently, by electrization the oxygen attracts azote ſo powerfully as to not only part with its own caloric, but alſo to diſlodge it from its union with azote.

He likewiſe allows that when this compound of oxygen with azote, this nitrous acid is electrified, the oxygen will acquire caloric and form oxygen gas : conſequently by electrization oxygen acquires ſo ſtrong an attraction to caloric that it will part with azote to combine with it, and form oxygen gas. This evident concluſion, ſo palpably contradicts the former, that either the experiments muſt be falſe, or the theory which pretends to explain them : but, we know that the experi-

ments are fair and concluſive ; conſequently, the theory is lame, and by no means equal to their explanation.

Theſe two experiments ſeemingly ſo contradictory to each other, are not ſo in reality, and may be moſt eaſily explained ; the inconſiſtency ariſing from Mr. Lavoiſier's principles, and not from the facts themſelves : but, were I to offer an explanation of them in this place, it would be premature, and could not be ſo well underſtood as when I come to ſpeak of thoſe gaſes, after explaining my ideas of the nature and compoſition of aeriform fluids in general, and of thoſe gaſes in particular.

Theſe, though not all the objections I have againſt theories of philoſophy, ancient or modern, are the chief of thoſe more immediately connected with my preſent ſubject. I ſhall therefore ſuſpend the enquiry into what or how others think, and purſue the ſteps which appear moſt proper to explain my own ideas and theory of the principles

of chemiſtry and the nature and formation of aeriform fluids; and thoſe who think differently are perfectly at liberty to give their reaſons for thinking otherwiſe, or not, juſt as they pleaſe.

SECTION II.

A ſummary View of the Elementary Principles of Bodies.

FROM what hath been advanced in the preceding ſection, it appears perfectly conſiſtent with reaſon and our knowledge of nature, to ſay, that every thing is material; and, conſequently, nothing can act, per ſe, at a diſtance from itſelf; therefore, all the operations of nature are effected by *particles* of *matter* in *contact* with each other.

Particles of matter ſeem to differ widely amongſt themſelves; ſome being obvious to our ſenſes, forming bodies more or leſs ſolid and compact, and poſſeſſing, evidently, a ſpecific gravity. Theſe give us our ideas of fixed ſolid matter, and theſe particles, forming the baſis, bulk and ſoli-

dity of every body, evident to our ſenſes, and poſſeſſed of ſpecific gravity, I for the ſake of diſtinction call *fixed particles* of matter. A needle, formed of iron, or ſteel, by its compactneſs, weight and evidence to our ſenſes, is an inſtance of a body compoſed of theſe *fixed* particles of matter.

The other kind of matter we are never ſenſible of but when it is peculiarly excited by being, or having been in contact, with thoſe fixed particles of matter; and then its general ſtate is that of a ſubtile fluid, poſſeſſing no ſenſible degree of ſpecific gravity, howſoever accumulated. In thoſe caſes, when evident, by its producing the phenomena of attraction or repulſion, it is ſurrounding the fixed particles of matter, or bodies compoſed of them, in an *atmoſpheric* ſtate, light, ſubtile, yielding, elaſtic and permeable; yet poſſeſſed of the power of evidently reſiſting the approach of a ſimilar atmoſphere; conſequently, its particles muſt be in a rectilinear ſtate of arrangement, extending from the ſolid particle, which it ſurrounds as a centre, like radii, in all directions, naturally; which lines of particles, not being contiguous,

but diverging as they recede from the centre, accounts for their ſubtilty and permeability.

An inſtance of this kind of matter, where particles are thus arranged, is the ſubtile magnetic atmoſphere, ſurrounding the pole of a needle compoſed of fixed particles of matter; and that the particles of this kind of matter, may be diſtinguiſhed from the particles of fixed matter, I call them *active* or *actuated* particles of matter.

As theſe active particles of matter, when evident to us by their attractive, or repulſive operations, are always in ſome ſtate of combination, or connexion with fixed matter, when they are always arranged in an atmoſpheric ſtate around it, it is reaſonable to ſuppoſe that the fixed particles of matter, by coming in contact with theſe active particles, excite them to arrange themſelves around it, in the ſame manner as when a number of ſteel filings are touched by a magnet, they being immediately excited to attract each other, and arrange themſelves in a radial manner; the

magnet being the exciting cauſe, and the centre of that arrangement.

The exiſtence of theſe *active* particles being inconteſtible, it is equally evident that they are of *two* kinds; ſimilar in their being excited by contact with fixed matter, to form themſelves into atmoſpheres around it, but, yet, being *ſpecifically different*; as is evident from the magnetic atmoſpheres ſurrounding the poles of a needle; each pole hath its magnetic atmoſphere; each atmoſphere is attractive to iron; the atmoſphere ſurrounding the north pole of one magnet, will *attract* that ſurrounding the ſouth pole of another; but the atmoſphere arranged round the north pole of one magnet, ſtrongly *reſiſts* the approach of a *ſimilar* atmoſphere, ſurrounding the north pole of another; and the ſame repulſion exiſts between the atmoſpheres ſurrounding the ſouth poles of two magnets: conſequently, the atmoſphere accompanying the north pole of a needle, is ſpecifically different from that ſurrounding the ſouth pole; becauſe ſo ſoon as they come in contact they *attract* each other, and draw their reſpective

poles together; but two *ſimilar* atmoſpheres have no attraction, but *reſiſt* or *repel* each other.

Theſe *active* particles, therefore, being of two kinds, I call one of them *phlogiſton*, and the other *æther*, for the ſake of diſtinction and perſpicuity.

Beſides this atmoſpheric ſtate of exiſtence, in which they draw the diſtant particles of fixed matter around which they are arranged, together, when one active principle ſurrounds one fixed particle, or maſs, and the other active principle the other fixed particle, diſtant from it; or in which they prevent two diſtant particles of fixed matter from coming together, when each fixed particle hath an atmoſphere of the ſame kind of active particles; theſe two active fluids, *æther* and *phlogiſton*, are capable of being *excited* by fixed matter, and then of *combining* with each other, ſo as to form a *ſubtile compound*, capable of *exiſting* in a ſtate of *ſeparation* from the fixed particles of matter, by which they were actuated. In this ſtate, according to the degree of excitement they

poſſeſſed at the moment of combination and liberation, they form fluids, poſſeſſed of different ſpecific properties, which, however, are extremely ſubtile, active and without any ſpecific gravity, ſuch are light and fire: one, or other, or both of which being always produced, whenever æther and phlogiſton, by attracting each other and drawing their reſpective fixed centres together, are left at liberty to ſeparate from their reſpective fixed centres, by thoſe centres attracting each other, and loſing their power, in conſequence, of detaining the æther or phlogiſton with which they were combined: as for inſtance, when æther and phlogiſton are excited by means of reſin and glaſs, to form themſelves into electric atmoſpheres around them, reſpectively, they attract, if within the reach of each other, and ſo ſoon as their reſpective fixed centres, the reſin and glaſs, approach near each other, the electric atmoſpheres of æther and phlogiſton, unite and paſs away in the ſtate of light, or fire.

The entire univerſe, therefore, is formed of particles of *matter*, in themſelves exactly ſimilar

throughout, being ſolid, or impenetrable points, monads, or atoms; and all the different forms, changes and varieties of nature, are produced, by the *different properties* given to theſe ſimple material particles.

Thoſe *properties* are of *two* general kinds. One portion of theſe original material particles, have, ſimply, the property of *attracting* the *other* particles of matter, in *all* points and directions, and *theſe* I diſtinguiſh by the name of *fixed particles* of *matter*. The *other* particles of matter, have the property of being *excited* by *contact* with the fixed particles of matter, to *attract* other particles *ſimilar* to themſelves, in *one direction only*, ſo as to form themſelves into *right lines*, compoſed of particles, *ſingly arranged*, in *contact*: conſequently, as the fixed particles attract theſe in *all* points and directions, theſe will *arrange* themſelves around the fixed matter, as their *centre*, and form an *atmoſphere* of radii, ſpherically ſurrounding the fixed centre; which radial lines of particles, diverge as they recede from the centre. Theſe I have called *active* particles of matter.

