FACTS *and* QUERIES *relative to* ATTRACTION *and* REPULSION. *By* THOMAS PERCIVAL, M.D. *&c.*

To the LITERARY *and* PHILOSOPHICAL SOCIETY.

MANCHESTER, DEC. 5, 1784.

I COMMUNICATED to you, a few weeks ago, ſome curious and valuable obſervations, on the phenomena which take place between oil and water, tranſmitted to me by my learned and very ingenious friend Dr. Wall, of Oxford. My engagements deprived me of the pleaſure and inſtruction, of attending their diſcuſſion in the ſociety: And, ſolicitous to recover what I have loſt, I truſt you will indulge me with permiſſion, to recall your attention to the ſubject, by the recital of a few miſcellaneous facts and enquiries, which the peruſal of that paper ſuggeſted to my mind.

I. If a glaſs tumbler, containing equal parts of water and of oil, in ſuch quantity as to occupy two thirds of it, be ſuſpended by a cord, and ſwung backwards and forwards, the oil will remain perfectly ſmooth and undiſturbed, whilſt the water, below, is in violent commotion. But if the oil be poured out, and its place ſupplied with

with water, the fluid will remain perfectly tranquil, throughout the whole veſſel, although the ſame motion be given to it as before. I have frequently repeated this experiment, and have ſometimes varied it, by ſubſtituting rectified ſpirit of wine, in the place of water. The oil then being the heavier fluid, becomes agitated, whilſt the ſpirit remains at reſt. Dr. Franklin, who firſt noticed this ſingular phenomenon, informs us, that he ſhewed it to a number of ingenious perſons. "Thoſe," ſays he, "who are but "ſlightly acquainted with the principles of "hydroſtatics, &c. are apt to fancy, immediately, that they underſtand it, and readily "attempt to explain it: But their explanations "have been different, and, to me, not very "intelligible. Others more deeply ſkilled in "thoſe principles, ſeem to wonder at it, and "promiſe to conſider it. And I think it is "worth conſidering. For a new appearance, if "it cannot be explained by our old principles, "may afford us new ones, of uſe perhaps in "explaining ſome other obſcure parts of natural "knowledge."* It is with diffidence, I offer as a conjecture, that the fact, in queſtion, may ariſe from a *repulſive power*, ſubſiſting between the particles of oil and water, and depending poſſibly on the vibrations of that ſubtle æther,

* See Dr. Franklin's Letters and Papers on philoſophical ſubjects, p. 438.

which

which Sir Isaac Newton supposes to pervade all bodies. For, when this æther is excited into motion, by percussion or agitation, its elastic force is augmented, because it becomes denser in the pulses of its vibrations, than in a quiescent state.* But in proposing this hypothesis, I may perhaps be chargeable with the paradoxical opinion of a celebrated French philosopher, M. Fontenelle, who asserts, that if there be more than one way of accounting for any appearances in nature, there is a general presumption, that they proceed from causes, which are least obvious and familiar. I shall not, therefore, at present, enlarge upon this point, as it would anticipate what may be better urged, in our subsequent conversation. But the facts, above recited, furnish a presumption, that the effect of oily substances, on the crystallization of salt, is, in part, owing to a mechanical cause. At Droitwich, it is the practice, as appears by Dr. Wall's quotation from the history of Worcestershire, to throw, into the brine pan, a piece of resin, about the size of a pea, to produce a finer granulation. The more resin they use, the smaller will be the grain of the salt; and if a lump, of the size of two walnuts, were put into the pan, the particles of salt would be so minute as not to be capable

* On the properties of Æther, consult Dr. Bryan Robinson's Works, *passim*.

of

of subsiding. Resin, butter, or tallow, when liquefied by the heat of the boiling brine, float upon its surface, and will remain perfectly smooth and undisturbed, whilst the water, beneath, may be put into strong agitation, by the action of the fire. Such agitation must break down the crystals of salt, as they shoot; and consequently, only small granules will be produced.