Theſe active particles are of *two* kinds ; when *either* kind is *excited* by contact with fixed matter, it *attracts* particles of the *ſame* kind into *atmoſpheric arrangement* ; and *two* atmoſpheres of the *ſame* kind, ſurrounding two fixed centres, have *no* attraction for each other, but *reſiſt* every attempt to bring them into the ſame place : but if an atmoſphere of *one* kind be brought in contact with an atmoſphere of the *other* kind, they will *attract* each other, ſo as to draw their reſpective fixed centres into contact. To one kind of theſe active particles I give the name of *æther, and the* other I diſtinguiſh by that of *phlogiſton.*

The fixed particles are drawn together by theſe active particles, ſo as to form bodies more or leſs ſolid and bulky, according to the proportion of each, which enters into their compoſition : while the active particles themſelves, by contact with thoſe fixed particles, arrange themſelves in an atmoſpheric, rectilinear form around them ; in which ſtate they produce all the appearances of attraction, and repulſion, and all the various mu-

tations and operations of nature, which preſent themſelves to the philoſophic mind; or, by combining together, in the ſtates of light and fire, they give beauty, life and activity to the whole.

With theſe data I ſhall therefore proceeed, and upon them ſhall found my future inveſtigations.

SECTION III.

Particles of fixed matter, by being combined with one or other of the active kinds of matter, form fixed principles, of great activity, the alkaline and the acid principles.

THE univerſality of the two active kinds of matter, which may, with great propriety, be called the two active principles, æther and phlogiſton, and their powerful attraction to the fixed particles of matter, can leave no room to doubt that *every fixed* particle is combined with, and actuated by *one* or *other* of thoſe *active* principles; for, in their original ſtate, they muſt have been expoſed to one or other of them, and, in conſequence of that expoſure, they would be immediately attracted, and form a combination, never more to be diſunited: nothing being more pow-

erfully attractive to either the fixed or active particles, than, in that original ſtate, they were to each other: conſequently, whatever kind of active matter any fixed particle was originally expoſed to, with that kind it is, and muſt be, forever united, to a certain extent: and that *indiſſoluble combination* forms a *fixed principle*, partaking of the fixity of the fixed particle, and of the the activity of the active matter with which it is formed, and poſſeſſing *peculiar properties*, depending upon the *kind* of *active matter* with which the fixed particles are combined.

Though all fixed particles, therefore, are ſimilar, yet thoſe which are actuated by *æther*, acquire properties *different* from thoſe combined with *phlogiſton*; and as all of them muſt be united to either phlogiſton or æther, the whole of the fixed particles muſt form *two compound*, or *fixed principles*: thoſe combined with *æther* forming *one*, and thoſe with *phlogiſton* the *other fixed principle*.

But, as æther and phlogiſton have different *ſpecific* properties, 'tis evident, that the fixed

particles, actuated by *one*, muſt poſſeſs *ſpecific* properties *different* from thoſe combined with the *other*: and theſe two compound, or fixed principles, are the earthy or *alkaline* and the *acid principles* of chemiſts; each poſſeſſing its peculiar properties, according to the nature of the active principle which enters into its compoſition; and each having a ſtrong attraction to the other, on account of the *natural attraction* which ſubſiſts between æther and phlogiſton, in ſimilar ſtates of excitement.

In my Elementary Principles of Nature, I have entered more fully into the conſideration of this ſubject, than is neceſſary in my preſent undertaking; and have offered my reaſons for ſuppoſing that the *alkaline principle*, is compoſed of a particle of *fixed matter*, actuated by an atmoſphere of *æther*, to a certain extent; and that the *acid principle* is formed of *fixed matter* united to *phlogiſton*. If this ſuppoſition be admitted, that natural attraction between æther and phlogiſton, will readily account for the attraction of the *alkaline* principle to phlogiſton; becauſe its activity and

powers, as a principle, depend upon the æther combined with its fixed particle to a certain extent; and, likewiſe, for the attraction of the *acid* principle to *æther*, on account of its ſpecific properties, depending, upon its fixed particle, being actuated, ſo as to become a fixed principle, by its combination with *phlogiſton*.

And that the ſuppoſition is true, appears from many conſiderations; to inſtance one, the baſis of a metal is evidently an earth; and the firmneſs, ſolidity, or attractive force, by which its particles are compacted together, evidently depends upon phlogiſton; for, deprive it of that, and it loſes its compactneſs and metallic properties, and becomes a looſe incoherent maſs. Now, if its compactneſs is loſt, by taking away its phlogiſton, it is juſt to ſuppoſe, that that phlogiſton was the attractive power which kept its component particles of earth together; and, conſequently, that the active principle, upon which the active powers of the earthy principle depends, is attracted by the interpoſing phlogiſton, and therefore is *ætherial*: for, if the properties of the earthy principle, as a principle

depended upon phlogiſton, it is natural to ſuppoſe that the particles of metallic earth, would be more powerfully attracted to aggregation, in proportion as their atmoſpheres of phlogiſton were *diminiſhed*; becauſe the more expanded thoſe atmoſpheres are, the more powerfully they muſt reſiſt approximation; and the more they are diminiſhed, the greater muſt be their excitement, and power of aggregative attraction.

But I forbear to enter further into the ſubject here, becauſe it is not my immediate object: it being ſufficient for my preſent purpoſe, to obſerve, that the *earthy* or *alkaline principle* is *attractive* to, and capable of *combining* with *phlogiſton*; and, that the *acid principle* is as powerfully *attractive* to *æther*; that in their *ſimple* ſtates, they *attract*, *combine* with and *neutralize* each other; and, that, when the alkaline principle is united to phlogiſton, and the acid principle to æther, in proper circumſtances, the æther and phlogiſton will unite together, and ſeparate from their reſpective baſes, which, by thoſe means are brought together and combine with each other.

But as *each* of theſe *fixed principles* is capable of attracting an atmoſphere, either of phlogiſton or of æther, according to its nature, it muſt naturally follow, as theſe fixed principles are the *actuating centres*, which excite their reſpective active fluids to become atmoſpheres around them, that the atmoſpheric particles *neareſt* the centre, muſt be *moſt excited:* as for example, the pole of a needle in a magnetic ſtate, is ſurrounded by æther, or phlogiſton in an atmoſpheric ſtate; that pole gives excitement to thoſe active particles, in conſequence of which they attract each other in right lines, diverging from each other as they recede from the exciting centre; and their excitement, or attractive force *diminiſhes*, as *that diſtance* from the centre *increaſes*: ſo it muſt be with phlogiſton and æther alſo, when excited to form atmoſpheres around the alkaline or acid principles, by being attracted by them; and, as the attractive power of the magnetic atmoſphere, when very conſidebly diſtant from its exciting pole, is ſcarcely perceptible, ſo, alſo, the peculiar properties and degree of activity of phlogiſton, or æther, when

widely diſtant from their reſpective centres of the fixed principles, are ſcarcely evident.

The *diſtinguiſhing property* of *phlogiſton*, when it is excited to form an *atmoſphere* around particles of the earthy principle, is *alkalinity*; conſequently, when that phlogiſtic atmoſphere is of *ſmall* extent, its activity is *great*, and its *alkaline* property is *very evident*; as for inſtance in volatile alkali; but, if that atmoſphere becomes *more* extenſive, by the acquiſition of more phlogiſton, its alkaline property, or its activity muſt be *leſs*, as when volatile alkali is changed into alkaline air; and, if the quantity of phlogiſtic atmoſphere be ſtill *increaſed*, its alkalinity will *wholly diſappear*; as is evident when that alkaline air is converted into inflammable air.

That peculiar kind of activity which is communicated to æther, when excited by being attracted to ſurround the acid principle, we call *acidity*: the *leſs* the quantity of æther, thus excited around the acid principle, the *greater* its activity, or, in other words, the *more* evident its acidity; as for

inſtance, when in the ſtate of nitrous acid: but, if thoſe ætherial atmoſpheres be *more* extended, by the further addition of æther, their activity, or acidity will be *leſs*; or if *widely* extended, their acidity will be *no longer ſenſible*, as is the caſe when nitrous acid is converted into pure air.

Alkalinity, therefore, is no other than the *peculiar* ſtate of *excitement*, which is given to *phlogiſton*, when in an *atmoſpheric* ſtate around particles of the *earthy principle*; and, when *æther* is *excited*, by being attracted by the *acid principle*, its *peculiar*, ſtate of *activity* we call *acidity*: and, if, when in the ſtates of an alkali and an acid, theſe two principles be brought together, the *peculiar* activity of *each* active principle, will *counteract that* of the *other*, and give place to *mutual attraction*, which will terminate in *combination* and *neutrality*.

SECTION IV.

Chemical affinities are the evident attractions taking place between the two active principles, when one, or both are in a ſtate of combination with the fixed principles.

AS fixed particles of matter are never met with unleſs in a ſtate of combination with one, or other of the active principles, and as all the activity, or evident properties of matter are produced by theſe active principles alone, or in combination with the fixed particles of matter, it is evident that *chemical affinities* are no other, than the combinations which take place between theſe *active principles*; which are ſubject to change, as their circumſtances change from an imperfect connexion, to a more favourable opportunity of

combination, according to the reſpective degree of excitement which each active principle is poſſeſſed of: for, if phlogiſton is in a ſtate of great excitement, it will attract æther in a degree of moderate excitement, rather than nothing; but, if another body be added whoſe æther is more excited, that æther is more capable of attracting and ſatisfying that phlogiſton, than the weakly excited æther already combined with it; in conſequence of which it will diſlodge the former, and, taking its place, will more completely ſaturate the phlogiſton of the earthy body.

For example, fixed alkali is accompanied with phlogiſton in a very active ſtate; the acetous acid is combined with æther in a moderate ſtate of excitement, which will, however, combine with the alkali, and, in a conſiderable quantity will neutralize it; but if vitriolic acid be added, whoſe æther is in a greater ſtate of excitement, as is evident from its greater acidity, this æther, will, by its greater activity, diſlodge the acetous acid, and, taking its place, will neutralize the alkali, and form a very cloſe union with it, on account of the

ſimilarly great degree of excitement, of the phlogiſton of the one, and the æther of the other.

But as, on account of the ſtrong attraction between the two fixed, the two active, and the fixed and active principles, few ſubſtances are to be met with which do not contain the four, in ſome proportion or other; and as their decompoſitions and conſequent new combinations, muſt depend upon the ſtate of activity, and proportionate quantity of each principle, forming the ſubſtances mixed together, it would be prepoſterous to attempt, with our contracted powers and imperfect knowledge, to give a full explanation of them; therefore I ſhall diſmiſs the ſubject here, with theſe obſervations, that chemical affinities are no other than one active principle attracting the other; and that decompoſition is effected when one active principle, imperfectly connected, meets with the other active principle in more favourable circumſtances, or in a ſtate of excitement more nearly reſembling its own; the circumſtances of the other principles, not preventing the ſeparation and new combination in conſequence.

It may, perhaps, not be improper, however, to obſerve that though bodies compoſed of ſimilar principles, have no chemical affinity to each other, yet, they can form an imperfect kind of union with each other, in certain circumſtances; for inſtance, two different acids will mix together, on account of the water with which they are combined, to which *each* hath an affinity; and for the ſame reaſon two kinds of alkali will mix with each other in a ſtate of ſolution.

SECTION V.

The degree of ſolidity, or compactneſs of bodies, depends upon the proportion, or ſtate of the active matter combined with their fixed principles.

THE degrees of ſolidity of bodies are numerous, but they may be reduced to three general ſtates, ſolids, liquids and aeriform fluids; to theſe might be added a fourth, that of extremely ſubtile fluids, ſuch are light, fire and the magnetic and electric fluids; but as theſe are only compoſed of the two active principles, without any admixture of fixed matter, they do not properly claſs with the former, or belong to this ſection.

The force by which the particles of ſolid bodies are held together, is called the *attraction* of *cohe-*

ſion ; which, like every other attraction between different particles of matter, is effected by the action of the two active principles, accompanying the fixed particles, upon each other.

The *compactneſs* of bodies, does not altogether depend upon the quantity of fixed matter entering into their compoſition, for wood is more compact than mercury, though it does not contain nearly ſo much fixed matter as mercury does.

Particles of the *earthy* principle have no attraction to æther, but they have to phlogiſton, and to the acid principle ; conſequently, they may be attracted together into a ſolid form by the intervention of particles of the acid principle, or by phlogiſton ; but if the quantity of phlogiſton be conſiderable, they will be leſs forcibly attracted together, ſo as to admit of motion amongſt themſelves from ſlight cauſes, which ſtate we call *fluidity* ; and if the quantity of phlogiſton be very conſiderable, ſo as to form complete atmoſpheres around each earthy particle, they will be in an *aeriform ſtate*.

The acid principle, in like manner, will be either ſolid, fluid, or aeriform, according to the quantity of æther combined with it ; if that quantity be ſmall, it will be ſo powerfully attracted and excited by the contiguous particles of the acid principle, as to firmly connect them together in a ſolid form ; but if greater, its connecting power will be proportionately leſs ; and if very great, it will ſo far prevent their mutual approximation, as to keep them in an aeriform ſtate.

A body entirely compoſed of the earthy principle and phlogiſton, may by that quantity of phlogiſton be rendered fluid, the phlogiſton being in *too great* a proportion, to be *ſufficiently excited* to keep the particles of earth *firmly* together, ſo as to form a ſolid ; as for inſtance mercury : while another body, chiefly compoſed of the earthy principle, with a *ſtill greater* proportion of phlogiſton, may be in a ſolid ſtate ; for example wood : the reaſon is that the *earthy* particles of the wood are *partly* attracted together by ſome particles of the *acid principle*, while the æther, accompanying thoſe acid particles, at the ſame time attracts the

the redundant phlogiſton, by which means the four principles become fixed; the activity of the æther and phlogiſton being exerted upon each other, produce an attraction by which the whole are firmly held together.

Every ſolid body, therefore, owes its compactneſs either to the two fixed principles attracting each other: to the particles of either of the fixed principles, with a ſmall proportion of the active particles to which it hath an affinity, in quantity juſt ſufficient to be ſtrongly excited by, and ſtrongly attract the neighbouring fixed particles between which it is interpoſed, into combination: or to the two fixed and two active principles in certain proportions, ſtrongly, mutually and cloſely attracting each other.

Fixed particles of matter in a ſtate of fluidity, or in the rarer form of air, are always rendered ſo, by being connected with a large proportion of one, or other of the *active fluids*, æther and phlogiſton; or if the fluid, contains both the fixed principles, the two active fluids, being in differ-

ent ſtates of excitement, may conſpire to keep them aſunder, ſo as to give them their fluid form—or they may be rendered fluid by the interpoſition of water, or fire; or even aeriform, if the quantity of fire, ſeparating the active fluids in the compoſition by entering into arrangement with them, be ſufficiently great.

SECTION VI.

The ſpecific gravity of bodies, depends upon the quantity of fixed matter they reſpectively contain.

IN whatſoever manner the fixed particles of matter are connected with, and ſurrounded by the active particles of matter, they ſtill are acceſſible to either of the active principles; becauſe, as thoſe active particles, by contaction with fixed particles of matter, become excited to arrange themſelves in right lines, not contiguous, 'tis evident that in that radial or atmoſpheric ſtate, there muſt be *numberleſs intermediate ſpaces*, through which *other active particles* can paſs, in every direction, without reſiſtance, even ſo far, as the central particle of fixed matter itſelf; and, as the active particles of matter *always* become more

or leſs excited, by coming in contact with fixed matter, 'tis evident, that were either *æther* or *phlogiſton*, in a diſengaged ſtate, to come in contact with any ſubſtance, containing fixed matter, they would become *excited* around that ſubſtance; and on this property the *attraction* of *gravitation* depends.

Phlogiſton and æther are univerſally preſent, and univerſally extended; they penetrate to the centre of the earth, and to the centre of every particle of the fixed principles compoſing it; and not only the earth, they pervade alſo the ſun, and to the very centre of *every ſolid* in the univerſe: by thus pervading all matter, they, from *that matter*, receive an *excitement*, in conſequence of which they become *attractive* to each other; the lines of *ætherial* particles, excited by one body, and extending towards others, *attract* the *phlogiſtic* lines of particles excited by, and extended from thoſe other bodies, and vice verſa.