II. Every one has experienced the suffocating effects of air, loaded with the effluvia of burnt grease, or the snuff of a lamp. When such fumes are inspired, there is the sensation of a conflict in the lungs, which essentially differs from what is felt, on breathing either fixed or inflammable air. And is not the most easy solution of it, to suppose, that the air quits the oily, to unite with the watery vapours, which are brought into contiguity, by this action of the animal œconomy; and that a strong repulsion succeeds? "For, as, in algebra, where "affirmative quantities vanish and cease, where "negative ones begin, so, in mechanics, where "attraction ceases, there a repulsive power ought "to succeed," according to the doctrine of Sir Isaac Newton. It is, also, an axiom, laid down by this great philosopher, that "to the same "natural effects, we must always assign, as "far as possible, the same causes." I shall therefore proceed to illustrate this subject, by other more decisive examples of *repulsion*; after premising

premising a few observations on that species of *attraction*, which appears to be the converse of it.

III. That the particles of homogeneous bodies have an affinity to, and consequently attract each other, is consonant both to analogy and observation. Fluids manifest this property, by their disposition to assume a globular figure, and by the rushing together of these globules, when brought within their reciprocal sphere of activity. A similar attraction subsists between heterogeneous substances, which is distinct from that of *cohesion*, as it partakes of an *elective* nature, and yet cannot be deemed *chemical*, because no combination is produced by it, so intimate, as to manifest any change of properties. This may be illustrated by the increase of power, in the suspension of weights, which a hair acquires, by being moistened with different liquids. For such additional strength is not proportioned, precisely, to the tenacity of the liquid employed; and probably subsists in a duplicate ratio, compounded of the affinity which the parts of the liquid bear to each other, and to the minutest fibres of the hair. The particles of water attract one another more strongly, than they attract polished wood or stone; whilst, on the contrary, they are less forcibly attracted by each other than by glass. This is evinced by the common experiment with capillary tubes. For the water, which ascends, must have quitted the con-

tact of the water left behind, contrary to their mutual affinity, as well as to the law of gravitation. The particles of quickſilver, like water, are attracted by glaſs. For if a ſmall globule of this metal be laid upon unſullied paper, and touched with a piece of clean poliſhed glaſs, the quickſilver will adhere to the latter, in preference to the former, and may be drawn away with it. But the relation of mercury to glaſs is of inferior force, to that which ſubſiſts between its own particles. This will appear by dipping a bent tube, open at both ends, into a veſſel, filled with quickſilver, which will enter into the tube, but ſtand within it, below the ſurface of the mercury, at a depth, proportionate to the diameter of the tube. * It is unneceſſary to adduce further inſtances of this attraction; and I ſhall endeavour to ſhew, that where it does not ſubſiſt, a repulſive power apparently takes place. This, according to the laws of optics, has been deduced from the globules of rain, which lie on the leaves of colewort, whoſe luſtre and mobility are ſo ſtriking to the eye. For, on a cloſe inſpection of them, it is found, that the luſtre is produced by a copious reflection of light, from their flattened inferior parts. It has alſo been further obſerved, that when a drop

* Conſult Dr. Jurin's Experiments, Philoſophical Tranſactions, No. 363; alſo Cotes's Hydroſtatical Lectures, p. 231.

rolls

rolls along a leaf, which has been wetted, its brightness disappears, and the green leaf, before hardly discernible, is now seen clearly through it. From these facts it is inferred, that the globule does not touch the plant; but that it is suspended at some distance, in the air, by the force of a repulsive power; because there could not be any copious reflection of white light, from its under surface, unless a real interval subsisted between that surface and the plant. * This hypothesis accounts for the volubility of the drop, and for its leaving no trace of moisture, where it rolls. From the like reasoning it hath been concluded, that when a polished needle is made to lie on water, it is not in contact with that fluid, but forms, by repulsion, a bed, whose concavity is much larger than its own bulk. Hence it is readily conceived, how the needle swims upon a liquid, lighter than itself; since the quantity of water, displaced by it, may be equal to its weight. Can it be philosophical, to attribute such a phenomenon to the tenacity of water, or to the attraction subsisting between its particles?