'Tis evident, therefore, that the larger the maſs of matter, the greater muſt be the number

of lines of active particles, thus excited to ſurſurround it; and, conſequently, the greater its power of attraction, by which leſſer bodies will be drawn to it, if no other power prevents; and *this kind* of *attraction* is called *gravitation.*

The *ſpecific gravity* therefore, of any body, is proportionate to the *quantity* of *fixed particles* of matter it contains; becauſe they alone are capable of giving, or being acted upon by this ſtate of excitement of the active fluids producing the attraction of gravitation.

Particles of fixed matter, being already ſurrounded by theſe active principles in other ſtates of excitement, are not prevented from being ſubject to this attraction of gravitation, no more than a needle is hindered by a magnetic atmoſphere from acquiring an atmoſphere of the electric fluid; for the active fluids, in *this ſtate* producing gravitation, have no action upon *thoſe* ſurrounding active particles of matter in different ſtates of excitement, no more than the electric fluid hath upon the ſame principles in a magnetic ſtate;

they only penetrate the void ſpaces of the atmoſpheres formed by the former, till they come in contact with the fixed centres; by which they become excited, and form lines of particles, extending from one body to another, whoſe only property is that of *drawing* the two bodies together.

The ſpecific gravity, therefore, of any body, cannot be either increaſed or diminiſhed by any quantity of fire, light, æther, or phlogiſton, either added to, or taken from it; becauſe they are active principles, or compoſed of active principles; and in their ſtates of combination with fixed matter, or with each other, their excitement is *ſo different* from that producing the attraction of gravitation, that they have no ſenſible attraction to æther or phlogiſton in that ſtate of ſlight excitement, producing the attraction of gravity, which is given to the diſengaged and univerſally diffuſed æther and phlogiſton by fixed particles of matter alone: conſequently, as they, in that ſtate, have no action upon æther or phlogiſton when in different ſtates of excitement, by

chemical union with fixed matter, the ſpecific gravity of any body cannot be affected by the quantity of æther or phlogiſton united to that body, but by the number of fixed particles of matter alone, which enters into its compoſition; for *they alone* can give to æther and phlogiſton, that ſtate of excitement producing the attraction of gravity, and conſequently, *they only* can be affected by them in that ſtate.

SECTION VII.

On Fire and Light.

BEFORE I enter upon the ſubject of aeriform fluids, it will not be improper to ſay ſomething concerning fire and light; ſince they are ſo intimately connected with the ſubject, and ſo eſſentially neceſſary in the operations, by which aeriform fluids are produced.

I have ſaid that fire is formed when æther and phlogiſton, attracting each other, are left at liberty to ſeparate from their reſpective fixed principles; which happens when thoſe fixed principles, by being brought together by them, ſo perfectly ſatisfy each other, that they have no longer any attraction to their reſpective active principles.

For example, the candle, now burning before me, conſiſts chiefly of phlogiſton united to the alkaline or earthy principle; as all combuſtible bodies do, in ſome proportion or other.

Pure air, which conſiſts of the acid principle rendered aeriform by æther, forms a conſiderable part of the atmoſpheric air in the room. Fire having been applied to the candle, that fire, by its power of entering into arrangement with the phlogiſtic atmoſpheres of the earthy particles of the candle, ſo far extended thoſe phlogiſtic atmoſpheres, as to weaken their affinity with the earthy principle; in conſequence of which, that phlogiſton became capable of acting upon the ætherial atmoſpheres of the pure air, and the acid, central particles of the pure air, were drawn into contact with the earthy particles of the candle, and combined with them to ſaturation; the æther and phlogiſton thus united were ſet at liberty and flew off in the ſtate of fire with light. This fire, by its general attraction to all active matter, partly enters into the remaining part of the candle, promotes the expanſion of its phlogiſton, and

keeps up the combuſtion; while part is attracted by the two fixed principles, from which it was ſeparated, in their new ſtate of combination, and elevates them into vapour. When that vapour meets with other ſubſtances, containing a leſs proportion of fire than itſelf, part of that fire leaves thoſe particles, which, being only expanded into the ſtate of vapour by means of that fire, by its being taken from them, they become condenſed into a fluid ſtate, and form water, if the acid and earthy particles were in ſuch a ſtate, as to perfectly neutralize each other: but, if the earthy principle exceded in quantity, or had not a ſufficient proportion of phlogiſton; or the combuſtion was not ſufficiently violent, to enable the two fixed principles to combine perfectly, then, the imperfect combuſtion, or the exceſs of earthy matter will form a precipitate, or reſiduum under the form of ſoot.

So again when pure air, compoſed of the acid principle and æther, is mixed with a ſufficient quantity of inflammable air, conſiſting of the alkaline principle and phlogiſton, and exploded to-

gether, the ætherial and phlogiſtic atmoſpheres of the two airs, attract each other, draw their reſpective fixed principles into contact, and become at liberty to combine and paſs away in the ſtate of flame; the two fixed principles combining with each other, and forming water; being perfectly neutral, if the two airs were perfect in their qualities and proportions and the combuſtion properly conducted. *Fire*, therefore, is no other than *æther* and *phlogiſton*, when they *combine* forcibly together, and are ſet at liberty, by their reſpective fixed centres ſaturating each other, and therefore no longer *detaining* them in their atmoſpheric ſtate of arrangement.

This fire, then, diffuſes itſelf, into all the bodies, around, by its general attraction to the æther or phlogiſton they naturally contain; it therefore, in a meaſure, incorporates itſelf with thoſe atmoſpheres, increaſes their extent, and, conſequently, weakens their union with their reſpective fixed particles, and renders all bodies, more or leſs, liable to decompoſition, in proportion to the quantity in which it is preſent.

But as the powers, properties and activity of fire, depend upon the *freedom* and *excitement* of its æther and phlogiſton when they combine, when it is attracted by the active atmoſpheres of other bodies into arrangement with them, ſo as to expand them, by that attraction and detention, it loſes a great part of its activity, and can no longer render itſelf evident to us, on account of its fixity ; but ſo ſoon as the circumſtances of that body, thus expanded by the fire taken into arrangement with its component active principles, are altered, ſo that its proper active fluids can again come into contact, and contract themſelves to their proper mode of arrangement, the particles of fire, being puſhed aſide and no longer attracted, recover their former activity, and ſhew their uſual effects as fire, ſenſibly at liberty.

Fire, therefore, being a compound of æther and phlogiſton, and capable of weakening the chemical affinities of bodies by attracting, combining with, and expanding the active principles in their compoſition, it muſt oftimes happen that the

fixed principles of thoſe bodies, when ſeparated by its interpoſition, if they be in ſtates of conſiderable activity, will decompoſe the fire itſelf; each fixed principle attracting that active principle of the fire to which it hath an affinity.

For inſtance, mercury is compoſed of the earthy principle and phlogiſton: pure air of the acid principle and æther.

The phlogiſton of the mercury, is ſo cloſely combined with the earthy principle, that the æther of the pure air in its expanded ſtate, hath no ſenſible action upon it, in the common temperature of the atmoſphere; but, if the mercury be heated, the fire, mixing itſelf with the phlogiſton in its compoſition expands it, till it is leſs powerfully attracted by the earthy principle, when, it becomes attractive to the æther of the pure air. The effect of this attraction, is, to draw the fixed centres of the reſpective active principles into contact; the acid principle of the pure air is, therefore, drawn to the earthy principle of the mercury, when, they attract each other,

combine and form a calx; in which ſtate each fixed principle loſes its attraction, to the active principle formerly attending it; and the æther and phlogiſton, combining, form fire, or light, and, being at liberty, paſs away. But, if this calx of mercury, compoſed of the earthy and acid principles attracting and ſatisfying each other, be put into a cloſe veſſel, and ſtrongly heated, the quantity of fire, inſinuating itſelf between the earthy and acid principles, will deſtroy their union, and prevent them from being in contact, or nearly ſo; in conſequence of which, they can no longer attract and ſatisfy each other; therefore, the attractive power of *each*, will be exerted upon the *active principle* with which it hath an affinity, of which the *fire* itſelf is compoſed: the earth of the mercury will attract *phlogiſton*, and recover its metallic luſtre and properties; and the acid principle will attract the æther, which was combined with that phlogiſton; by which æther its particles will become aeriform, and expand into the ſtate of pure air.

The *earth* of mercury, therefore, if its phlo-

giſton is as it were looſened from it, by the interpoſition of a moderate quantity of fire, and that phlogiſton be attracted by the æther of pure air, will *combine* with the *acid* principle and form a calx; leaving the phlogiſton and æther to paſs away in the ſtate of fire: but, if this calx be expoſed to ſo great a degree of heat, as to entirely ſeparate the acid principle from the earth, each fixed principle, being in a ſtate of great activity, and no longer capable of exiſting in the ſtate of combination with the other, they muſt neceſſarily return to their priſtine ſtate, by decompoſing the fire, which, by its interpoſition diſſolves their union with each other. For this degree of heat does not deſtroy the attraction of the earthy principle to phlogiſton, or of the acid principle to æther, but it entirely prevents the earthy principle from attracting the acid principle, by diſuniting them; therefore, as their attraction to each other is deſtroyed, the attraction of each is neceſſarily exerted upon the active principle with which it hath an affinity.

In all probability this decompoſition of fire, is

effected in ten thouſand operations of nature.—Without the preſence of a certain quantity of fire vegetation is at a ſtand; light itſelf without fire is inſufficient; but vegetation may go on without light; though it ſeems neceſſary to give beauty and perfection to the vegetable creation. Light itſelf is no other than the ſame two principles, æther and phlogiſton, only in a different ſtate, from what they are in when they form fire. We know that light, when it falls upon an opaque body is actually changed into fire, becauſe the quantity of fire, produced by means of light, is always in proportion to the quantity of light thrown upon the opaque body; and that fire, thus produced, is evidently the light itſelf which is converted into fire, becauſe neither the air, nor any alteration in the principles, or compoſition of the opaque body, are neceſſary to its production; as is ſufficiently evident from throwing light, collected into a focus, upon a piece of black marble, for inſtance, in vacuo:—the great quantity of light, thrown upon it, is loſt, as light, and an intenſe heat, or great quantity of fire is formed, without the preſence of air, or any change being

made in the principles of the marble, more than their being expanded by the fire produced.

When the ſun, therefore, becomes more vertical and his rays more direct, at the approach of ſpring, they are alſo more numerous, and the face of nature is more enlightened. This light, falling upon the earth and the vegetable kingdom, by the opacity of the ſoil, of the ſtems and branches of plants, &c. and afterwards of their ſpringing leaves, is changed into fire; which increaſing in quantity with the increaſing light, and commixing itſelf with the *active principles* contained in vegetables, expands them till they no longer attract their *fixed* principles into a torpid *ſolid*, or a *ſluggiſh lentor*. The juices become fluid, and the more ſolid parts acquire an increaſe of activity from the fire combined with them; the fixed principles, thus rendered more diſtant, attract each other together, leſs forcibly; and, conſequently, their powers of attraction, which were exerted upon, and ſatisfied with each other, before, now ſeek for ſomething elſe to act upon; they, therefore, actually ſeize upon whatever is

preſent in a ſtate capable of being decompoſed by them; in conſequence of which action, certain kinds of air, light, and even fire itſelf are liable to be decompoſed by them; and the neceſſary and proper principles are taken into their compoſition, ſo as to ſupport their growth and be converted, by the proceſs of vegetation, into that endleſs variety of forms and qualities, which the vegetable kingdom preſents to our ſenſes.

By means of fire, therefore, vegetables and even minerals may be rendered capable of decompoſing water, light, and even fire itſelf, and of taking certain parts, or principles from them, into their own compoſition.

In ſhort, the whole of what is neceſſary to be ſaid, in this place, on *fire*, is, that whenever an atmoſphere of *æther* united to the acid principle, is in a ſimilar ſtate of excitement with an atmoſphere of *phlogiſton*, ſurrounding its centre of the alkaline principle, they attract each other; the conſequence of that attraction, is that their reſpec-

tive fixed centres are brought towards each other; and if nothing be preſent to prevent thoſe two fixed principles from entering into ſtrict union, they will form a neutral compound, and having no longer any ſtrong attraction to their reſpective atmoſpheres, the *æther* and *phlogiſton* combine, and form fire; in which ſtate they diffuſe themſelves around.

This fire readily pervades all bodies: it not only inſinuates itſelf between the lines of active particles, arranged to a greater or leſs extent around all fixed particles of matter, but it hath alſo the power, by its general attraction to æther and phlogiſton, of inſinuating itſelf among their particles in their arrangement; in conſequence of which, their atmoſpheric extent is increaſed, and the body which they partly form is expanded in all directions, in proportion to the quantity of fire taken into that arrangement; but, in this caſe, the fire is but ſlightly detained, and readily quits that body, to enter into any contiguous one containing a leſs quantity of it,

If the quantity of fire be ſo great as to expand the component atmoſpheres, connecting fixed particles together, ſo much as to deſtroy their peculiar ſtate of combination, and put them into a very different one, as for example, changing a ſolid into a fluid, or a fluid into vapour; the component atmoſpheres, by being thus expanded, loſe much of their attractive force upon each other, and exert it upon the interpoſing *fire*, which is, therefore, more ſtrictly detained by them, and its *activity* or *ſenſible* action is leſs evident; but ſtill it is *undecompoſed*, and will gradually make its eſcape into colder bodies, if near it, till the component atmoſpheres of the ſubſtance can again attract each other, ſo forcibly as to recover their former more compact ſtate; when, at the very moment of this re-arrangement, the remaining part of the fire, which kept them expanded, is in a great meaſure puſhed out of that arrangement, and becomes ſenſibly active; as is abundantly evident in many operations, when bodies ſuddenly change from a rarer, to a more ſolid form.

If a ſubſtance compoſed of the two fixed principles, in a ſtate of great activity, attracting and ſaturating each other, be expoſed to the action of a great quantity of fire, a quantity ſo great as to *remove* thoſe *two fixed* principles, *from* each other, by its *interpoſition*; they, being no longer capable of touching, attracting, and ſatisfying each other, will, *ſingly*, exert their whole attractive force upon the *fire* itſelf; the *acid* principle attracting its *æther*, and the *earthy* principle its *phlogiſton*; by which means a portion of the fire is entirely *decompoſed*; and being no longer fire, now that its principles are diſunited, each active principle gives *new properties*, to the *fixed principle* by which it is attracted and detained.

With reſpect to light, I, in this place, have little more to ſay, than that it is evidently compoſed of *æther* and *phlogiſton*; and its eſſential properties ſeem to depend upon its *velocity*; for if it be impeded in its progreſs by an opaque body, the force with which it meets the reſiſting body, is ſufficient to *alter* the *mode* of *combination* of its

æther and *phlogiſton*, which immediately *change* into *fire*.

It appears, however, to me highly probable, that light is no other than the æther and phlogiſton, *univerſally* expanded through creation, *thrown* into *undulations*, by means of any ignited body, or in fact by fire, or by means of æther and phlogiſton in other ſtates of activity, capable of putting them in motion: that their rarity, and the *velocity* with which their *undulations* are made, afford ſufficient data to explain the *reflections* and *refractions* of light, and likewiſe their being changed into the ſtate of *fire*, when they meet with *reſiſtance* ſufficient to *arreſt* their motion, and deſtroy their *properties*, *as light*; and this conjecture appears to me much more reaſonable, than to ſuppoſe, that *every* body, giving *light*, is rendered luminous by the light contained *within itſelf*, or formed by the *decompoſition* of its *own principles*. But this ſubject, at preſent, I ſhall no further inſiſt upon.

But, whether light be a part of the luminous body by which it is rendered evident, or whether it be the æther and phlogiſton every where preſent, put in motion by an ignited body, it is ſtill *æther and phlogiſton*, in a *certain ſtate* of *activity*, and is capable of being *decompoſed*, and its æther and phlogiſton may ſeparately be taken into compoſition with the fixed principles of bodies, in certain ſtates of excitement, in the ſame manner as fire is; and, in many caſes, it ſeems to be more readily decompoſed than fire itſelf; for inſtance, the acid principle, in the ſtate of nitrous acid, will attract *æther* from light, and form itſelf, by the acquiſition of that æther, into pure air, more readily, than it will from fire alone; while the phlogiſton, ſeparated from that æther, by light being decompoſed, is attracted by the earthy principle, ſeparated from that acid, which, by the acquiſition of that phlogiſton, becomes more coloured, and diffuſes itſelf in the ſubnatant acid.