IV. The attractions and repulsions between those exhalations that are termed DEW, and certain substances exposed to them, are still more remarkable, than the facts which have been

* See Newton's Optics, Query 29. Also Physical and Literary Essays, vol. II. p. 25.

already recited. M. Muſſchenbroek placed different bodies, for the reception of theſe vapours, on the terrace of the obſervatory at Utrecht, and found that ſome caught them abundantly, others only in a ſmall quantity, but that a third ſort repelled them altogether.* M. du Fay, of the French Academy, repeated theſe experiments, and fully proved that, whilſt the dew fell copiouſly into veſſels of glaſs, not the leaſt moiſture was apparent in veſſels of poliſhed metal, contiguous to them. To be aſſured whether the difference was always the ſame, in all circumſtances, between vitrified ſubſtances and metals, he ſet a China ſaucer in the middle of a ſilver plate, and, on one ſide, adjoining to it, put a ſilver veſſel, very like the ſaucer, upon a China plate. The former, viz. the China ſaucer, was covered with dew, although the plate, which ſpread four inches around it, had not a ſingle drop. The China plate, alſo, received the dew, whilſt the ſilver veſſel, that was in the middle, remained as dry, as when it was firſt expoſed.

The ſame ingenious philoſopher endeavoured to aſcertain, whether a China ſaucer, ſet upon a plate of metal, in the manner above deſcribed, did not receive more dew than it would have done, if expoſed quite alone. To accompliſh this deſign, he took two watch cryſtals, of equal

* Introd. ad Philoſ. Nat. vol. II. p. 990.

dimenſions,

dimensions, and placed the one upon a plate of silver, the other upon a plate of China, each with its concavity uppermost. That which was upon the silver plate, he surrounded with a ferrel, of the same metal, well polished, that no watery particles might attach themselves to the convex surface of the glass. Thus circumstanced, he exposed the crystals, several days successively, in a proper situation, and always found five or six times more dew in that, which was on the China plate, than in the other placed on silver: And this may be regarded as a presumptive proof, that the moisture repelled from the metal, was attracted by the China. That there subsisted such a repulsion, is confirmed by the following observation of M. du Fay, with regard to the crystal on the silver plate. He informs us, that the small quantity of dew on the inside, was only near the center, in minute drops; and that, round the border, there was a space of five or six lines, perfectly dry, towards which the drops regularly decreased, in magnitude; as if the silver ferrel had *driven away* the dew from that part of the glass, which was contiguous to it. These experiments were repeated thirty times, with invariable success.* And Dr. Watson, now Bishop of Landaff, has lately confirmed them, by some very curious trials, of a similar kind, made to determine the quantity of vapours

* Vid. Hist. de l'Acad. des Scienc. 1749.

which ascend, in a given space, from the surface of the earth. "By means of a little bees wax," says he, "I fastened a half-crown very near, but "not quite contiguous to the side of the glass, "and setting the glass, with its mouth down- "wards, on the grass, it presently became "covered with vapour, except that part of it, "which was near to the half-crown. Not only "the half-crown itself, was free from vapour, "but it had hindered any from settling on the "glass, which was near it, for there was a little "ring of glass surrounding the half-crown, to "the distance of a quarter of an inch, which "was quite dry, as well as that part of the glass, "which was immediately under the half-crown; "it seemed as if the silver had repelled the water "to that distance. A large red wafer had the "same effect as the half-crown; it was neither "wetted itself, nor was the ring of glass, con- "tiguous to it, wetted. A circle of white paper "produced the same effect, so did several other "substances, which it would be tedious to "enumerate." *

Do not the instances of repulsion, here adduced, with various others, which may perhaps be recollected and noticed by the Gentlemen present, warrant us to conclude, that this principle is a powerful agent, in the operations of nature? To this cause, the air we breathe owes, pro-

* Watson's Chemical Essays, vol. III. p. 64.

bably,

bably, its existence and elasticity; the light, which illuminates our globe, its rapid motions and diversified inflections; and fire, its genial, expansile, and animating energy. Is it, therefore, consistent with analogy, to exclude repulsion from that branch of physics, which chemistry comprehends? The subject certainly merits further investigation: And I shall state, to my friend Dr. Wall, the facts and queries, which I have now laid before this Society; that he may communicate to us, such limitations or confirmations of his doctrine, as an attentive review of it may suggest, to his ingenuous and philosophic mind.

EXTRACTS *of* TWO LETTERS *from Dr.* WALL *of* OXFORD, *to Dr.* PERCIVAL, *in Reply to the foregoing* QUERIES *concerning* ATTRACTION *and* REPULSION; *communicated to the* LITERARY *and* PHILOSOPHICAL SOCIETY. *Read January* 12, 1785.

DEAR SIR,

IT gives me great pleasure to think that my paper on oil, &c. was so far approved, as to be thought worthy of a place in your Memoirs. I am by no means positive, that my hypothesis