Having thus briefly mentioned the properties of fire and light, more ſtrictly chemical, it will

not be improper to take a general view of *water*, and its leading principles and properties, as being alſo generally concerned in chemiſtry and aeriform fluids.

SECTION VIII.

On Water.

WATER is now ſo clearly proved to be a compound, that few will contradict the aſſertion, and none will ever be able to bring proofs to the contrary.

The late grand and accurate experiment, made at paris, by Meſſrs. Fourcroy, Vauquelin and Seguin, in which 1039 grains of hydrogenous and 6210 of oxygenous gaſes, amounting to 7249 grains, being ſlowly decompoſed, produced 7245 grains of pure water, a ſmall reſiduum of compound gas remaining, is ſo deciſive, that no doubt can remain of water being formed of the baſes of thoſe two airs, attracting, or ſaturating each other; and as it is equally well known, that an

alkali may be converted by fire and the electric fluid into Inflammable air, and that an acid may, by the ſame means, be converted into pure air, and as the expanded atmoſpheres of each kind of air, during their combuſtion with each other, diſappear, in the forms of fire, or light, it is very evident, that *water* is formed by the *acid* and *alkaline principles*, to a certain degree *deprived* of their active atmoſpheres, attracting and neutralizing each other.

This neutral compound of the two fixed, or the acid and alkaline principles, ſeems, however, to take place before the fixed principles are very far deprived of their reſpective active atmoſpheres, becauſe, when deprived of fire, ſo far as to be no longer fluid, at the moment of congelation the natural tendency to arrangement of the active fluids, is evident in the regular manner in which the particles of water arrange themſelves, when they become *ice:* 'tis likewiſe evident in the ſtrong affinity betwixt this compound and fire, which is readily taken into arrangement with the remaining part of the active atmoſpheres, by

which they loſe their power of conſolidation, and become fluid, or *water*; which atmoſpheres may be ſo widely extended by their attraction to fire, if preſent in a ſufficient quantity, as to expand into the ſtate of vapour, in which ſtate, however, the water is not decompoſed, but, only ſo far expanded, by the interpoſition of fire, that one compound, or aqueous particle of the acid and alkaline principle, no longer attracts any other aqueous particle; the attraction between the acid and alkaline principle ſtill remaining, though but ſlightly combined and very liable to decompoſition.

Water, being a compound of the two fixed principles, hath a general attraction to moſt bodies, whether compoſed of *either* of the *fixed principles*, or *both* of them; particularly *thoſe*, whoſe fixed particles are in a ſtate of conſiderable *activity*, ſuch as acids, alkalis and ſalts; in conſequence of which general attraction, it weakens their attraction for each other, and inſinuates itſelf among them, ſo as to render them in a ſtate of ſolution, when preſent in a ſufficient quantity;

in which ſtate, the body diſſolved, or diluted by it, is not decompoſed, or altered in its ſpecific properties, but by its component parts being thus divided, and their attraction to each other diminiſhed, they are more ſubject to decompoſition, than when free from the interference of water.

This *general attraction* of *water* to the *fixed principles* of bodies; is ſomething ſimilar to the *general attraction* of *fire* to the *active principles* of bodies; and the effect of each, reſpectively, is, by *interpoſition* to weaken the mutual attraction, exiſting between the component particles of bodies, by which they become expanded, and more readily decompoſed, in certain circumſtances.

It was obſerved in the ſection on fire, that when the two fixed principles, in conſiderable ſtates of activity, or having active atmoſpheres of very ſmall extent, are forcibly ſeparated from each other by any means, as by fire, or the electric fluid, ſo as to be no longer within the reach of each other, that they then will exert their activity upon the active principle to which each hath

an affinity, and which they find preſent in the fire or electric fluid by which they become ſeparated, ſo, that being no longer capable of exiſting as a neutral compound, each fixed principle ſatisfying the other, they will *each* attract an atmoſphere of active particles, and become aeriform; conſequently, water, being a compound of the two fixed principles, is liable to decompoſition.

If the electric fluid be tranſmitted through water, properly confined, as in the Haerlem experiment, the electric ſhock, by its violent effect, ſeparates the two fixed principles, ſo, that they can no longer attract each other; the alkaline particles therefore attract phlogiſton from the paſſing electric fluid, and, at the ſame time, the acid particles attract æther, and each becomes aeriform; the alkaline particles, with their phlogiſtic atmoſpheres, being in the ſtate of inflammable, and the acid particles of pure air; when the two airs thus mixed together are formed in quantity ſufficient to diſplace part of the water, ſo that the electric fluid muſt paſs through a portion of the gaſes, the next electric ſhock, accends the æthe-

rial and phlogiſtic atmoſpheres, which, ruſhing into flame, draw the two fixed principles together, as their reſpective atmoſpheres burn away, till they are left united, and neutralizing each other, in their original ſtate of water.

Water, indeed, is readily decompoſed in numberleſs circumſtances; particularly when expanded by fire, and expoſed to the action of ſubſtances, whoſe principles are conſiderably diſunited and rendered active, by the ſame means. If, then, *one* of the *fixed principles* of water be attracted by the heated ſubſtance, and that ſubſtance can ſupply the *active principle* naturally attracted by the *other fixed principle* of the water, the water will be readily decompoſed; *one* of its *fixed principles* combining with the *ſubſtance* employed, and the *other* becoming *aeriform* by means of the *active fluid diſlodged* from that heated body. As for inſtance, iron is compoſed of the alkaline or earthy principle and phlogiſton; water of the alkaline and acid principles, by means of fire the two principles forming each ſubſtance are violently ſeparated, in conſequence of which, the earthy baſe of

the iron attracting the *acid principle* of the *water*, have a tendency to combine; and by that attraction taking place, the earth of the iron leſs forcibly attracts its *phlogiſton*, which, is therefore attracted by the nearly diſengaged *alkaline principle* of the *water*, and a real change of principles *then* takes place. The *acid particles* of the *water* combine with the earthy baſe of the iron, and form a calx; and, at the ſame time, the *phlogiſton* diſengaged from the iron is attracted by the diſengaged *alkaline particles* of the *water*, and ſurrounds them in an atmoſpheric ſtate, ſo as to form *inflammable air*.

Water, therefore, is formed whenever the *two fixed*, the *acid* and *alkaline principles* are *deprived* of their *active atmoſpheres*, to a certain degree; chiefly by combuſtion, and *combine* together in a certain proportion, ſo as to form a *perfectly neutral reſiduum*, or *compound*: it is *generally attractive* to the *fixed principles* of moſt bodies, and is capable of being *decompoſed* by certain other ſubſtances, particularly when *one* of its fixed principles is *attracted*, and the *other*, at the ſame time, is *ſuppli-*

ed with the *active principle* to which it hath a natural attraction, ſo as to enable it to take the form of *air*.

Having thus taken a general view of the principles of chemiſtry, and its chief agents, I ſhall proceed to the general theory of aeriform fluids, the particular object of this eſſay.

SECTION IX.

The general Theory of Aeriform Fluids, or Gaſes.

FROM what hath been advanced in the preceding pages, it appears evident, that a *ſimple particle* of *air* is formed of a *particle* of *one* of the *fixed principles*, as the baſis, or centre, ſurrounded by a number of *particles* of *one* of the *active principles*.

The principle of *acidity*, one of the fixed principles, naturally attracts that active principle, which I call *æther*; and the *alkaline*, or *other fixed principle*, hath a ſtrong affinity with the *other active principle*, or *phlogiſton*.

If a particle of either of the fixed principles, be, by any means, put into an active ſtate, the

other fixed principle not being preſent to combine, or capable of uniting with it, if that active principle, with which it hath a natural affinity, be preſent, it will immediately exert its attractive power upon thoſe active particles, by which they will become *excited* to attract each other into arrangement. But, the nature of this *excitement* of the *active particles*, is ſuch, that they attract each other only in *one point*, or *direction*, ſo as to form a *line* of *particles*, *ſingly arranged*, *in contact* with each other, immediately extending from the fixed particle by which they are excited. *Every* particle of active matter, therefore, which is in *contact* with the *ſurface* of the *fixed* particle, becomes capable of attracting and exciting *other ſimilar particles* into a *rectilinear arrangement*; and, therefore, the fixed particle, as the centre, will be ſurrounded by ſo *many lines* of active particles, ſingly arranged in contact, as there are *active particles* in *contact* with it; theſe lines of active particles extending from the centre, in all directions, to a certain diſtance, gradually *diverge* from each other, as their diſtance from the centre increaſes; and, as the fixed particle of matter is the centre

of excitement, their activity and force of arrangement muſt *diminiſh*, as their diſtance from that central ſource of excitement, *increaſes*; being greateſt near the centre, and leaſt at the circumference or greateſt extent.

Aeriform fluids are light; their ſpecific gravity is very ſmall when compared with that of water, for inſtance; conſequently, the number of fixed particles of matter they contain, in any certain quantity, by meaſurement, is much leſs than is contained in an equal bulk of water; the ſpecific gravity entirely depending upon the proportion of the *fixed principle* or *principles* in any given ſubſtance, as was particularly explained in the ſection on the ſpecific gravities of bodies.

The power of reſiſtance in theſe active atmoſpheres, when fully extended, is ſmall; becauſe the particles, being arranged *one* by *one*, the reſiſtance made by any ſingle particle, can only equal the *force* by which it is *attracted* by the *particle* in *contact* with it, nearer to the centre; *conſequently*, having *no lateral ſupport*, the reſiſtance made by

any *ſingle line* of *active particles*, muſt be *ſmall*; and, if, by yielding to the force of preſſure, they come in contact with the neighbouring lines, their *united force* of *counteraction*, eſpecially when conſiderably expanded from their centre, will ſtill be *inconſiderable*.

But, as theſe active particles have a *certain force*, or *power* by which they naturally *arrange* themſelves in a rectilinear manner, 'tis evident, if the preſſure made upon them, ab extra, by which they were forced out of their natural direction, be taken away, or the particle of air hath freedom of motion in every, or any other direction, but that of the reſiſting body, that, in the former caſe, the *diſtorted lines* will *inſtantly return* to their *natural rectilinear form*; and, in the latter, the particle of air will be *puſhed aſide* by the *force* of *arrangement*, maintaining itſelf againſt the preſſure endeavouring to deſtroy it. Upon this force or power, by which the active particles naturally attract each other in a rectilinear manner, the *elaſticity* of *aeriform fluids* depends.

It may, therefore, be compreſſed, by any force, *greater* than the *ſum* of the *forces* of *arrangement*, of the particles, or lines of particles acted upon; and, when that preſſure is taken away, the atmoſpheres will *again expand*, with a *force*, proportionate to the *degree* of *diſtortion*, and the number of *lines ſuffering* that diſtortion; the elaſtic force of *expanſion* gradually *diminiſhing*, as they approach *nearer* to their *natural direction*.

Air is likewiſe capable of great expanſion by means of fire.—For, when ſpeaking of fire, it was obſerved, that it hath a general attraction to the two active principles, when in an atmoſpheric ſtate, around particles of fixed matter, by which, it not only inſinuates itſelf into the inſterſtices between the atmoſpheric lines of particles, but, it alſo is capable, when preſent in conſiderable quantity, by means of its general attraction, of intruding itſelf into *arrangement* with them; by which, thoſe atmoſpheres muſt conſequently be *expanded* to a *greater extent* from their reſpective centres, and *thoſe centres* muſt, therefore, become *more diſtant* from *each other*.

In this caſe, however, the fire is only *interpoſed*, not *decompoſed*; and, though it weakens the attraction between the fixed centre and its active atmoſphere, and makes them more ready to be decompoſed, or entirely ſeparated, yet, if a body, containing a leſs proportion of fire, be brought into contact, the fire eſcapes from its arrangement, paſſes into the colder body, and leaves the active particles to return to their former ſtate of arrangement; when, they occupy no more ſpace than they did before their expanſion.

The air in the lower parts of the atmoſphere, near the ſurface of the earth, muſt be greatly compreſſed, by the weight of the air above it; conſequently, the *atmoſpheric arrangement* around the fixed centre of every particle of air, in theſe lower parts, muſt be *greatly diſtorted*, and thoſe lines *cloſely preſſed together*: when, therefore, the receiver of an air-pump is *partly* exhauſted, part of this preſſure being taken away, thoſe atmospheric lines around each remaining fixed centre, will gradually recover their rectilinear ſtate, and expand, ſo as to ſtill fill the receiver; and if the

exhauſtion be carried further, till *each atmoſphere* acquires its full extent, they will gradually attract the *fire* from the receiver, and that from ſurrounding bodies, to *take into* their *arrangement*, and *increaſe* their *extent*; as is evidently proved by the ſinking of the mercury in the thermometer, as the exhauſtion proceeds.

SECTION X.

Simple aeriform fluids are of two kinds.

AS all aeriform fluids are formed either of the alkaline, or the acid principle, or both, ſurrounded by atmoſpheres of phlogiſton, or æther, or both, according to their reſpective affinities, it is evident, that the *ſimple gaſes*, containing no more than *one* of the *fixed principles* as their baſe, can only be of *two kinds : one kind* have baſes of the *alkaline*, and the *other* of the *acid principle* ; conſequently, as the *alkaline principle* is only attractive to the *phlogiſtic* active fluid, and the *acid principle* to *æther*, *all ſimple* aeriform fluids are either compoſed of the *alkaline principle* with *phlogiſton*, or of particles of the *acid principle* with *atmoſpheres* of *æther*.

There being then only *two kinds* of *ſimple gaſes*, phlogiſtic and ætherial, it muſt follow, likewiſe, that there are only *two perfect ſimple airs*, or *gaſes*; *one* formed by the pure alkaline principle with its *full atmoſphere* of phlogiſton, and the *other* compoſed of the acid principle, in its ſimpleſt ſtate, with a *complete atmoſphere* of æther.

Either the *alkaline*, or *acid principle*, in certain ſtates of activity, when expoſed to the action of æther and phlogiſton, or bodies compoſed with them, in certain circumſtances, will attract the active principle with which it hath an affinity, and become *aeriform*.

Either of the fixed principles, ſimply rendered aeriform by means of its proper active principle, but not in the *full quantity* and *extent* which it is capable of, forms an aeriform fluid, but *leſs perfect* than the former; for the imperfect atmoſphere, being of *leſs* extent, is *more active* than when the atmoſphere is of its *full* extent; the *activity* of every atmoſphere *diminiſhing*, in propor-

tion as it becomes *more diſtant* from the exciting fixed centre.

The *moſt perfect* aeriform ſtate, therefore, of the *alkaline principle*, is that, which is produced by ſimply expoſing it to the action of æther and phlogiſton, either in the ſtate of fire, or of the electric fluid; when, by their interpoſition, *it* is *ſeparated* from any connexion with the acid principle, it decompoſes them, and ſeizes their *phlogiſton*; when, therefore, by theſe means, it hath acquired its *greateſt extent* of atmoſphere, its alkaline properties are no longer evident, as is the caſe when volatile alkali, by means of fire and the electric fluid, is converted into *inflammable air*; which is, therefore, the *moſt perfect* ſtate of the *alkaline principle*, rendered *aeriform* by means of *phlogiſton*.

The *acid principle* will, likewiſe, acquire its *moſt perfect* aeriform ſtate, by the ſame means; the acid principle attracting the *æther* of the fire, or electric fluid; when it hath, therefore, acquired its *full extent* of *ætherial* atmoſphere, it ſhews

no ſigns of acidity, and is in its *moſt perfect* ſtate; as is the caſe with pure nitrous acid, which, by means of the *æther* it acquires, by expoſure to the action of fire, or the electric fluid, becomes *perfectly aeriform*, and is in fact *pure air*.

Inflammable air, is, therefore the moſt perfect of the *phlogiſtic* aeriform fluids with baſes of *alkali*, and *pure air* of the *ætherial fluids* with baſes of the *acid principle*. If theſe two be mixed together, in a proper proportion, they will have little ſenſible action upon each other, becauſe each atmoſphere is ſo fully and widely extended around its reſpective baſis, as to be ſcarcely excited and nearly inactive; but, if they be ſtill more extended by fire, they will then actually *ſeparate* from their former *arrangement*, and, acquiring activity by ignition, will *themſelves combine* and form *fire*, and, communicating their activity to the reſt, the *whole* of the *phlogiſtic* and *ætherial* atmoſpheres will ruſh *together*; their reſpective baſes, by that means, will be brought into *contact* and form a *neutral compound*,—*water*;—and, the *phlogiſtic* and *ætherial* atmoſpheres, thus violently acquiring

their *liberty*, will *combine* and eſcape in the form of *flame*, in which is fire and light.

If an alkali be thrown into the ſtate of air by means of phlogiſton, but where that phlogiſtic atmoſphere is of *leſs extent*, and, conſequently, *imperfect*, that phlogiſton will be *ſenſibly active*, as being more excited by being leſs diſtant from the exciting fixed centre; as is the caſe when volatile alkali is changed, by heat, into *alkaline air*: which, however, ſeems not to be *entirely* compoſed of the pure alkaline principle, and phlogiſton.

So, likewiſe, when an acid acquires, by the ſame means, æther enough to render it aeriform, but not ſo much as to change it to pure air, it is poſſeſſed of *evident chemical activity* and forms an acid air; though not *wholly* formed of the acid principle with æther.

If this alkaline and acid air be mixed together, the phlogiſton of the one, and the æther of the other, being each in ſimilar ſtates of activity, will

inſtantly attract each other and draw their reſpective fixed centres together ; the alkaline and acid centres, thus brought into contact, will unite and form a neutral ſalt ; while the phlogiſtic and ætherial atmoſpheres, being in great part diſengaged, will combine, and, producing heat, will gradually eſcape, as the combination of the two gaſes proceeds.

But, if inflammable air be mixed with vitriolic acid air for inſtance, or pure air with alkaline air, the atmoſpheres of *one* being *full*, *perfect* and *extended* till the power of excitement from the fixed centre *ceaſes*, while thoſe of the *other* are *imperfect*, of *ſmaller extent* and *conſiderably active*, though one atmoſphere is phlogiſtic and the other ætherial they will *not* attract each other,—they cannot combine, while *each* continues in *that* ſtate of excitement, ſo *different* from *that* of the *other* ; becauſe, in conſiderably different ſtates of excitement, æther and phlogiſton cannot combine ; for, to enable them to unite, their action upon each other muſt be *mutual* and *equal*. Therefore, it is evident, that when one is much excited and

the other but little, the *ſtrong* attraction of *arrangement* amongſt the *particles much excited*, will *exceed* the *weak* attraction of *combination* exerted by the *contrary particles* but *little excited*; therefore, the weaker attraction, from the contrary principle, will not be able to overcome the ſtronger attraction of arrangement, by which the active particles, compoſing the more excited atmoſphere, are held together; conſequently, the two gaſes, tho' one is phlogiſtic and the other ætherial, will remain mixed together, tho' undecompoſed and, ſingly, unaltered.

No two aerial atmoſpheres of æther and phlogiſton, therefore, can attract each other and combine, unleſs the *external* particles of the *one*, are in a ſimilar ſtate of *excitement* and *activity*, or nearly ſo, with the *moſt diſtant* particles, forming the *extremity* of each atmoſpheric line of the *other*; or, unleſs by fire, or other violent means, they be put into *that ſtate* of *equal excitement*; becauſe it is the *laſt*, or *moſt diſtant* particle of *each* atmoſpheric line, alone, that is capable of *acting* upon *any other* particle; and attraction and combination

muſt *firſt begin* with *them*, and proceed, by communication, to the next particles in arrangement, till the fixed centres are brought together: becauſe, were a particle of phlogiſton to be applied to the 2nd *particle* from the extremity of any atmoſpheric line of ætherial particles, *that* 2nd *particle* could have *no attraction* to it—all *its* excitement and activity being exerted upon the *particle* before and that *beyond* it, which, by that excitement and power are held in *arrangement*; and, conſequently, it hath no power of attraction but what is already employed. But, if an extreme, or moſt diſtant particle of phlogiſton, is *equally excited* with an *extreme*, or terminating *particle* of æther, they will combine, and draw the 2nd, or next particle of æther, into contact with the 2nd, or ſucceeding particle of phlogiſton, which two ſucceding particles will, *then*, become *attractive* to *each other*; becauſe the two extreme particles by attracting each other, no longer attract and are attracted by thoſe ſucceeding particles nearer the fixed centre, as they were before, when they were excited by the attraction of arrangement alone; for, by the attraction of arrangement, *each* active particle is

attracted by *that* in contact with it, nearer the fixed centre, and by that attraction becomes *excited* to *attract* that *exciting particle* in return; and, at an *oppoſite point* becomes capable of *attracting another particle*, with a force nearly equal to that by which it is attracted; ſo, that particles of æther, or phlogiſton, when excited by fixed matter to arrangement, are ſimilar to the filings of iron when actuated by a magnet; in their common ſtate they are without order, but, when the magnet is applied, the particle next the magnet is excited; it then attracts and is attracted by *one* extremity of the next filing; which, by that means, becomes excited at its *other* extremity to attract the next ſucceeding particle of iron, and ſo on, progreſſively, till the arrangement of the filings is complete; each attracting and being attracted by the *particle* of iron, immediately *preceding* and *ſucceeding* it; the *laſt*, or *extreme* particle, however, being *only* attracted and attracting at *one* of its poles, the other pole being equally excited, is ready to *exert* its *power* upon any thing, with which it hath an affinity; if, in a ſtate of excitement ſimilar to its own.

Were, therefore, æther and phlogiſton, in *ſimilar* ſtates of *excitement*, at *equal diſtances* from their reſpective fixed centres, it is evident, that an atmoſpheric line compoſed of 100 particles of æther, would attract an atmoſpheric line of phlogiſton containing 100 particles, their excitement being equal; but, if the atmoſpheric line of phlogiſton was compoſed with 120 particles, the *laſt*, or the 120th *particle* of phlogiſton, from the centre, would *not* be ſo *much excited* as the 100th particle of æther; and its force of attraction of *combination* with that ætherial particle, would not *equal* the force of the attraction of *arrangement* by which that 100th particle of æther, is attracted, by its contiguous, or 99th particle of æther; the two atmoſpheres, therefore, would have *no ſenſible action* upon each other.

And, were we to ſuppoſe that the laſt particle of æther, being at the diſtance of 100 from its centre, would attract the 100th particle of phlogiſton from its centre; and that, if that extreme ætherial particle was applied to the 100th particle of phlogiſton, being the 20th from the extremity

of the line of which it forms a part, a little recollection would ſoon inform us of the error; becauſe, *that* particle of phlogiſton being in *arrangement*, *each* of its active poles are occupied, and *all* its *powers* of *attraction* are *already exerted* upon the particles of phlogiſton already in *contact* with it; conſequently, it could not form any combination with the ætherial particles, unleſs the particles of phlogiſton were removed from its pole moſt diſtant from the fixed centre, while the other pole ſtill remained attracted in arrangement, and both its poles conſequently excited.

There are, therefore, but *two general* kinds of *air*:—aeriform fluids with atmoſpheres of *phlogiſton*, ſurrounding particles of the *alkaline principle*; and with atmoſpheres of *æther* accompanying particles of the *acid principle*:—and there are but *two* aeriform fluids, *perfect* and *ſimple*, which are *inflammable air*, where the alkaline principle is ſurrounded by phlogiſton, to its *utmoſt extent* of *attraction*; and *pure air*, which is formed of the acid principle, ſurrounded by as much æther as it is capable of *giving proper excitement* to.

But, there are many other aeriform fluids; ſome chiefly compoſed of the alkaline principle with phlogiſton; others of the acid principle and æther;—ſome with atmoſpheres conſiderably excited and active, and others with atmoſpheres not ſenſibly active;—but theſe, being chiefly compoſed of *all* the *four* principles, in ſome proportion or other, open a field, too wide to be entered into at this time; my preſent intention being only to take a *general view* of the ſubject, and not to enter into particulars.

FINIS.

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